



October 2018

NATIONAL AIR AND SPACE MUSEUM

Smithsonian's Efforts
to Improve Reliability
of Its Revitalization
Project's Cost
Estimate Are Ongoing

GAO Highlights

Highlights of [GAO-19-78](#), a report to congressional committees

Why GAO Did This Study

The Smithsonian's National Air and Space Museum is home to the world's largest collection of historic aircraft and spacecraft, attracting millions of visitors annually (see fig.). Since the museum on the National Mall opened in 1976, substantial degradation of the building's mechanical systems and exterior façade has occurred, posing risks to the museum's collections, staff, and visitors. To address these and other issues, the Smithsonian is undertaking a federally funded whole-building revitalization project, with construction planned for late 2018 through mid-2024. The Smithsonian estimated the total project costs at \$666 million but committed to identifying cost savings to cap the budget at \$650 million.

The Explanatory Statement accompanying the Consolidated Appropriations Act, 2017, included a provision for GAO to review and analyze these cost estimates. This report: (1) describes the status of the National Air and Space Museum revitalization project and (2) examines the extent to which the Smithsonian's estimate has the characteristics of a reliable cost estimate.

GAO analyzed project documents; interviewed Smithsonian officials, contractors, and consultants; and compared the Smithsonian's methodologies for developing its December 2017 cost estimate for the National Air and Space Museum revitalization, which was based on the project's fully developed design, with best practices identified in GAO's *Cost Estimating and Assessment Guide*.

View [GAO-19-78](#). For more information, contact Heather Krause at (202) 512-2834 or krauseh@gao.gov.

October 2018

NATIONAL AIR AND SPACE MUSEUM

Smithsonian's Efforts to Improve Reliability of Its Revitalization Project's Cost Estimate Are Ongoing

What GAO Found

The Smithsonian Institution (Smithsonian) has completed planning and design work for its National Air and Space Museum revitalization project and started the first of two construction phases in October 2018. This phased approach should allow the building to remain open to the public during construction. In August 2018, the Smithsonian finalized a "guaranteed maximum price" (GMP) contract, which generally sets the maximum amount that the Smithsonian is to pay for construction services. In preparation for construction, Smithsonian also awarded a contract for demounting and transporting the museum's artifacts to off-site storage. To date, the Smithsonian has used or allotted \$250 million of its prior-year appropriations for the project's planning, design, and initial construction. The Smithsonian plans to request \$400 million in total from fiscal years 2019 through 2022 to fund construction and other project-related activities.

National Air and Space Museum on the National Mall



Source: Smithsonian Institution - National Air and Space Museum. | GAO-19-78

GAO found that the Smithsonian's December 2017 cost estimate substantially met three of the four best practices outlined in GAO's *Cost Estimating and Assessment Guide* and that the Smithsonian is taking steps to institute practices to enhance the estimate's credibility. GAO's best practices help ensure reliable cost estimates that are comprehensive, well documented, accurate, and credible. The Smithsonian's cost estimate substantially met comprehensive, well-documented, and accurate characteristics because, among other attributes, it included ground rules and assumptions, documented steps to calculate cost components, and was adjusted for inflation. The Smithsonian's cost estimate only partially met best practices for the credible characteristic. Specifically, while the Smithsonian had completed a risk analysis and a sensitivity analysis when the project design was 35 percent complete, it postponed updating the analyses when the design was completed because it determined that the analyses could benefit from project schedule information that was concurrently being developed. By postponing the update, the Smithsonian did not have current information available to inform its GMP contract negotiations and was therefore not able to consider how existing risks may have changed or to ensure that the cost of the GMP contract appropriately reflected new risks. However, in May 2018 the Smithsonian contracted to have these analyses updated based on the revised estimate that incorporates the negotiated GMP cost. By updating the analyses, the Smithsonian will be better able to make decisions and mitigate risks as construction progresses. Further, updating these analyses will improve the credibility of the cost estimate and better position the Smithsonian to make well-informed budget requests to Congress for remaining project costs.

