



## Testimony

Before the Subcommittee on Space and  
Aeronautics, Committee on Science,  
Space, and Technology, House of  
Representatives

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# NASA ARTEMIS PROGRAMS

## Lunar Landing Plans Are Progressing, but Challenges Remain

Statement of William Russell, Director, Contracting and  
National Security Acquisitions

# GAO Highlights

Highlights of [GAO-24-107249](#), a testimony before the Subcommittee on Space and Aeronautics, Committee on Science, Space, and Technology, House of Representatives

## Why GAO Did This Study

The National Aeronautics and Space Administration (NASA) is committing billions of dollars to return humans to the lunar surface and initiate human exploration of Mars. The missions, known collectively as Artemis, involve the development and integration of multiple systems and programs.

This testimony focuses on NASA's progress toward achieving the Artemis missions, as well as the challenges the agency faces in conducting them. This statement is based on past GAO reports on the Artemis enterprise and our annual assessment of NASA's major projects.

## What GAO Recommends

GAO has made numerous recommendations to reduce NASA's acquisition risk and improve NASA's management of its portfolio of major projects, which includes projects supporting the Artemis missions. NASA has generally agreed with the recommendations and implemented changes in response to many of them. However, it needs to take additional actions to fully address all of them.

As of May 2023, GAO identified six open recommendations related to Artemis as being a priority for implementation. For example, NASA concurred with our December 2019 recommendation to create a life-cycle cost estimate for the Artemis III mission but has not yet implemented it.

View [GAO-24-107249](#). For more information, contact William Russell at (202) 512-4841 or [russellw@gao.gov](mailto:russellw@gao.gov).

January 17, 2024

## NASA ARTEMIS PROGRAMS

### Lunar Landing Plans are Progressing but Challenges Remain

#### What GAO Found

NASA has made progress demonstrating key capabilities needed to support its Artemis missions:

- **Artemis I**, an uncrewed test flight, successfully launched in November 2022, which demonstrated the initial capability of the Space Launch System and Exploration Ground Systems.
- For **Artemis II**, the first flight with crew, NASA is currently conducting integration and testing of the crew capsule and the launch pad.
- NASA and its contractors continue to make progress on technologies supporting **Artemis III**, the first crewed lunar landing mission. For example, the human landing system contractor has conducted two test flights of its human landing system.

#### Notional Depiction of the Human Landing System



Source: SpaceX. | GAO-24-107249

Despite this progress, NASA still faces several challenges:

- **Ambitious schedules.** In November 2023 ([GAO-24-106256](#)), GAO found that the Artemis III lunar landing was unlikely to occur in December 2025, as planned, given delays and remaining technical work. In January 2024, NASA adjusted the launch date to September 2026 to allow contractors time to complete a significant amount of remaining complex work.
- **Artemis III mission cost.** In December 2019 ([GAO-20-68](#)), GAO found that NASA did not plan to establish an official cost estimate for this mission. NASA concurred with a GAO recommendation to establish one but has not yet done so. While NASA requested \$6.8 billion to support Artemis III programs in its fiscal year 2024 budget request, decision-makers have limited knowledge into the full scope of Artemis III mission costs.
- **Acquisition management.** NASA's largest, most complex projects, including those that support the Artemis missions, continue to shape the agency's portfolio. When these projects exceed their cost baselines and require cost reserves to meet their funding needs, it has a cascading effect on other projects. NASA officials are exploring ways to better manage this project cost and schedule growth.

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January 17, 2024

Chairman Babin, Ranking Member Sorensen, and Members of the Subcommittee:

Thank you for the opportunity to discuss the National Aeronautics and Space Administration's (NASA) efforts to return astronauts to the surface of the moon and, ultimately achieve human exploration of Mars. In the fiscal year 2024 President's budget request, NASA requested at least \$38 billion over the next 5 years to support this ambitious undertaking, known collectively as the Artemis missions. The projects supporting the Artemis missions are complex and specialized, and often push the state of the art in space technology. Executing Artemis missions will require extensive coordination across several NASA programs to ensure systems operate together seamlessly and safely. The Artemis missions will also partner with contractors to develop, demonstrate, and produce critical components as part of a strategy to leverage commercial investment and interest in space technology.

