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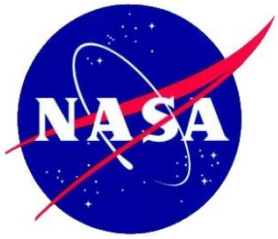
IG-21-018

Artemis Status Update



Office of Inspector General

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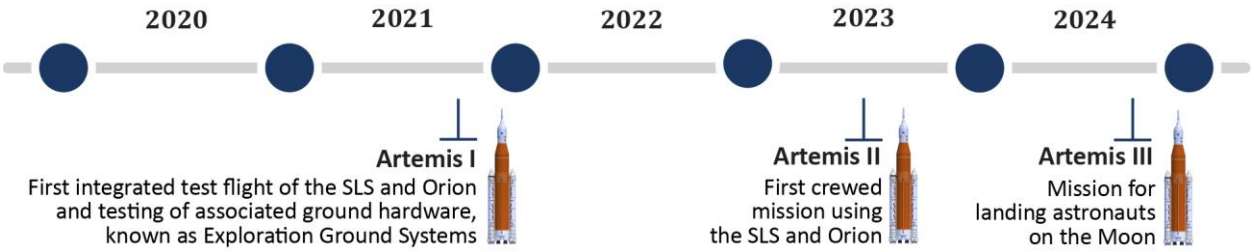
INTRODUCTION

NASA's current plans for the first three missions of its Artemis program include exploration missions to orbit the Moon in 2021 (uncrewed) and 2023 (crewed) using the Space Launch System (SLS) rocket and Orion Multi-Purpose Crew Vehicle (Orion), culminating in a mission landing astronauts on the surface of the Moon in late 2024 (see Figure 1). With total costs for Artemis missions through fiscal year (FY) 2025 projected to reach $86 billion, NASA's development of a deep-space human exploration capability to reach the Moon as a precursor to Mars is the Agency's most ambitious and costliest ongoing activity.

Figure 1: Artemis Missions Through Planned Moon Landing



Source: NASA Office of Inspector General (OIG) presentation of Agency information.

While NASA had been working for the past decade to return astronauts to the Moon, in March 2019 the White House directed the Agency to accelerate its timetable by approximately 4 years in order to land on the Moon by the end of 2024. Although the new Administration has expressed support of the Artemis program, it has not spoken in any detail about its human exploration plans or its intent to maintain the goal of a 2024 lunar landing.

As NASA moves forward, it will be critical for the Agency to address a number of challenges to successfully meet Artemis-related mission and program milestones.[1] This includes providing transparent reporting and calculation of program costs, realistic schedules, and clearly defined system requirements; solidifying international partnerships; and balancing the use of commercial space capabilities with traditional acquisition approaches. Over the past decade, our oversight work has found that NASA consistently struggles to address these significant issues, each of which will likely be further exacerbated by the current timetable for Artemis missions I through III. Adding to these issues in the near term are the challenges associated with the coronavirus disease 2019 (COVID-19) pandemic, a change in presidential administration, and FY 2021 funding for the Human Landing System (HLS) ($850 million) that was approximately 75 percent less than requested in the FY 2021 President's budget request ($3.4 billion).

This report provides a status update on the Agency's progress on achieving milestones for the major programs that support Artemis. This high-level synopsis largely draws from and updates our recent audit work on the Artemis program. Although we make no formal recommendations in this report, we continue to monitor the Agency's efforts towards achieving a lunar landing and its follow-on plans