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Abbreviations

CMc	construction manager as constructor
CWE	current working estimate
GMP	guaranteed maximum price (contract)

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October 25, 2018

The Honorable Lisa Murkowski
Chairman
The Honorable Tom Udall
Ranking Member
Subcommittee on Interior, Environment, and Related Agencies
Committee on Appropriations
United States Senate

The Honorable Ken Calvert
Chairman
The Honorable Betty McCollum
Ranking Member
Subcommittee on Interior, Environment, and Related Agencies
Committee on Appropriations
House of Representatives

The Smithsonian Institution's (Smithsonian) National Air and Space Museum (Air and Space Museum) on the National Mall is home to the world's largest collection of historic aircraft and spacecraft and annually attracts millions of visitors.¹ However, substantial degradation of the museum's mechanical systems used for heating and cooling and to its exterior façade poses risks to its collections, staff, and visitors. The building's original mechanical systems have exceeded their 40-year lifespans and cannot maintain desired temperature and humidity levels, exposing the collections to potential damage. Further, warped and cracked limestone panels on the building's exterior are at risk of falling, a risk that could create a safety hazard for staff and visitors. To address these deficiencies, the Smithsonian is undertaking a whole-building revitalization project, budgeted to cost \$650 million, to modernize building systems and replace the limestone façade. Among other improvements, the project aims to increase energy efficiency and strengthen the building's capacity to withstand blasts and earthquakes.

A reliable cost estimate provides the basis for informed investment decision making, realistic budget formulation, and resource allocation.

¹Smithsonian's National Air and Space Museum also includes the Steven F. Udvar-Hazy Center in Chantilly, Virginia. For the purpose of this report, Air and Space Museum refers only to the building located on the National Mall in Washington, D.C.

The Explanatory Statement accompanying the Consolidated Appropriations Act, 2017, included a provision for us to review and analyze the Smithsonian's cost estimate for the Air and Space Museum revitalization project.² This report:

- describes the status of the project, and
- examines the extent to which the Smithsonian's cost estimate has the characteristics of a reliable cost estimate.

To describe the status of the Air and Space Museum revitalization project, we analyzed project documents obtained from the Smithsonian and conducted interviews with Smithsonian's officials, its design and construction management contractors, and its cost-estimating consultant. In addition, to gain further insight into the scope of this project, we conducted a site visit of locations within the Air and Space Museum where major work elements of the revitalization project will occur.

To examine the extent to which the Smithsonian's cost estimate for the Air and Space Museum's revitalization project has the characteristics of a reliable cost estimate, we compared the Smithsonian's methodologies and assumptions for developing its estimate with characteristics of a reliable cost estimate in GAO's *Cost Estimating and Assessment Guide (Cost Guide)*.³ Our analysis enabled us to determine whether the Smithsonian's cost estimate was comprehensive, well documented, accurate, and credible. As part of this review, we examined the cost estimate associated with the project's "100 percent design" as well as related life-cycle cost and risk and sensitivity analyses.⁴ In addition, we conducted interviews with Smithsonian officials, its design and

²Explanatory Statement in the 2017 Committee Print of the House Committee on Appropriations on H.R. 244/Public Law 115-31, at 1138, accompanying the Consolidated Appropriations Act, 2017, Pub. L. No. 115-31, 131 Stat. 244.

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

⁴We used Smithsonian's December 2017 current working estimate (CWE) as the basis of our analysis. This estimate incorporates the construction estimate, based on 100 percent design documents and reconciled between Smithsonian's construction contractor and the design team's cost-estimating consultant. For the purpose of this report, we refer to the December 2017 CWE, with the incorporated reconciled construction estimate, as the December 2017 cost estimate. The "100 percent design" is the stage of the design process on a project when drawings and specifications are completed for construction bid purposes.

construction contractors, and its cost estimating consultant to further understand the project's estimated costs.

We conducted this audit from October 2017 to October 2018 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 based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings based on our audit objectives.

Background

The Air and Space Museum, located on the National Mall in Washington, D.C., opened in 1976 and has approximately 161,145 square feet of exhibit galleries (see fig. 1). Designed for 2-million visitors per year, the 5-millionth visitor crossed the threshold only 6 months after opening day. The Air and Space Museum continues to be one of the most visited museums in the world, and hosts more than 7-million visitors annually. Notable artifacts featured in the museum include the 1903 Wright Flyer; the Spirit of St. Louis; and the Apollo 11 command module, Columbia.