We previously highlighted NASA's progress toward achieving the lunar landing mission, such as establishing integration processes and completing some lunar program development activities. We also reported on the challenges NASA faces in developing and integrating these systems and missions.<sup>1</sup> Improving acquisition management—which has been a long-standing challenge at NASA—will play a key role in successfully executing the Artemis enterprise.<sup>2</sup>

You asked us to testify today on our work examining NASA's lunar programs. My statement focuses on (1) progress NASA has made on its Artemis missions, and (2) challenges the agency faces in conducting these missions.

This statement is based on our previously issued reports on NASA's Artemis efforts, including reports that focus on the lunar programs necessary to support the Artemis III missions and our annual assessment of NASA's major projects. We also compared original Artemis mission

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<sup>1</sup>GAO, *NASA Lunar Programs: Improved Mission Guidance Needed as Artemis Complexity Grows*, [GAO-22-105323](#) (Washington, D.C.: Sept. 8, 2022); and *NASA Artemis Programs: Crewed Moon Landing Faces Multiple Challenges*, [GAO-24-106256](#) (Washington, D.C.: Nov. 30, 2023).

<sup>2</sup>GAO, *High-Risk Series: Efforts Made to Achieve Progress Need to be Maintained and Expanded to Fully Address All Areas*, [GAO-23-106203](#) (Washington, D.C.: Apr. 20, 2023).

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dates from previously obtained NASA documentation to the new dates announced by NASA in January 2024 to determine any delays. The reports cited throughout this statement include detailed information on their scope and methodology.

We conducted the work on which this statement is based 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.

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## Background

### Key Elements of NASA's Planned Return to the Moon

The goal of NASA's Artemis enterprise is to return U.S. astronauts to the surface of the moon, establish a sustained lunar presence, and, ultimately, achieve human exploration of Mars. To do so, NASA programs are developing multiple highly complex and interdependent systems that will need to be integrated to support individual Artemis missions.

- The Artemis I and II missions are the first uncrewed and crewed demonstration missions, respectively, of the Space Launch System (SLS) launch vehicle, the Orion Multi-Purpose Crew Vehicle (Orion), and the associated ground systems, known as Exploration Ground Systems (EGS).
- The Artemis III mission will leverage contracts with commercial companies to develop the human landing system (HLS) and space suits. NASA awarded firm-fixed-price indefinite delivery, indefinite quantity contracts to two companies, SpaceX and Axiom Space, to develop these capabilities.<sup>3</sup>
  - SpaceX is developing the HLS, which will provide crew access to the lunar surface and demonstrate initial capabilities required for deep space missions.
  - Axiom Space is developing modernized space suits, which consist of a combination of a pressure garment and life support

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<sup>3</sup>NASA also awarded a task order to Collins Aerospace to begin development activities on a space suit capability for Artemis III. However, we did not include these activities in our work upon which this statement is based.

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components that together will provide capacity for at least 8 hours of lunar surface activity.