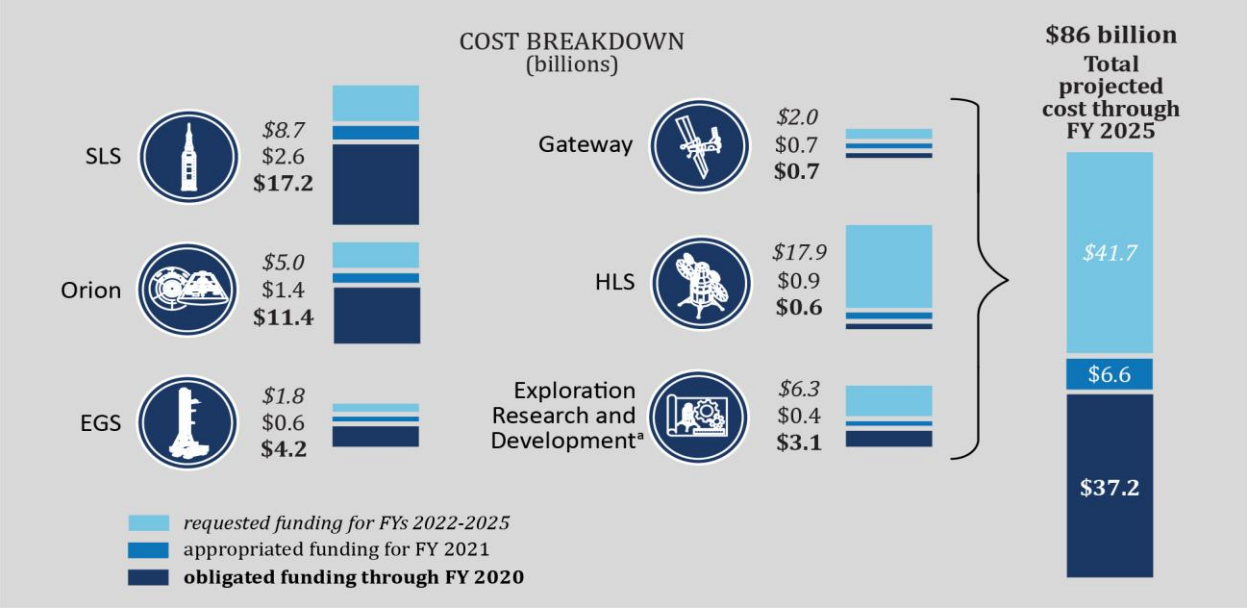
[1] NASA, *Artemis Plan: NASA's Lunar Exploration Program Overview* (September 2020) describes the Agency's Moon to Mars exploration approach.

to send a crewed mission to Mars in the 2030s. See Appendix B for a summary of open recommendations made in our previous reviews of the major programs that support Artemis.

Background

NASA's Human Exploration and Operations Mission Directorate (HEOMD) manages the activities of the two organizations responsible for developing Artemis systems: Exploration Systems Development (ESD) is responsible for SLS, Orion, Exploration Ground Systems (EGS), and the Artemis I and II missions; and Advanced Exploration Systems (AES) is in charge of the Gateway and HLS programs, other exploration research and development offices, and Artemis III and additional Artemis missions. In 2020, the Agency further clarified its lunar ambitions with publication of the Artemis Plan and established—and is continuing to stand up—a Systems Engineering and Integration Office at the HEOMD-level to define requirements and exploration architectures to integrate systems and activities across the mission directorate.[2] In total, NASA has spent $37.2 billion to date on Artemis-related program activities. Figure 2 presents a cost breakdown for NASA's Artemis missions by program.[3]

Figure 2: Artemis Mission Programs (as of March 2021)



Source: NASA OIG presentation of Agency data.

Amounts are rounded. Total overall funding may not equal the sum of the rounded amounts.

[a] Exploration research and development fund other areas such as development of exploration and lunar systems and human research programs.

[2] NASA's Artemis Plan outlines the programs and plans for its Artemis missions—aimed at setting a sustainable course to the Moon, landing humans on the Moon in 2024, and extending lunar missions and preparing for Mars. NASA HEOMD's Systems Engineering and Integration Office is responsible for translating the Agency's human space exploration vision into an integrated portfolio by defining actionable program objectives and requirements for HEOMD organizations to implement.