Figure 1: Smithsonian's Air & Space Museum on the National Mall



Source: Smithsonian Air and Space Museum. | GAO-19-78

The Air and Space Museum Revitalization Project is a federally funded effort administered by the Smithsonian's Office of Planning, Design and Construction. Beginning with the 2013 cladding-replacement feasibility study, there have been several follow-on assessments and studies performed during the planning phase, forming the basis for subsequent design work. The Smithsonian's design contractor began designing the

project in 2015 and completed the design in 2017.⁵ The Smithsonian, in coordination with its design contractor and cost estimating consultant, updated the project's cost estimate at sequential stages during the project's design, to include when the design was 35 percent, 65 percent, and 100 percent complete.⁶ In December 2017, based on the 100 percent design, the Smithsonian estimated the project's total cost to be \$666 million, but it has since committed to identifying cost savings to cap the project's budget at \$650 million. The Smithsonian plans for construction to occur from late 2018 through mid-2024. In a separate, privately funded "exhibit transformation project," the Smithsonian is seeking to raise approximately \$250 million in private donations to fund the renovation of the museum's 22 galleries to be completed in sequence with the phases of the revitalization project.⁷

The revitalization project's goals, among others, are to:

- *Modernize building systems:* To maintain the desired environmental conditions for the museum's artifacts as well as to optimize energy performance and take advantage of sustainability opportunities (such as installing efficient plumbing fixtures to reduce water consumption), the Smithsonian plans to replace the mechanical, plumbing, and fire systems, and upgrade the electrical and data systems, including the audio-visual systems.
- *Replace exterior features:* The Smithsonian plans to replace each of the 13,000 limestone panels on the building façade, many of which have been damaged from moisture and exposure to temperature variations and are at risk of detaching from the building (see fig. 2).⁸ The project will also replace other exterior building elements, including the glass walls, skylights, and roof.
- *Improve safety and security:* The Smithsonian plans to upgrade the building structure to better resist blasts and seismic events, expand

⁵The Smithsonian's design contractor continued to provide services in the pre-construction and construction stages of the project.

⁶The Smithsonian's contracted construction manager also provided input for the 65 percent and the 100 percent cost estimate updates.

⁷The exhibit transformation project is outside the scope of our review.

⁸The Smithsonian plans to replace the museum's limestone panels with Colonial Rose granite, which Smithsonian officials determined presented the fewest technical challenges and production risks and was compatible in texture and color to the existing façade.

the entry vestibules to enable more efficient security screening, and make site improvements to enable easier access. For example, the redesign of the building's landscaping will open up the terraces to meet current accessibility requirements.

Figure 2: Warping of the Exterior's Limestone Panels at the Smithsonian's Air and Space Museum



Source: GAO. | GAO-19-78

In addition to construction components, the revitalization project involves non-construction activities, such as dismantling and moving the museum's artifacts to a storage space during construction, and leasing office space for displaced employees.

Smithsonian Has Completed Planning and Design Work and Has Begun First Phase of 6-Year Construction Project