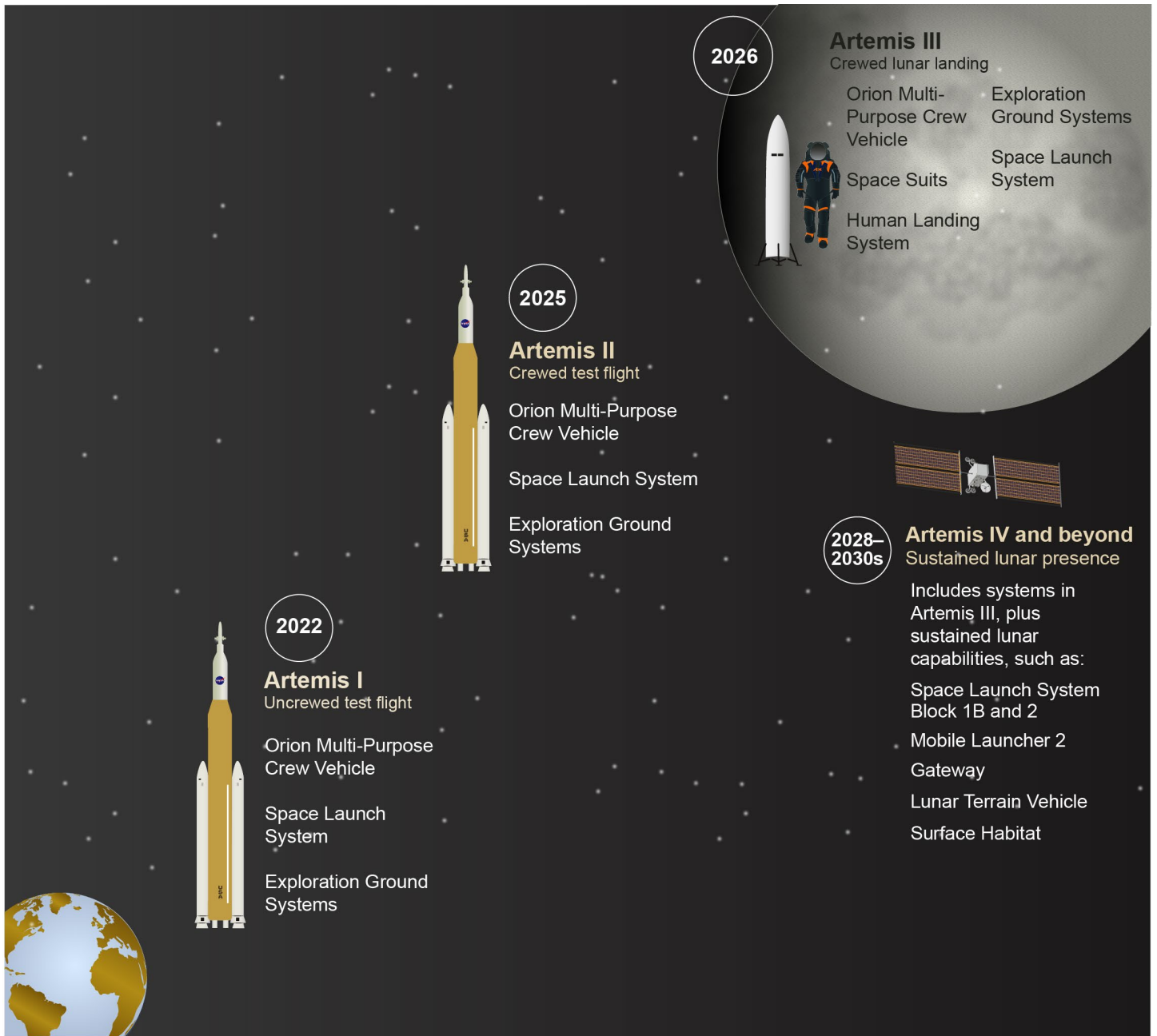
- The Artemis IV and later missions plan to focus on establishing a sustainable lunar presence. For example, NASA is developing a lunar orbiting outpost—called the Gateway—as a habitat and safe work environment for astronauts. NASA also plans to use the SLS Block 1B and Mobile Launcher 2, which will provide additional capability in these later missions.
- NASA stated that later missions on and around the moon will help prepare for the types of mission durations and operations it will experience on human missions to Mars.<sup>4</sup>

See figure 1 for the programs needed to accomplish the Artemis missions.

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<sup>4</sup>NASA, *Artemis Plan: NASA's Lunar Exploration Program Overview* (September 2020).

**Figure 1: Key NASA Programs Supporting Artemis Missions**



Source: GAO presentation of NASA documentation. | GAO-24-107249

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## NASA Public-Private Partnerships

NASA has expanded its effort to contract with commercial companies, especially for its human spaceflight efforts. For example, NASA established the Commercial Crew and Cargo Program Office in 2005 to encourage the growth of the private spaceflight sector in the U.S. According to NASA, the public-private partnerships established by this program office represented a new way of doing business in the realm of human spaceflight.

NASA has continued to build on this experience to support the Artemis missions to return humans to the lunar surface. For example:

- The HLS program is using commercial partnerships to develop and jointly deploy a landing system to transport humans to and from the lunar surface. NASA expects that its commercial partners will heavily leverage NASA technology and expertise throughout the development process, leading to a lunar transportation system that will deliver humans to the lunar surface. NASA also expects that its commercial partners will develop and demonstrate a more sustainable HLS for subsequent crewed missions. In July 2021, NASA exercised a \$2.9 billion option on its contract with SpaceX to provide crew access to the lunar surface and demonstrate initial capabilities for deep space missions.<sup>5</sup>
- NASA's Extravehicular Activity (EVA) Development project, which oversees space suit development, is also using commercial partnerships to develop a modernized space suit and associated hardware for lunar surface exploration. In May 2022, NASA awarded firm-fixed-price indefinite delivery, indefinite quantity contracts to Axiom Space and Collins Aerospace. These companies are to provide safe and reliable commercial extra-vehicular activities in microgravity and partial gravity environments on the International Space Station and the lunar surface for Artemis missions.<sup>6</sup> In September 2022,