[3] The program calculations include HEOMD costs only (beginning in FY 2012) and do not include Artemis-related projects under NASA's Science Mission Directorate such as the Lunar Discovery and Exploration Program that manages lunar surface payload deliveries, develops technology for lunar science, and conducts lunar mapping in support of the Artemis missions. Science Mission Directorate costs related to Artemis are being examined in our ongoing audit project A-20-008-01 on NASA's Artemis missions.

ARTEMIS ELEMENTS ENTERING CRITICAL PHASE

As the Agency works toward meeting an Artemis I launch date of November 2021, NASA must address a series of critical issues with Artemis hardware and software components as they prepare the disparate systems for integration. Successfully addressing these outstanding issues while ensuring adequate cost control and schedule margin will be critical to the success of the Artemis program over its next phase of development and integration.

Second Green Run Hot Fire Test of SLS Completed

The SLS is being built to meet the Agency's long-term human exploration goal of landing humans on Mars.[4] The first three Artemis missions will use the SLS's Block 1 configuration consisting of a core stage with four RS-25 engines, two solid rocket boosters, and the upper stage including an Interim Cryogenic Propulsion Stage (ICPS).[5] For Artemis IV and beyond, NASA plans to use SLS's Block 1B configuration, which swaps out the ICPS and replaces it with a more powerful Exploration Upper Stage (EUS) consisting of larger fuel tanks and four RL-10 engines. By the end of FY 2020, NASA had spent more than $17 billion on the SLS—NASA's "critical path" for the Artemis missions—and is projected to spend an additional $11.3 billion through FY 2025.[6]

As we previously reported, each of the major contracts for developing the SLS for Artemis I has experienced technical challenges, performance issues, and requirement changes that have resulted in $2 billion of overall cost increases and at least 2 years of schedule delays.[7] After months of preparation and delays, in January 2021 NASA performed the hot fire test—the last of its Green Run tests—on the SLS core stage's four RS-25 engines to ensure the rocket was ready for the first Artemis mission.[8] However, NASA's testing software prematurely ended the planned 8-minute test after 67 seconds to reduce the risk of damaging the core stage. A "redo" of the hot fire test planned for late February 2021 was postponed to address an issue with a valve supplying liquid oxygen to one of the RS-25 engines. In March 2021 the Agency conducted the second hot fire test and in April 2021 completed its analysis of over 8 minutes' worth of data and found all primary test objectives were met. The SLS core stage is now being prepared for transport to Kennedy Space Center (Kennedy) in Florida.

Delays in completing a successful hot fire test places further pressure on NASA's planned schedule to launch Artemis I in 2021 because EGS's integration of the SLS, Orion, and associated ground hardware

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[4] Congress directed NASA to use the SLS rocket through the National Aeronautics and Space Administration Authorization Act of 2010, Pub. L. No. 111-267, 124 Stat. 2805 (2010).

[5] The ICPS will serve as the second stage for the first three Artemis launches. Based upon a similar design used on the Delta IV Heavy rocket, the ICPS is a liquid-oxygen and liquid-hydrogen system with a single RL-10 engine.

[6] FY 2025 figure based on the FY 2021 President's budget request. The critical path refers to the sequential path of tasks in a network schedule that represents the longest overall duration from "time now" or presently through project completion. Any slippage of the tasks in the critical path will increase the project's duration.

[7] NASA OIG, *NASA's Management of Space Launch System Program Costs and Contracts* (IG-20-012, March 10, 2020).

