



G A O

Accountability * Integrity * Reliability

Briefing on the Uranium Processing Facility Factors Leading to Cost Increases

**For
Congressional Committees
April 2013**

Introduction

- The Y-12 National Security Complex in Oak Ridge, Tennessee, is the National Nuclear Security Administration's (NNSA) site for conducting enriched uranium activities, producing uranium-related components for nuclear warheads and bombs, and processing nuclear fuel for the Navy. NNSA is a separately organized agency within the Department of Energy (DOE).
- The site has received periodic upgrades, but NNSA officials said that support utilities, equipment, and buildings need to be modernized for the Y-12 plant to continue to meet its mission.

Introduction

- According to NNSA, the Y-12 plant's current enriched uranium operations
 - have an inefficient workflow due to the patchwork of facilities and equipment;
 - require materials to be transported between multiple buildings during processing;
 - experience continually rising operations and maintenance costs and frequent outages and work interruptions due to facility age and deterioration;
 - do not meet a number of current regulatory and design standards, including those for protection against fire and natural occurrences, such as earthquakes or tornados;
 - involve processes that could expose workers to radiological contamination or other dangers; and
 - require a significant number of security personnel to patrol a 154-acre protected area.



Introduction

- In 2004, NNSA decided to construct the Uranium Processing Facility (UPF).¹ According to NNSA, the UPF will
 - consist of a single, consolidated uranium processing and component production facility less than half the size of the existing Y-12 plant facilities;
 - reduce the costs of enriched uranium processing by using modern processing equipment and consolidated operations; and
 - use new technologies and other features that provide better worker protection and environmental health and safety.
- The UPF is to be built adjacent to the Highly Enriched Uranium Materials Facility (HEUMF)—the nation’s central repository for such materials—and the facilities will be joined. Constructed from 2004 to 2009, HEUMF is responsible for the receipt, shipment, and interim and long-term storage of current and projected inventories of highly enriched uranium.
- The upper bound of the UPF’s cost range has increased from approximately \$1.1 billion in 2004 to \$6.5 billion in 2012.

Objectives, Scope and Methodology

- At the request of the Senate Appropriations Committee, Subcommittee on Energy and Water Development, and in accordance with the requirements contained in the National Defense Authorization Act for Fiscal Year 2013, GAO is to report quarterly on the UPF.
- Our objective for this first briefing was to identify factors that contributed to UPF's cost increase. Subsequent briefings will focus on technology readiness and risk management, among other things.
- To do this work we:
 - reviewed pertinent cost estimate documents prepared by NNSA, the UPF contractor, and the U.S. Army Corps of Engineers (Corps);
 - visited the Y-12 plant to receive briefings and tour the current enriched uranium facilities;
 - interviewed
 - NNSA headquarters officials
 - NNSA and contractor officials at the Y-12 plant
 - officials from the Corps, which conducted an independent cost estimate (ICE) of the UPF in 2011.
- NNSA reviewed a draft version of this presentation for factual accuracy. NNSA provided technical clarifications, which we incorporated as appropriate.

Scope and Methodology

- We conducted this performance audit from January 2013 to April 2013 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.

Results in Brief

- Overly optimistic assumptions contained in multiple cost estimates prepared between 2004 and 2011 are the primary factors that contributed to UPF's cost increase. Specifically:
 - initial UPF cost estimates were largely based on inaccurate cost estimates for HEUMF, and
 - revised UPF cost estimates assumed that annual appropriations would not be subject to budget constraints.
- In June 2012, the Deputy Secretary of Energy approved an updated cost range and deferred significant portions of the original scope. According to NNSA documentation, this deferral was due, in part, to the project's increased cost estimate and to accelerate the completion of the highest priority scope.
- In August 2012, the contractor concluded that UPF's roof would have to be raised 13 feet and the start of construction would be delayed, among other things. These factors resulted in approximately \$540 million in additional costs and occurred because the contractor did not adequately manage and integrate the design work subcontracted to four other contractors. Given these additional costs, it is unclear if the cost estimate range approved in June 2012 remains valid.



Background

- In 1990, GAO designated DOE program management as a high-risk area vulnerable to fraud, waste, abuse, and mismanagement. GAO's most recent high-risk list narrowed this focus to NNSA and DOE's Office of Environmental Management major projects (i.e., projects over \$750 million).
- DOE has taken steps to address GAO's concerns, including developing an order that defines DOE's project management principles and process: Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets*. NNSA is required to manage the UPF project in accordance with this order.
- DOE's order defines a project management process consisting of a series of management reviews and approvals, called "critical decisions" (CD), that are required to move a project forward from project planning and design to implementation.
 - CD 0: Approve mission need and a rough order of magnitude cost range.
 - CD 1: Approve an approach and preliminary cost range.
 - CD 2: Approve the performance baseline—defined as a project's cost, schedule, and scope—and develop a definitive cost estimate.
 - CD 3: Approve the start of construction.
 - CD 4: Approve the start of operations.