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<sup>5</sup>NASA first awarded the HLS contract to three providers in May 2020. In April 2021, NASA announced the selection of SpaceX for the award of the contract to develop the Artemis III human landing system. After the award, Blue Origin and Dynetics filed bid protests with GAO, which GAO denied in July 2021. GAO, *Blue Origin Federation, LLC; Dynetics, Inc.-A Leidos Company*, B-419783; B-419783.2; B-419783.3; B-419783.4, July 30, 2021, 2021 ¶ CPD 265 (Washington, D.C.: July 30, 2021). Subsequently, in August 2021, Blue Origin filed a complaint with the U.S. Federal Court of Claims. The court dismissed this complaint in November 2021. *Blue Origin Fed. LLC v. United States*, Fed. Cl., No. 21-1695C (Nov. 4, 2021).

<sup>6</sup>An indefinite delivery, indefinite quantity contract provides for an indefinite quantity, within stated limits, of supplies or services during a fixed period. The government places orders for individual requirements. FAR 16.504(a).

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## NASA Continues to Make Progress Demonstrating Capabilities Needed for the Lunar Landing Mission

NASA issued a \$229 million order under Axiom's contract for the development and demonstration of a suit for lunar surface activities. Axiom is required to provide space suits that will allow crew to successfully perform exploration and science missions on the lunar surface during the Artemis III mission.

Since we reported on the status of the Artemis missions and programs in March 2022, NASA has demonstrated a number of initial capabilities needed to support the lunar landing mission.<sup>7</sup> Examples of key events include the following:

- **Artemis I** successfully launched on November 16, 2022, with the Orion capsule safely returning to Earth on December 11, 2022. SLS and EGS demonstrated their initial capabilities during this first test flight.
- **Artemis II** integration and testing with the Orion crew capsule is ongoing. In October 2023, NASA joined together the Orion crew module and service module. Now that the crew and service modules are integrated, the team will power up the combined crew and service module for the first time. After power on tests are complete, Orion will begin altitude chamber testing, which will put the spacecraft through conditions as close as possible to the environment it will experience in the vacuum of deep space.

NASA plans to conduct several key integration and test events, for example, ground system testing of the new launch pad systems. Teams will conduct a variety of tests and continue ground systems upgrades. These preparations include testing the pad's emergency egress system. After testing at the pad is complete, the mobile launcher will travel to the Vehicle Assembly Building in preparation for rocket stacking operations ahead of launching Artemis II.

- NASA continues to make progress on its integration and risk management plans for the **Artemis III** mission. In September 2022, we found that NASA had established several mechanisms for identifying and tracking Artemis III risks—including a risk database, scorecard, and cross-program risk reviews—and had begun implementing them.<sup>8</sup>

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<sup>7</sup>GAO, *NASA Lunar Programs: Moon Landing Plans Are Advancing but Challenges Remain*, [GAO-22-105533](#) (Washington, D.C.: Mar. 1, 2022).

<sup>8</sup>[GAO-22-105323](#).



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Further, in November 2023, we found that NASA had made progress completing several important milestones with contractors to develop the HLS and space suits needed to support the Artemis III mission.<sup>9</sup>

- NASA and SpaceX completed several important milestones and made progress in designing and testing components of the HLS Starship. SpaceX is currently developing a commercial Starship vehicle to transport humans and cargo to low-Earth orbit, the moon, and Mars. The HLS Starship system consists of the SpaceX Super Heavy booster (launch vehicle) and HLS Starship (the vehicle that provides crew access to the lunar surface). SpaceX is also developing a propellant tanker and on-orbit propellant depot for its lunar landing mission concept.

Additionally, SpaceX conducted launches of its commercial Starship in April and November 2023. The two test flights provided SpaceX with early in-flight data on the engines, vehicle tanks, and primary structures, among other things. These test flights are important steps towards eventually testing the lander's propellant transfer capabilities in space. We found that these were key development tests for achieving the planned crewed landing.

- Axiom made progress in developing the space suits by completing several milestones, including the mission concept review in December 2022 and the Certification Baseline Review in March 2023. To deliver and demonstrate lunar surface space suits and associated systems, Axiom is leveraging many aspects of NASA's previously developed design. According to Axiom representatives, they entered preliminary design review in September 2023 and completed the crew capability assessment.