[8] The Green Run is a series of eight tests on the core stage flight hardware for the SLS, with the hot fire test ending the series. These tests verify the stage is ready for the first and future Artemis missions.

takes approximately 10 months from delivery of the SLS core stage to Kennedy from its testing site at Stennis Space Center in Mississippi. Moreover, delays to the Artemis I launch will impact the schedule for future Artemis missions.[9] At the same time, the COVID-19 pandemic has challenged the timetable for Artemis II, reducing schedule margins for manufacturing the SLS core stage and Launch Vehicle Stage Adapter by an estimated 3 months and increasing projected development costs by $363 million as of the end of FY 2020.[10] For Artemis III, although the definitization of NASA's contract with The Boeing Company—scheduled for March 2021—has still not been completed, core manufacturing is ongoing.[11]

Despite these delays, the SLS has continued to make progress. In December 2020, NASA completed its Critical Design Review for the EUS.[12] In addition, the Europa Clipper mission was initially set to launch in 2023 using an SLS, potentially causing schedule delays for Artemis missions due to the lack of available SLS vehicles. However, NASA is exploring flexibilities provided in the Agency's FY 2021 appropriations to solicit for a commercial launch vehicle for the Clipper, a result that would ensure a more stable manifest for future Artemis missions.[13] To learn more about the NASA Office of Inspector General's (OIG) audit work of the SLS Program, see NASA's Management of the Space Launch System Stages Contract and NASA's Management of Space Launch System Program Costs and Contracts.

Orion Elements in Final Integration and Testing at Launch Site

Orion serves as NASA's exploration vehicle for the Artemis missions to carry crew beyond low Earth orbit; sustain and support up to four astronauts during in-space operations; and provide reentry, descent, and landing back to Earth. Orion is composed of the Launch Abort System, Crew Module, Service Module, and the Spacecraft Adapter connecting Orion to the SLS.

In January 2021, Orion was transferred to the EGS Program for integration with the SLS and associated ground equipment at Kennedy. Six months earlier, we reported that the Orion Program has experienced over $900 million in cost growth through 2019, a figure expected to rise to at least $1.4 billion through 2023.[14] In the same timeframe, the Program's schedule for Artemis I slipped 3 years while the schedule for Artemis II slipped 2 years with additional delays likely as Orion completes development efforts for

[9] Government Accountability Office, *NASA Human Space Exploration: Significant Investments in Future Capabilities Require Strengthened Management Oversigh*t (GAO-21-105, December 15, 2020), and NASA program documentation. The Agency requires 20 months to complete launch preparation activities between the first and second Artemis missions.

[10] Impacts from COVID-19 increased cost projections for FY 2020 by $8 million and by $355 million in future years.

[11] To "definitize" a contract is to write the specific requirements of a program or project into the contract. NASA policy generally requires definitization of contracts within 6 months of an undefinitized contract action.

[12] Critical Design Review is the life-cycle review in which the decision authority evaluates the integrity of the project's design and its ability to meet mission requirements with appropriate cost and schedule margins and acceptable risk within defined project constraints, including available resources. This review also determines if the design is appropriately mature to continue into the final design and fabrication phase.

[13] The Europa Clipper is an orbiter mission to study the habitability of Europa, one of Jupiter's moons. We previously reported to Congress that risks to the Europa mission and Artemis program could be reduced by removing the requirement for Europa to use the SLS. NASA OIG, letter to Congress, *Follow-up to May 2019 Audit of Europa Mission: Congressional Launch Vehicle Mandate* (August 27, 2019).

[14] NASA OIG, *NASA's Management of the Orion Multi-Purpose Crew Vehicle Program* (IG-20-018, July 16, 2020). The Orion Program excluded $17.5 billion in its Agency Baseline Commitment (ABC) costs from FY 2006 to FY 2030, significantly limiting visibility into how the Program has spent or plans to spend its money. The ABC is the cost and schedule baselines committed to Congress against which a program is measured.

these missions. The Service Module that the European Space Agency is developing for the Artemis II mission currently reflects a "no-margin" schedule with a delivery date of early July 2021. Like the SLS, the Orion Program has also been challenged by the COVID-19 pandemic, resulting in at least 3 months of schedule delay and $146 million in projected cost increases as of the end of FY 2020.[15]