Background

- According to our cost estimating guide, high-quality cost estimates are: (1) well-documented, (2) comprehensive, (3) credible, and (4) accurate.²
- At CD 0 and CD 1, a cost estimate may be presented as a range. The estimate range (lower and upper bounds) is established by considering a risk analysis conducted by the project team. The upper bound of the cost range represents a scenario where there is a high likelihood of occurrence of the identified risks.
- At CD 2, a cost estimate is usually provided as a single point that is risk adjusted and captures the total cost to acquire the capital asset.

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

Background

- In general, a cost estimate (range or point) includes:
 - the price and amount of resources (e.g., labor, commodities, etc.) needed to accomplish a scope of work, stated in constant dollars;
 - contractor controlled management reserve (i.e., “known unknowns”);
 - escalation costs that account for the effects of inflation between the time the estimate is prepared and when a given scope of work is to be performed;
 - contingency funds held at or above the government program office for items that are outside of the contractor’s control (i.e., “unknown unknowns”);
 - confidence levels that determine the likelihood that a project can be completed at a specific cost. The greater the confidence level, the greater the amount of contingency is needed because the tendency is for costs to overrun rather than underrun.



Background

- In January 2010, we reported on DOE's project cost-estimating function.³ We found that DOE did not have a cost-estimating policy and that the cost-estimating guide it developed in the 1990s was out of date and did not include important components. For example, the guide assigned responsibilities to offices that no longer existed and was based on policies that had been canceled. We have ongoing work on cost estimating at DOE.
- In November 2010, DOE took steps to enhance project oversight by requiring an ICE for projects with values over \$100 million.
- As shown in table 1, the UPF's estimated cost has increased, its completion date has been delayed, and substantial portions of its original scope have been deferred.

Background

Table 1: UPF’s Cost, Schedule, Scope, and Key Assumptions Over Time

Date / critical decisions	Cost range	Proposed start of construction	Proposed start of operations	Scope	Key cost assumptions
2004 / CD 0	\$600 million to \$1.1 billion (2004 constant dollars)	2008	2012	Consolidates all uranium operations	Proposed costs to construct HEUMF could be used as basis for UPF estimate.
2007 / CD 1	\$1.4 to \$3.5 billion (escalated dollars) ^a	2011	2018	Consolidates all uranium operations	Proposed costs to construct HEUMF could be used as basis for UPF estimate.
2010 / NNSA directed the contractor to update the CD 1 cost estimate	\$4.2 to \$6.5 billion (escalated dollars) ^a	2011	2022	Consolidates all uranium operations	Annual appropriations would not be subject to budgetary constraints.
2011 / Army Corps of Engineers Independent Cost Estimate	\$6.5 to \$7.5 billion (escalated dollars) ^a	2011	2023	Consolidates all uranium operations	Annual appropriations would not be subject to budgetary constraints.
2012 / CD 1 reaffirmation, which is required by Order 413.3B if original CD 1 cost range increases by more than 50 percent	\$4.2 to \$6.5 billion (escalated dollars) ^a	2012	2023	Does not consolidate all uranium operations ^b	Scope reduced to building exterior, all support systems, and Building 9212 capabilities, which include uranium purification and casting. All other capabilities deferred.

^a Escalated dollars account for the effects of inflation between the time the estimate is prepared and when a given scope of work is to be performed.

^b Scope does not include capabilities of Building 9204-2E (assembly and dismantlement, among other things), Building 9215 (machining), and Building 9998 (product certification).

Background

- NNSA owns the buildings, equipment, and the components produced at the Y-12 plant, but the site is operated under contract to NNSA by Babcock & Wilcox Technical Services Y-12, LLC (B&W), a partnership of the Babcock & Wilcox Company and Bechtel Corporation.
- B&W is also the contractor managing the UPF design.
- B&W has subcontracted portions of the design work to four other contractors.
- The UPF Federal Project Director is the federal official with primary responsibility for management of the project and oversight of B&W.

Background

Proposed UPF design in 2004



Shows the planned UPF (labeled by its name at the time: EUMF, or the Enriched Uranium Materials Facility) and the HEUMF in 2004. An underground tunnel would connect the two facilities.

Proposed UPF design in 2010



Shows the planned UPF in 2010, which would be linked to HEUMF by an above-ground connector.