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## NASA Faces Challenges Related to Artemis Schedule, Cost, and Acquisition Management

While NASA continues to develop capabilities needed to support its Artemis efforts, the agency faces several challenges. These include an ambitious Artemis III schedule, a lack of transparency into Artemis mission and program costs, and other acquisition management challenges.

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<sup>9</sup>[GAO-24-106256](#).

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## Updated Artemis III Mission Time Frames Acknowledge Remaining Work

In January 2024, NASA announced new mission dates. It shifted Artemis II from the most recent estimate of November 2024 to September 2025 and Artemis III from the most recent estimate of December 2025 to September 2026. NASA officials stated that this shift will allow additional time to complete testing and remaining technical work. The revised NASA estimates show a 2-year delay from the original launch dates for the Artemis II and Artemis III missions. Table 1 depicts the changes to the planned mission dates.

**Table 1: Original and Planned Dates for First Three Artemis Missions as of January 2024**

Artemis mission	Originally planned launch date	Current planned launch date
Artemis I	November 2018	Successfully launched November 2022
Artemis II	April 2023	September 2025
Artemis III	September 2024	September 2026

Source: GAO analysis of NASA documentation. | GAO-24-107249

In our November 2023 report, we found that a variety of factors made the previous December 2025 lunar landing date unlikely.<sup>10</sup> These factors included an ambitious schedule, delays to key events, and remaining technical work. Specifically, we found that, if the HLS development takes as many months as NASA major projects do on average, the Artemis III mission would likely occur in January 2027. Our analysis found that past NASA projects that have launched since 2010 took 92 months from project start to launch, while NASA’s planned development time for the HLS was 79 months. Additionally, we found that the HLS program and SpaceX had delayed eight out of 13 key events by between 6 and 13 months. According to NASA, the updated mission time frames will allow SpaceX and Axiom additional time for testing and refinements ahead of the Artemis III mission.

The HLS and Extravehicular Activity and Human Surface Mobility programs will need to complete a significant amount of complex technical work to achieve the planned September 2026 lunar landing goal. For example, SpaceX has remaining development work on both the Raptor engine and on-orbit propellant transfer technology to mature them. Likewise, Axiom has significant work to complete, including maturing critical technologies for the space suit life support system, procuring suit

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<sup>10</sup>[GAO-24-106256](#).

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components that are susceptible to supply chain delays, and qualifying the suit for flight.

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## Mission and Program Costs Are Not Transparent

To date, NASA has not yet prepared an estimate of how much the Artemis III mission—or subsequent Artemis missions—are likely to cost. Similarly, it does not plan to measure the production costs for the SLS rockets that constitute a significant proportion of future Artemis-related costs. As such, decisionmakers will have limited information available to help inform decisions on the overall lunar investment.

- **Artemis III mission costs.** In December 2019, we found that NASA estimated that Artemis III may cost between \$20 billion and \$30 billion, but the agency did not plan to establish an official cost estimate.<sup>11</sup> At that time, we recommended that it do so. NASA agreed with the recommendation and indicated it would provide a preliminary cost estimate for the Artemis III mission by the end of calendar year 2020. NASA did not do so at that time. Subsequently, in February 2023, NASA officials stated that they are developing a methodology to provide Congress with an assessment of costs for each Artemis mission. NASA officials stated that the mission estimates will include the cost of hardware production, integration costs, and operations costs, but did they not provide a time frame for when this would be completed. Implementing our previous recommendations to develop a life-cycle cost estimate for the Artemis III mission as a whole will enable NASA to effectively monitor total mission costs and give Congress valuable insight into mission affordability when making decisions about each year’s budget.
- **SLS production costs.** In September 2023, we found that NASA does not plan to measure production costs for the SLS program.<sup>12</sup> Since SLS’s first launch for Artemis I in November 2022, NASA plans to spend billions of dollars to continue producing multiple SLS components—such as core stages and rocket engines—needed for future Artemis missions. These ongoing production costs are not captured in a cost baseline, which limits transparency and efforts to monitor the program’s long-term affordability. This is important because the production and other costs for the SLS program account for more than one-third of NASA’s budget request for programs required to return to the moon. For example, in the President’s budget

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<sup>11</sup>GAO, *NASA Lunar Programs: Opportunities Exist to Strengthen Analyses and Plans for Moon Landing*, [GAO-20-68](#) (Washington, D.C.: Dec. 19, 2019).

