United States Government Accountability Office

Report to Congressional Committees

July 2025

NASA

Assessments of Major Projects

LUNAR EXPLORATION **ASTROPHYSICS** **PLANETARY SCIENCE** **AERONAUTICS**

GAO-25-107591

GAO Highlights

Highlights of GAO-25-107591, a report to congressional committees

July 2025

NASA

Assessments of Major Projects

Why GAO Did This Study

The National Aeronautics and Space Administration (NASA) plans to invest about $74 billion in estimated life cycle costs for its portfolio of major projects (those with costs over $250 million). House explanatory statements have included provisions for GAO to prepare status reports on these projects.

GAO assessed the (1) cost and schedule performance of NASA's major projects in development, and (2) historical cost performance of NASA's major projects included in GAO annual reviews since 2009. This report also includes summaries of NASA's 38 major projects.

GAO collected and analyzed data on the 38 current NASA major projects, visited NASA facilities, and interviewed officials. GAO analyzed cost and schedule performance for 18 projects in development with cost and schedule baselines. GAO also collected and analyzed cost data for 53 historical projects that have completed or are in the final stage of development.

What GAO Recommends

In its prior work, GAO made multiple recommendations to improve NASA's management of major projects. NASA generally agreed with these recommendations. As of June 2025, NASA had not yet fully implemented two recommendations that GAO identified as high priority to improve acquisition management.

For more information, contact William Russell at russellw@gao.gov.

What GAO Found

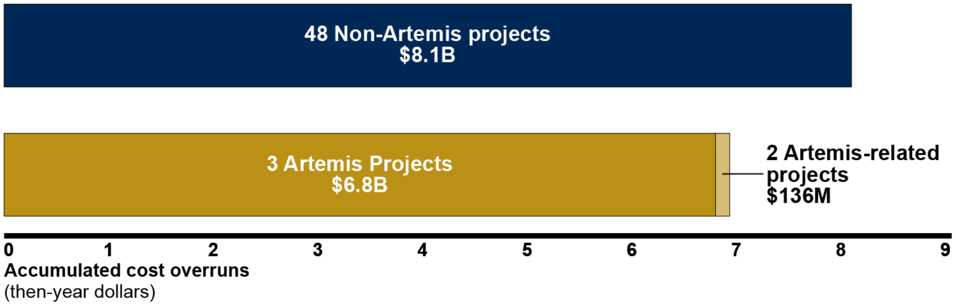
NASA major projects aim to explore the solar system, advance aeronautic technologies, and return U.S. astronauts to the lunar surface through the Artemis missions. These major projects are increasingly focused on Artemis—building a sustained human presence on the moon and ultimately traveling to Mars.

The cost and schedule performance of NASA's 18 major projects in development (those that are building and testing their designs) generally remained unchanged over the last year. The four projects that experienced annual cost growth collectively reported over $500 million in overruns. NASA's human spaceflight crew capsule, known as the Orion Multi-Purpose Crew Vehicle program, accounts for over $360 million of this total annual cost growth.

Most major NASA projects since GAO's first assessment in 2009 have avoided significant cost overruns. GAO found that of the 53 major projects that have completed development or are currently in the final phase of development, 30 remained under the statutory threshold for reporting cost overruns. Specifically, these 30 project's development costs did not exceed their baselined cost estimates by 15 percent or more. When a project's overrun rises to this threshold, NASA is required to take certain steps. For example, it must notify congressional committees of the overrun and update the project's cost or schedule plans.

At the same time, Artemis and Artemis-related cost overruns are an increasing proportion of the portfolio's overall overruns. Three Artemis projects account for nearly $7 billion of the total overruns—or almost half of the overruns collectively experienced by the 53 projects.

Accumulated Cost Overruns for 53 NASA Major Projects That Completed or Are in Final Phase of Development Since GAO's First Annual Assessment in 2009



Source: GAO analysis of NASA data. | GAO-25-107591

The growing Artemis portfolio could drive cost performance in the future, since NASA recently initiated nine new Artemis projects with estimated total costs over $20 billion. These projects are interdependent, meaning that challenges and delays in one can create challenges and delays for all of them. Further, delays to mission dates can also increase costs. As the Artemis projects progress in development, the agency has taken steps to help manage and mitigate risks, such as creating more oversight of programs through the Moon to Mars office.

United States Government Accountability Office

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Abbreviations

AEPS	Advanced Electric Propulsion System
AOS	Atmosphere Observing System
ASI	Agenzia Spaziale Italiana
BOLE	Booster Obsolescence and Life Extension
CCP	Commercial Crew Program
CCRS	Capture, Containment and Return System
CDR	critical design review
CGI	Coronagraph Instrument
COSI	Compton Spectrometer and Imager
CoDICE	Compact Dual Ion Composition Experiment
DARPA	Defense Advanced Research Projects Agency
DART	Double Asteroid Redirection Test
DAVINCI	Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging
DRACO	Demonstration Rocket for Agile Cislunar Operations
DSL	Deep Space Logistics
EGS	Exploration Ground Systems
EHP	Extravehicular Activity and Human Surface Mobility Program
EPFD	Electrified Powertrain Flight Demonstration
ERO	Earth Return Orbiter
ESA	European Space Agency
ESO	Earth System Observatory
EUS	Exploration Upper Stage
EVA	Extravehicular Activity
GE	GE Aerospace
GLAST	Gamma-ray Large Area Space Telescope
GPM	Global Precipitation Measurement Mission
GRACE-C	Gravity Recovery and Climate Experiment-Continuity
GRACE-FO	Gravity Recovery and Climate Experiment Follow-On
GRAIL	Gravity Recovery and Interior Laboratory
HALO	Habitation and Logistics Outpost

HLS	Human Landing System
ICESat-2	Ice, Cloud, and Land Elevation Satellite-2
ICON	Ionospheric Connection Explorer
IMAP	Interstellar Mapping and Acceleration Probe
ISRO	Indian Space Research Organisation
ISS	International Space Station
InSight	Interior Exploration using Seismic Investigations, Geodesy, and Heat Transport
JPL	Jet Propulsion Laboratory
JWST	James Webb Space Telescope
KDP	key decision point
LADEE	Lunar Atmosphere and Dust Environment Explorer
LBFD	Low Boom Flight Demonstrator
LCRD	Laser Communications Relay Demonstration
LDCM	Landsat Data Continuity Mission
LRO	Lunar Reconnaissance Orbiter
LTV	Lunar Terrain Vehicle
MAVEN	Mars Atmosphere and Volatile EvolutioN
MCR	mission concept review
MDR	mission definition review
ML2	Mobile Launcher 2
MMS	Magnetospheric Multiscale
MSL	Mars Science Laboratory
MSR	Mars Sample Return
MUSE	MUlti-slit Solar Explorer
NEO	Near Earth Object
NISAR	NASA—ISRO Synthetic Aperture Radar
Orion	Orion Multi-Purpose Crew Vehicle
NPP	National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project
OCO	Orbiting Carbon Observatory
ORR	operational readiness review
OS	Orbiting Sample
OSAM-1	On-orbit Servicing, Assembly, and Manufacturing 1
OSIRIS-REx	Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer
PACE	Plankton, Aerosol, Cloud, ocean Ecosystem
PDR	preliminary design review
PPE	Power and Propulsion Element
PSP	Parker Solar Probe
RBI	Radiation Budget Instrument
RBSP	Radiation Belt Storm Probes

Roman	Nancy Grace Roman Space Telescope
RPOD	rendezvous proximity operations and docking
SBG	Surface Biology and Geology
SDO	Solar Dynamics Observatory
SDR	system definition review
SEP	Solar Electric Propulsion
SFD	Sustainable Flight Demonstrator
SGSS	Space Network Ground Segment Sustainment
SIR	system integration review
SITF-Q	System Integration and Test Facility – Qualification
SLD	Sustaining Lunar Development
SLS	Space Launch System
SMAP	Soil Moisture Active Passive
SOFIA	Stratospheric Observatory for Infrared Astronomy
SPHEREx	Spectro-Photometer for the History of the Universe, Epoch of Reionization and Ices Explorer
SRL	Sample Retrieval Lander
SRR	system requirements review
SWOT	Surface Water and Ocean Topography
TBD	to be determined
TDRS	Tracking and Data Relay Satellite
TESS	Transiting Exoplanet Survey Satellite
TIR	Thermal Infrared
TRL	technology readiness level
USDV	United States Deorbit Vehicle
UVEX	UltraViolet EXplorer
VenSAR	Venus Synthetic Aperture Radar
VERITAS	Venus Emissivity, Radio Science, InSAR, Topography, and Spectroscopy
VIPER	Volatiles Investigating Polar Exploration Rover
VNIR	visible near infrared
VSWIR	Visible and Short Wave Infrared
WISE	Wide-field Infrared Survey Explorer

U.S. GOVERNMENT ACCOUNTABILITY OFFICE
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July 1, 2025

Congressional Committees

Each year, the National Aeronautics and Space Administration (NASA) invests billions of dollars in a wide-ranging portfolio of major projects to help execute important missions. We define major projects as those projects or programs with an estimated life-cycle cost of over $250 million.[1] NASA's major projects aim to observe Earth's oceans, land, and atmosphere; explore the solar system; and advance aeronautics research, among other things. Increasingly, NASA's major projects are focused on executing an ambitious series of Artemis missions to extend human presence beyond low-Earth orbit to the lunar surface and beyond. As of fiscal year 2025, NASA estimates that the total life-cycle cost of its 38 major projects will be at least $74 billion. Of the 38 major projects, 18 are in development, or the phase in which NASA is building and testing hardware.

NASA's planning and execution of its major projects has been on our high-risk list continuously for over 3 decades due to the agency's history of cost growth and schedule delays in developing its major systems. In our 2025 high-risk report, we found that NASA continues to face challenges controlling cost growth and schedule delays for its most expensive and highest priority projects.[2] NASA has taken steps to reduce its acquisition risks and improve project cost and schedule performance. Further reducing risk will be critical as NASA embarks on several new, large projects, including projects needed to conduct the Artemis missions. These projects are complex and specialized, and often rely on state-of-the-art space technology.

The explanatory statement of the House Committee on Appropriations accompanying the Omnibus Appropriations Act, 2009 includes a provision

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[1] For the purposes of our report, we use the term "project" to refer to capabilities under single project programs that NASA manages under a discrete baseline such as the Human Landing System (HLS) Initial Capability, HLS Sustaining Capability, and Space Launch System (SLS) Block 1B. We also use the terms "project" and "program" interchangeably when referring to single project programs that include the capability upgrades mentioned above, such as SLS, the Exploration Ground Systems (EGS), and the Orion Multi-Purpose Crew Vehicle (Orion).

[2] GAO, *High-Risk Series: Heightened Attention Could Save Billions More and Improve Government Efficiency and Effectiveness*, GAO-25-107743 (Washington, D.C.: Feb. 25, 2025).

for us to prepare project status reports on selected large-scale NASA programs, projects, and activities which we refer to as major projects.[3] The explanatory statement accompanying the Consolidated Appropriations Act, 2024 includes a similar provision.[4]

This is our 17th annual report on NASA's major projects. Our objectives were to assess the (1) cost and schedule performance of NASA's major projects in development and (2) historical cost performance of NASA's major development projects included in our annual reports since 2009.

This report also includes 38 project summaries of NASA's major projects. Appendix I includes (1) 27 individual assessments for NASA projects and programs that have either passed key milestones or are expected to exceed $2 billion in total life-cycle costs; (2) 11 descriptions of projects that are early in their life cycles and are not expected to exceed $2 billion in total life-cycle costs; and (3) one summary that provides additional detail on NASA's Artemis missions. When NASA determines that a project has an estimated life-cycle cost of over $250 million, we include that project in our annual review through its launch or the end of its development.

To conduct our analyses, we collected cost, schedule, and technology maturity data via data collection questionnaires sent to NASA headquarters and project offices. To assess the cost and schedule performance and technology maturity of NASA's portfolio of major projects, we analyzed these data, and, where appropriate, compared them against best practices we identified in our prior work on product development.[5]

To assess the historical cost performance of NASA's major projects that have been in development and included in our annual reports since 2009, we began by identifying the 53 projects that have completed or are in the final stage of development. We analyzed the final cost overruns we previously reported and then identified projects that made statutory

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[3] See Explanatory Statement, 155 Cong. Rec. 4419, 4593 (2009), on H.R. 1105, the Omnibus Appropriations Act, 2009, which became Pub. L. No. 111-8.

[4] Explanatory Statement, 170 Cong. Rec. S1398 (daily ed., Mar. 5, 2024), accompanying the Consolidated Appropriations Act, 2024, Pub. L. No. 118-42.

[5] GAO, *Technology Readiness Assessment Guide: Best Practices for Evaluating the Readiness of Technology for Use in Acquisition Programs and Projects [Reissued with revisions on Feb. 11, 2020.]*, GAO-20-48G (Washington, D.C.: Jan. 7, 2020).

notifications to congressional committees related to cost overruns.[6] Further, we reviewed notifications and reports to congressional committees, as well as agency documentation, to identify and categorize the reasons that NASA reported as causes for cost overruns over the 30 percent statutory threshold for a reauthorization.[7]

For the individual project summaries, we also visited multiple NASA centers, reviewed monthly status reports, analyzed data obtained through our questionnaires, and interviewed project officials. Appendix II contains detailed information on our scope and methodology.

We conducted this performance audit from May 2024 to July 2025 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

NASA's Project Management Policy and Life Cycle for Major Projects

The primary NASA policy that guides its project management for major projects is NASA Procedural Requirements 7120.5F.[8] This policy establishes the requirements by which NASA formulates and implements projects, including the life-cycle phases.

The life cycle for NASA space flight projects consists of two phases: (1) formulation, which takes a project from concept development to preliminary design; and (2) implementation, which includes activities like building, launching, and operating the system. NASA further divides formulation and implementation into phases A through F. Major projects must get approval from senior NASA officials at key decision points

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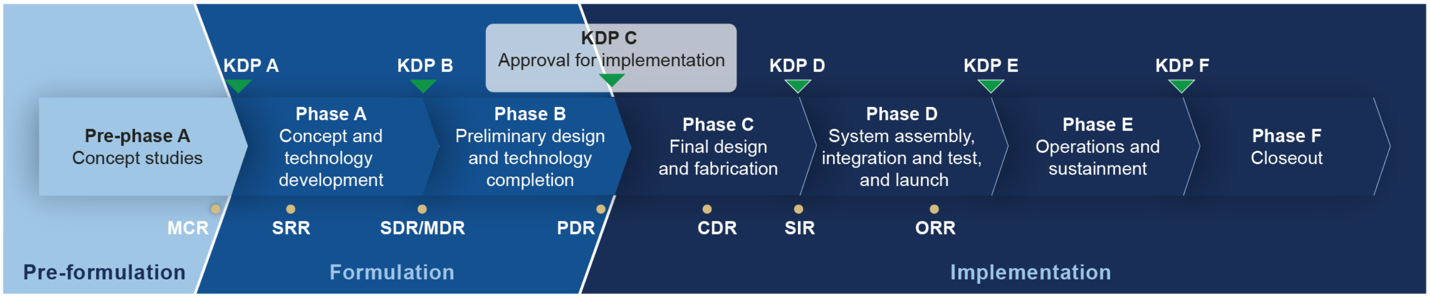
[6] 51 U.S.C. § 30104(d)(3). NASA's notifications and reports under the statute are to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate. See id. § 30104(d)(3), (e).

[7] Id. § 30104(e)(1)(A), (f).

[8] NASA, *NASA Space Flight Program and Project Management Requirements,* Procedural Requirements 7120.5F (Aug. 3, 2021).

before they can enter each new phase. Figure 1 depicts NASA's life cycle for space flight projects.

Figure 1: NASA's Life Cycle for Space Flight Projects



Management decision reviews

▼ KDP = key decision point

Technical reviews

● MCR = mission concept review

● SRR = system requirements review

● SDR/MDR = system definition review/mission definition review

● PDR = preliminary design review

● CDR = critical design review

● SIR = system integration review

● ORR = operational readiness review

Source: GAO analysis of NASA data. | GAO-25-107591

Project formulation consists of phases A and B:

- Prior to beginning phase A, NASA conducts a mission concept review to evaluate the feasibility and maturity of proposed mission concepts and associated planning.
- In phase A, a project team develops a range of cost and schedule estimates for uses such as budget planning. During this phase, the agency is to conduct a system requirements review and system definition review/mission definition review. These reviews help ensure that the project's performance requirements and proposed system architecture or technical approach are aligned with the mission's performance requirements.
- During phase B, the project team develops programmatic measures and technical leading indicators that track various project metrics such

as requirement changes, staffing demands, and mass and power utilization. Near the end of formulation, leading up to the preliminary design review, the project team is to complete technology development and the preliminary design.[9] Formulation culminates in a review at key decision point C, at which point senior leaders determine whether and how the project proceeds into the next phase and approves any additional actions. This is also the point where cost and schedule baselines are set.

Implementation follows key decision point C and consists of phases C, D, E, and F. In this report, we refer to projects in phases C and D as being in development.

- The project team is to hold a critical design review during the latter half of phase C to determine whether the design performs as expected and is stable enough to support proceeding with the final design and fabrication. After the critical design review and just prior to beginning phase D, the project team completes a system integration review to evaluate the readiness of the project and associated supporting infrastructure to begin system assembly, integration, and test.
- In phase D, the project team performs system assembly, integration, test, and launch activities. During the latter half of phase D, the project team is to hold an operational readiness review to ensure that all system and support hardware, software, personnel, and procedures are ready for operations.
- Phases E and F consist of operations, sustainment, and project closeout.

NASA Cost and Schedule Commitments

Major NASA projects have two sets of cost and schedule commitments—the management agreement and the agency baseline commitment.

- **Management agreement.** According to NASA policy, the management agreement should be viewed as a contract between

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[9] Technology readiness levels (TRL) are a type of measurement system used to assess the maturity level of a particular technology. TRLs are important inputs into systems engineering events—such as a project's preliminary design review and critical design review—and can expose knowledge gaps. Our technology readiness guide states that technologies are considered critical if they are new or novel or used in a new or novel way and needed for a system to meet its operational performance requirements within defined cost and schedule parameters (i.e., cost and schedule targets set at key decision point B or C). For more information on TRLs, see appendix VI.

NASA and the program or project manager.[10] The executing center's project manager has the authority to manage the project within the parameters outlined in this agreement, which includes cost and schedule reserves that the project manager controls.[11] Cost reserves are for costs that projects expect to incur—for instance, risk mitigations—but are not yet allocated to a specific part of the project. Schedule reserves are extra time in project schedules that managers can allocate to specific activities, elements, and major subsystems to mitigate delays or address unforeseen events. If the project requires additional time or money beyond the management agreement, NASA headquarters may allocate headquarters-held reserves, which represent the difference between the agency baseline commitment and the management agreement.

- **Agency baseline commitment**. The agency baseline commitment includes the cost and schedule baselines against which the agency's performance on a project is measured. The baselines generally include life-cycle costs broken out by formulation, development, and operations; and a key schedule milestone event such as a launch readiness date to denote the end of development and the start of operations.[12]

To inform the management agreement and the agency baseline commitment, each project with a life-cycle cost estimate of greater than $250 million must also develop a joint cost and schedule confidence level unless NASA waives the requirement. A joint cost and schedule confidence level is an integrated analysis of a project's cost, schedule, risk, and uncertainty. The result of this analysis indicates a project's likelihood of meeting a given set of cost and schedule targets.

The total amount of cost and schedule reserves held at the project level varies based on where the project is in its life cycle. NASA's policy on whether projects are required or recommended to hold certain levels of

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[10] NASA's spaceflight program and project management policy describes a program as a strategic investment by a mission directorate or mission support offices with a defined architecture and/or technical approach, requirements, funding, and a management structure that initiates and directs one or more projects. The policy further describes a project as a specific investment identified in a program plan having defined requirements, a life-cycle cost, a beginning, and an end.

[11] NASA refers to cost reserves as unallocated future expenses.

[12] For projects and programs that plan continuing operations and production with an unspecified end point, the operations cost estimate is established as part of the operational readiness review for 5 years and updated and documented annually for the next 5-year period.

cost and schedule reserves at key project milestones also varies by NASA center. Projects track their reserves between phases to help ensure they hold reserves consistent with these requirements.

When a project is no longer meeting certain conditions in the agency baseline commitment, NASA replans or rebaselines the project. In certain cases, NASA is required to notify Congress when this occurs. See table 1 for an overview of characteristics of NASA replans and rebaselines.