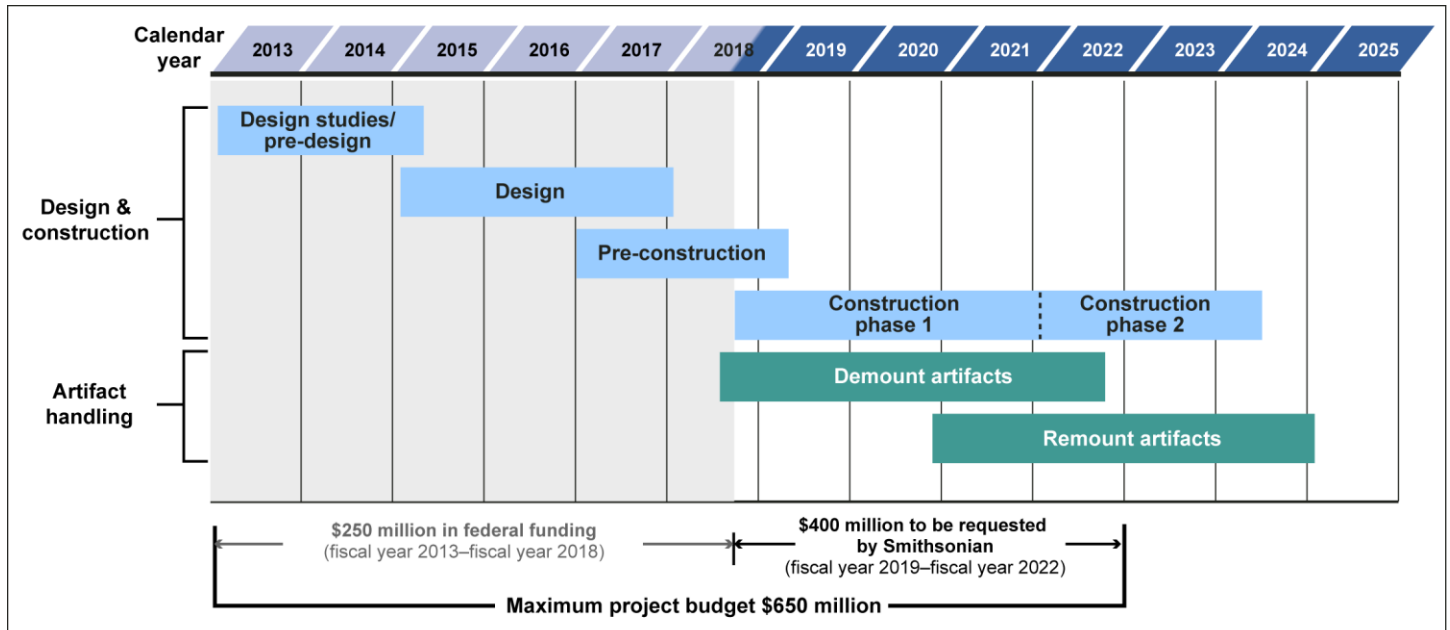
Project Status and Plan Going Forward

As of August 2018, the Smithsonian had completed all planning and design activities for the revitalization project and was preparing for construction, which began in October 2018 and is expected to continue through mid-2024 (see fig. 3). In August 2018, the Smithsonian finalized a contract for artifact-handling services. It includes, for example, demounting artifacts from the museum in preparation for construction and transporting the artifacts to their storage location.⁹ In August 2018, the Smithsonian also completed negotiations on a “guaranteed maximum price” (GMP) contract with its construction manager.¹⁰ The GMP contract sets the maximum price that the Smithsonian will pay the contractor for construction work associated with the revitalization project, absent any changes to the project scope that require an upward or downward price adjustment. The Smithsonian used the 100 percent cost estimate from December 2017 as the basis for negotiating the GMP contract with its construction manager.

⁹The Smithsonian’s construction manager won the award for and is to perform the artifact handling services.

¹⁰The Smithsonian is using the “construction manager as constructor” (CMc) project delivery method for the revitalization project. This delivery method generally involves the CMc providing input to the owner and the owner’s design contractor on the design and cost of the project as it progresses through the design stages. Under this method, when the project is ready for construction, the owner and CMc negotiate an agreement for the CMc to construct the project, typically at a guaranteed maximum price.

Figure 3: Sequencing of Work for the National Air and Space Museum’s Revitalization Project