Factors that Contributed to UPF's Cost Increase: 2004 and 2007 Cost Estimates Were Largely Based on Inaccurate Cost Estimates for HEUMF

- According to federal officials, prior to developing the 2004 UPF cost estimate, NNSA directed B&W to use the estimated cost to construct HEUMF as the basis for the UPF estimate because the facilities were to be similar in form and design. However, HEUMF provided an inaccurate cost basis because:
 - HEUMF's estimated cost increased substantially. According to NNSA officials, the reasons for the increase included changes to security policy and the need to meet rigorous nuclear facility construction quality requirements.
 - HEUMF is less complex than UPF. HEUMF was designed as a storage facility for highly enriched uranium, in contrast to the more complex assembly/disassembly, processing, and machining operations that are to be housed in UPF.

Factors that Contributed to UPF's Cost Increase: 2004 and 2007 Cost Estimates Were Largely Based on Inaccurate Cost Estimates for HEUMF

- The 2004 UPF cost estimate when the project was at CD 0 (\$600 million to \$1.1 billion in 2004 constant year dollars) used the 2004 HEUMF cost estimate to obtain a cost per square foot, and then increased that by 25 percent to account for UPF's larger number of floors and mezzanines.⁴
- However, this assumption was overly optimistic because HEUMF's 2004 cost estimate was \$321 million, but the facility's actual final cost was \$527 million, a 64 percent increase.
- According to a senior NNSA project official, the agency did not fully account for UPF's complexity (as compared to HEUMF) in its 2004 cost estimate. For example, this official said that the utilities needed to support UPF's production mission are more numerous and provide a much larger amount of electricity than the utilities needed to support HEUMF's storage mission.

⁴If the estimate is presented in escalated dollars, B&W officials said that the upper bound of the cost estimate would be \$1.3 billion.

Factors that Contributed to UPF's Cost Increase: 2004 and 2007 Cost Estimates Were Largely Based on Inaccurate Cost Estimates for HEUMF

- The 2007 UPF cost estimate when the project was at CD 1 (\$1.4 to \$3.5 billion):
 - updated the 2004 estimate to reflect increased labor prices, among other things;
 - included \$1.1 billion in contingency funds to address risks that were not under the control of the project, such as material and commodity cost growth, and the key NNSA document supporting this decision cited project execution difficulties experienced by the HEUMF;
 - did not fully meet all four characteristics of a high-quality cost estimate. We reported in 2010 that the estimate was partially well-documented, partially comprehensive, somewhat credible, and somewhat accurate.⁵

Factors that Contributed to UPF's Cost Increase: UPF's 2010 and 2011 Cost Estimates Assumed Annual Appropriations Would Not Be Subject to Budget Constraints

- In 2010, B&W updated the 2007 CD 1 cost estimate. NNSA directed the update to develop a resource-loaded project schedule, among other things. The 2010 cost estimate (\$4.2 to \$6.5 billion):
 - Assumed a funding profile, where annual appropriations:
 - were not subject to budgetary constraints;
 - could change significantly year-to-year as the UPF moved between phases (e.g., design work, site preparation, construction, facility start-up testing).
 - NNSA officials told us that, historically, DOE construction projects have not been funded in this manner.
 - Showed increased methodological rigor over the 2004 and 2007 cost estimates as B&W followed an engineering build-up or “bottoms-up” estimate.
 - This method builds the overall cost estimate by summing detailed estimates done at lower work levels while employing industrial engineering principles.
 - For example, B&W representatives told us that they developed the overall cost estimate by combining detailed estimates for the over 200 engineering systems (e.g., heating, ventilation, and air conditioning as well as equipment instrumentation and controls) needed in the UPF.

Factors that Contributed to UPF's Cost Increase: UPF's 2010 and 2011 Cost Estimates Assumed Annual Appropriations Would Not Be Subject to Budget Constraints