Table 1: Characteristics of NASA Program Replans and Rebaselines

	Description	Potential congressional reporting requirement
Replan	A replan is a process by which a program updates or modifies its plans. It is driven by changes in program or project cost parameters, such as if development cost growth is 15 percent or more of the estimate in the baseline report or a major milestone is delayed by 6 months or more from the baseline's date. A replan does not require a new project baseline to be established.	When the NASA Administrator determines that development cost growth is likely to exceed the development cost estimate by 15 percent or more, or a program milestone is likely to be delayed from the baseline's date by 6 months or more, NASA must submit a report to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate.[a]
Rebaseline	Rebaselining is the process that results in a change to the project's agency baseline commitment. NASA initiates a rebaseline if the estimated development cost exceeds the baseline development cost estimate by 30 percent or more, or if the NASA Associate Administrator determines other events make a rebaseline appropriate.	In addition to the replan reporting noted above, should a program exceed its development cost baseline by more than 30 percent, the program must be reauthorized by Congress and rebaselined in order to expend funds to continue work beyond a specified time frame.[b]

Source: GAO analysis of NASA policy and 51 U.S. Code Sec. 30104. | GAO-25-107591

[a] 51 U.S.C. § 30104(e)(1).

[b] 51 U.S.C. § 30104(f).

NASA Projects We Reviewed in Our 2025 Assessment

This year, NASA's portfolio of major projects includes 38 projects. Eighteen of these projects are in development, meaning they set cost and schedule baselines against which project performance can be measured.[13] Nineteen of the projects are in formulation and have not yet set cost or schedule baselines. One project, the Commercial Crew Program, has a tailored project life cycle and project management requirements and did not establish a cost or schedule baseline.

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[13] Appendix III includes a list of the projects in development in this year's portfolio with their current cost and schedule estimates.

Of the 38 projects in the portfolio, 15 were designated as category 1 and 11 are related to the Artemis missions.[14] 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. NASA has begun development of the multiple highly complex, interdependent systems required to enable lunar surface exploration.

Figure 2 illustrates all 38 projects and programs we reviewed this year, by life-cycle phase, and includes designations for those related to the Artemis missions or that are category 1.

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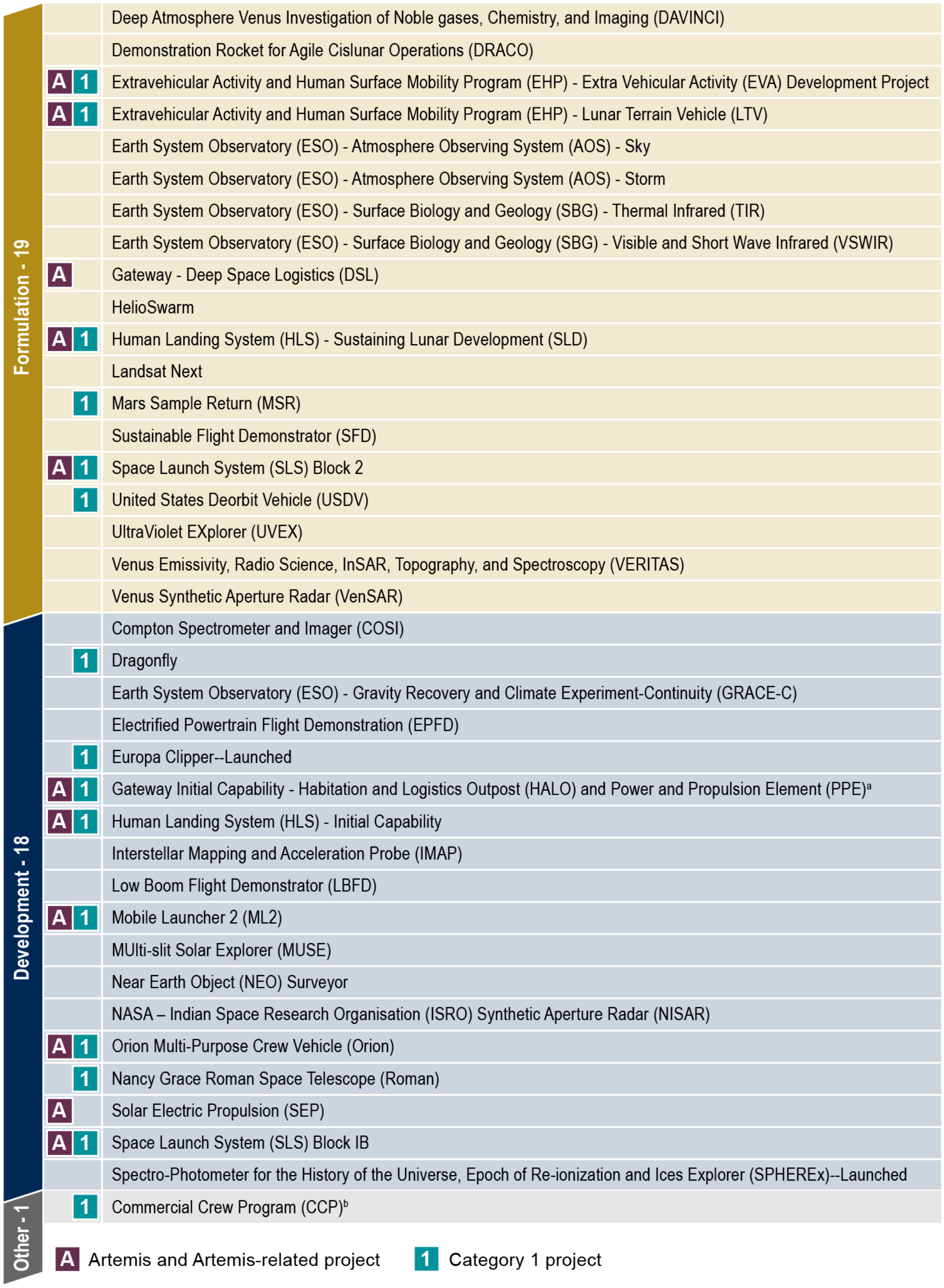
[14] NASA identifies its highest priority, most expensive projects and programs as category 1 projects. These projects typically have life-cycle cost estimates of $2 billion or more. However, projects can also be classified as category 1 due to other factors. These factors include the project's level of radioactive material, distinction as a human space flight project, or its priority level. Priority level is determined by the importance of the activity to NASA, the extent of international participation (or joint effort with other government agencies), or level of risk associated with the development of the spacecraft or payload.

Figure 2: Major NASA Projects and Programs Reviewed in GAO’s 2025 Assessment



Formulation - 19		Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging (DAVINCI)
		Demonstration Rocket for Agile Cislunar Operations (DRACO)
	A 1	Extravehicular Activity and Human Surface Mobility Program (EHP) - Extra Vehicular Activity (EVA) Development Project
	A 1	Extravehicular Activity and Human Surface Mobility Program (EHP) - Lunar Terrain Vehicle (LTV)
		Earth System Observatory (ESO) - Atmosphere Observing System (AOS) - Sky
		Earth System Observatory (ESO) - Atmosphere Observing System (AOS) - Storm
		Earth System Observatory (ESO) - Surface Biology and Geology (SBG) - Thermal Infrared (TIR)
		Earth System Observatory (ESO) - Surface Biology and Geology (SBG) - Visible and Short Wave Infrared (VSWIR)
	A	Gateway - Deep Space Logistics (DSL)
		HelioSwarm
	A 1	Human Landing System (HLS) - Sustaining Lunar Development (SLD)
		Landsat Next
	1	Mars Sample Return (MSR)
		Sustainable Flight Demonstrator (SFD)
	A 1	Space Launch System (SLS) Block 2
	1	United States Deorbit Vehicle (USDV)
		UltraViolet EXplorer (UVEX)
		Venus Emissivity, Radio Science, InSAR, Topography, and Spectroscopy (VERITAS)
		Venus Synthetic Aperture Radar (VenSAR)
Development - 18		Compton Spectrometer and Imager (COSI)
	1	Dragonfly
		Earth System Observatory (ESO) - Gravity Recovery and Climate Experiment-Continuity (GRACE-C)
		Electrified Powertrain Flight Demonstration (EPFD)
	1	Europa Clipper--Launched
	A 1	Gateway Initial Capability - Habitation and Logistics Outpost (HALO) and Power and Propulsion Element (PPE)[a]
	A 1	Human Landing System (HLS) - Initial Capability
		Interstellar Mapping and Acceleration Probe (IMAP)
		Low Boom Flight Demonstrator (LBFD)
	A 1	Mobile Launcher 2 (ML2)
		MUlti-slit Solar Explorer (MUSE)
		Near Earth Object (NEO) Surveyor
		NASA – Indian Space Research Organisation (ISRO) Synthetic Aperture Radar (NISAR)
	A 1	Orion Multi-Purpose Crew Vehicle (Orion)
	1	Nancy Grace Roman Space Telescope (Roman)
	A	Solar Electric Propulsion (SEP)
	A 1	Space Launch System (SLS) Block IB
		Spectro-Photometer for the History of the Universe, Epoch of Re-ionization and Ices Explorer (SPHEREx)--Launched
Other - 1	1	Commercial Crew Program (CCP)[b]

A Artemis and Artemis-related project

1 Category 1 project

Source: GAO analysis of NASA data. | GAO-25-107591

[a] The Gateway Initial Capability’s estimates include the cost and schedule of the PPE and HALO projects—which will launch together—the launch vehicle, and portions of program mission execution essential for the launch. Therefore, GAO reviewed Gateway Initial Capability as a single project in its

cost and schedule analyses, but reviewed Gateway–HALO and Gateway–PPE separately for technology maturity and other programmatic elements in the individual assessments.

[b] The Commercial Crew Program has a tailored project life cycle and project management requirements and did not establish a cost or schedule baseline. It is not included in GAO's cost and schedule analyses for the development portfolio.

Appendix IV includes a list of all the projects that have completed development and been included in our annual reports since 2009.

Recent GAO Work on Selected NASA Projects

Over the past 11 years, we issued several in-depth reports assessing NASA's progress in acquiring its largest projects and programs.[15] For example, in November 2023, we found that while the Human Landing System (HLS) program had made some progress, the program's schedule to support an Artemis III crewed lunar landing in December 2025 was ambitious.[16] In July 2024, we determined that while the Gateway program's projects—including the Power and Propulsion Element (PPE) and Habitation and Logistics Outpost (HALO)—made varying degrees of progress over the prior year. They face several significant challenges, including meeting their mass targets.[17] In October 2024, we reported that the Exploration Ground Systems (EGS) program was making progress with refurbishing and modifying the mobile launcher needed for Artemis II and Artemis III, but that these activities were taking longer than planned and the program had limited time to address potential issues.[18]

Since we initially designated NASA's acquisition management as high-risk, we have made numerous recommendations to help the agency reduce its acquisition risk. NASA has generally agreed with our recommendations and implemented changes in response to many of them, but it needs to take additional actions to fully address all of them. As of June 2025, NASA had not yet fully implemented two recommendations we identified as high priority to improve acquisition management. For example, in 2014, we recommended that NASA establish a separate cost and schedule baseline for work required to support the Space Launch System (SLS) Block I Artemis II mission and report this information to the Congress through NASA's annual budget

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[15] A list of our related products is included at the end of this report.

[16] GAO, *NASA Artemis Programs: Crewed Moon Landing Faces Multiple Challenges,* GAO-24-106256 (Washington, D.C.: Nov. 30, 2023).

[17] GAO, *Artemis Programs: NASA Should Document and Communicate Plans to Address Gateway's Mass Risk*, GAO-24-106878 (Washington, D.C.: July 31, 2024).

[18] GAO, *NASA Artemis Missions: Exploration Ground Systems Program Could Strengthen Schedule Decisions*, GAO-25-106943 (Washington, D.C.: Oct. 17, 2024).

submission.[19] While NASA has taken steps to respond to this recommendation, such as generating and updating a 5-year operational cost estimate, it has not yet set a baseline for SLS program costs for Artemis II.

NASA's Cost and Schedule Performance for Projects in Development Remained Stable after 2 Years of Improvement

The majority of the 18 major projects in development did not experience cost growth or schedule delays since last year's report. In addition, the portfolio's cumulative cost and schedule performance remained relatively unchanged in 2025 due to four projects leaving the portfolio.

Most Major Projects in Development Did Not Experience Annual Cost Overruns or Schedule Delays in the Last Year

In the last year, 14 of the 18 major projects in development reported no cost growth or schedule delays. Six of these projects were reporting their estimates for the first time and eight projects reported no change or an underrun from last year. See table 2.

Table 2: Annual Development Cost Overruns and Schedule Delays for Major NASA Projects and Programs in Development since GAO's 2024 Assessment

		Changes since 2024 GAO assessment	
Annual performance status	**Project(s)**	**Schedule delay (months)**	**Cost growth (dollars in then-year millions)**
First-year estimate reported	COSI, Dragonfly, EPFD, ESO-GRACE-C, ML2, MUSE	N/A	N/A
No change from prior year	Gateway Initial Capability[a], HLS Initial Capability, IMAP, NEO Surveyor, Roman, SEP, SLS Block 1B	0	0
Underrunning prior estimate	SPHEREx[a]	(1)	0
Overrunning prior estimate	Orion[b]	7	363.0

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[19] GAO, *NASA: Actions Needed to Improve Transparency and Assess Long-Term Affordability of Human Exploration Programs*, GAO-14-385 (Washington, D.C.: May 8, 2014).

		Changes since 2024 GAO assessment	
Annual performance status	Project(s)	Schedule delay (months)	Cost growth (dollars in then-year millions)
	Europa Clipper	0	50.7
	NISAR[b]	8	40.9
	LBFD	11	59.7
Totals		**25**	**514.3**

Legend: COSI: Compton Spectrometer and Imager; EPFD: Electrified Powertrain Flight Demonstration; ESO-GRACE-C: Earth System Observatory Gravity Recovery and Climate Experiment - Continuity; ML2: Mobile Launcher 2; MUSE-Multi-slit Solar Explorer; HLS: Human Landing System; IMAP: Interstellar Mapping and Acceleration Probe; NEO: Near Earth Object; Roman: Nancy Grace Roman Space Telescope; SEP: Solar Electric Propulsion; SLS: Space Launch System; SPHEREx: Spectro-Photometer for the History of the Universe, Epoch of Re-ionization and Ices Explorer; Orion: Orion Multi-Purpose Crew Vehicle; NISAR: NASA - Indian Space Research Organisation (ISRO) Synthetic Aperture Radar; LBFD: Low Boom Flight Demonstrator.

Source: GAO analysis of NASA data. | GAO-25-107591

Note: Positive values indicate cost growth or launch delays. Values in parentheses indicate cost decreases or earlier than planned launch dates. Data for GAO's current assessment were collected as of January 2025 with exceptions: SPHEREx cost data is as of February 2025, LBFD cost and schedule data are as of March 2025, and NISAR schedule data is as of April 2025.

[a] This table does not include a minor cost growth for Gateway Initial Capability of approximately $0.1 million dollars or an $8.3 million reduction in development costs for SPHEREx from last year's estimate. The SPHEREx project attributes that reduction to the removal of operations costs that were inadvertently included in the prior year development costs.

[b] Orion cost is currently under review. The NISAR project's cost and schedule are under review. Until these reviews are complete, information presented is based on the latest estimates that GAO received from NASA.

Four of the 18 major projects in development experienced annual cost growth in 2025, collectively reporting a total of $514.3 million in cost overruns. Specifically:

- Orion Multi-Purpose Crew Vehicle (Orion) reported a $363 million development cost increase that resulted from several technical and development issues including: performance issues with the crew capsule heatshield identified during the Artemis I flight; repairing crew module batteries; design issues within the life-support system, and software development. The Orion program's cost growth represents 71 percent of the portfolio's annual cost growth.
- Europa Clipper reported a $50.7 million development cost increase that resulted from increased estimates of funding needed to get to the October 2024 launch and complete final development activities. NASA added this funding to further resolve radiation hardening issues, complete deferred software development, and address cost increases due to inflation.

- NASA - Indian Space Research Organisation (ISRO) Synthetic Aperture Radar (NISAR) reported a $40.9 million development cost increase that resulted from the radar antenna reflector issues discovered in early 2024. While the radar antenna was in India for installation on the spacecraft, the project office found thermal issues that could have resulted in antenna deployment problems. To address the issue, the radar antenna reflector was shipped to the U.S. from India. Once mitigations were finished, the radar antenna was sent back to India to await launch.
- Low Boom Flight Demonstrator (LBFD) reported a $59.7 million development cost increase, that resulted from contractor performance and technical issues.

Three of the 18 major projects in development reported annual schedule delays this year:

- LBFD’s 11-month delay resulted from several prime contractor performance and technical issues, including software and subsystem testing delays, findings during engine run testing, subsystem issues, and challenges in the transition to the integrated test phase.
- Orion’s 7-month delay resulted from several ongoing program activities including the program’s efforts to investigate the Artemis I heatshield issues and develop mitigations. These efforts will allow the agency to use the current heatshield design for Artemis II while a new heatshield is being designed and manufactured for Artemis III. In addition, the program has spent time resolving technical issues identified during testing of the crew module electrical and life support systems, as well as fixing the crew module batteries ahead of Artemis II. NASA reported that these vehicle changes were required to ensure crew safety and mission success for Artemis II.
- NISAR’s at least 8-month delay resulted from the radar antenna reflector issue noted above. Originally, the project planned to fix the radar antenna reflector, including shipments to and from the U.S., in time to support the launch schedule. However, while addressing the issue in the U.S., the project determined that further thermal mitigations were necessary. This delayed the return of the radar antenna reflector to the Indian Space Research Organisation (ISRO). The extended delay resulted in a possible launch date within an eclipse window—when the project cannot launch. According to NASA documentation, ISRO, which is responsible for setting the NISAR launch date, expects a launch readiness date of no earlier than June 2025.

The current Orion development cost estimate does not yet align with the new April 2026 Artemis II launch date. The updated Orion development cost estimate, including the additional $363 million reported this year, is based on activities needed to support a September 2025 Artemis II launch date. Moon to Mars program officials stated the agency is updating the schedule and cost estimates for the new Artemis mission dates. However, more cost increases are likely, as the program continues to review its costs and adjusts to the new launch date.

Cumulative Cost and Schedule Performance of NASA’s Portfolio of Major Projects in Development Remains Relatively Stable

The cumulative cost and schedule performance of the 18 major projects in development remained unchanged in 2025 despite portfolio changes.[20] Specifically, cumulative development cost overruns remained unchanged, at about $4.4 billion, and cumulative development schedule delays decreased from 14.5 years to 13.1 years. See figure 3.

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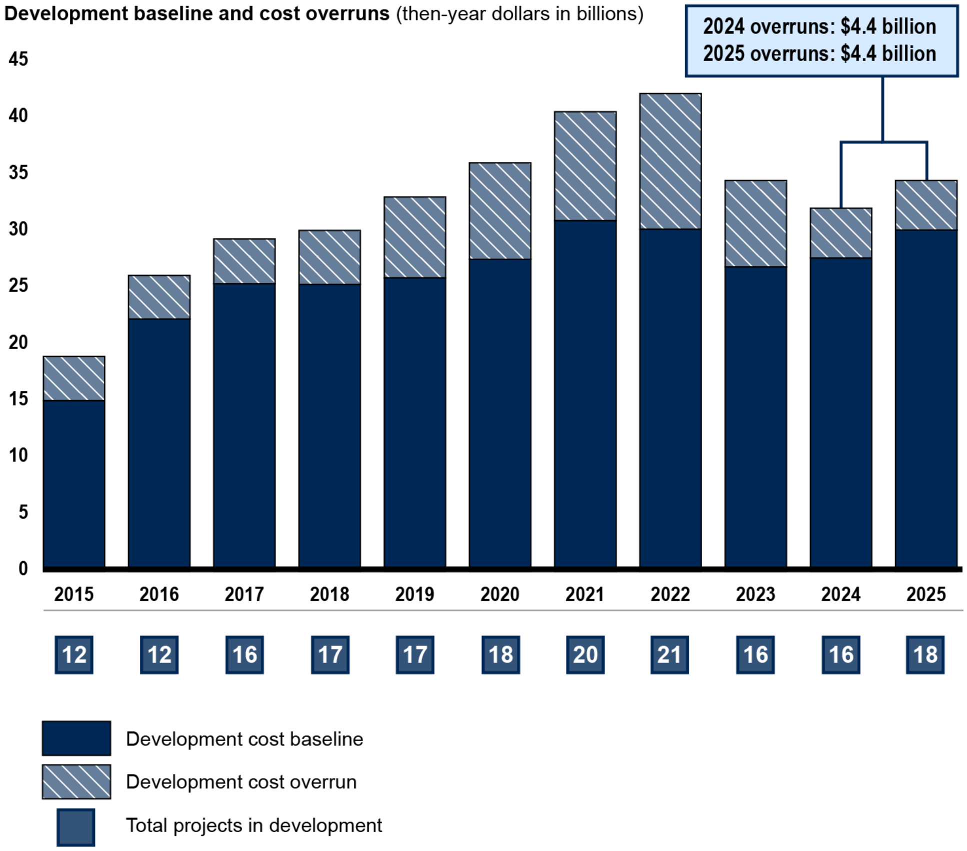
[20] For a comprehensive list of cumulative cost and schedule performance by project, see appendix V.