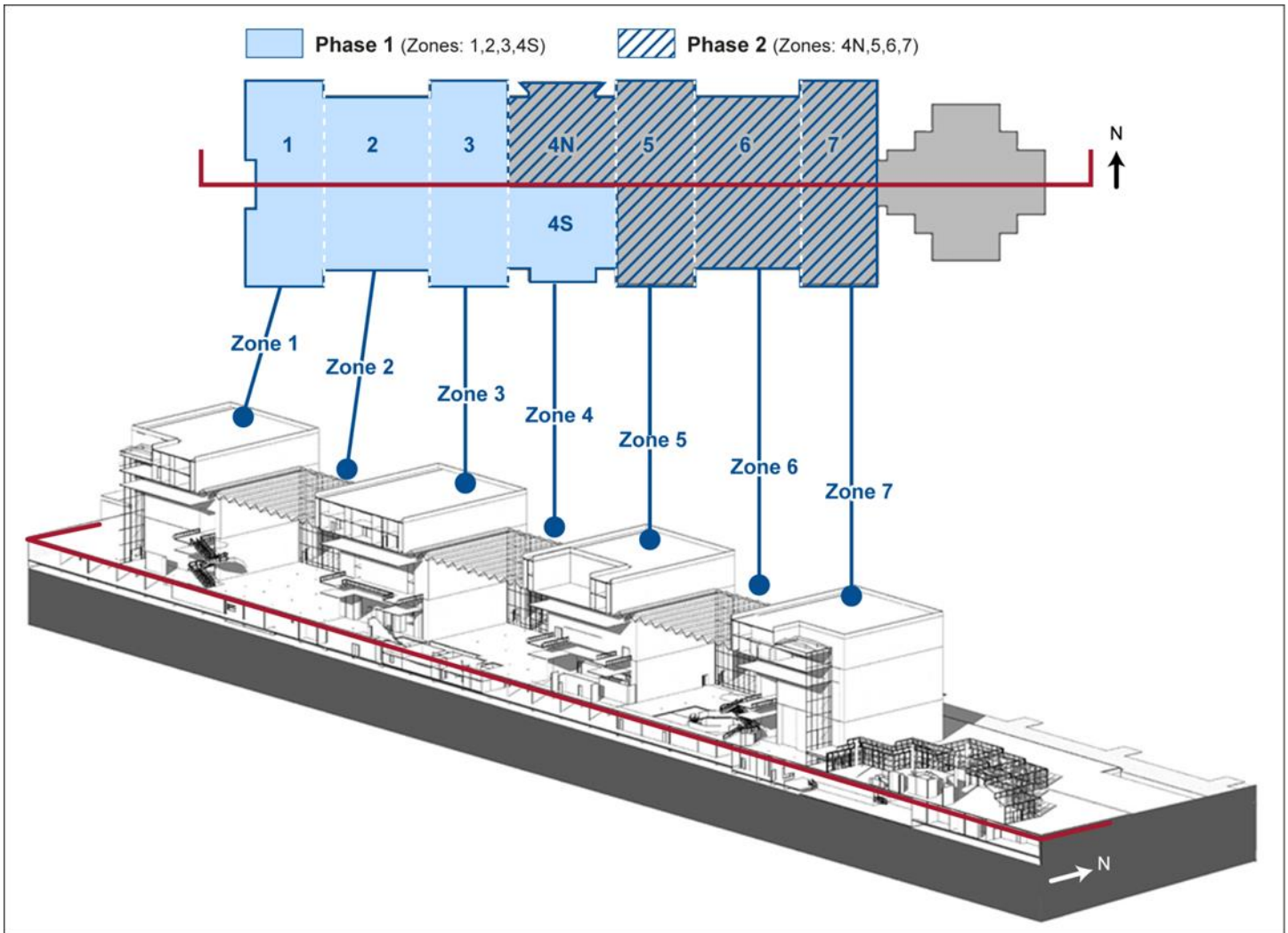


Source: GAO analysis of Smithsonian Air and Space Museum information. | GAO-19-78

Planned Sequencing

The Smithsonian plans two construction phases, with work progressing along zones from the western to the eastern half of the building (see fig. 4). The Smithsonian plans to keep the building open to the public during construction, allowing visitors in the zones not currently under construction.

Figure 4: Planned Phasing of Construction Work for the National Air and Space Museum's Revitalization



Source: Smithsonian Institution – Office of Planning, Design and Construction. | GAO-19-78

Keeping the construction on schedule depends on the Smithsonian's coordination and sequencing of project activities. Key activities include completing the Dulles Collections Storage Module Project, moving artifacts, and procuring granite panels for the façade.

- *Dulles Collections Center Storage Module Project:* According to Smithsonian officials, before relocation of artifacts out of the Air and

Space Museum can occur, construction of the Dulles Collections Center Storage Module must be completed.¹¹ Smithsonian officials expect the \$58.4-million storage module—funded separately from the revitalization project—to be completed in January 2019.

- **Artifact moves:** In advance of construction, more than 3,600 artifacts housed in the museum’s 22 galleries must be removed. Under the Smithsonian’s contract for artifact-handling services, artifacts are to be demounted and, according to Smithsonian officials, moved to the Dulles Collections Center Storage Module in coordination with the planned sequencing of construction.¹² As construction is completed, the Smithsonian plans to return approximately half of these artifacts to the museum to be displayed with artifacts currently in storage or on display at other locations. The Smithsonian plans to place the remaining artifacts in long-term storage; display them at the Udvar-Hazy Center, Chantilly, VA; or loan them to other museums.
- **Granite panel procurement:** For the project to remain on schedule, the exterior construction work must proceed at the same pace as the work occurring inside the building. To ensure the granite panels for the building’s façade are on site at the time they are scheduled to be installed, Smithsonian officials said they must be ordered well in advance. This timing allows for the vendor’s time-intensive work of quarrying, cutting, polishing, and transporting the panels to the project site. According to Smithsonian officials, procuring the granite panels is a priority effort for its construction manager.