In November 2020, during final assembly of the Orion for Artemis I, engineers identified an issue with a redundant component on one of the spacecraft's Power and Data Unit (PDU) communications cards located in the Crew Module Adapter (CMA).[16] Given the limited accessibility to this PDU, NASA determined that disassembling the CMA to remove and address the faulty component would put the spacecraft at higher risk of damage than not addressing the issue. Since removing the faulty redundant component would also result in added delays to Orion's readiness for the Artemis I launch, NASA accepted the risk and proceeded into integration without replacing the component. NASA officials report this issue did not result in additional schedule delays for integrating Orion with the SLS and associated ground equipment. To learn more about NASA OIG's audit work examining the Orion Program, see NASA's Management of the Orion Multi-Purpose Crew Vehicle Program.

EGS Integrating Key Hardware, Software, and Ground Systems Elements of the Artemis Program

EGS develops and operates the systems and facilities—such as the mobile launchers and Vehicle Assembly Building—needed to process, integrate, and launch rockets and spacecraft.[17] As noted above, the EGS Program received Orion for processing in January 2021, and as of March 2021, completed assembly of the SLS's two booster rockets and continued to integrate them onto NASA's mobile launcher (ML-1) within the Vehicle Assembly Building for the Artemis I mission launch. While the EGS Program has begun to integrate SLS boosters onto ML-1, modifications to the mobile launcher to accommodate the SLS for Artemis I and II have cost $693 million through January 2020 —$308 million over budget—and the Program is running more than 3 years behind schedule.[18] Looking ahead, ML-1 faces a risk of further cost increases and schedule slippage as it completes testing for Artemis I and undergoes modifications for Artemis II. ESD officials stated Artemis I testing is near completion and any remaining cost and schedule growth related to testing will be minimal. However, the Agency identified cost and schedule risks associated with the plans to modify the ML-1 to support crewed missions starting with Artemis II.

NASA currently plans to utilize ML-1 to launch the first three Artemis missions. The Agency is also developing a second mobile launcher (ML-2) for future, larger variants of the SLS. In March 2020, we reported that while the Agency has taken positive steps to address lessons learned from its project modifying ML-1 to accommodate the SLS, NASA is missing opportunities to improve project management and oversight of its $486 million ML-2 project.[19]

[15] Impacts from COVID-19 increased cost projections for FY 2020 by $5 million and by $141 million for future spending.

[16] PDUs help provide communication between Orion's flight computers and its components.

[17] The mobile launcher is the ground structure that will be used to assemble, process, and launch the combined SLS/Orion spacecraft from Launch Pad 39B at Kennedy.

[18] NASA OIG, Audit of NASA's Development of Its Mobile Launchers (IG-20-013, March 17, 2020).

[19] IG-20-013.

We previously reported challenges with two software systems—Spaceport Command and Control System (SCCS) and Ground and Flight Application Software (GFAS)—supporting ground systems for the Artemis program.[20] In April 2021, SCCS completed its Design Certification Review and is now certified for Artemis I.[21] With the completion of SLS's Green Run testing, GFAS program officials are better positioned to finish verification and validation activities. To learn more about NASA OIG's audit work of the EGS Program, see Audit of the Spaceport Command and Control System, Audit of NASA's Development of Its Mobile Launchers, and NASA's Development of Ground and Flight Application Software for the Artemis Program.

Gateway Program Finalizing Critical Requirements, Contracts, and Agreements

Gateway is a planned outpost or small space station that will orbit the Moon to facilitate a sustainable, long-term human cislunar and lunar surface presence as well as a staging point for deep space exploration.[22] Initial Gateway elements consist of the Power and Propulsion Element (PPE) and the Habitation and Logistics Outpost (HALO), which provides a docking location for Orion, living and working spaces for crewmembers staying less than 30 days, and logistics capabilities. For the Artemis III mission, the Agency allowed HLS contractors the choice to dock with Gateway or directly to Orion for the first lunar landing. NASA officials said subsequent Artemis missions will dock with Gateway.