Figure 3: Cumulative Development Cost Overruns for NASA's Portfolio of Major Projects



Source: GAO analysis of NASA data. | GAO-25-107591

Notes: The years in the figure are the years that GAO issued its annual assessment of major projects. Data for GAO's current assessment are as of January 2025 except for SPHEREx, which is as of February 2025 and LBFD data which is as of March 2025.

Projects leaving the portfolio positively affected cumulative cost and schedule performance. For example, NASA launched two projects—Psyche and Plankton, Aerosol, Cloud, ocean Ecosystem (PACE)—that had been in the portfolio since 2019. These launches removed $1.4 billion of development costs, including $159 million in cumulative cost overruns and 15 months of cumulative schedule delays from the portfolio.

- Psyche accounted for approximately $116 million in cumulative cost overruns and 14 months of cumulative schedule delays.

- PACE accounted for approximately $43 million in cumulative cost overruns and 1 month of schedule delay.

In addition to projects leaving the development portion of the portfolio, NASA canceled two projects—On-orbit Servicing, Assembly, and Manufacturing (OSAM-1) and Volatiles Investigating Polar Exploration Rover (VIPER)—which removed projected development costs of $1.65 billion from the portfolio. Prior to NASA's decision to cancel the projects, both had been facing cost growth and schedule delays. Collectively, these two projects had accounted for $338.5 million in projected cumulative development cost overruns and 27 months of cumulative schedule delays.[21]

The Orion project has driven and could continue to drive the portfolio's current cumulative development cost performance. To date, the program's $3.2 billion development cost overrun accounts for 73 percent of the portfolio's total cumulative development cost overruns. Most of the Orion cost overruns—$2.5 billion—stem from NASA's August 2021 decision to rebaseline the program, which, in part, added significant new requirements. The Orion program cost and schedule rebaseline reflected:

- adding scope, including developing a rendezvous, proximity operations, and docking (RPOD) capability and optical communications capabilities;
- incorporating poorer than expected cost performance since the previous baseline;
- addressing the impact of COVID-19 as well as program facility impacts at Johnson Space Center, Kennedy Space Center, and Michoud Assembly Facility; and
- resolving schedule and technical issues with the European Space Agency-provided service module.

When assessed against the 2021 cost and schedule rebaseline, the Orion program has experienced $684 million dollars of development cost growth and a 2-year delay.

The program's cost and schedule rebaseline also extended the Orion development effort through Artemis III, which is when the additional

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[21] According to NASA documentation, as of January 2024, NASA had obligated approximately 75 percent or $1.5 billion of the OSAM-1 project's total life-cycle cost. According to NASA documentation, as of June 2024, the VIPER project had obligated nearly 90 percent or $453 million of its total life-cycle cost.

RPOD capability is expected to be demonstrated. As a result, the Orion program's cost and schedule performance will continue to contribute to the cumulative portfolio's performance until the Artemis III mission—scheduled for mid-2027—when the complete scope of the program's development baseline has been demonstrated.

Most NASA Projects Avoided Significant Cost Overruns, but the Scope of Artemis Projects Could Drive Future Cost Performance

Most Major Projects Since GAO's 2009 Annual Report Avoided Significant Cost Overruns

Since our initial report in 2009, most of the 53 major projects that completed development or that are currently in their final phase of development remained under the statutory thresholds related to cost overruns.[22] Of these 53 projects, 48 completed development by proceeding into the operations phase or by ending their development early due to cancelation. These projects are listed in appendix IV. The other five projects are currently in their final phase of development.[23] In regard to the statutory threshold, 30 of those 53 projects remained under both the 15 percent threshold for notification of a cost overrun to congressional committees and the 30 percent threshold for reauthorization.[24]

Congress established cost and schedule thresholds at which NASA must notify congressional committees of project overruns. A NASA project triggers a congressional notification requirement when it is likely to exceed its development cost baseline by 15 percent or to incur 6 months of schedule delays, and must be reauthorized by Congress if it exceeds its development cost baseline by more than 30 percent. For the purposes of our analysis, we identified projects that met the threshold for notification based on a cost overrun and did not identify projects that met

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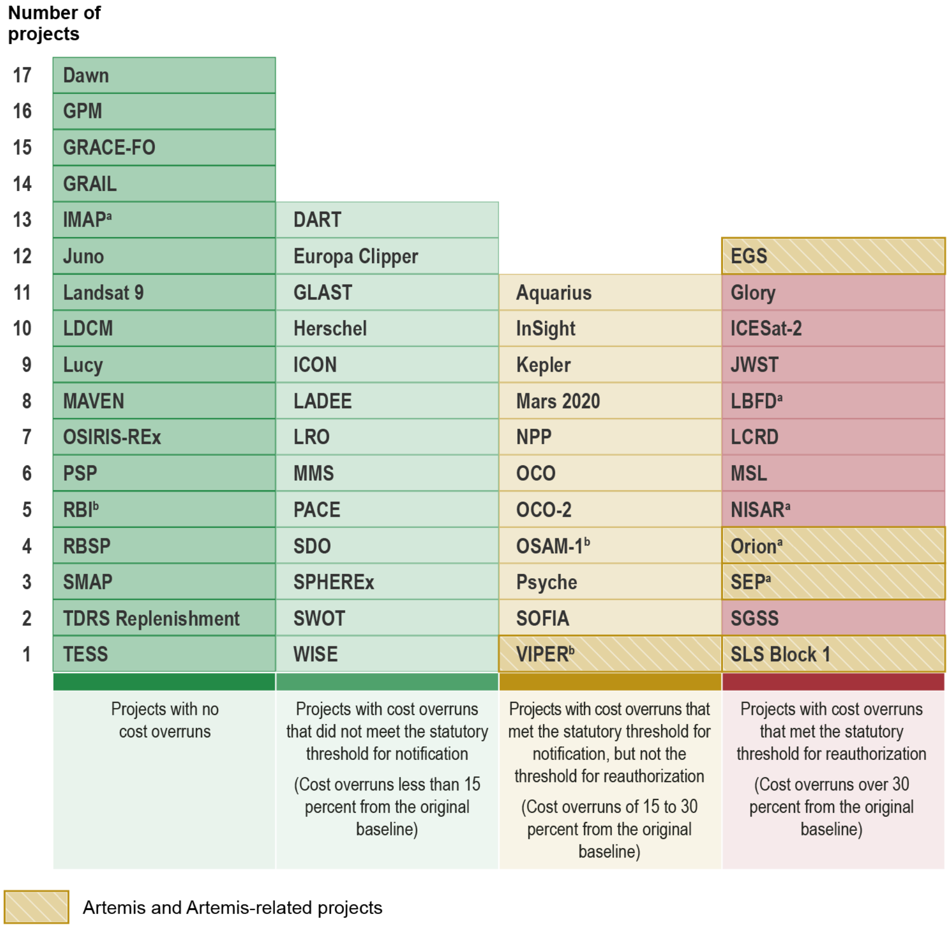
[22] 51 U.S.C. § 30104(d)(3), (f).

[23] See appendix II for additional details on our methodology.

[24] 51 U.S.C. § 30104(d)(3) and (f).

the threshold for notification based solely on schedule delays. See figure 4.

Figure 4: Development Cost Outcomes for NASA Major Projects That Completed Development or Are in the Final Phase of Development Since GAO's 2009 Annual Report



Number of projects				
17	Dawn			
16	GPM			
15	GRACE-FO			
14	GRAIL			
13	IMAP[a]	DART		
12	Juno	Europa Clipper		▨ EGS
11	Landsat 9	GLAST	Aquarius	Glory
10	LDCM	Herschel	InSight	ICESat-2
9	Lucy	ICON	Kepler	JWST
8	MAVEN	LADEE	Mars 2020	LBFD[a]
7	OSIRIS-REx	LRO	NPP	LCRD
6	PSP	MMS	OCO	MSL
5	RBI[b]	PACE	OCO-2	NISAR[a]
4	RBSP	SDO	OSAM-1[b]	▨ Orion[a]
3	SMAP	SPHEREx	Psyche	▨ SEP[a]
2	TDRS Replenishment	SWOT	SOFIA	SGSS
1	TESS	WISE	▨ VIPER[b]	▨ SLS Block 1
	Projects with no cost overruns	Projects with cost overruns that did not meet the statutory threshold for notification (Cost overruns less than 15 percent from the original baseline)	Projects with cost overruns that met the statutory threshold for notification, but not the threshold for reauthorization (Cost overruns of 15 to 30 percent from the original baseline)	Projects with cost overruns that met the statutory threshold for reauthorization (Cost overruns over 30 percent from the original baseline)

▨ Artemis and Artemis-related projects

Legend: GPM: Global Precipitation Measurement Mission; GRACE-FO: Gravity Recovery and Climate Experiment Follow-On; GRAIL: Gravity Recovery and Interior Laboratory; IMAP: Interstellar Mapping and Acceleration Probe; LDCM: Landsat Data Continuity Mission; MAVEN: Mars Atmosphere and Volatile EvolutioN; OSIRIS-REx: Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer; PSP: Parker Solar Probe; RBI; Radiation Budget Instrument;RBSP: Radiation Belt Storm Probes; SMAP: Soil Moisture Active Passive; TDRS: Tracking and Data Relay Satellite; TESS: Transiting Exoplanet Survey Satellite; DART: Double Asteroid Redirection Test; GLAST: Gamma-ray Large Area Space Telescope; ICON: Ionospheric Connection Explorer; LADEE: Lunar Atmosphere and Dust Environment Explorer; LRO: Lunar Reconnaissance Orbiter; MMS: Magnetospheric Multiscale; PACE: Plankton, Aerosol, Cloud, ocean Ecosystem; SDO: Solar Dynamics Observatory; SPHEREx: Spectro-Photometer for the History of the Universe, Epoch of Reionization and Ices Explorer; SWOT: Surface Water and Ocean Topography; WISE: Wide-field Infrared Survey Explorer; InSight: Interior Exploration using Seismic Investigations, Geodesy, and Heat Transport; NPP: National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project; OCO: Orbiting Carbon Observatory; OSAM-1: On-orbit Servicing, Assembly, and Manufacturing 1; SOFIA: Stratospheric Observatory for Infrared Astronomy; VIPER: Volatiles Investigating Polar Exploration Rover; EGS: Exploration Ground Systems; ICESat-2: Ice, Cloud, and Land Elevation Satellite-2; JWST: James Webb Space Telescope; LBFD: Low Boom Flight Demonstrator; LCRD: Laser Communications Relay Demonstration; MSL: Mars Science Laboratory; NISAR: NASA – Indian Space Research Organisation (ISRO) Synthetic Aperture Radar; Orion: Orion Multi-Purpose Crew Vehicle; SEP: Solar Electric Propulsion; SGSS: Space Network Ground Segment Sustainment; SLS: Space Launch System.

Source: GAO presentation of NASA information. | GAO-25-107591

Notes: The statutory thresholds are in 51 U.S.C. § 30104(d)(1) and (f). This analysis is based on final cost overruns that were published in GAO's annual reports. GAO excluded the Commercial Crew Program because it has a tailored project life cycle and did not establish a baseline against which to measure cost performance. Data for GAO's current assessment are as of January 2025 except SPHEREx, which is as of February 2025, and LBFD data, which is as of March 2025.

[a]These projects are currently in their final phase of development in NASA's acquisition cycle.

[b]These projects were canceled during development.

According to our analysis of the historical data in figure 4, 30 projects remained under both the 15 percent and 30 percent statutory thresholds.

We previously reported that for 17 of these 30 projects, the agency completed development or is nearing the end of development within the original cost baseline.[25] While these cost outcomes are notable, these projects had varying outcomes against their original baseline schedule estimates. Specifically:

- Eleven projects completed development within their original baseline cost and schedule estimates. Dawn, Gravity Recovery and Interior Laboratory, Juno, Landsat-9, Landsat Data Continuity Mission, Lucy, Mars Atmosphere and Volatile EvolutioN, Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer, Parker Solar Probe, Soil Moisture Active Passive, and Transiting Exoplanet Survey Satellite launched with costs at or below their original cost baselines and at or ahead of their original baseline schedules.
- Four projects completed development within their original baseline cost but behind their original schedule estimates. Global Precipitation Measurement mission, Gravity Recovery and Climate Experiment Follow-On, Radiation Belt Storm Probes, and Tracking and Data Relay Satellite Replenishment launched with costs below their cost baselines but did experience some delays to their original schedule baselines.
- One project completed development within its original baseline cost estimate but was canceled early. NASA canceled the Radiation Budget Instrument project in January 2018 prior to incurring any

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[25] GAO, *NASA: Assessments of Major Projects*, GAO-22-105212 (Washington, D.C.: June 23, 2022); *NASA: Assessments of Major Projects*, GAO-19-262SP (Washington, D.C.: May 30, 2019); *NASA: Assessments of Major Projects*, GAO-18-280SP (Washington, D.C.: May 1, 2018); *NASA: Assessments of Major Projects*, GAO-17-303SP (Washington, D.C.: May 16, 2017); *NASA: Assessments of Selected Large-Scale Projects [Reissued on March 26, 2015]*, GAO-15-320SP (Washington, D.C.: Mar. 24, 2015); *NASA: Assessments of Selected Large-Scale Projects*, GAO-14-338SP (Washington, D.C.: Apr. 15, 2014); *NASA: Assessments of Selected Large-Scale Projects*, GAO-13-276SP (Washington, D.C.: Apr. 17, 2013); *NASA: Assessments of Selected Large-Scale Projects*, GAO-12-207SP (Washington, D.C.: Mar. 1, 2012); and *NASA: Assessments of Selected Large-Scale Projects*, GAO-09-306SP (Washington, D.C.: Mar. 2, 2009).

overruns against the original cost baselines. The cancelation was due to continued contract cost growth, technical issues, and poor contractor performance.

- One project is currently within its original baseline cost estimate but still in development. The Interstellar Mapping and Acceleration Probe (IMAP) project is currently in its final phase of development and its latest estimates are within its cost and schedule baselines. This includes a launch later this year.

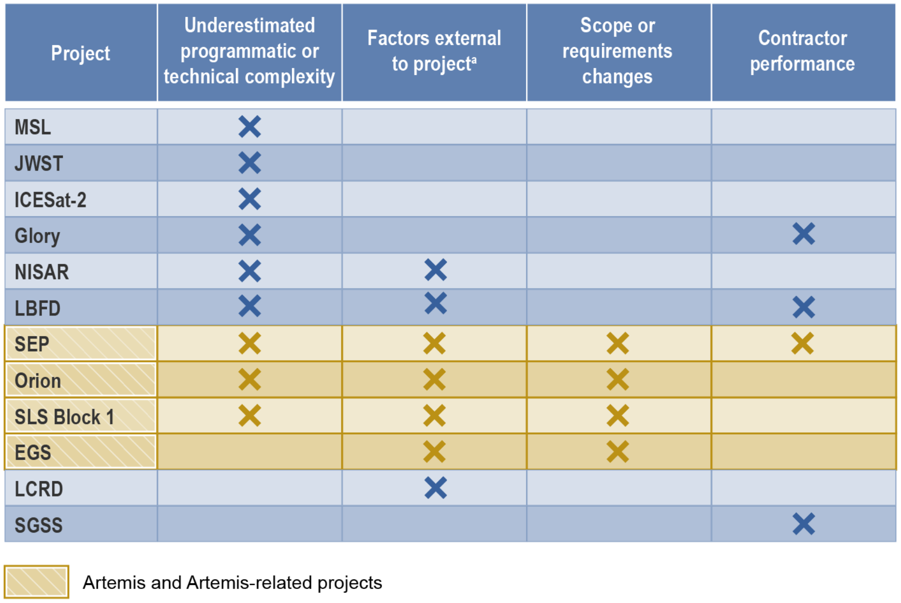
For 13 of the 30 projects, the agency completed development with some cost growth, but they did not meet the statutory threshold for congressional notification of 15 percent or more cost growth.

Further, 11 of the 53 projects met the statutory threshold for congressional notification of 15 percent or more cost growth but did not reach the statutory threshold of more than 30 percent for congressional reauthorization, as seen in figure 4. For example:

- NASA replanned the Interior Exploration using Seismic Investigations, Geodesy, and Heat Transport (InSight) project in 2016. It did so after experiencing issues with development on one of its instruments. The replan included a new cost profile with additional funding and schedule to repair the instrument.
- NASA canceled OSAM-1 and VIPER in 2024. It did so to avoid cost overruns that the agency estimated would have reached the 30 percent threshold for a reauthorization.
  - NASA notified congressional committees in February 2024 and reconfirmed in September 2024 that it was canceling OSAM-1 due to significant cost growth and schedule delays caused by a combination of poor vendor performance, in-house technical development challenges, and COVID-19.
  - The agency signed a decision memorandum in August 2024 canceling the Artemis-related VIPER program due to unacceptable known technical, cost, and schedule risks. These risks were associated with the completion and delivery of VIPER to the moon and would have likely resulted in further cost increases and schedule delays.

Lastly, 12 of the 53 projects met the statutory threshold for reauthorization (i.e., more than 30 percent cost growth), as also seen in figure 4. Our analysis of NASA documentation showed that these projects reported multiple factors contributing to the cost overruns. However, underestimated cost or technical complexity was a key factor consistently reported by most of the NASA projects, including two Artemis programs, SLS Block 1 and Orion, and one Artemis-related program, Solar Electric Propulsion (SEP). See figure 5.

Figure 5: Key Factors for Cost Overruns Reported by NASA Major Projects that Reached the Statutory Threshold for Reauthorization and Rebaselining



Project	Underestimated programmatic or technical complexity	Factors external to project[a]	Scope or requirements changes	Contractor performance
MSL	✕			
JWST	✕			
ICESat-2	✕			
Glory	✕			✕
NISAR	✕	✕		
LBFD	✕	✕		✕
▨ SEP	✕	✕	✕	✕
▨ Orion	✕	✕	✕	
▨ SLS Block 1	✕	✕	✕	
▨ EGS		✕	✕	
LCRD		✕		
SGSS				✕

▨ Artemis and Artemis-related projects

Legend: MSL: Mars Science Laboratory; JWST: James Webb Space Telescope; ICESat-2: Ice, Cloud, and Land Elevation Satellite-2; NISAR: NASA – Indian Space Research Organisation (ISRO) Synthetic Aperture Radar; LBFD: Low Boom Flight Demonstrator; SEP: Solar Electric Propulsion; Orion: Orion Multi-Purpose Crew Vehicle; SLS: Space Launch System; EGS: Exploration Ground Systems; LCRD: Laser Communications Relay Demonstration; SGSS: Space Network Ground Segment Sustainment.

Source: GAO presentation of NASA information. | GAO-25-107591

Note: The statutory threshold is in 51 U.S.C. § 30104(f).

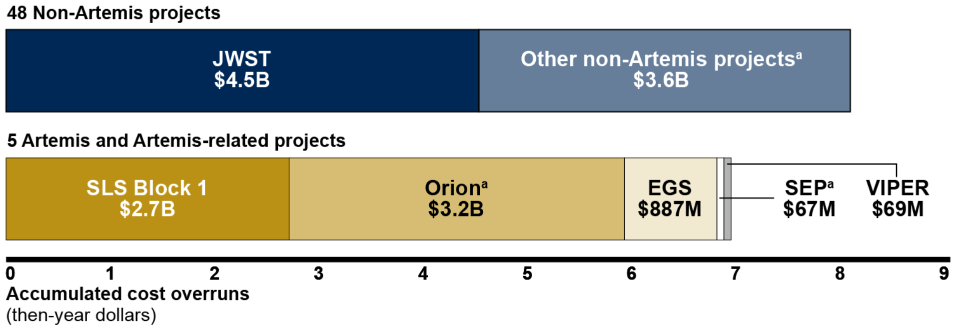
[a] Factors external to the project include areas outside the project’s management control such as issues associated with the COVID-19 pandemic or an externally funded host spacecraft or launch vehicle.

Agency officials indicated that in addition to the factors identified, contractor performance contributed to the SLS Block 1, EGS, and the James Webb Space Telescope (JWST) programs meeting the statutory threshold for reauthorization (i.e., 30 percent cost growth). Officials also noted that factors external to the project were another cause of JWST meeting the statutory threshold.

Artemis Projects Drove NASA's Recent Historical Overruns and Their Growing Scope Could Drive Future Cost Performance

Category 1 Artemis project cost overruns have driven NASA's portfolio performance in the 6 years since the Artemis missions were announced. Of the 53 projects we have reported on since 2009 that have either completed or are in the final phase of development, three Artemis projects—SLS Block 1, Orion, and EGS—have accumulated $6.8 billion in development cost overruns over their original baselines. The 48 non-Artemis projects included in this analysis contributed $8.1 billion in cost overruns over their original baselines. See figure 6 below.