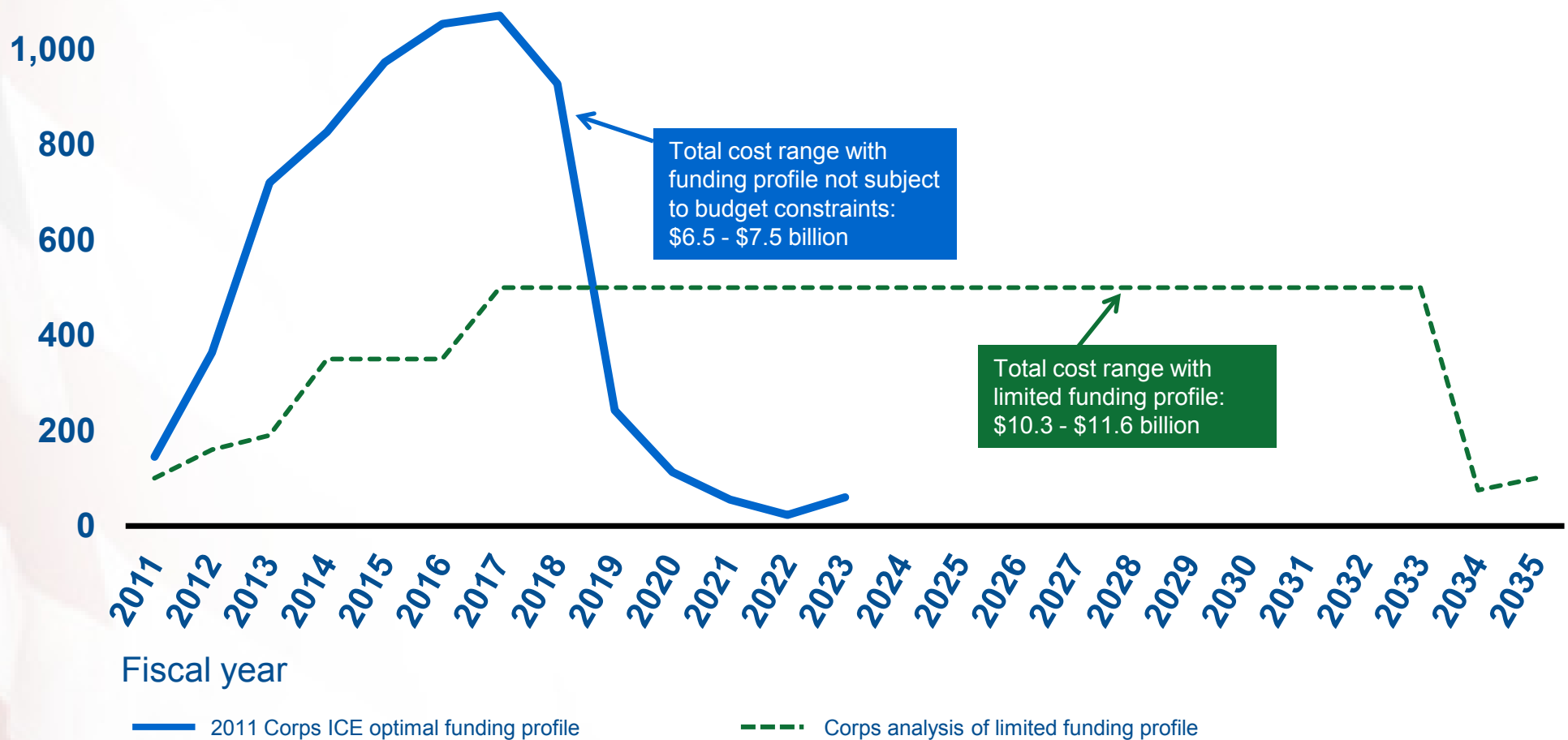
- From July 2010 to August 2011, the Corps conducted an ICE to assist the UPF federal management team determine the reasonableness of B&W's 2010 cost estimate. The ICE assumed, like the B&W estimate, that annual appropriations would not be subject to budgetary constraints.
- While the Corps was conducting its work, NNSA issued guidance in February 2011 that limited UPF funding to between \$200 million and \$500 million annually.
- In documentation explaining the funding limits, NNSA stated that the planned construction of UPF and the Chemistry and Metallurgy Research Replacement (CMRR) project at Los Alamos would be done so as “to not redirect funding from the core mission of managing the stockpile and sustaining the science, technology, and engineering capabilities of the nuclear security enterprise.”

Factors that Contributed to UPF's Cost Increase: UPF's 2010 and 2011 Cost Estimates Assumed Annual Appropriations Would Not Be Subject to Budget Constraints

- In 2011, the Corps provided cost estimates and the start of operations dates for both funding scenarios:
 - Annual appropriations not subject to budget constraints:
 - \$6.5 to \$7.5 billion and facility begins operations in FY 2023.
 - Over \$900 million required annually for 4 consecutive fiscal years.
 - Annual appropriations subject to budget constraints contained in NNSA's February 2011 guidance:
 - \$10.3 to \$11.6 billion and facility begins operations in FY 2035.
 - Appropriations limited to between \$200 and \$500 million annually.
- Officials told us that the longer schedule significantly increased the costs for level-of-effort activities (e.g., program management and systems engineering), which are needed throughout the project's duration.