In 2019, NASA selected Maxar Technologies and Northrop Grumman to develop the PPE and HALO, respectively. PPE is on a firm-fixed-price contract, and NASA expects to definitize the remainder of HALO's current cost-plus-incentive fee contract no later than June 2021.[23] At the time of our November 2020 report, the Gateway program faced challenges related to the PPE's propulsion system development, vehicle weight, and mass levels, as well as defining requirements for the HALO component to avoid schedule delays and cost increases.[24] In January 2021, the program reported no schedule margin for a January 2024 launch with the PPE component facing the same challenges reported in November 2020.[25] Combined with issues in HALO's thermal control systems, as of March 2021 the program faces up to 12 months of schedule risk.

[20] SCCS is the command and control system that interfaces with the launch vehicle, spacecraft, and ground support equipment such as pumps, motors, and valves, in support of processing and launch. GFAS are the applications and displays that run on top of the SCCS architecture and are used to perform operations such as processing and launch. GFAS provides software for control and monitoring of launch vehicle and spacecraft for use during processing, testing, checkout, countdown, and launch.

[21] The Design Certification Review evaluates engineering documentation to ensure that the system has been verified to meet all program requirements, validated to meet all stakeholder expectations, and that traceability exists to the evidence supporting certification.

[22] Cislunar generally refers to the space between Earth and the Moon. Cislunar space includes low Earth orbit, medium Earth orbit, geosynchronous Earth orbit, and other orbits, such as low lunar orbit and near-rectilinear halo orbit, the intended orbit for the Gateway.

[23] A firm-fixed-price contract provides a set price that does not change even if the contractor's costs increase during performance. A cost-plus-incentive-fee contract is a cost-reimbursement contract that provides for an adjusted fee based on whether the contractor is meeting certain cost, performance, or schedule metrics.

[24] NASA OIG, *NASA's Management of the Gateway Program for Artemis Missions* (IG-21-004, November 10, 2020).

[25] IG-21-004.

To reduce costs and mitigate the risks associated with a rendezvous in orbit, NASA decided in 2020 to launch the PPE and HALO together in 2024 rather than on separate rockets and integrating the two elements once in orbit. As we reported in November 2020, the Agency suggested that an integration on the ground and a co-manifested launch of the PPE and HALO would also result in time savings. However, the requirements changes resulting from co-manifesting the PPE and HALO launches are not certain to result in the Agency's suggested savings and instead have led to schedule delays.[26] In February 2021, NASA selected Space Exploration Technologies Corp (SpaceX) to launch the PPE and HALO no earlier than May 2024 aboard a Falcon Heavy rocket. The total cost of the launch to NASA is $331.8 million, including the launch service and other mission-related costs.

In addition to NASA contracts for Gateway, international partners will provide important contributions to the lunar outpost including advanced external robotics, additional habitation, and refueling capability. In October 2020, the European Space Agency agreed to contribute habitation and refueling modules and enhanced lunar communications; in November 2020, the Canadian Space Agency agreed to contribute external robotics; and in December 2020, Japan Aerospace Exploration Agency agreed to partner with NASA to provide Gateway's International Habitation module with an environmental control and life support system, batteries, thermal control, and imagery components. We plan to review NASA's international partnerships in future audits. To learn more about NASA OIG's audit work of the Gateway program, see NASA's Management of the Gateway Program for Artemis Missions.

HLS Moving from Initial Design to Development on a Budget Approximately One-Quarter of NASA's Request

The HLS Program will design and develop the lunar lander to ferry astronauts from either the orbiting Orion or Gateway to the Moon's surface. In April 2020, NASA selected three companies to begin designing and early development on the HLS.[27] While the Agency requested over $3 billion in its FY 2021 budget to accelerate the program's development, Congress provided $850 million or approximately 25 percent of the amount requested.