Figure 6: Accumulated Cost Overruns for 53 NASA Major Projects That Completed or are in the Final Phase of Development since GAO's First Annual Assessment in 2009



Legend: JWST: James Webb Space Telescope; SLS: Space Launch System; Orion: Orion Multi-Purpose Crew Vehicle; EGS: Exploration Ground Systems; SEP: Solar Electric Propulsion; VIPER: Volatiles Investigating Polar Exploration Rover.

Source: GAO analysis of NASA data. | GAO-25-107591

Note: Of the 53 total projects, 48 projects completed development either by successfully completing their key development schedule milestone or by experiencing cancelation in their development phase, and five projects are currently in their final phase of development.

[a] Five projects—NASA - Indian Space Research Organisation Synthetic Aperture Radar, Interstellar Mapping and Acceleration Probe, Low Boom Flight Demonstrator, Orion, and SEP are currently in the final phase of development.

Most of the Artemis projects are category 1, which means that they have added complexity and cost to the portfolio. For example, the Orion project, a category 1 project, has an estimated development cost of nearly $10 billion. The total development cost for all 27 non-category 1 projects that have completed development and been included in our annual reports since 2009 is also $10 billion.

To accomplish future Artemis missions, NASA is in the formulation or early development phase for nine additional Artemis projects that are estimated to cost over $20 billion. Four of the nine new Artemis projects, Mobile Launcher 2 (ML2), SLS Block 1B, Gateway Initial Capability, and HLS Initial Capability are in the early stages of development with baseline costs of nearly $11.5 billion. The remaining five—Extravehicular Activity and Human Surface Mobility Program (EHP) – Extravehicular Activity (EVA Development), EHP – Lunar Terrain Vehicle, Gateway – Deep Space Logistics, HLS Sustaining Lunar Development, and SLS Block 2—are in the formulation phase with preliminary estimated costs of at least another $10 billion.

The growing complexity and scope of future Artemis projects could drive NASA's cost performance in the future. As we noted above, technical complexity has been a common factor cited by NASA for projects with significant overruns in the past. As the number of Artemis projects grows, so does the challenge of integrating them together. These highly complex and interdependent systems will need to be successfully integrated to support individual Artemis missions, which are more complex than any previous human space flight programs. While cost and schedule growth can occur on any project, increases associated with NASA's most costly and complex missions can have cascading effects on the affordability of the rest of the portfolio.

We previously made recommendations to help NASA strengthen the management of its Artemis projects and reduce risks of future cost overruns. For example, to improve insight into mission costs, in December 2019, we recommended that NASA create a life-cycle cost estimate for the Artemis III mission.[26] NASA agreed with the recommendation; however, NASA has not yet created this cost estimate. Officials stated that the agency would establish cost and schedule commitments for projects but not the overall mission. We have designated this recommendation as high priority.

To improve insight into future missions' schedules, in October 2024, we recommended that NASA perform a schedule risk analysis for EGS and ML2 prior to beginning integrated operation activities.[27] NASA partially concurred with our recommendation and plans to monitor schedule risk using tools such as annual budget requests, baseline performance reviews, and frequent meetings between EGS and its Moon to Mars office. We believe that responding to our open recommendations could help strengthen NASA's project management.

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[26] GAO, *NASA Lunar Programs: Opportunities Exist to Strengthen Analyses and Plans for Moon Landing*, GAO-20-68 (Washington, D.C.: December 19, 2019).

[27] GAO-25-106943.

The agency has taken steps to improve the management of its projects, including Artemis projects, which could help mitigate the risk of future cost overruns. For example, NASA:

- In response to statute, established Moon to Mars program office in 2023 to better integrate programs and projects in their missions;[28]
- Delayed setting baselines for SLS Block 1B, Mars Sample Return, and ML2 until requirements were more stable;
- Established the Chief Program Management Officer position in 2022 that, according to NASA officials, has used its influence to help projects meet cost and schedule commitments and establish attainable baselines, as well as to improve the overall program management function within NASA; and
- Completed several initiatives as part of its high-risk corrective action plan to strengthen cost and schedule estimate workforce.

NASA's Artemis portfolio continues to grow in terms of numbers of projects, cost, and technical complexity. We will continue to monitor the implementation of these efforts and any effect they may have on portfolio management.

Agency Comments

We provided a draft of this report to NASA for its review and comment. In its written comments, reprinted in appendix VII, NASA generally agreed with the findings of the report. NASA also provided technical comments, which have been addressed in this report, as appropriate.

We are sending copies of the report to the NASA Administrator and interested congressional committees. In addition, the report will be available at no charge on GAO's website at http://www.gao.gov.

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[28] Pub. L. No. 117-167, § 10811 (2022) (codified at 51 U.S.C. § 20302 note).

If you or your staff have any questions about this report, please contact me at RussellW@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made major contributions to this report are listed in appendix VIII.

//SIGNED//

William Russell
Director, Contracting and National Security Acquisitions

List of Committees

The Honorable Jerry Moran
Chair
The Honorable Chris Van Hollen
Ranking Member
Subcommittee on Commerce, Justice, Science, and Related Agencies
Committee on Appropriations
United States Senate

The Honorable Jerry Moran
Chair
The Honorable Tammy Duckworth
Ranking Member
Subcommittee on Aviation, Space, and Innovation
Committee on Commerce, Science, and Transportation
United States Senate

The Honorable Hal Rogers
Chairman
The Honorable Grace Meng
Ranking Member
Subcommittee on Commerce, Justice, Science, and Related Agencies
Committee on Appropriations
House of Representatives

The Honorable Mike Haridopolos
Chairman
The Honorable Valerie Foushee
Ranking Member
Subcommittee on Space and Aeronautics
Committee on Science, Space, and Technology
House of Representatives

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Appendix I: Individual Project Summaries

In the following section, we present 38 project summaries:

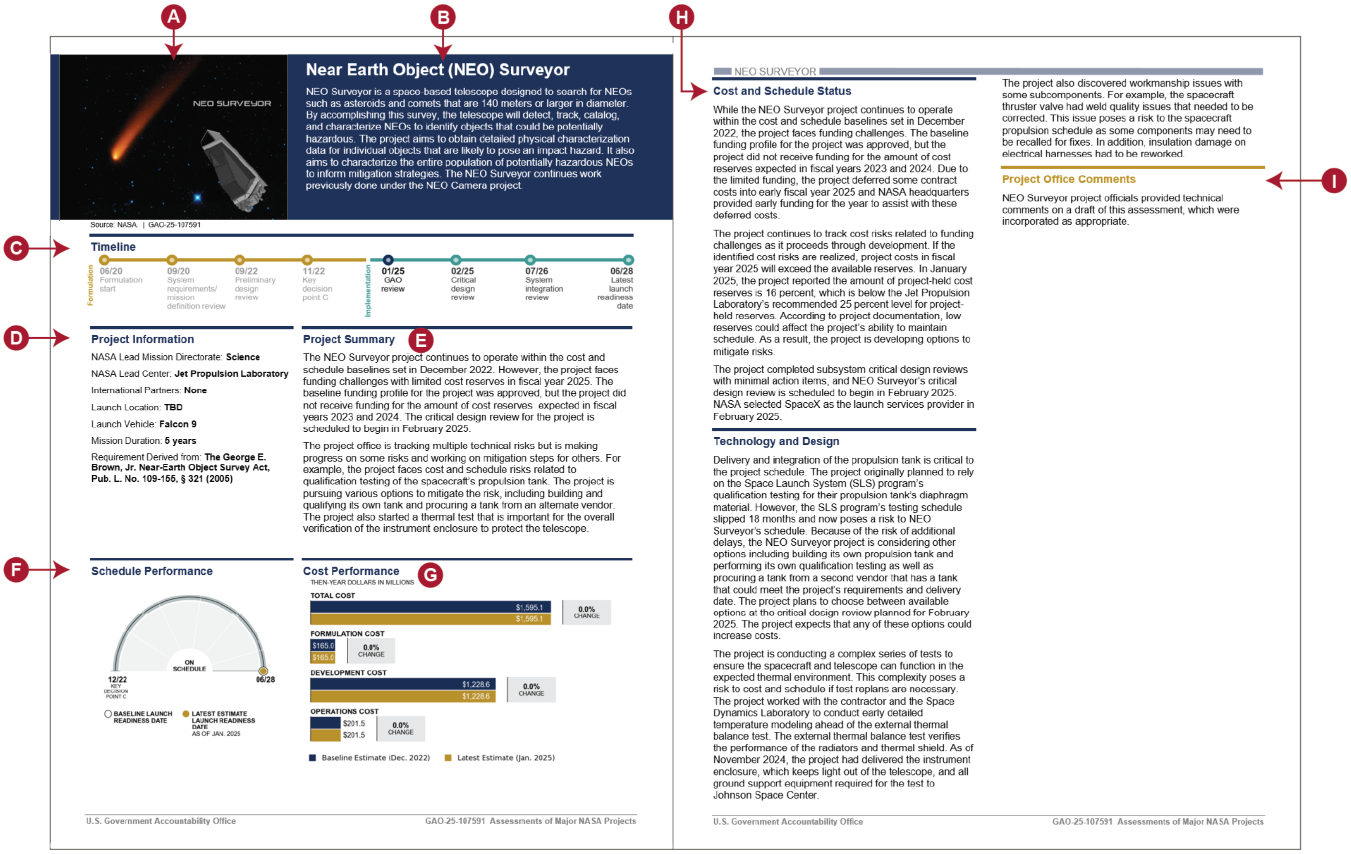
- There are 27 assessments in a two-page or one-page profile format. We provide assessments for projects and programs that have proceeded past their preliminary design review or that the National Aeronautics and Space Administration (NASA) has designated as category 1.
    - Each of these assessments generally includes a description of the project or program's objectives; information about the NASA centers and international partners involved in the project; the project's cost and schedule performance; and a brief narrative describing the current status of the project. These assessments also describe the challenges we identified. We outline the extent to which each project faces cost, schedule, or performance risks, if applicable.
    - Two-page assessments include a timeline identifying key project dates; a section on the cost and schedule status; and project office comments. Other sections are based on the major activities or risks for the individual project.
    - One-page assessments were generally for projects that did not identify several major challenges this year.
    - For Mars Sample Return, we generated a two-page assessment to include a graphic of the different architectures under consideration.
- There are 11 descriptions of projects that are early in formulation—or have not yet held preliminary design review—and that NASA has not designated as category 1.

We also included an infographic of NASA's Artemis missions, including the projects involved and timing of each mission, as well as a notional depiction of the key activities of mission.

We provided NASA's project offices with an opportunity to review drafts of the summaries and the Artemis infographic prior to their inclusion in this report. The project offices provided both technical corrections and general comments. We integrated the technical corrections as appropriate and summarized the general comments at the end of each project assessment.

See figure 7 for an illustration of an example assessment layout. Additional source information for images and figures can be found in appendix IX.

Figure 7: Illustration of an Example Project Assessment



Near Earth Object (NEO) Surveyor

NEO Surveyor is a space-based telescope designed to search for NEOs such as asteroids and comets that are 140 meters or larger in diameter. By accomplishing this survey, the telescope will detect, track, catalog, and characterize NEOs to identify objects that could be potentially hazardous. The project aims to obtain detailed physical characterization data for individual objects that are likely to pose an impact hazard. It also aims to characterize the entire population of potentially hazardous NEOs to inform mitigation strategies. The NEO Surveyor continues work previously done under the NEO Camera project.

Source: NASA. | GAO-25-107591

Timeline

Project Information

NASA Lead Mission Directorate: **Science**

NASA Lead Center: **Jet Propulsion Laboratory**

International Partners: **None**

Launch Location: **TBD**

Launch Vehicle: **Falcon 9**

Mission Duration: **5 years**

Requirement Derived from: **The George E. Brown, Jr. Near-Earth Object Survey Act, Pub. L. No. 109-155, § 321 (2005)**

Project Summary

The NEO Surveyor project continues to operate within the cost and schedule baselines set in December 2022. However, the project faces funding challenges with limited cost reserves in fiscal year 2025. The baseline funding profile for the project was approved, but the project did not receive funding for the amount of cost reserves expected in fiscal years 2023 and 2024. The critical design review for the project is scheduled to begin in February 2025.

The project office is tracking multiple technical risks but is making progress on some risks and working on mitigation steps for others. For example, the project faces cost and schedule risks related to qualification testing of the spacecraft's propulsion tank. The project is pursuing various options to mitigate the risk, including building and qualifying its own tank and procuring a tank from an alternate vendor. The project also started a thermal test that is important for the overall verification of the instrument enclosure to protect the telescope.

Schedule Performance

Cost Performance

U.S. Government Accountability Office

GAO-25-107591 Assessments of Major NASA Projects

NEO SURVEYOR

Cost and Schedule Status

While the NEO Surveyor project continues to operate within the cost and schedule baselines set in December 2022, the project faces funding challenges. The baseline funding profile for the project was approved, but the project did not receive funding for the amount of cost reserves expected in fiscal years 2023 and 2024. Due to the limited funding, the project deferred some contract costs into early fiscal year 2025 and NASA headquarters provided early funding for the year to assist with these deferred costs.

The project continues to track cost risks related to funding challenges as it proceeds through development. If the identified cost risks are realized, project costs in fiscal year 2025 will exceed the available reserves. In January 2025, the project reported the amount of project-held cost reserves is 16 percent, which is below the Jet Propulsion Laboratory's recommended 25 percent level for project-held reserves. According to project documentation, low reserves could affect the project's ability to maintain schedule. As a result, the project is developing options to mitigate risks.

The project completed subsystem critical design reviews with minimal action items, and NEO Surveyor's critical design review is scheduled to begin in February 2025. NASA selected SpaceX as the launch services provider in February 2025.

Technology and Design

Delivery and integration of the propulsion tank is critical to the project schedule. The project originally planned to rely on the Space Launch System (SLS) program's qualification testing for their propulsion tank's diaphragm material. However, the SLS program's testing schedule slipped 18 months and now poses a risk to NEO Surveyor's schedule. Because of the risk of additional delays, the NEO Surveyor project is considering other options including building its own propulsion tank and performing its own qualification testing as well as procuring a tank from a second vendor that has a tank that could meet the project's requirements and delivery date. The project plans to choose between available options at the critical design review planned for February 2025. The project expects that any of these options could increase costs.

The project is conducting a complex series of tests to ensure the spacecraft and telescope can function in the expected thermal environment. This complexity poses a risk to cost and schedule if test replans are necessary. The project worked with the contractor and the Space Dynamics Laboratory to conduct early detailed temperature modeling ahead of the external thermal balance test. The external thermal balance test verifies the performance of the radiators and thermal shield. As of November 2024, the project had delivered the instrument enclosure, which keeps light out of the telescope, and all ground support equipment required for the test to Johnson Space Center.

The project also discovered workmanship issues with some subcomponents. For example, the spacecraft thruster valve had weld quality issues that needed to be corrected. This issue poses a risk to the spacecraft propulsion schedule as some components may need to be recalled for fixes. In addition, insulation damage on electrical harnesses had to be reworked.

Project Office Comments

NEO Surveyor project officials provided technical comments on a draft of this assessment, which were incorporated as appropriate.

U.S. Government Accountability Office

GAO-25-107591 Assessments of Major NASA Projects

Ⓐ Illustration of the spacecraft, instrument, aircraft, launch vehicle, ground system, or space suit.

Ⓑ General description of the mission's objectives.

Ⓒ **Timeline** identifying key dates for the project including when the project began formulation, held major design reviews, began implementation after key decision point (KDP) C, and launched or fielded an operating capability.

Ⓓ **Project Information:** Information on the responsible NASA center and lead mission directorate, international partners, launch plans, mission duration, and the source of the mission's requirements.

Ⓔ **Project Summary:** Brief narrative describing the current status of the project.

Ⓕ **Schedule:** For projects in formulation, the preliminary launch readiness target date or range of dates. For projects in implementation, the approved schedule baseline and latest estimate.

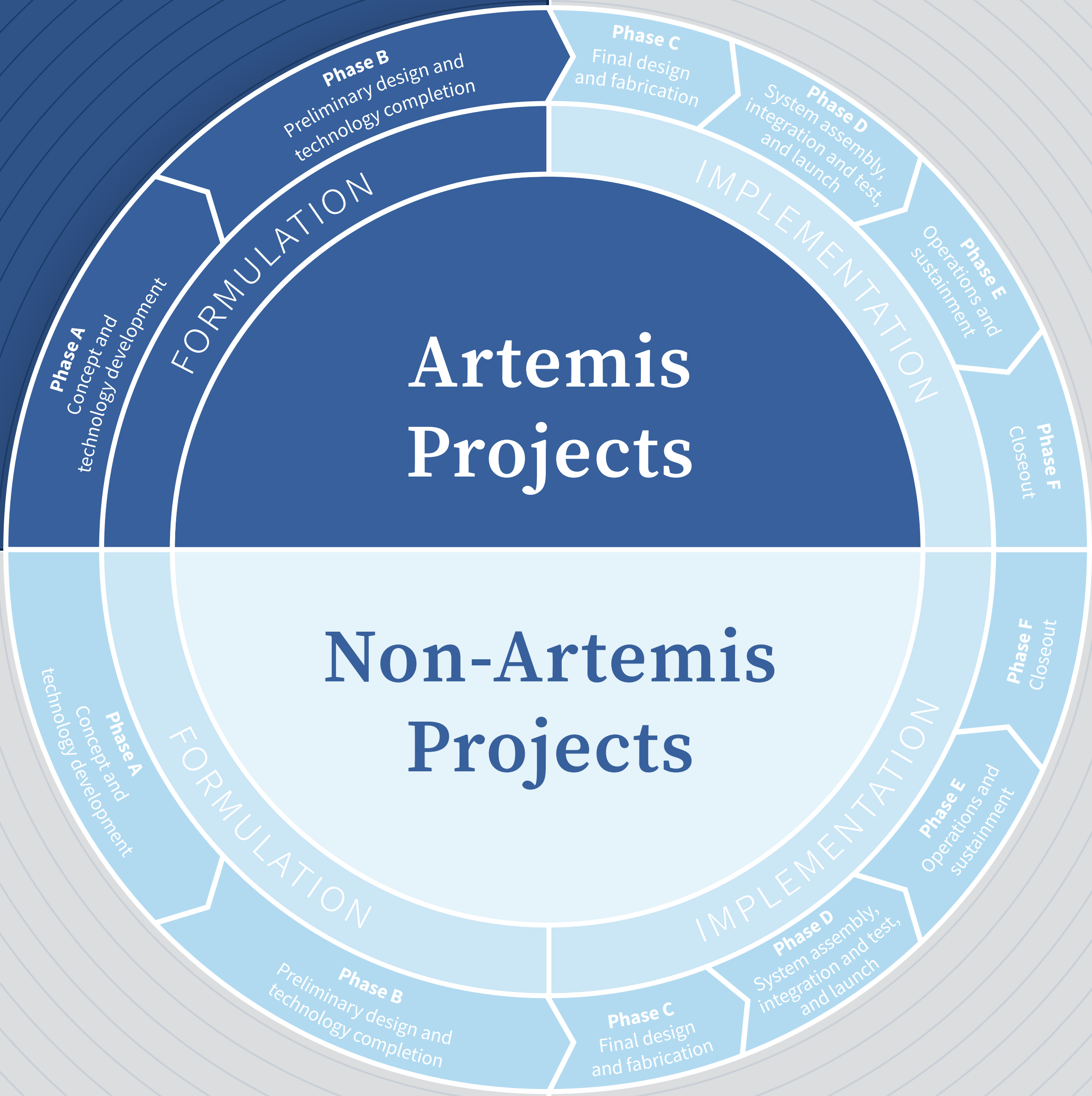
Ⓖ **Cost:** For projects in formulation, the preliminary cost estimate. For projects in implementation, the approved cost baseline and latest estimate.

Ⓗ The second page of the assessment includes a section on the cost and schedule status and project office comments. Other sections are based on the major activities or risks for the individual project.

Ⓘ **Project Office Comments:** General comments provided by the cognizant project office.