UPF's 2010 and 2011 Cost Estimates Assumed Annual Appropriations Would Not Be Subject to Budget Constraints, but NNSA Later Limited Funding

1,200 UPF cost and schedule under different funding profiles (dollars in millions)





UPF's Current Cost Estimate Does Not Include Significant Portions of Original Scope

- In February 2012, NNSA deferred portions of the UPF's scope that was included in all prior cost estimates and slightly increased the project's funding profile.⁶ In explaining this decision, NNSA documentation stated that:
 - the cost range contained in the Corps ICE challenged NNSA's ability to complete the entire original scope for less than \$6.5 billion (i.e., the upper limits of the cost range presented by B&W in 2010) and
 - scope is being deferred in order to accelerate the transition of Building 9212 capabilities into UPF. Building 9212 was constructed in the 1940s and is the highest priority scope. According to the UPF Federal Project Director, Building 9212 capabilities will compose approximately 70 percent of UPF's processing equipment.
- In June 2012 and during the CD 1 reaffirmation process, which is required by DOE Order 413.3B when a cost estimate increases by more than 50 percent, the Deputy Secretary of Energy approved this reduced-scope UPF at a cost range of \$4.2 to \$6.5 billion.
 - The UPF had a point estimate of \$5.2 billion as well as \$1.2 billion in NNSA contingency.
 - According to NNSA officials, these amounts were developed to meet the NNSA policy requirement that cost estimates be developed at the 85 percent confidence level.

⁶NNSA has continued to increase the project's planned funding profile. According to NNSA's FY 2014 budget request for UPF, the agency plans to request an average of approximately \$531 million for FY 2014 through FY 2018 with the maximum request being \$640 million in FY 2018.

NNSA Determined That the UPF Would Need to Be Enlarged, Resulting in Additional Costs

- In August 2012, B&W concluded that UPF's roof would have to be raised 13 feet to ensure, among other things, the processing equipment would fit into the facility.
- NNSA officials told us that this problem arose because B&W did not adequately manage and integrate the design work subcontracted to four other contractors.
- Based on this issue, NNSA rated B&W's FY 2012 UPF performance as "unsatisfactory." Agency officials told us that B&W did not earn any award fee for its UPF work in FY 2012.
- NNSA documents state that addressing this space/fit issue will require substantial design re-work, cost an additional \$540 million, delay the start of construction, and delay the start of facility operations by 13 months.
- Earlier analyses identified this issue as a potential project risk, but it was not considered to be one of the project's most significant risks, according to NNSA officials, as its impact to the UPF's cost was estimated to be approximately \$80 million.

NNSA Determined That the UPF Would Need to Be Enlarged, Resulting in Additional Costs

- In October 2012, NNSA updated the June 2012 point estimate from approximately \$5.2 billion to \$5.8 billion to reflect the additional costs associated with the space/fit issue. These costs were paid out of NNSA contingency.
- NNSA officials said that they did not update the June 2012 range estimate (\$4.2 to \$6.5 billion) because, among other reasons, the project's estimate will undergo a complete review to establish the cost baseline at CD 2.
- B&W representatives said that they are planning to submit CD 2 materials to NNSA in September 2013 and expect to receive approval by June 2014.



NNSA Determined That the UPF Would Need to Be Enlarged, Resulting in Additional Costs

- It is unclear if the project's current cost range of \$4.2 to \$6.5 billion remains valid because:
 - NNSA's current point estimate is \$6.0 billion as design costs for certain processing equipment has increased;
 - the space/fit issue required approximately 45 percent of NNSA's contingency to address; NNSA's contingency planning did not account for such a large sum of money being needed to address this risk;
 - several identified project risks, including all risks related to construction activities, remain and would require mitigation if they were to occur.
- It is possible that additional funds will be needed to ensure there is sufficient contingency to complete the UPF within a cost range that meets NNSA's 85 percent confidence level. As part of the CD 2 process, NNSA plans to establish a firm cost baseline by June 2014.

Next Steps: UPF Cost Estimate

- As stated above, B&W representatives said that they are planning to submit required CD 2 materials to NNSA in September 2013 and expect to receive approval by June 2014.
- DOE Order 413.3B requires an ICE at CD 2.
- GAO could assess, under this mandate or in a separate request, the extent to which UPF's CD 2 cost estimate meets the best practices established in our cost guide.



GAO on the Web

Web site: <http://www.gao.gov/>

Congressional Relations

Katherine Siggerud, Managing Director, siggerudk@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

Copyright

This is a work of the U.S. government and is not subject to copyright protection in the United States. The published product may be reproduced and distributed in its entirety without further permission from GAO. However, because this work may contain copyrighted images or other material, permission from the copyright holder may be necessary if you wish to reproduce this material separately.