NASA's plan was to "downselect" from three contractors to one or two to begin the HLS development phase with award of a development contract in April 2021. According to NASA officials, the wide gulf in funding between what the program requested and what it received in FY 2021 jeopardized the Agency's plan to select two contractors to build the HLS. At the time, officials expressed concern that selecting a single contractor would result in a lack of redundancy and potenially higher, less sustainable future HLS costs due to a lack of competition. Nevertheless, on April 16, 2021, NASA announced award of a $2.9 billion contract to SpaceX for the HLS. Despite selecting a single contractor, the reduction in funding will likely slow HLS development and extend its schedule. Given the lunar lander's central role, any development delays could jeopardize NASA's plans to land astronauts on the Moon in 2024 or the foreseeable future.

[26] IG-21-004.

[27] The selected contractors were Blue Origin, Dynetics Incorporated, and SpaceX.

CONCLUSION

NASA has made significant progress with the Artemis missions including stacking the SLS solid rocket boosters onto the mobile launcher, delivering Orion to Kennedy for final integration, and stabilizing future launch manifests. In addition, in September 2020 the Agency issued its Artemis Plan outlining the programs and plans for its Artemis missions—aimed at setting a sustainable course to the Moon, landing humans on the Moon in 2024, and extending lunar missions and preparing for Mars. HEOMD is also continuing to stand up a Systems Engineering and Integration Office intended to translate the Agency's human spaceflight vision into implementable architectures, provide actionable program requirements for HEOMD organizations, and clarify responsibilities between ESD and AES for Artemis I through III and subsequent missions. To the Agency's credit, much of this work occurred amidst Center closures, supply chain disruptions, and other challenges associated with the COVID-19 pandemic.

Nonetheless, the Agency faces significant challenges that we believe will make its current plan to launch Artemis I in 2021 and ultimately land astronauts on the Moon by the end of 2024 highly unlikely. Following delivery of the core stage to Kennedy, NASA will shift its focus to its first-time integration of the SLS, Orion, and EGS systems for the Artemis I launch. Integration and final systems testing is a complex and time-consuming process that often discovers issues in need of costly rework. Given all of these factors, a planned 2021 Artemis I launch is in jeopardy of slipping to 2022, a delay that would cascade and push back the launch of Artemis II into at least the third quarter of 2023, ultimately impacting the launch date for Artemis III. The Artemis program also faces challenges integrating and launching the PPE and HALO, the first Gateway components. With respect to development of the critical human landing system, NASA received only about 25 percent of its budget request for the HLS Program, putting new pressure on the Agency to meet the 2024 timeline.

Although the new Administration has publicly expressed support for the Artemis missions, it has not weighed in on the Agency's current plans for a lunar landing by the end of 2024. Nonetheless, achieving any date close to this ambitious goal—and reaching Mars in the 2030s—will require strong, consistent, sustained leadership from the President, Congress, and NASA, as well as stable and timely funding.

MANAGEMENT'S COMMENTS AND OUR EVALUATION

Although we made no recommendations in this report, we provided a draft copy to NASA management. Technical comments provided by management have been incorporated as appropriate.

Major contributors to this report include Ridge Bowman, Space Operations Director; James Smith, Project Manager; Benjamin Patterson; and Lauren Suls.

If you have questions about this report or wish to comment on the quality or usefulness of this report, contact Laurence Hawkins, Audit Operations and Quality Assurance Director, at 202-358-1543 or laurence.b.hawkins@nasa.gov.

Paul K. Martin
Inspector General

APPENDIX A: SCOPE AND METHODOLOGY

For this report, we conducted a review between November 2020 and April 2021 to provide an update on the current status of the Artemis programs. We reviewed our prior oversight work from 2016 through 2020 to identify program progress and challenges (see Appendix B for a list of all open recommendations from audits of Artemis-related programs). To update our prior work, we relied on ongoing work under the Artemis missions audit (A-20-008-01) to collect information and report on updates from the relevant program offices and Agency officials. Specifically, we reviewed documentation or interviewed officials from HEOMD and the SLS, Orion, EGS, Gateway, and HLS program offices. In addition, we used NASA press releases to identify and report on current statuses and ongoing and upcoming events. We did not independently verify the information provided by the Agency and are reporting it here as provided to us.