Source: GAO analysis. | GAO-25-107591

- Extravehicular Activity and Human Surface Mobility Program **(EHP)** - Extravehicular Activity **(EVA)** Development
- EHP – Lunar Terrain Vehicle **(LTV)**
- Human Landing System **(HLS)** – Sustaining Lunar Development **(SLD)**
- Space Launch System **(SLS)** Block 2



Source: GAO analysis of NASA data. | GAO-25-107591

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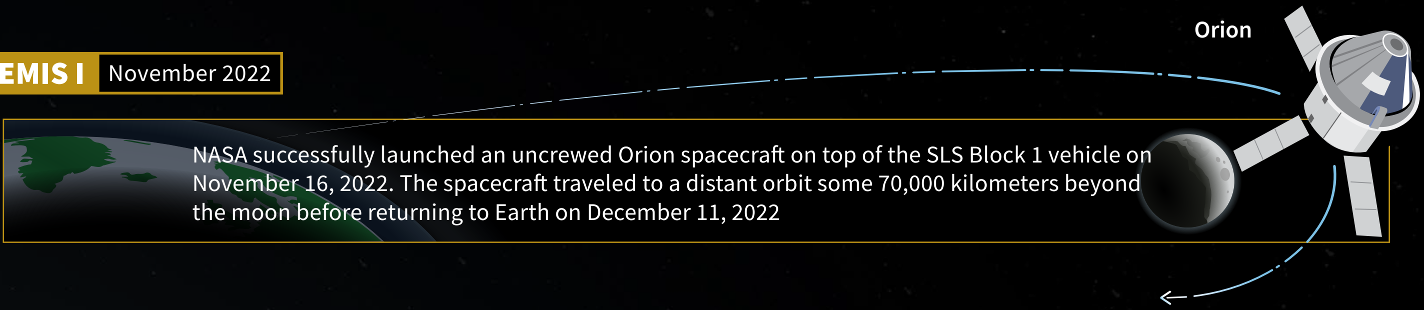
MAJOR NASA PROJECTS AND PROGRAMS SUPPORTING ARTEMIS MISSIONS

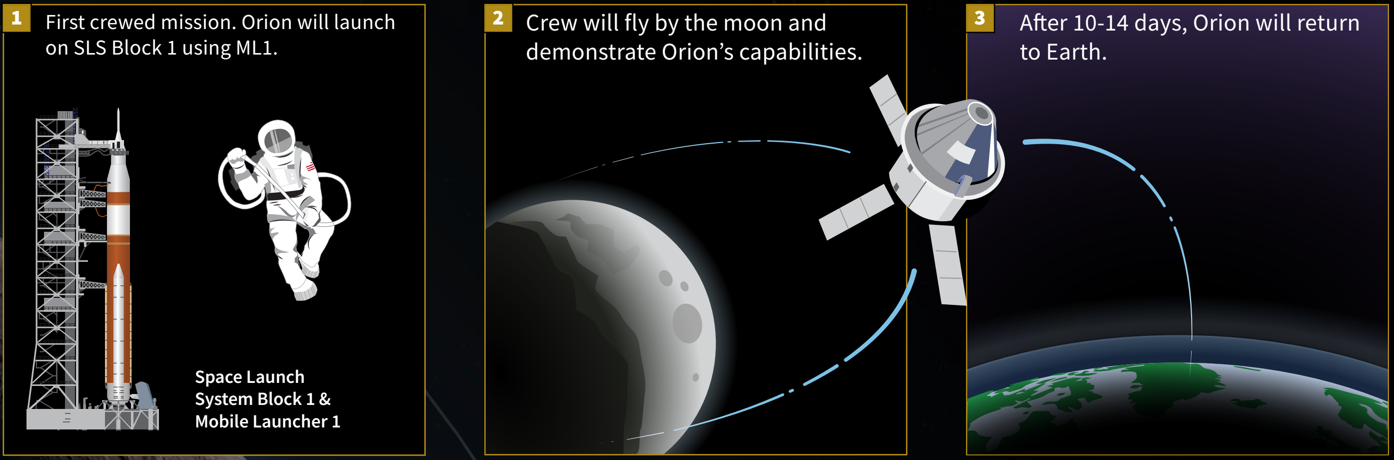
NASA broadly refers to its series of missions to return astronauts into lunar orbit and onto the lunar surface as Artemis. These missions require extensive coordination across NASA programs, contractors, and international partners. Initial missions will focus on establishing a long-term presence around the moon and later missions will focus on sending the first astronauts to Mars. The graphics below and on the following page are high-level, notional summaries of the key activities for each mission.

ARTEMIS I November 2022



NASA successfully launched an uncrewed Orion spacecraft on top of the SLS Block 1 vehicle on November 16, 2022. The spacecraft traveled to a distant orbit some 70,000 kilometers beyond the moon before returning to Earth on December 11, 2022

ARTEMIS II April 2026



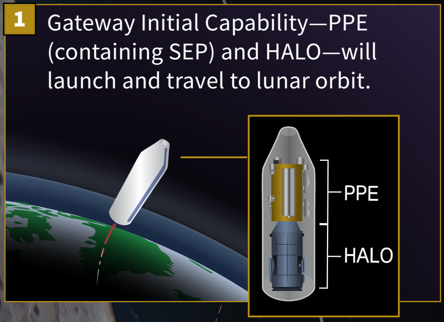
1. First crewed mission. Orion will launch on SLS Block 1 using ML1.
2. Crew will fly by the moon and demonstrate Orion's capabilities.
3. After 10-14 days, Orion will return to Earth.

ARTEMIS III Mid 2027

1. SpaceX's Starship containing new lunar EVA space suits will launch and refill with fuel before traveling to lunar orbit.
2. Crew will launch in Orion on SLS Block 1 using ML1.
3. Orion will dock with Starship in lunar orbit.
4. Crew will land Starship on lunar surface and conduct operations in new suits.
5. Crew will return to Orion in Starship.
6. Crew will return to Earth in Orion.

Source: GAO analysis of NASA documentation (data and images); manuelhuss/stock.adobe.com (moon image); SpaceX (Starship image); NASA (Artemis logo). | GAO-25-107591

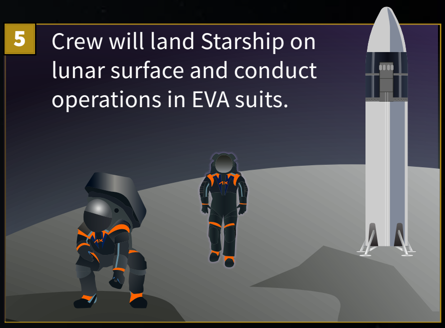
ARTEMIS IV September 2028

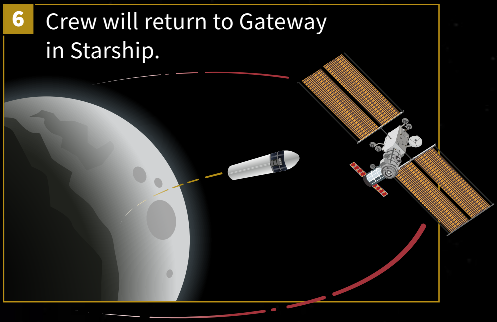

1 Gateway Initial Capability—PPE (containing SEP) and HALO—will launch and travel to lunar orbit.

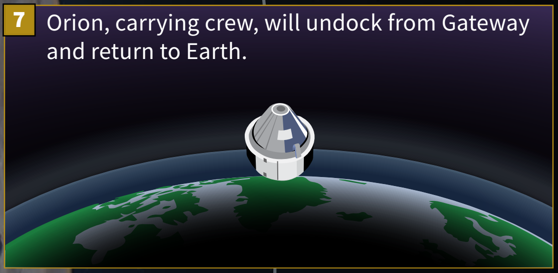

2 Starship containing lunar EVA space suits will launch and refill with fuel before traveling to lunar orbit.

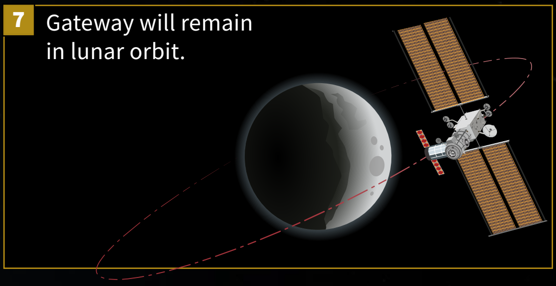

3 Crew will launch in Orion with the I-HAB element of Gateway on the SLS Block 1B using ML2.


4 Orion, I-HAB, and Starship will separately dock with Gateway.


5 Crew will land Starship on lunar surface and conduct operations in EVA suits.

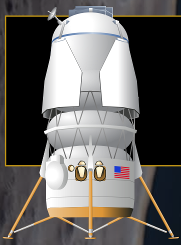

6 Crew will return to Gateway in Starship.

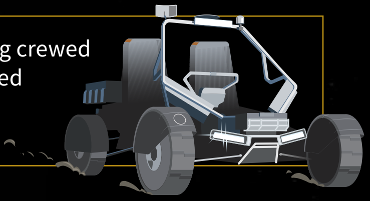

7 Orion, carrying crew, will undock from Gateway and return to Earth.


7 Gateway will remain in lunar orbit.

ARTEMIS V March 2030

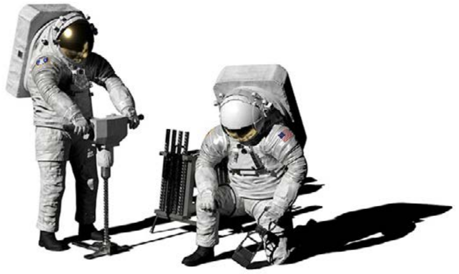
Artemis V will add capabilities to the Gateway and lunar operations to support a lasting crewed presence on the moon. These additional capabilities include internationally contributed modules to the Gateway; a second lunar lander provided by Blue Origin, called Blue Moon; and a lunar terrain vehicle.


Human Landing System - Blue Moon


Lunar terrain vehicle (notional)

Legend:
Extravehicular Activity **(EVA)**
Habitation and Logistics Outpost **(HALO)**
International Habitat **(I-HAB)**
Lunar Terrain Vehicle **(LTV)**
Mobile Launcher 1 **(ML1)**
Mobile Launcher 2 (ML2)
Orion Multi-Purpose Crew Vehicle **(Orion)**
Power and Propulsion Element **(PPE)**
Solar Electric Propulsion **(SEP)**
Space Launch System **(SLS)**

Source: GAO analysis of NASA documentation (data and images); manuelhuss/stock.adobe.com (moon image); SpaceX (Starship image); Blue Origin (Blue Moon image); Analytical Mechanics Associates (LTV image). | GAO-25-107591



Source: NASA. | GAO-25-107591

Extravehicular Activity and Human Surface Mobility Program (EHP) – Extravehicular Activity (EVA) Development Project

The EVA Development project is responsible for providing space suits and other hardware to support astronaut activities on the lunar surface for Artemis missions and the International Space Station (ISS). The project office oversees the contractor that will demonstrate, certify, and deliver: (1) tools the crew will use for science and maintenance tasks; (2) interfaces the crew will use to connect to other systems, like the Human Landing System (HLS) and ISS; and (3) space suits, including the portable life-support backpack and the pressurized garment that wraps around the astronauts. EHP manages the EVA Development project.

Timeline

Project Information

NASA Lead Mission Directorate: **Exploration Systems Development**

NASA Lead Center: **Johnson Space Center**

International Partners: **None**

Launch Location: **N/A**

Launch Vehicle: **HLS and Commercial Resupply Services**

Mission Duration: **10 years**

Requirement Derived from: **NASA Strategic Plan**

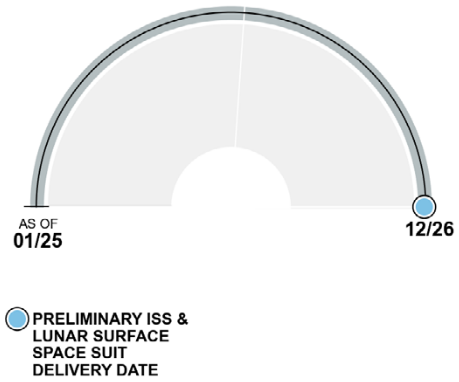
Project Summary

In June 2024, NASA reported that NASA and Collins mutually agreed to end Collins's development efforts on the ISS space suit. NASA authorized Axiom to continue work on the ISS space suit development through the critical design review, and modified Axiom's Artemis EVA demonstration task order to include an improved telecommunications demonstration during the Artemis III mission. Axiom successfully completed the Artemis and ISS preliminary design reviews in March 2024 and December 2024, respectively.

Project officials stated that NASA and Axiom will complete a joint lunar and ISS space suit critical design review in early 2026. Further, these project officials said that NASA and Axiom will conduct a vacuum chamber test of the lunar space suits in early 2026 as part of the critical design review milestone. Axiom will mature several critical technologies after successful completion of the vacuum chamber test, including the portable life-support system backplate.

According to EVA Development risk documentation, the project's top risks include Axiom's space suit design not meeting certain NASA requirements and having one space suit provider. These risks could cause schedule delays that affect Axiom's delivery of the space suits.

Preliminary Schedule



Preliminary Cost

THEN-YEAR DOLLARS IN MILLIONS

Cost and Schedule Status

In June 2024, NASA reported that NASA and Collins mutually agreed to descope Collins's ISS space suit task orders and that this ended Collins's ISS space suit demonstration. According to NASA officials, Collins delayed completing its preliminary design review from June 2023 to April 2024 due to a notable amount of incomplete work. NASA officials said they planned to have Axiom and Collins achieve preliminary design review by spring 2024.

In 2024, NASA authorized Axiom to continue work on ISS space suit development through the critical design review, under a task order that includes an option for further ISS suit demonstration. To address the risk that Collins might encounter performance issues, NASA previously issued a task order to Axiom to begin work on an ISS suit through the certification baseline review.

In May 2024, NASA modified Axiom's Artemis EVA demonstration task order to include the Artemis Communications Demonstration during the Artemis III mission. Project officials said this demonstration is a telecommunications effort to improve communication between the lunar space suits and the HLS lander at greater distances.

Axiom successfully completed preliminary design reviews for both the Artemis and ISS suits in March 2024 and December 2024, respectively. NASA held the project-level preliminary design review-informed sync review in August 2024. Project officials stated that they closed the review based on their risk assessment that Axiom would be able to meet NASA's expectations, but only for the Artemis III mission. The project plans to complete a second sync review in June 2025 to assess Axiom's ISS space suit development before holding the KDP C milestone.

After KDP C, NASA and Axiom will conduct several additional reviews of the space suit design, including a critical design review and sync review. Project officials stated that NASA and Axiom will complete a joint lunar and ISS space suit critical design review in early 2026. NASA plans to hold the critical design review-informed sync review in 2026 after Axiom's completion of the joint lunar and ISS space suit critical design review.

Technology and Design

Project officials said that NASA and Axiom will conduct human testing, including a vacuum chamber test of the lunar space suits, in early 2026. Axiom is required to complete the vacuum chamber test of the space suit as part of the critical design review milestone.

Axiom will mature several critical technologies after successful completion of the vacuum chamber test, including the portable life-support system backplate, multi-gas sensors, and thermal loop pumps. The portable life-support system backplate is the base for other life-support components. The multi-gas sensors are used to detect potentially hazardous carbon dioxide concentrations in the suit. The thermal loop pumps provide the water flow to control the temperature in the suit. Project officials stated that production activities for the qualification suit are driving the schedule, particularly the assembly of the backplate for the portable life-support system. The backplate must be completed before other components of the life-support system can be assembled for the first qualification unit of the space suit.

Axiom expects the space suit for both the Artemis and ISS missions to be nearly identical. Key changes are primarily associated with the pressure garment system given the differences in the ISS microgravity environment compared to the lunar surface. Project officials stated that more robust changes between the space suits will accommodate the interconnections between the Axiom suit design and the ISS, which is an older system. These changes will enable the ISS to provide life-support resources such as oxygen and water to the space suit. Project officials said Axiom designed the lunar suit interfaces to connect with the HLS Starship, which is a more modernized system connection than between the lunar suits and the ISS.

Other Issues to Be Monitored

The project is tracking several risks related to Artemis and ISS space suit development. According to project documentation, one of the project's top risks is that Axiom's space suit design currently does not meet certain NASA requirements. For example, Axiom's system exceeds the allowable mass and requires more resources (such as oxygen and water) than NASA allocated. If Axiom's design continues to not meet performance requirements, it could cause schedule delays for final delivery of the suit to NASA.

The project is also tracking a risk related to having one space suit provider. According to NASA risk documentation, this could lead to delays in critical milestones and increased costs, thereby jeopardizing overall mission success. Project officials are working to mitigate the risk by collaborating more closely with Axiom to develop joint test plans and other required project documents and enabling Axiom to conduct more pressurized suit testing. The project plans to reduce risk by increasing pressurized suit testing time.

Project Office Comments

In commenting on a draft of this assessment, project officials stated that the EVA Development project office, within EHP, expects to complete Axiom's critical design review for the Artemis III and ISS demonstration task orders in late 2025 or early 2026. They said that the project has completed the in-room portion of the preliminary design review-informed sync review and plans to complete it in June 2025, after which the project will proceed to KDP C in late-summer 2025. Officials further stated that the project office continues to put emphasis on risk mitigations, especially regarding the single vendor risk. Officials also provided technical comments, which were incorporated as appropriate.

Source: Analytical Mechanics Associates. | GAO-25-107591

Extravehicular Activity and Human Surface Mobility Program (EHP) – Lunar Terrain Vehicle (LTV)

The LTV is a transportation system that will enable crew members to explore the lunar surface and allow NASA to conduct remote science operations. NASA intends for the LTV to be available for the Artemis V mission—planned for 2030—and future missions. In addition to serving as a mode of transportation, the LTV will: (1) transport and deploy small payloads; (2) conduct science operations with its robotic arm; (3) produce multimedia content of landings, points of interest, and crew activities; and (4) support science activities between crewed missions.

Project Information

NASA Lead Mission Directorate: **Exploration Systems Development**

NASA Lead Center: **Johnson Space Center**

International Partners: **None**

Launch Location: **To be determined by LTV contractor(s)**

Launch Vehicle: **To be determined by LTV contractor(s)**

Mission Duration: **10 years**

Requirement Derived from: **Space Policy Directive 1, and 2022 NASA Strategic Plan**

Next Major Project Event: **Key decision point B (February 2026 – Under Review)**

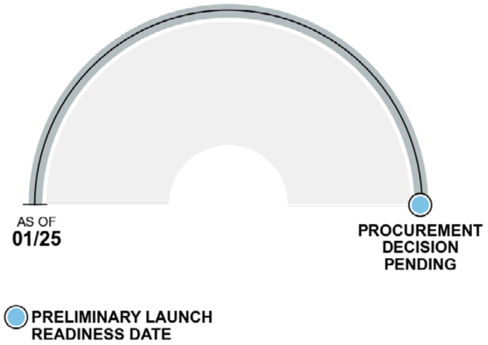
Project Summary

In March 2024, NASA awarded indefinite delivery/indefinite quantity contracts to three contractors—Intuitive Machines, Lunar Outpost, and Venturi Astrolab—and issued initial firm-fixed price task orders for the LTV feasibility assessment phase. The project expects this initial phase to last approximately 12 months, through preliminary design review. After this phase, the program plans to issue a task order to one contractor that would culminate in an uncrewed lunar surface demonstration. Each contractor completed its system requirements review by November 2024 and is working toward its individual preliminary design review in 2025.

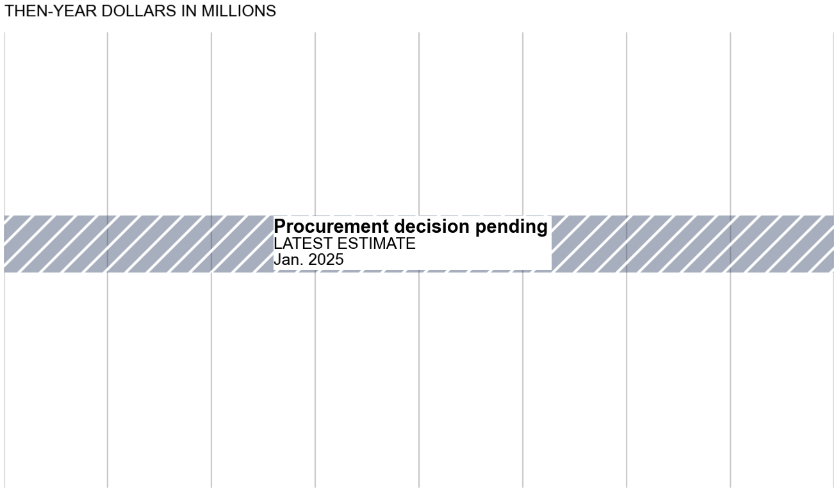
The project performed fit checks with Axiom's space suit in the project's Ground Test Unit, and with the contractors' LTV mockups. Using a system that simulates lunar gravity, the program completed joint testing with the space suits and the contractors' mockups.

According to the project, there are risks related to LTV's launch vehicle and lander technology maturity. To mitigate both risks, the project plans to participate in the oversight of the contractors' LTV designs and approaches for system that will deliver it to the lunar surface. The project also expects to conduct contractor delivery system concept reviews at the end of the feasibility phase, in the second quarter of fiscal year 2025.

Preliminary Schedule



Preliminary Cost



Project Office Comments

LTV project officials provided technical comments on a draft of this assessment, which were incorporated as appropriate.