<sup>12</sup>GAO, *Space Launch System: Cost Transparency Needed to Monitor Program Affordability*, [GAO-23-105609](#) (Washington, D.C.: Sep 7, 2023).

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submission for fiscal year 2024, NASA requested \$6.8 billion for the five programs that will be required for Artemis III. The SLS program accounted for about \$2.5 billion, or 37 percent of that request. Implementing our prior recommendations to establish cost and schedule baselines that capture these ongoing, recurring production costs could improve transparency into the program.

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## Acquisition Management Challenges

NASA has made improvements to its acquisition management policies and practices—a long-standing challenge at NASA—in recent years. However, it still faces challenges in its ability to manage its costliest and most complex programs, such as those that are critical to support the Artemis missions. Several of the key improvements we have reported on since March 2022 include the following examples:

- In our June 2022 report, we found that the agency institutionalized some strategic, senior-level reviews to understand and address the ongoing risks that its portfolio may face.<sup>13</sup> For example, the agency holds monthly reviews chaired by the NASA Associate Administrator to discuss issues requiring leadership awareness and identify solutions to challenges as they arise. NASA officials told us that senior management periodically assesses mission directorate portfolios, focusing on Category 1 and other highly visible programs and projects during these meetings.<sup>14</sup>
- In August 2022, NASA updated its corrective action plan as part of its efforts to address recent programmatic performance and its inclusion in our biennial High-Risk Report.<sup>15</sup> The plan describes a number of actions the agency intends to take to improve acquisition and program management.
- In our April 2023 High-Risk Update, we found that NASA completed several initiatives to strengthen its cost and schedule estimating capacity and is embracing tools to support better management practices.<sup>16</sup> We noted, however, that NASA will need to identify ways

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<sup>13</sup>GAO, NASA: Assessments of Major Projects, [GAO-22-105212 \(Washington, D.C.: June 23, 2022\)](#).

<sup>14</sup>Projects designated as Category 1 are NASA's highest priority projects and generally have life-cycle costs over \$2 billion.

<sup>15</sup>[GAO-23-106203](#).

<sup>16</sup>[GAO-23-106203](#).

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to improve its management of Category 1 projects to continue reducing acquisition risk and demonstrating progress.

These Category 1 projects drive cumulative cost performance for the entire portfolio when they overrun their baselines. In our 2023 assessment of major NASA projects, we found that NASA anticipated setting baselines for six Artemis programs.<sup>17</sup> As these projects enter the portfolio, they will drive the agency's acquisition performance over the next several years. NASA senior leaders said that recent efforts intended to help control project cost and schedule growth include having projects (1) document when they deviate from the agency's policy for establishing cost and schedule baselines and (2) develop plans to remove work if cost growth or schedule delays occur. These officials said they plan to explore additional ways to control project costs and schedules, specifically for Category 1 projects.

In summary, NASA has made important progress on its Artemis efforts, but completing the lunar landing mission remains challenging. NASA needs to continue to find ways to better manage the cost of its most complex programs. Further, NASA has not yet determined how much Artemis III and future Artemis missions are likely to cost, limiting critical information needed by decision-makers about the lunar mission. Implementing our past recommendations will help NASA to improve in these critical areas.

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Chairman Babin, Ranking Member Sorensen, and Members of the Subcommittee, this completes my prepared statement. I would be pleased to respond to any questions that you may have at this time.

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## GAO Contact and Staff Acknowledgments

If you or your staff have any questions about this testimony, please contact William Russell, Director, CNSA at (202) 512-4841 or [russellw@gao.gov](mailto:russellw@gao.gov). Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this statement.

GAO staff who made key contributions to this testimony are Kristin Van Wychen (Assistant Director); Erin Roosa (Analyst-in-Charge); John Armstrong; Breanne Cave; Edward Harmon; Tonya Humiston; Erin

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<sup>17</sup>GAO, *NASA: Assessments of Major Projects*, [GAO-23-106021](#) (Washington, D.C.: May 31, 2023).

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Kennedy; John Ortiz; Sylvia Schatz; Kate Sharkey; Juli Steinhouse; Kevin Walsh; Alyssa Weir; and Tonya Woodbury.

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