Project’s Funding

Previous congressional direction has supported the use of the Smithsonian’s appropriations for planning, design, and initial construction activities. According to Smithsonian officials, they plan to request appropriations through fiscal year 2022 to fund remaining construction and non-construction activities. Based on its \$650-million project budget, from fiscal years 2013 through 2017, the Smithsonian has expended \$52

¹¹The three-story facility located adjacent to the Steven F. Udvar-Hazy Center (Udvar-Hazy) in Chantilly, VA, will provide off-site storage space for artifacts that have been removed from the Air and Space Museum in preparation for construction. According to Smithsonian officials, after completion of the revitalization project, the agency intends to use this facility to house artifacts currently stored at an inadequate facility in Suitland, MD.

¹²According to Smithsonian officials, 21 artifacts are to remain in the building to be protected on-site during construction due to their size or sensitivity. For example, these officials told us that the Soviet-era missiles housed in the building cannot be relocated, without appropriate diplomatic approvals, as moving them would violate an existing treaty between the U.S. and the former Soviet Union.

million in appropriations to fund planning, design, and some pre-construction activities. The explanatory statement accompanying fiscal year 2018 appropriations for the Smithsonian directed \$198 million to be used for the National Air and Space Museum Revitalization project.¹³ The Smithsonian plans to use the fiscal year 2018 appropriations to fund the artifact-moving contract and the initial construction work under the GMP contract, including purchase of the granite panels for the building façade. The Smithsonian plans to request the remaining \$400 million in increments from fiscal years 2019 through 2022 to fund non-construction support activities and the remaining construction work.

Smithsonian's Cost Estimate Has Most Characteristics of a Reliable Cost Estimate, and Smithsonian Is Planning to Improve the Estimate's Credibility

Our assessment of the Smithsonian's December 2017 cost estimate for the Air and Space Museum Revitalization project found that it substantially met most but not all of GAO's cost estimation best practices. GAO's *Cost Guide* defines the four characteristics of a reliable cost estimate—comprehensive, well-documented, accurate, and credible—and their associated best practices.¹⁴ A cost estimate is considered reliable if it fully or substantially meets all four characteristics. While the Smithsonian's cost estimate substantially met three of the four characteristics of a reliable cost estimate, it only partially met the credibility characteristic. (See table 1.)

¹³Explanatory Statement in the 2018 Committee Print of the House Committee on Appropriations on H.R. 1625/Public Law 115-141, at 1188, accompanying the Consolidated Appropriations Act, 2018, Pub. L. No. 115-141, 132 Stat. 348.

¹⁴[GAO-09-3SP](#).

Table 1: GAO’s Assessment of How the Smithsonian Institution’s Cost Estimate for the National Air and Space Museum’s Revitalization Project Aligns with Best Practices for Cost Estimating

Characteristic	Best practice	Overall assessment
Comprehensive	<ul style="list-style-type: none"> The cost estimate includes all life-cycle costs. The cost estimate completely defines the program, reflects the current schedule, and is technically reasonable. The cost estimate work breakdown structure is product-oriented, traceable to the statement of work/objective, and at an appropriate level of detail to ensure that cost elements are neither omitted nor double-counted. The cost estimate documents all cost-influencing ground rules and assumptions. 	Substantially met ^a
Well-documented	<ul style="list-style-type: none"> The documentation captures the source data used, the reliability of the data, and how the data were normalized. The documentation describes in sufficient detail the calculations performed and the estimating methodology used to derive each element’s cost. The documentation describes step by step how the estimate was developed so that a cost analyst unfamiliar with the program could understand what was done and replicate it. The documentation describes the technical baseline for construction components, and the data in the baseline are consistent with the estimate. The documentation provides evidence that the cost estimate was reviewed and accepted by management. 	Substantially met ^a
Accurate	<ul style="list-style-type: none"> The cost estimate results are unbiased, not overly conservative or optimistic, and based on an assessment of most likely costs. The estimate has been adjusted properly for inflation. The estimate contains few, if any, minor mistakes. The cost estimate is regularly updated to reflect significant changes in the program so that it is always reflecting current status. Variances between planned and actual costs are documented, explained, and reviewed. The estimate is based on a historical record of cost estimating and actual experiences from other comparable programs. 	Substantially met ^a
Credible	<ul style="list-style-type: none"> The cost estimate includes a sensitivity analysis that identifies a range of possible costs based on varying major assumptions, parameters, and data input. A risk and uncertainty analysis was conducted that quantified the imperfectly understood risks and identified the effects of changing key cost-driver assumptions and factors. Major cost elements were cross-checked to see whether results were similar. An independent cost estimate was conducted by a group outside the acquiring organization to determine whether other estimating methods produce similar results. 	Partially met ^b