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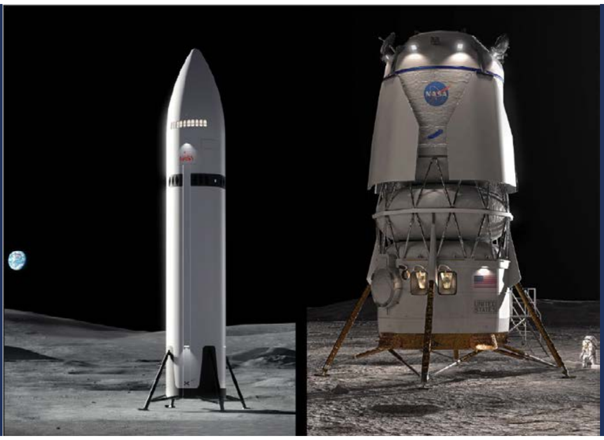


Source: SpaceX and Blue Origin. | GAO-25-107591

Human Landing System (HLS) – Sustaining Lunar Development (SLD)

The HLS program's SLD effort will demonstrate expanded capabilities beyond Artemis III to support a lasting crewed presence on the moon. These capabilities include transporting additional crew, docking with the Gateway—a sustainable outpost in lunar orbit—and operating near the lunar south pole for extended durations. SpaceX and Blue Origin will each develop lunar landers to deliver these expanded capabilities for the Artemis IV and V missions, respectively. NASA will certify that the lunar lander designs meet NASA requirements and are safe for crew.

Project Information

NASA Lead Mission Directorate: **Exploration Systems Development**

NASA Lead Center: **Marshall Space Flight Center**

International Partners: **None**

Launch Location: **Blue Origin–Cape Canaveral, FL; and SpaceX–multiple launch locations**

Launch Vehicle: **Blue Origin–New Glenn; and SpaceX–Super Heavy Booster**

Mission Duration: **6–33 days**

Requirement Derived from: **Space Policy Directive 1**

Next Major Project Event: **Blue Origin–Critical Design Review; and SpaceX–Preliminary Design Review**

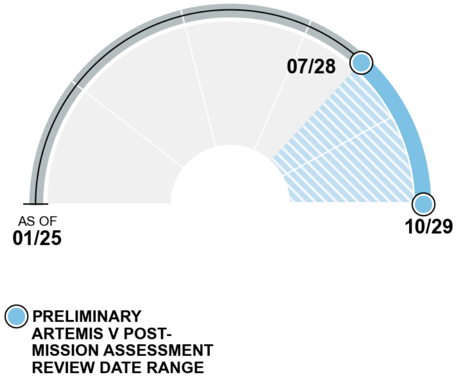
Project Summary

SpaceX and Blue Origin are working toward their next design reviews. SpaceX held an SLD certification baseline review in May 2023 and is working toward its preliminary design review in August 2025. SpaceX and NASA also plan to hold the HLS Initial Capability critical design review in 2025. Blue Origin held a preliminary design review in February 2024 and plans to complete its critical design review in August 2025.

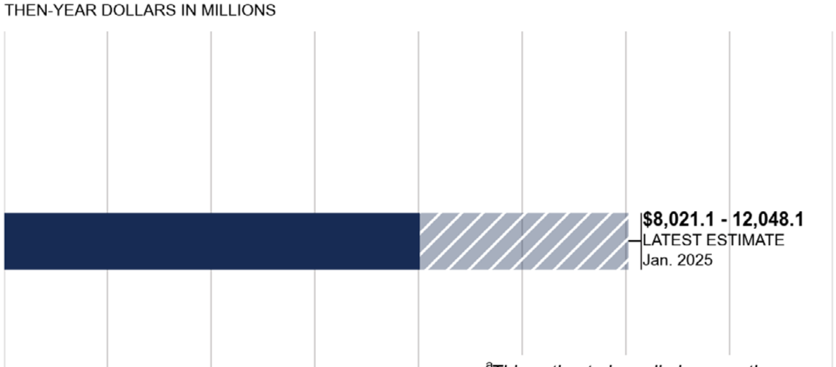
HLS officials said Blue Origin had to conduct additional work after its preliminary design review because its lunar lander design did not meet NASA's propellant and mass requirements. These officials said that Blue Origin completed additional design analysis and showed progress in meeting the mass requirement. Blue Origin conducted New Glenn's first flight—reaching its intended orbit and deploying its payload—in January 2025. It plans to conduct additional test flights to achieve NASA's Launch Services Program certification, among other things. Blue Origin plans to conduct New Glenn's second flight in spring 2025.

NASA is tracking a risk for each provider related to inadequate controls for flammable materials. The amount of oxygen and cabin pressure in the SLD lander atmosphere could create conditions for fire propagation, potentially resulting in loss of mission or crew. The project is conducting tests to better understand material flammability in the lander and techniques to prevent fires from starting and spreading.

Preliminary Schedule



Preliminary Cost[a]



[a]*This estimate is preliminary as the project is in formulation, and there is uncertainty regarding the costs associated with the design options being explored. NASA uses these estimates for planning purposes.*

Project Office Comments

HLS program officials provided technical comments on a draft of this assessment, which were incorporated as appropriate.

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Space Launch System (SLS) Block 2

The SLS Block 2 is a planned evolution of the SLS Block 1B. NASA plans for Block 2 to become the workhorse vehicle for sending cargo to the Moon, Mars, and other deep space destinations. Block 2 will retain the core stage, RS-25 engines, and Exploration Upper Stage used on SLS Block 1B but replace the two shuttle-derived solid rocket boosters with improved advanced boosters. The advanced boosters will allow heavier payloads to be lifted into space. SLS Block 2 will lift up to 130 metric tons of payload to low-Earth orbit—the heaviest planned SLS payload thus far—for future Artemis missions.

Source: NASA. | GAO-25-107591

Project Information

NASA Lead Mission Directorate: **Exploration Systems Development**

NASA Lead Center: **Marshall Space Flight Center**

International Partners: **None**

Launch Location: **Kennedy Space Center, FL**

Launch Vehicle: **N/A**

Mission Duration: **Varied based on destination**

Requirement Derived from: **NASA Authorization Act of 2010**

Next Major Project Event: **Key Decision Point C (To be determined)**

Project Summary

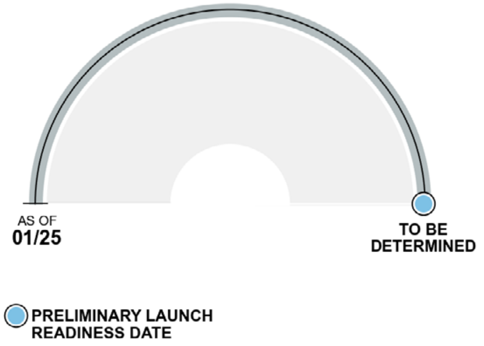
NASA has not yet established formal cost baselines or preliminary cost estimates for SLS Block 2. It did, however, establish some preliminary schedules. NASA is planning to establish formal cost and schedule baselines for SLS Block 2 no earlier than mid-2027. It plans to fly the SLS Block 2 for the first time on Artemis IX, no earlier than March 2034.

In 2020, NASA awarded a contract for Booster Obsolescence and Life Extension (BOLE) development to support Artemis IX. The BOLE effort represents the most significant design change on the SLS Block 2 vehicle. Officials stated that the BOLE effort includes developing a new, more powerful booster with new carbon fiber composite casings and addressing electronic parts obsolescence issues.

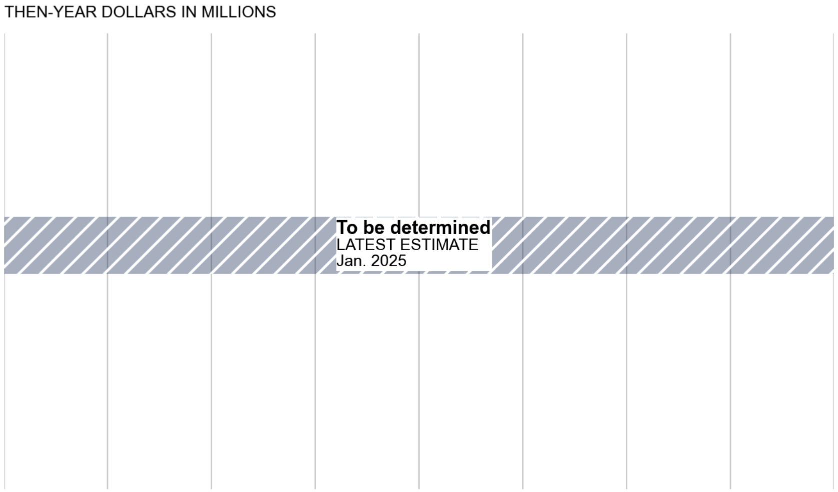
NASA completed the BOLE preliminary design review in January 2025, and the contractor has cast the five motor segments necessary for conducting full-scale hot fire booster ground testing scheduled for June 2025. The program expects to use the results of these activities to inform schedules for the SLS Block 2 program level preliminary design and critical design reviews, as well as integrated mission planning.

One of NASA's top risks for SLS Block 2 is that loads analysis—which evaluates the structural integrity of a rocket during launch—may reveal the need for additional analysis, testing, or costly redesigns later in development.

Preliminary Schedule



Preliminary Cost



Project Office Comments

The SLS Block 2 project office was provided with a draft of this assessment and did not have any technical corrections or comments.

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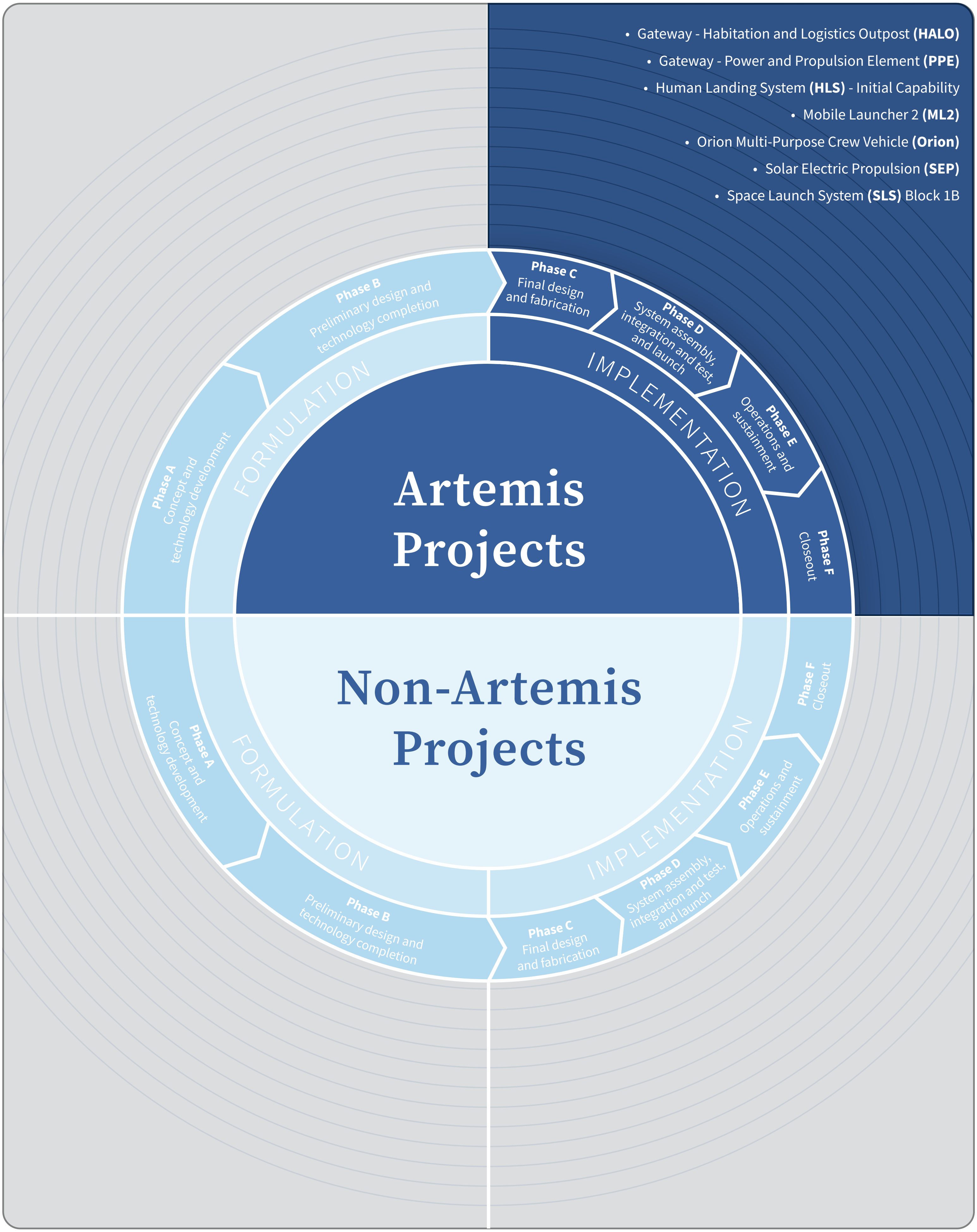

- Gateway - Habitation and Logistics Outpost **(HALO)**
- Gateway - Power and Propulsion Element **(PPE)**
- Human Landing System **(HLS)** - Initial Capability
- Mobile Launcher 2 **(ML2)**
- Orion Multi-Purpose Crew Vehicle **(Orion)**
- Solar Electric Propulsion **(SEP)**
- Space Launch System **(SLS)** Block 1B

Source: GAO analysis of NASA data. | GAO-25-107591

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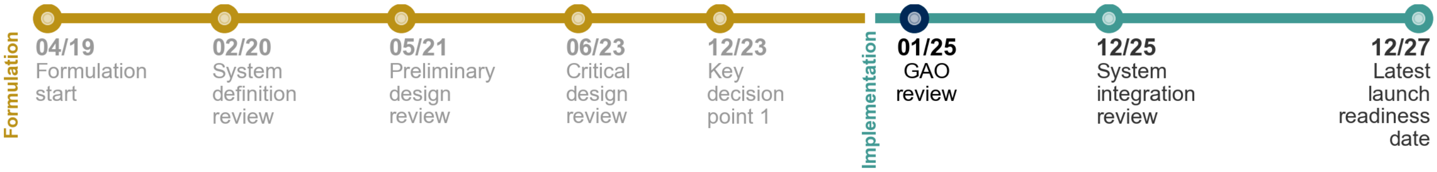
Gateway – Habitation and Logistics Outpost (HALO)

The HALO will be the initial crew module for the Gateway. It will provide living quarters, as well as communication functions to the lunar surface and for visiting vehicles. It will also augment life support functions in conjunction with NASA's Orion Multi-Purpose Crew Vehicle. The HALO will also have docking ports to connect with other components. NASA plans to integrate the HALO and the Power Propulsion Element (PPE) on the ground and launch them together, known as comanifesting. The HALO project is responsible for managing the integration, test, and launch of the comanifested PPE and HALO.

Source: NASA. | GAO-25-107591

Timeline



Project Information

NASA Lead Mission Directorate: **Exploration Systems Development**

NASA Lead Center: **Johnson Space Center**

International Partners: **European Space Agency, Japan Aerospace Exploration Agency, Canadian Space Agency**

Launch Location: **Kennedy Space Center, FL**

Launch Vehicle: **Falcon Heavy**

Mission Duration: **15 years**

Requirement Derived from: **Space Policy Directive 1 and 2018 NASA Strategic Plan**

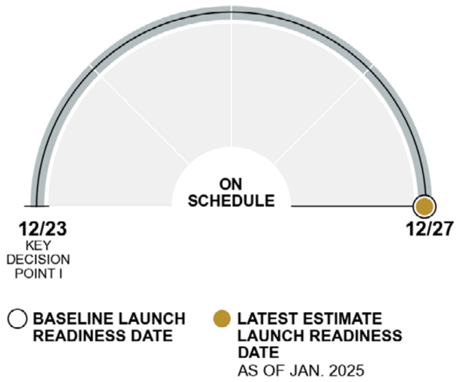
Project Summary

The HALO project is operating within the cost and schedule baselines established for the Gateway Initial Capability—comprised of the PPE and the HALO—in December 2023.

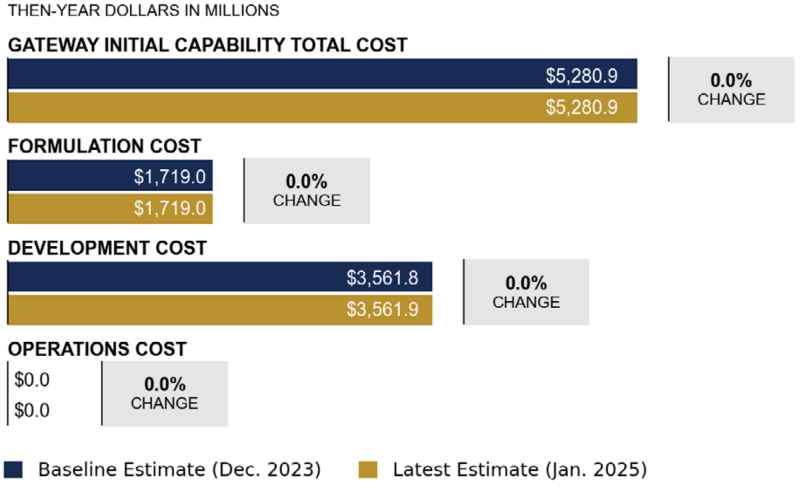
The HALO project is experiencing delays to its internal testing and review schedule. The project delayed its system integration review by 13 months due to delays in primary structure testing and module delivery.

The HALO project faces several challenges as it advances to its system integration review in December 2025. First, the HALO project continues to experience challenges related to the comanifested vehicle exceeding its mass allocation. The HALO's mass is the primary driver of the overage. The HALO project is working to identify additional opportunities for mass reduction and is assessing how the mass reduction opportunities will impact the project's overall schedule. Additionally, the project is tracking a risk that the communication network that links the integrated Gateway vehicle, might not work as planned.

Schedule Performance



Cost Performance



Cost and Schedule Status

The HALO project is operating within the cost and schedule baselines established in December 2023 for the Gateway Initial Capability, which is both the HALO and the PPE together as a comanifested vehicle. The cost baseline of $5.3 billion includes the costs for the initial capability, the launch vehicle, and program support for integration and launch. The HALO project makes up a little more than one-third of the overall cost. The schedule baseline is the comanifested vehicle launch readiness date of December 2027. The HALO project is working to an October 2026 delivery date of the HALO module to the Gateway program for integration with the PPE.

The HALO project is working with its contractor, the PPE project, NASA, and its international partners to update its internal project schedule. Program officials stated that the comanifested vehicle needs to launch at least a year before the September 2028 Artemis IV mission to allow time for the vehicle to transit from Earth to the moon and prepare for docking. Therefore, NASA would need to integrate the HALO and the PPE and launch them by September 2027 to support the mission.

The HALO project experienced delays to its internal testing and review schedule and delayed its system integration review by 13 months. It delayed and split the system integration review into two reviews, due to delays in primary structure testing and module delivery. The HALO project experienced delays in primary structure testing and module delivery because cracks were detected in the welds made in the primary structure after initial installation. The project mitigated the welding issues. The first system integration review will occur in March 2025, prior to module delivery. The second review will occur in December 2025 and project officials said that it will focus on environmental testing through completed assembly.

Project officials said they assembled a team to evaluate opportunities for internal schedule improvements. For example, to mitigate schedule risks, project officials said they may accelerate the timeline for the assembly, integration, and test phase; implement parallel work shifts; or expedite the mitigation of technical risks.

The project reported that in September 2024, it converted the baseline contract from a firm-fixed-price contract to a cost-plus-award-fee contract and extended the period of performance through May 2029. According to project officials, due to the update, the HALO contract value increased by $374 million, resulting in a new overall contract value of $1.7 billion. Project officials also reported that the contract negotiations included software and design updates such as additional software to integrate the vehicle system. Officials stated that the project made this change to address software integration challenges.

Technology and Design

The HALO project is progressing through its assembly, integration, and test phase and successfully completed critical environmental testing. Although the project is approaching its system integration review, several key technical challenges remain.

First, the HALO project continues to experience challenges related to the comanifested vehicle exceeding its mass allocation. The HALO’s mass is the primary driver of the overage and project officials said it is the largest area of concern for the whole Gateway mission design. Officials stated that as of December 2024, its predicted mass is 1,184 kilograms over its allocation.

To address this concern, the project identified about 1,000 kilograms of mass reduction opportunities and is developing a plan to implement them. For example, the project plans to optimize the size of the batteries on the HALO module, reducing its mass by 72 kilograms. Project officials said that after the identified mass reduction opportunities have been evaluated and a final list of changes are approved, they will understand the effect that the mass risk will have on the project’s schedule. As of February 2025, the project completed several mass reduction opportunity assessments, implemented two mass reduction designs, and continues to assess mass reduction opportunities.

A second technical challenge is that the communication network that links the integrated Gateway vehicle might not work as planned, which could result in loss of control of the Gateway. In October 2024, the project approved a design change to remove the external hardware for the communication network from the PPE and instead rely on the internal hardware for the communication network on the HALO. HALO project officials explained that this mitigation option is a major risk reduction—issues with hardware fixed to the outside of the spacecraft are likelier than issues with hardware fixed to the inside of the spacecraft as debris can affect externally fixed hardware. Further, officials said that removing external hardware from the PPE also reduces mass for the Gateway mission as wires will be used to connect the PPE to the HALO. Officials stated that no additional mass will be added to the HALO with this mitigation option.