To identify and calculate the current costs of the programs, we used financial information from NASA accounting systems, as previously identified and used in *NASA's Management of the Gateway Program for Artemis Missions* audit report (IG-21-004). The financial information used in our update is from FYs 2012 through 2020. To identify and calculate the FY 2021 appropriations amounts for each program we used the Consolidated Appropriations Act, 2021.[28] To identify and calculate the planned spending for FYs 2022 through 2025, we used the FY 2021 President's budget request, including the annual requests for each program.

[28] Consolidated Appropriations Act, 2021, Pub. L. No. 116-260 (2020).

APPENDIX B: OPEN AUDIT RECOMMENDATIONS

Below is a summary of NASA OIG open recommendations from audits reviewing Artemis programs.

Table 1: Open Artemis Program Audit Recommendations

Recommendation Number	Recommendation
***NASA's Management of the Gateway Program for Artemis Missions* (IG-21-004, November 10, 2020)**	
1	Baseline the Gateway requirements and specifications in contract modifications prior to updating and awarding the PPE and HALO fixed-price contracts.
2	Ensure PPE and HALO delivery and launch dates are realistic by including sufficient schedule margin in their development schedules.
3	Develop a HEOMD policy that establishes a reasonable amount of recommended schedule margin by phase of program or project.
4	Confirm at selection the launch system provider for the co-manifested PPE and HALO will meet spacecraft mass, length, and other requirements.
5	Work with the contractors to obtain a credit for the amount already spent on launch services under the PPE contract.
6	Take action to enforce NASA policy to definitize contracts within 6 months of award.
7	Definitize the remaining development and delivery portion of the HALO contract by PDR plus 3 months.
8	Ensure the maturity of system requirements are fully understood before selecting the acquisition method and contract type for future acquisition strategies supporting Artemis and Mars missions by describing the state of the program requirements in the acquisition strategy memorandum for each new acquisition.
***NASA's Management of the Orion Multi-Purpose Crew Vehicle Program* (IG-20-018, July 16, 2020)**	
2	To the extent practicable, adjust the production schedules for Artemis IV and V to better align with the successful demonstration of Artemis II to reduce schedule delays associated with potential rework.

Recommendation Number	Recommendation
***NASA's Management of Space Launch System Program Costs and Contracts* (IG-20-012, March 10, 2020)**	
2	Review HEOMD and NASA program management policies, procedures, and ABC reporting processes to provide greater visibility into current, future, and overall cost and schedule estimates for the SLS Program and other human space flight programs. This review shall include the following: b. Establishing methodologies and processes to track and set cost commitments for Artemis II. c. Determining reporting and tracking procedures for setting cost and schedule commitments, and monitoring progress throughout the entire life cycle of the SLS Program (through at least 2030).
5	Conduct a thorough review of each major SLS contract's scope of work and technical requirements needed to complete the period of performance to assist in eliminating incremental contract value increases to the contract and lessen contract management burden, as in the case of the Boosters contract.
***Audit of NASA's Development of Its Mobile Launchers* (IG-20-013, March 17, 2020)**	
3	Ensure life cycle and milestone reviews incorporate programmatic and technical risks and are conducted with the Associate Administrator for Human Exploration and Operations Mission Directorate and other senior Agency officials.
4	Require the ML-2 project to develop an ABC separate from the EGS Program.
***Audit of the Spaceport Command and Control System* (IG-16-015, March 28, 2016)**	
1	Commission an independent assessment to evaluate the status of the SCCS software development effort and determine the necessary steps to reduce the risk of further cost, schedule, and performance issues, including consideration of acquiring commercial command and control software to replace some or all of the system currently under development.

Source: NASA OIG.

APPENDIX C: REPORT DISTRIBUTION

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(Assignment No. A-20-008-02)