Source: GAO analysis of the cost estimate for Smithsonian’s Air & Space Museum revitalization project. | GAO-19-78

^aSubstantially met: GAO reviewed Smithsonian’s evidence and determined that Smithsonian followed most of the practices associated with the characteristic.

^bPartially met: GAO reviewed Smithsonian’s evidence and determined that Smithsonian followed about half of the practices associated with the characteristic.

Comprehensive

The Smithsonian's cost estimate substantially met the comprehensive characteristic. For example, in addition to the cost estimate, the Smithsonian performed a life-cycle assessment, which calculated the annual maintenance and energy costs projected over the building's 40-year economic life. The cost estimate defined construction-related costs (about 80 percent of the total project cost) in a work breakdown structure and non-construction activities (about 20 percent of the total project cost) in a high level description.¹⁵ Further, the cost estimate included ground rules and assumptions for construction and non-construction costs. However, the estimate did not identify specific assumptions related to the Smithsonian's reducing the project's total estimated cost from \$666 million to \$650 million. Constraining the budget to a target price, lower than the estimated cost, creates risks to the project's implementation that may result in additional funding requirements or a reduction in the project's scope, or a combination of the two. According to Smithsonian officials, they anticipate being able to perform the work at a reduced cost through application of "value engineering" and scope adjustments.¹⁶

Well-documented

The Smithsonian's cost estimate substantially met the well-documented characteristic. The estimate documentation included detailed calculations showing logical accrual of construction and non-construction cost components. In addition, Smithsonian officials provided documentation that described the step-by-step process they used to develop the estimate, as well as the basis for cost growth and contingency factors that they used in the estimate. Further, senior officials reviewed and approved the estimate. However, the estimate lacked background information on the source of data, and there was no technical baseline for non-construction costs. Smithsonian officials said that source data for construction costs could not be obtained because the majority of the data used to develop these costs came from vendor quotes and the Smithsonian's construction manager's and the cost-estimating consultant's internal proprietary cost databases. In response to our

¹⁵Construction-related costs include work to be performed by the construction contractor and subcontractors, contingency, and construction supervision and administration. Non-construction activities include pre-construction work, engineering and design services, leasing of swing space for displaced employees, artifact moves, building commissioning, and security.

¹⁶"Value engineering" is an organized effort that analyzes the requirements of a project for the purpose of achieving the essential functions at the lowest total costs over the life of the project. Smithsonian identified approximately \$13 million in estimated savings through value-engineering reviews conducted as of April 2018. These savings are reflected in the project's \$666-million estimate.

request, Smithsonian officials provided additional data clarifying some non-construction baseline costs used in the estimate.

Accurate

The Smithsonian's cost estimate substantially met the accurate characteristic. The estimate was adjusted properly for inflation and did not contain any arithmetic errors. The Smithsonian updated the cost estimate at successive stages in the design process; according to Smithsonian officials, they intend to continue to update the estimate, with actual costs, throughout construction. In addition, Smithsonian officials provided reports detailing how they tracked cost revisions across design iterations. Further, Smithsonian officials stated that their estimate was informed by actual experiences from comparable projects, such as the recently constructed National Museum of African American History and Culture. However, as noted above, the Smithsonian reduced the cost estimate by \$16 million without documenting the rationale or justification for the change. The Smithsonian made this reduction not based on its assessment of most likely costs but rather to match the \$650-million capped amount that it cited in its budget request. As previously noted, the Smithsonian plans to apply value engineering and adjust the project's scope, as needed, to perform the work at a reduced cost.