Project Office Comments

In commenting on a draft of this assessment, HALO project officials reported that the project is working to identify additional opportunities for mass reduction while simultaneously evaluating the impacts of recently approved mass reduction opportunities to the project’s schedule. Project officials also provided technical comments on a draft of this assessment, which were incorporated as appropriate.

Gateway – Power and Propulsion Element (PPE)

The PPE will be a spacecraft that provides power, communication, and the ability to change orbits, among other things, to the Gateway—a sustainable outpost planned for lunar orbit. The PPE also aims to demonstrate advanced solar electric propulsion (SEP) technology to support future human space exploration. NASA is managing the development of SEP as a separate project. NASA plans to integrate the PPE and the Gateway's Habitation and Logistics Outpost (HALO) on the ground and launch them together. Integration of the HALO and the PPE will create one vehicle for launch, known as a comanifested vehicle.

Source: NASA. | GAO-25-107591

Timeline

Project Information

NASA Lead Mission Directorate: **Exploration Systems Development**

NASA Lead Center: **Glenn Research Center**

International Partners: **Canadian Space Agency, European Space Agency**

Launch Location: **Kennedy Space Center, FL**

Launch Vehicle: **Falcon Heavy**

Mission Duration: **15 years**

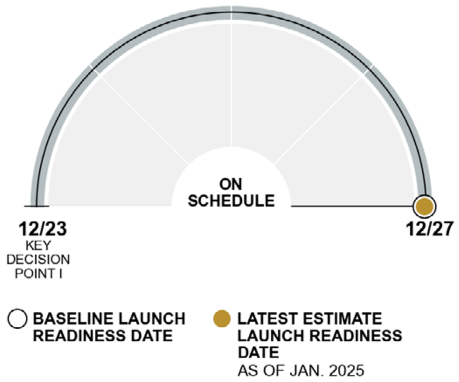
Requirement Derived from: **Space Policy Directive 1 and 2018 NASA Strategic Plan**

Project Summary

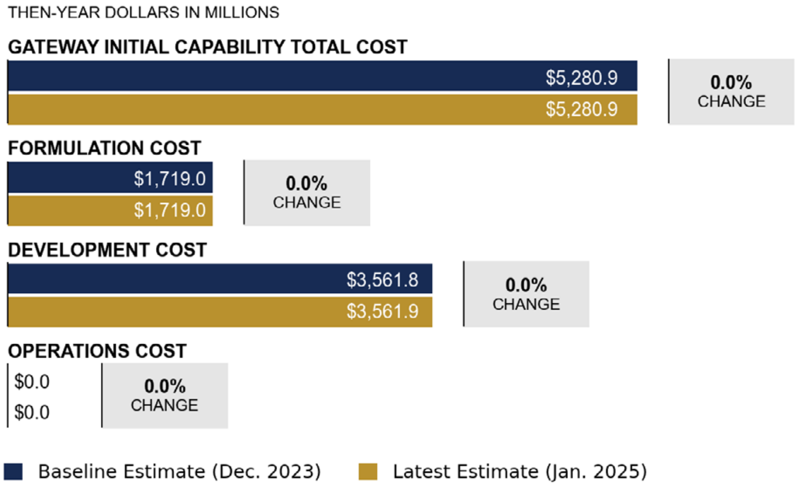
The PPE project continues to operate within cost and schedule baselines established for the Gateway Initial Capability—comprised of the PPE and the HALO—in December 2023. The total contract value is now over $1 billion due to requirements changes. Project officials said future contract modifications are expected to have minor effects on project cost and schedule relative to prior modifications.

The PPE project has made progress on integrating the spacecraft and on maturing its technologies and design, with plans to deliver the PPE for integration with the HALO in November 2026. In conjunction with the Gateway program, the project continues its efforts to reduce its mass to meet mass limits on the comanifested vehicle. The project is tracking risks related to the failure of critical hardware and testing procedures on the solar array, among others. It is also addressing a risk involving the PPE's ability to sufficiently control the Gateway's positioning on-orbit when larger and heavier visiting vehicles are docked with it.

Schedule Performance



Cost Performance



Cost and Schedule Status

The PPE project continues to operate within cost and schedule baselines established for the Gateway Initial Capability—which is comprised of the PPE and the HALO—in December 2023. The cost baseline of $5.3 billion includes the initial capability, the launch vehicle, and program support for integration and launch. The PPE project makes up a little less than one-third of the overall cost. The schedule baseline is for the comanifested vehicle launch readiness date of December 2027.

The project plans to deliver the PPE for integration with the HALO in November 2026. The PPE project continues to work with its contractor, the HALO and SEP projects, NASA, and its international partners to update its internal project schedule to align with the Artemis mission schedule.

The value of the PPE project's contract has increased by 172 percent due to requirements changes to align the PPE's capabilities to the needs of the Gateway. The total contract value is now over $1 billion. Project officials said they expect that additional changes to cost and schedule resulting from remaining planned contract modifications will be minor relative to prior modifications. These remaining planned contract modifications are to address cybersecurity requirements and risk reduction testing for the solar array, among other items.

Technology and Design

The project held its critical design review in March 2024 after a delay of 5 months to complete subsystem design work. It reported that it released over 90 percent of its design drawings by the time of this review, which is aligned with our best practices. Releasing 90 percent of design drawings before the critical design review reduces the risk of cost growth and schedule delays.

Two of the project's nine critical technologies remained below technology readiness level (TRL) 6 after the critical design review. Our best practice for technology maturity states that critical technologies should achieve TRL 6 by preliminary design review to minimize risks for further product development. None of the project's critical technologies met the best practice. As of January 2025, one critical technology remains at TRL 5. Project officials said that this technology will reach TRL 6 when it completes qualification testing.

Integration and Test

The PPE project has made progress on integrating the spacecraft. Specifically, it assembled, tested, and installed the propellant tanks and the first flight equipment panel. Assembly, test, and integration of the spacecraft is the project's critical path—the part of the schedule with the least amount of schedule reserve available.

The project is tracking a risk that the solar array model used for testing will not fully capture on-orbit behavior that could exceed design limits. To mitigate this risk, project officials said they refined the testing approach to test each component individually rather than as a full solar array. The supplier also redesigned part of the system that deploys the solar array to improve its performance. If modeling of the array is inadequate, an on-orbit structural failure could cause the array to not produce enough electrical power or result in loss of the ability to carry out lunar surface operations until repairs are completed.

The project is also tracking a risk that critical hardware, including propellant tanks, could fail during launch or wear out over the life of the PPE. The contractor is updating its plan to address these issues based on NASA feedback following the critical design review.

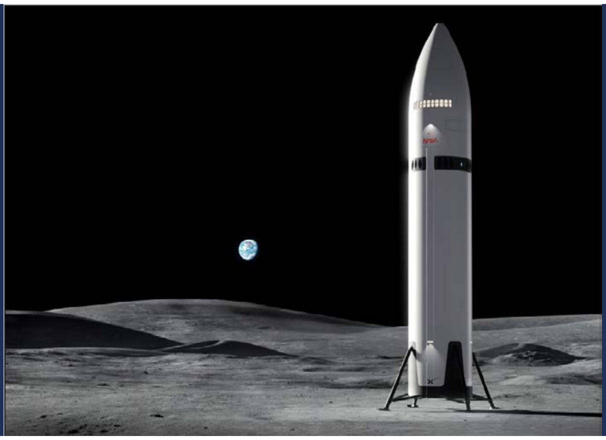
The project continues efforts to reduce the mass of the PPE, which exceeds its allocation on the comanifested vehicle by 170 kilograms as of November 2024. This assumes the propellant tanks are filled—referred to as wet mass. Without propellant—known as dry mass—the PPE is about 35 kilograms over its allocation. Officials reported that the contractor is making progress and is expected to meet the dry mass requirement. Officials said decisions regarding how much propellant the PPE will carry will be addressed at the Gateway program level. The PPE is required to carry 200 kilograms of xenon propellant to provide 15 years of on-orbit life without the need to refuel. Carrying less fuel or more mass could result in a longer transit time to orbit. This would expose the spacecraft to more of the effects of radiation, which could damage spacecraft electronics.

The Gateway program is tracking a risk regarding the PPE's ability to control the Gateway's positioning on-orbit when larger and heavier visiting vehicles—including the Human Landing System—are docked with it. The program is exploring having the Logistics Module share control of the Gateway with the PPE to address this risk.

In October 2024, the project closed the risk that the PPE network hardware, which allows the PPE to communicate with other Gateway components, might not meet performance requirements. The Gateway program control board decided to remove the network hardware from the PPE and instead leverage the hardware in the HALO. Project officials reported that this solution would simplify the design, reduce schedule risk, and provide a wider array of potential options to address future challenges.

Project Office Comments

In commenting on a draft of this assessment, PPE project officials reported that, as of February 2025, the dry mass of PPE is about 85 kilograms below its allocation. Project officials also provided technical comments on a draft of this assessment, which were incorporated as appropriate.



Source: SpaceX. | GAO-25-107591

Human Landing System (HLS) - Initial Capability

The HLS is a transportation system that will provide crew access to the lunar surface and demonstrate initial capabilities required for deep space missions. NASA plans to use the HLS initial capability for the Artemis III mission to the moon. The HLS will deliver crew from lunar orbit to the lunar surface, provide capabilities for lunar surface extravehicular activities, and then return the crew and materials to lunar orbit to enable their return to Earth. As part of this mission, the HLS will dock with the Orion Multi-Purpose Crew Vehicle (Orion) in lunar orbit. Contractors will lead the design, development, testing, and evaluation of the HLS; NASA will certify its design and flight readiness.

Timeline

Project Information

NASA Lead Mission Directorate: **Exploration Systems Development**

NASA Lead Center: **Marshall Space Flight Center**

Launch Location: **Multiple launch locations including Kennedy Space Center, FL and Boca Chica, TX**

Launch Vehicle: **SpaceX Super Heavy Booster**

Mission Duration: **6.5 days**

Requirement Derived from: **National Space Policy Directive 1 and NASA Strategic Plan**

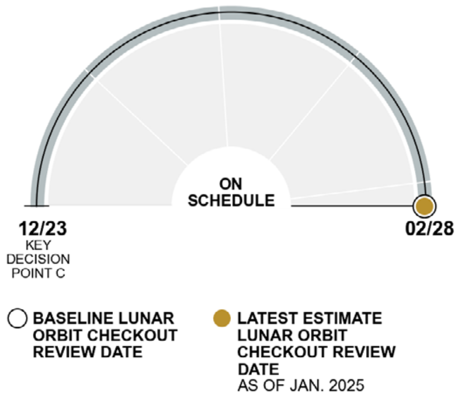
Project Summary

The HLS Initial Capability project is operating within the cost and schedule baselines NASA established for the project in December 2023. NASA tied the HLS initial capability schedule baseline to a lunar orbit checkout review in February 2028. The lunar orbit checkout review will examine the readiness of the HLS Starship to perform the Artemis III mission and receive crew from the Orion spacecraft.

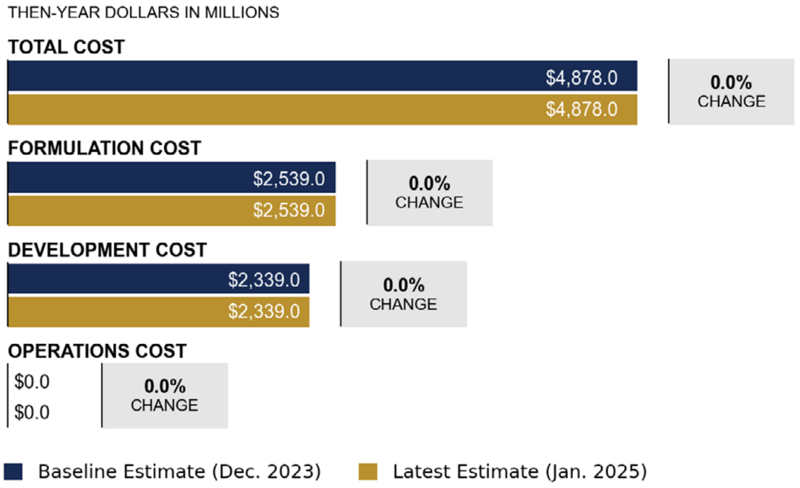
SpaceX conducted three successful flights of the Starship between June 2024 and November 2024. Two separate flights in January and March 2025 were not successful. It also has plans for flights demonstrating ship-to-ship cryogenic propellant transfer and an uncrewed lunar landing, both later in 2025.

One of the top risks facing the program is maturing propellant management technologies to support on-orbit storage and transfer of propellant. SpaceX plans to demonstrate the required systems during ongoing flight tests.

Schedule Performance



Cost Performance



Cost and Schedule Status

The HLS Initial Capability project is operating within the cost and schedule baselines that NASA established for the project in December 2023. The project's first operational flight will support the Artemis III mission. NASA tied the HLS Initial Capability schedule baseline to a lunar orbit checkout review in February 2028. The lunar orbit checkout review will examine the readiness of the HLS Starship to perform the Artemis III mission and receive crew from the Orion spacecraft. NASA set the HLS Initial Capability baseline life-cycle cost at about $4.9 billion. These baselined costs cover the effort through the post-mission assessment review. This assessment review will examine the success of the Artemis III mission and take place no later than 30 days after mission completion.

In December 2024, NASA announced delays to both the Artemis II and Artemis III missions. NASA attributed these delays to several causes, including technical challenges with the Orion capsule heatshield and batteries. NASA's current schedule for the Artemis III mission is now mid-2027.

The HLS project is assessing the impact of the delay of the Artemis III mission. Officials told us that as part of this process, they plan to begin updating associated schedules and negotiating contract modifications with SpaceX.

Technology and Design

SpaceX conducted three successful orbital flight tests of its Starship vehicle on top of its super heavy booster in June, October, and November 2024. During a seventh test flight in January 2025, however, the Starship vehicle broke apart over the Atlantic Ocean. SpaceX attributed the loss to a fire in the aft section of the Starship. During an eighth test flight in March 2025, the Starship vehicle again broke apart after an explosion in the aft section. The Federal Aviation Administration is requiring SpaceX to perform a mishap investigation into the loss of the Starship vehicle before resuming flight tests.

SpaceX's plan for landing astronauts on the moon requires multiple interactions between different vehicles in space. The first involves an on-orbit propellant transfer from multiple tanker Starship vehicles to a depot Starship vehicle in low-Earth orbit. Once the depot accumulates sufficient propellant, the HLS Lander will launch and dock with the depot for a propellant transfer before docking with the Orion spacecraft in lunar orbit. As part of its test campaign, SpaceX is planning a flight to demonstrate ship-to-ship cryogenic propellant transfer in 2025 followed by an uncrewed lunar landing demonstration.

NASA is tracking a risk that some of the necessary propellant management technologies or capabilities will not be adequately matured as planned. According to NASA documentation, this could impact the project's ability to verify and validate the SpaceX lunar mission architecture, resulting in delays to the Artemis III mission. SpaceX plans to demonstrate the required systems during ongoing flight tests.

NASA is also tracking a risk related to the adequacy of facilities available to teach astronauts how to manually control the HLS and to condition them to flight-like conditions anticipated during descent and landing on the lunar surface. The HLS Initial Capability concept of operations requires the HLS Initial Capability crew to be capable of performing a manual landing in some scenarios. This will require a mastery of certain skills, including an understanding of the vehicle dynamics. NASA is concerned that the planned training facilities do not have the capability to train the crews to a mastery level. This could result in an increased probability of loss of the vehicle, crew, and mission during the landing phase. NASA plans to better define the training requirements by the program critical design review, currently scheduled for some time in 2025.

Project Office Comments

HLS program officials provided technical comments on a draft of this assessment, which were incorporated as appropriate.

Source: NASA. | GAO-25-107591

Mobile Launcher 2 (ML2)

ML2 is a project within the Exploration Ground Systems program that will provide a new launch platform and tower for the Space Launch System (SLS) Block 1B vehicle with the upgraded Exploration Upper Stage. It will support the Artemis IV mission, currently planned for 2028. ML2's platform and tower will support the SLS vehicle and Orion Multi-Purpose Crew Vehicle (Orion) spacecraft during vehicle stacking, transportation to the launch pad, and launch. In addition, ML2 provides all fuel, power, and environmental control connections to the vehicle up until launch.

Timeline

Project Information

NASA Lead Mission Directorate: **Exploration Systems Development**

NASA Lead Center: **Kennedy Space Center**

International Partners: **None**

Requirement Derived from: **Consolidated Appropriations Act, 2018**

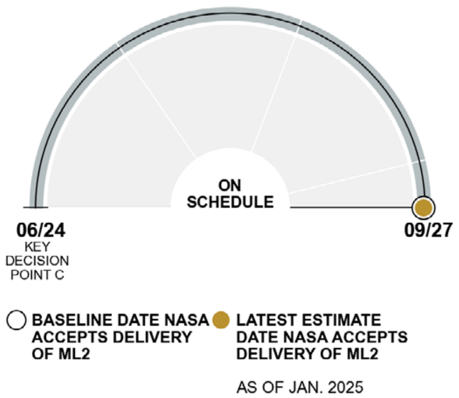
Project Summary

The National Aeronautics and Space Administration (NASA) established cost and schedule baselines for the ML2 project in June 2024. The cost baseline is about $1.9 billion, and the schedule baseline is September 2027 for the delivery of ML2 from Bechtel, the prime contractor, to NASA. Bechtel is working to a delivery date of November 2026, and its contract was modified in March 2024 to incentivize an earlier delivery. The schedule baseline does not include ML2 verification and validation activities planned for after the delivery and prior to Artemis IV, which NASA is tracking as the project's top risk. To mitigate this risk, the project plans to concurrently test the ML2 at the launch pad while Artemis III hardware is processed in the Vehicle Assembly Building.

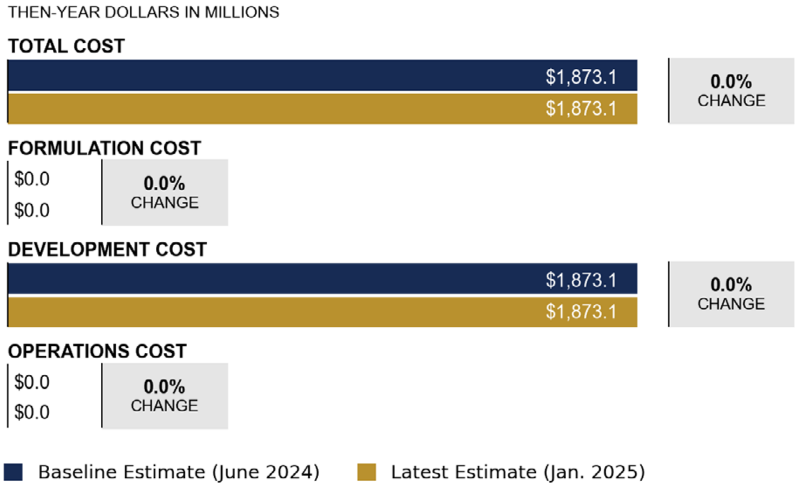
The project completed its critical design review. NASA and Bechtel continue to assess the design implications of higher-than-anticipated Artemis I launch-induced loads. The analysis is ongoing, so they have not yet determined the full cost implications.

Construction on the ML2 structure is underway. Bechtel installed the first tower module on the ML2 base in January 2025. Officials said there is some schedule risk for remaining modules but NASA expects the contractor to be able to support a November 2026 delivery of the tower.

Schedule Performance



Cost Performance



Cost and Schedule Status

In June 2024, NASA established cost and schedule baselines for the ML2 project based on a 70 percent joint cost and schedule confidence level, as required by NASA policy. The joint cost and schedule confidence level is an integrated analysis of a project's cost, schedule, risk, and uncertainty, which indicates a project's likelihood of meeting a given set of cost and schedule targets. The schedule baseline is September 2027 for Bechtel's delivery of ML2 to NASA. The cost baseline of approximately $1.9 billion includes all prime contractor efforts through delivery, as well as government furnished equipment and government provided project management and design support.

As of February 2025, NASA is working with the contractor to support a November 2026 delivery date of the tower. NASA modified its contract with Bechtel in March 2024 to increase the available award fee and add a new award fee component based on schedule milestones, among other things. The change is meant to motivate earlier delivery—the contractor will receive the highest single schedule milestone fee payment if it delivers ML2 by May 2026, but will not receive a schedule milestone award fee payment for the delivery if it is after November 2026. As of February 2025, project officials expect the contractor to be able to support a 2026 delivery, which is well in advance of the project's schedule baseline.