Credible

The Smithsonian's cost estimate partially met the credible characteristic. For example, the Smithsonian reconciled independent estimates from its cost-estimating consultant and construction manager in developing its estimate of construction costs. In addition, the Smithsonian contracted with an independent consultant to review plans and estimated costs for the artifact moves, which according to Smithsonian officials, is the largest non-construction cost component. However, crosschecks of major cost elements were not apparent in the construction-cost-estimating model we reviewed resulting in the estimate's minimally meeting the underlying best practice.¹⁷ In addition, while the Smithsonian completed a risk and uncertainty analysis (risk analysis) and a sensitivity analysis of the cost estimate when the project design was at the 35 percent complete mark, it did not update the analyses when the design was 100 percent complete resulting in the estimate's partially meeting the associated best

¹⁷A cross check involves applying different estimating methods to see if use of a different method produces similar results.

practices.¹⁸ According to Smithsonian officials, they intended to update the risk and sensitivity analyses upon completion of the 100 percent design and prior to GMP negotiations. However, these officials decided to postpone updating these analyses so that they could integrate the schedule proposal—which would significantly affect costs—that was concurrently being developed by the construction manager based on the 100 percent design. By postponing the update, the Smithsonian did not have current information available to inform its GMP contract negotiations. Because it had not updated these analyses prior to negotiating the GMP contract, the Smithsonian was not able to consider how previously identified risks may have changed or ensure that the cost of the GMP contract the Smithsonian negotiated appropriately reflected new risks. Having the 100 percent design risk assessment results available during negotiations could have benefitted the Smithsonian by providing greater certainty of the “confidence levels” associated with the estimated costs.¹⁹

Although the Smithsonian did not update the risk and sensitivity analyses for its cost estimate in time to inform its GMP contract negotiations, it had contracted with its consultant in May 2018 to update these analyses in accordance with the requirements set forth in GAO’s *Cost Guide*. Smithsonian officials said that they plan to update the project’s cost estimate based on the negotiated construction GMP and that their consultant is to use this estimate as the basis for updating the risk and sensitivity analyses inclusive of both construction and some non-construction costs such as for artifact moves.

Updating the risk and sensitivity analyses will provide Smithsonian the insight to make better-informed decisions and better mitigate risks as

¹⁸In completing the initial risk and sensitivity analyses, the Smithsonian identified key risks, such as availability of funds, affecting the project. For example, Smithsonian’s risk analysis considered delayed funding scenarios that evaluated the impact of a 5-year delay in receiving funding as well as the effect of receiving funding spread over 10 years. In the first scenario, the analysis determined that a 5-year delay would increase the estimated cost of the project by approximately 35 percent. In the second scenario, the analysis determined that spreading construction funding over 10 years (as opposed to over 5 years as currently planned) would increase the estimated cost of the project by approximately 7 percent.

¹⁹The “level of confidence” is the probability that a 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.

construction progresses, such as by determining the amount of funds to hold for risks due to unforeseen conditions and unanticipated change requests and mitigating the risks associated with artifact moves. Further, these risk and sensitivity analyses will enable Smithsonian to improve the credibility of the cost estimate, lessening those limitations that we identified with the December 2017 cost estimate and that affected its reliability. By having a reliable cost estimate, the Smithsonian will be in an improved position to make well-informed budget requests to Congress when seeking funding for remaining project costs.

Agency Comments

We provided a draft of this report to the Smithsonian for review and comment. The Smithsonian provided technical comments, which we incorporated as appropriate.

We are sending copies of this report to the appropriate congressional committees and the Smithsonian Institution. In addition, the report is available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staff have any questions about this report, please contact me at (202) 512-2834 or krauseh@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 key contributions to this report are listed in appendix II.



Heather Krause
Director, Physical Infrastructure

Appendix I: Organizations Contacted

We interviewed representatives from each of the following organizations:

Federal Government

- Smithsonian Institution
 - Office of Planning, Design and Construction
 - Office of Planning, Management and Budget
 - Office of Government Relations
 - National Air and Space Museum

Contractors

- Quinn-Evans Architects
- Dharam Cost Consulting
- Clark Smoot Consigli (CSC)

Appendix II: GAO Contact and Staff Acknowledgments

GAO Contact

Heather Krause, (202) 512-2834 or krauseh@gao.gov.

Staff Acknowledgments

In addition to the contact named above, Michael Armes (Assistant Director); Steve Schluth (Analyst in Charge); Melissa Bodeau; George Depaoli; Terry Dorn; Jennifer Echard; Geoffrey Hamilton; Jennifer Leotta; Mikaela Meyer; Malika Rice; Karen Richey; Rachel Stoiko; and Laurel Voloder made key contributions to this report.

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