NASA's top risk for ML2 is that there may be insufficient schedule margin for ML2 verification and validation testing between the Artemis III and IV missions. The testing is largely planned to occur after Bechtel's delivery of ML2. However, some of the testing activities require access to the launch pad or a modified Vehicle Assembly Building and cannot take place until Artemis III launches. Artemis III is planned for mid-2027, and Artemis IV is currently planned to launch no earlier than September 2028. That schedule provides less than 18 months to complete testing and first-time integration of ML2 with SLS Block 1B and Orion. As of February 2025, project risk documentation states that this testing could exceed the time allocated by 8 months, which could delay the Artemis IV mission. To mitigate this schedule risk, NASA officials said that they plan to conduct simultaneous ML2 verification and validation at the launch pad while Artemis III is processing in the Vehicle Assembly Building.

Design

NASA successfully completed both steps of the ML2 project's critical design review: step one for hardware and programmatic content in January 2024, and step two for software and verification and validation plans in June 2024. As of February 2025, ML2 officials reported that the design is complete for all but one subsystem.

NASA is currently tracking a top risk that an ongoing loads analysis may drive cost and schedule growth. According to project officials, the blast from the SLS boosters during launch created loads, or forces, on the ML1 structure that were higher than anticipated. NASA and Bechtel are taking a three-phase approach to examine the implications of the changed loads for the ML2 design. They completed phase one and the engineering design work for phase two, which identified ML2 modifications needed to withstand the greater loads. They then executed engineering design work to implement those modifications.

Phase three is underway as of February 2025 and will include engineering analysis of any calculations not addressed in earlier phases. Project officials said that phase three will be complete by the fourth quarter of 2025. According to NASA, the challenge with the loads analysis has been keeping the construction work going since the same employees are needed to support both efforts. As of February 2025, the project is working on estimates for the cost increases associated with the phase three analysis and modifications.

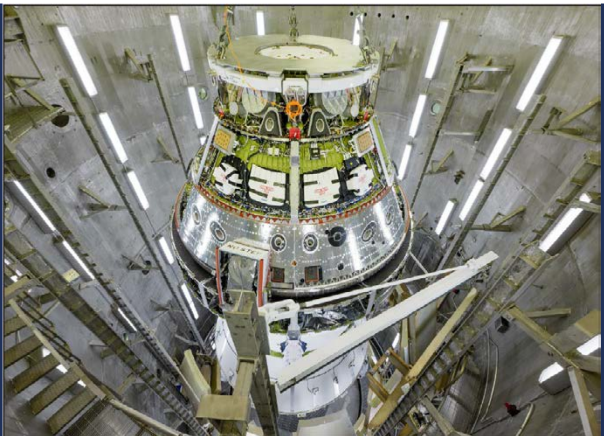
Construction

Construction of ML2 continues, with work underway on the base and assembly of portions of the tower occurring on the ground. The tower modules will be installed, or rigged and set on top of the base, after which NASA and the contractor will work to install umbilical arms. These arms will connect the tower to the rocket and spacecraft to provide electrical support and propellant, among other things. The contractor installed the first tower module on the ML2 base in January 2025, within the timeframe for a schedule milestone award fee payment. Project officials reported that as of May 2025, another three modules have been installed on the tower. They said that they plan to install the final three modules after they complete their construction and equipment installations by the end of June 2025, which they said is within the targeted range for one of the major milestones. Officials also reported that the first of several umbilicals was installed on the tower in May 2025, meeting the early schedule milestone date.

Project risk documentation states that electrical equipment deliveries are behind schedule, which could affect plans for installing future tower modules. Project officials said that electrical equipment is easier to install prior to the rig and set of a module because it is easier to access and install on the ground than other types of equipment.

Project Office Comments

Project officials provided comments on a draft of this assessment, which were incorporated as appropriate.



Orion Multi-Purpose Crew Vehicle (Orion)

Orion is being developed to transport and support astronauts beyond low-Earth orbit and will launch atop NASA's Space Launch System (SLS). The current design includes a crew module, service module, launch abort system, and rendezvous proximity operations and docking (RPOD) capability. The program successfully completed one uncrewed mission (Artemis I) in 2022 and is planning for the first crewed mission (Artemis II) in 2026. NASA plans to produce additional Orion capsules to transport crew for a planned 2027 lunar landing (Artemis III) and later missions. The Orion program is continuing to advance the development of the vehicle started under the canceled Constellation program.

Source: NASA. | GAO-25-107591

Timeline

Project Information

NASA Lead Mission Directorate: **Exploration Systems Development**

NASA Lead Center: **Johnson Space Center**

International Partners: **European Space Agency (ESA)**

Launch Location: **Kennedy Space Center, FL**

Launch Vehicle: **Space Launch System**

Mission Duration: **Up to 21 days active mission duration capability with four crew**

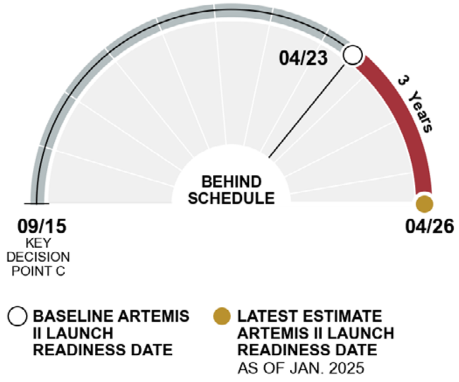
Requirement Derived from: **NASA Authorization Act of 2010**

Project Summary

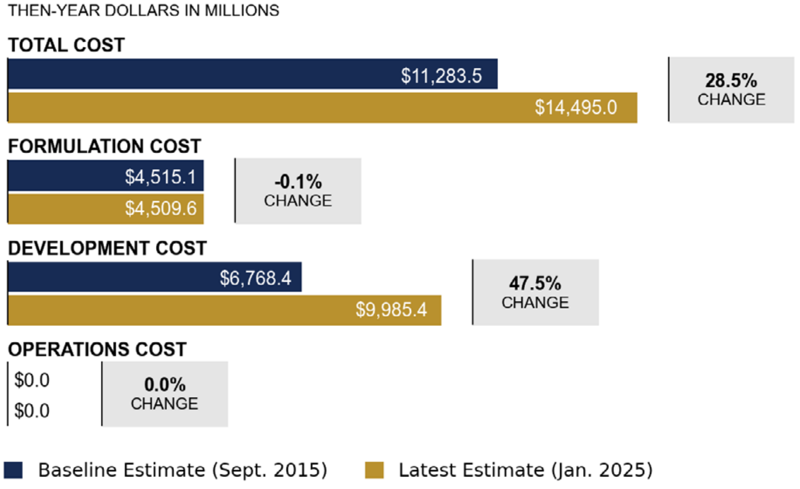
The Orion program increased its life-cycle costs by $363 million, which officials said was due to delays to the Artemis II launch to September 2025 arising from technical challenges. A NASA official also anticipates additional cost growth after the recent announcement of an April 2026 Artemis II launch readiness date. Orion's costs are now 5 percent above the 2021 rebaseline, and 28.5 percent above its original baseline. The 2021 rebaseline included among other things, the addition of the RPOD capability. According to NASA documentation, the delayed launch reflects the time needed to address several technical challenges, such as the heat shield issues discovered during Artemis I.

Integration and testing for the Orion Artemis II capsule is ongoing to support its planned delivery to Exploration Ground Systems in April 2025. This delivery will enable the start of integration with SLS to support an April 2026 Artemis II launch date. The agency also concluded its investigation into Orion's heat shield material loss that occurred during Artemis I. NASA plans to change the reentry trajectory for Artemis II and use an unmodified heat shield, but will modify the hardware for future missions to allow for more reentry options without the risk of repeating the technical issues seen in Artemis I.

Schedule Performance



Cost Performance – Under Review



Cost and Schedule Status

The Orion program increased its life-cycle cost estimate by an additional $363 million. This is 28.5 percent above the program's original baseline and 5 percent above its 2021 rebaseline. For the 2021 rebaseline, some cost increases reflected additional requirements for the RPOD capability, costs related to COVID-19, and other factors. According to program officials, the $363 million increase was to support delaying Artemis II's launch date by 9 months to September 2025 to address technical challenges. A NASA official said costs continue to be under review as they anticipate additional cost growth after NASA announced in December 2024 that Artemis II would occur in April 2026. According to NASA documentation, the updated schedule reflects time to address issues with the Orion crew module batteries, environmental control and life support systems controllers, and its heat shield. A NASA official said the delay was not driven by the capsule's heat shield investigation.

NASA currently plans to launch Artemis II in April 2026. To achieve this date, a NASA official said NASA plans to move the integrated Orion and SLS to the launch pad by the end of 2025 to conduct tests in advance of launch. A NASA official said the pad was modified since Artemis I to allow for additional access and servicing so that the integrated vehicle can remain at the pad until launch. According to the official, Orion's delivery to the Exploration Ground Systems program, planned for April 2025, will drive NASA's ability to maintain this planned schedule.

Integration and Test

Integration and testing for the Orion Artemis II capsule is ongoing in advance of the capsule's delivery to the Exploration Ground Systems program, when integration with SLS will begin. As of February 2025, the combined crew and service module had completed vacuum testing and was progressing with solar array installation.

Technical challenges have delayed Orion's schedule. This includes issues with the crew module batteries and the digital motor controllers that operate several environmental control and life support systems. NASA resolved these issues as of February 2025, with both the batteries and valves installed on the spacecraft and tested.

Heat Shield

The Orion program concluded its investigation of the heat shield material loss that occurred during Artemis I in late 2024, which led the agency to change the planned reentry trajectory for Artemis II. During Orion's reentry to Earth's atmosphere during Artemis I, the heat shield experienced unexpected material loss. According to NASA documentation, extensive analysis determined that the heat shield did not allow enough of the gases generated inside the heat shield's material to escape, which caused some material to crack and break off. NASA concluded that the current heat shield could be safely used with operational changes to reentry. For example, an official said that NASA will change the Artemis II reentry trajectory to be more constrained than Artemis I. The official said that the new trajectory limits launch window availability for Artemis II, but that it will help NASA in the long term because the agency needs experience working with targeted launch windows to support Artemis III.

For Artemis III, NASA plans to use a trajectory similar to Artemis I—a skip entry—and plans to modify the heat shield to eliminate the cracking and material loss. A skip entry provides flexibility for reentry by extending the range that Orion can fly after the point of reentry to a landing spot in the Pacific Ocean. The capsule dips into the upper part of the atmosphere and uses atmospheric drag to slow down, then skips back out of the atmosphere before reentering for a final descent. According to NASA, the skip entry is needed to consistently land precisely at a pre-determined location for future missions.

NASA is implementing enhancements to how future heat shields—for Artemis III and beyond—are manufactured to achieve uniformity and consistent permeability. A Moon to Mars official said in January 2025 that the manufacturing changes are underway, and a new heat shield should be ready by summer 2026. As of January 2025, a NASA official said that the heat shield is not driving Orion's readiness for Artemis III.

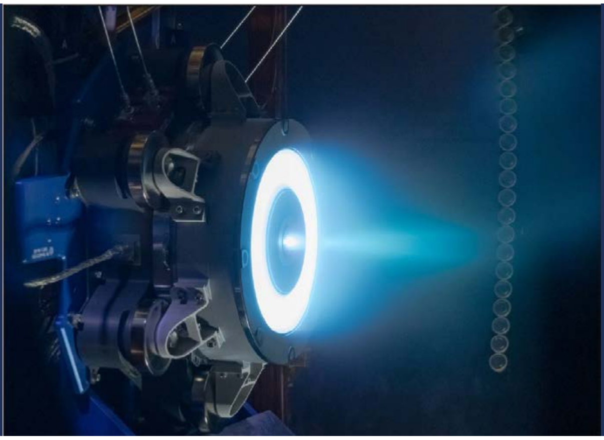
Other Issues to Be Monitored

The Orion program continues to make progress toward Artemis III readiness. For example, the European Space Agency delivered its European Service Module. The module was connected with NASA's crew module adapter in October 2024.

As of February 2025, the Orion program reported that leaks in the hydrazine valves planned for installation in the crew module and the first-time installation and integration of the docking system are driving the program's schedule for Artemis III. The program identified the cause of the valve leaks and is rebuilding and testing the valves. The docking system continues to progress through development and testing, and the program reports that it is not currently working any technical issues.

Project Office Comments

In commenting on a draft of this assessment, program officials stated that the cost and schedule impacts were caused by several technical challenges that were required to be addressed and mitigated in order to ensure crew safety and mission success for Artemis II. They also provided technical comments on a draft of this assessment, which were incorporated as appropriate.



Solar Electric Propulsion (SEP)

The SEP project is a technology demonstration that aims to develop high power electric propulsion technologies for NASA exploration. Solar electric propulsion uses energy from the sun to ionize and accelerate gas, resulting in higher fuel efficiency. This reduces the mass of propellant needed for spaceflight missions beyond low-Earth orbit compared to conventional chemical propulsion systems. The SEP project is developing an Advanced Electric Propulsion System (AEPS) that will fly on the Gateway's Power and Propulsion Element (PPE). Specifically, the project is building and testing two qualification thrusters and managing the assembly of three flight thrusters for the PPE.

Source: Jef Janis, Alcyon Technical Services. | GAO-25-107591

Timeline

Formulation

- **03/15** Formulation start
- **05/16** AEPS system requirements review
- **08/17** AEPS preliminary design review
- **02/20** Key decision point C

Implementation

- **03/22** AEPS critical design review
- **01/25** GAO review
- **11/25** Complete delivery of three AEPS flight thrusters to the PPE
- **01/29** AEPS life qualification test report complete

Project Information

NASA Lead Mission Directorate: **Space Technology**

NASA Lead Center: **Glenn Research Center**

International Partners: **None**

Launch Location: **Kennedy Space Center, FL (with PPE)**

Launch Vehicle: **Falcon Heavy (with PPE)**

Mission Duration: **15 years (with PPE)**

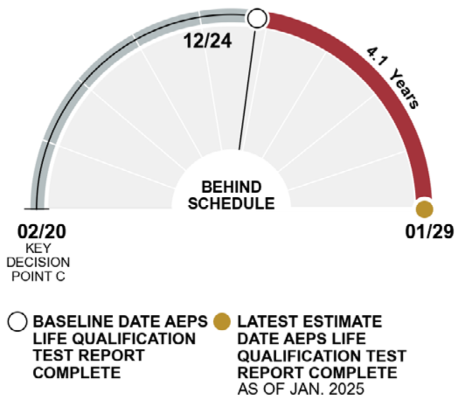
Requirement Derived from: **2018 Strategic Objectives 2.2, 3.1, 4.2**

Project Summary

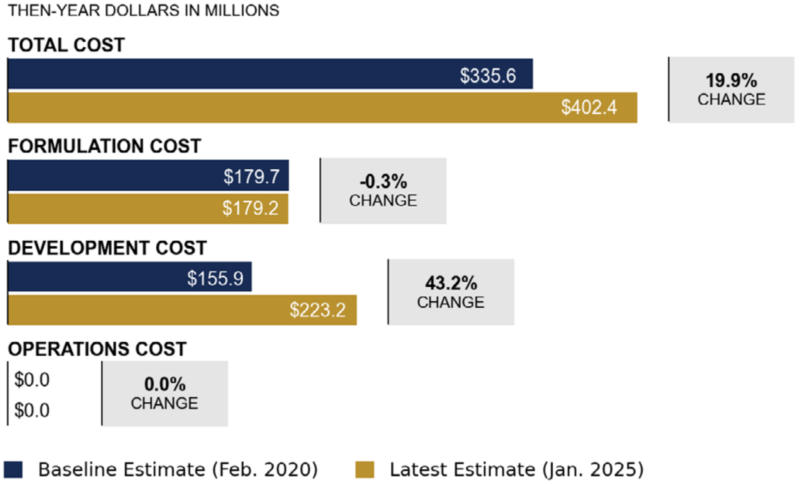
As of January 2025, the SEP project exceeded its previously rebaselined costs by $20 million and its schedule by 3 months. These increases occurred in 2023 because the project redesigned its thruster harnesses—the groupings of wire or cable that transmit signals and electrical power—in response to new requirements impacting hardware compatibility with the PPE spacecraft. NASA modified the SEP project's contract with Aerojet Rocketdyne twice to incorporate the harness requirements changes. Aerojet Rocketdyne replanned its schedule following the most recent modification. According to project documentation, the replanned schedule extended anticipated delivery dates for the three flight thrusters by several months.

The project's critical path to flight hardware delivery is completing the cathodes, which produce electrons for the thruster. The project redesigned the cathode to address concerns with welding that could create propellant leaks and is experiencing additional challenges with resolving issues that occurred during qualification testing of the cathode. Furthermore, the project also experienced delays in completing environmental testing of the first qualification model thruster due to issues at the Jet Propulsion Laboratory.

Schedule Performance



Cost Performance



Cost and Schedule Status

As of January 2025, the SEP project exceeded its previously rebaselined costs by $20 million and its schedule by 3 months. These increases occurred in 2023 because the project redesigned its thruster harnesses—the groupings of wire or cable that transmit signals and electrical power—in response to new requirements impacting hardware compatibility with the PPE spacecraft. The Exploration Systems Development Mission Directorate is responsible for the cost increase because the harnessing requirements changes stemmed from the PPE project.

NASA modified the SEP project's contract with Aerojet Rocketdyne in November 2023 and again in December 2024 to incorporate the harness requirements changes. Project officials said they do not expect to modify the contract again before they deliver the flight thrusters to the PPE project. Aerojet Rocketdyne replanned its integrated master schedule following the most recent modification. According to project documentation, he replanned schedule extended anticipated delivery dates for the three flight thrusters by several months and restored some schedule reserves, which had been reduced to zero.

Technology and Design

A critical step for the project is completion of the cathodes, which produce electrons for the thruster. During this process, the temperature changes from hot to cold and can cause stress to the cathode's joints. The project and its contractor have experienced challenges in completing welding on these joints. For example, the project determined that welding on the cathode exceeded allowable porosity limits—a measure of voids or defects that could reduce the strength of the weld. According to project officials, if these welds failed after launch, it could create a propellant leak that could lead to an electrical breakdown. To address the issue, the project redesigned the cathode to increase the number of welds from two to six.

In addition, the project has experienced delays in qualifying the cathode hardware. The project began component qualification of the cathodes in January 2024, with vibration and shock testing to simulate the launch environment. However, the project paused thermal vacuum testing in May 2024 when it discovered that target test temperatures could not be reached on some components without exceeding limits on other components. To address the issue, the contractor modified target test temperatures and test procedures. The thermal vacuum test resumed in October 2024 and concluded in December 2024. However, some components did not perform as expected during the test. As of January 2025, the project is investigating the cause of these issues and determining next steps before proceeding with the next phase of testing.

The project resolved technical issues related to the redesigned thruster harnesses and completed fabrication and installation on the three flight thrusters in late 2024. In October 2024, officials reported that all planned testing and analysis of the harness redesign was complete.

The project completed assembly of the first flight model thruster—including the redesigned harness and the first of the redesigned cathodes—and completed vibration testing in January 2025. Project officials said completion of the cathode is key to completing assembly of the thrusters, and that delays past January 2025 could create schedule pressure on testing and qualifying the thrusters.

The project began conducting environmental testing on the first of two qualification models in May 2024. However, the remaining step in the series of environmental tests—thermal vacuum testing—was delayed to early 2025 due in part to test set-up issues including readiness of the lift equipment at the Jet Propulsion Laboratory. To address these issues, the project is planning a series of check out tests of the test facility using an engineering test unit thruster. As of January 2025, some of these activities had been delayed because of wildfires in the area surrounding the Jet Propulsion Laboratory.

Project Office Comments

In commenting on a draft of this assessment, SEP project officials stated that the project's critical path is completing the qualification testing and the project does not complete when the flight thrusters are delivered because qualification wear testing needs to be completed. They said that delays at the Jet Propulsion Laboratory have slipped the completion of qualification testing by 11-months. Project officials also provided technical comments on a draft of this assessment, which were incorporated as appropriate.

Source: NASA. | GAO-25-107591

Space Launch System (SLS) Block 1B

The SLS Block 1B is a planned evolution of the SLS Block 1 launch vehicle. The SLS Block 1 is NASA's first human-rated, heavy-lift vehicle since the Saturn V and is intended to enable deep-space Artemis and Mars missions. The SLS Block 1B will retain the core stage, RS-25 engines, and solid rocket boosters from Block 1, but replace the interim cryogenic propulsion stage with the more powerful Exploration Upper Stage (EUS) and adapters for payloads. The EUS will have four RL-10 engines with a total of 97,000 pounds of thrust, which will increase the amount of mass the SLS Block 1B can deliver to the moon and other destinations.

Timeline

Project Information

NASA Lead Mission Directorate: **Exploration Systems Development**

NASA Lead Center: **Marshall Space Flight Center**

International Partners: **None**

Launch Location: **Kennedy Space Center, FL**

Launch Vehicle: **N/A**

Mission Duration: **Varied based on destination**

Requirement Derived from: **NASA Authorization Act of 2010**

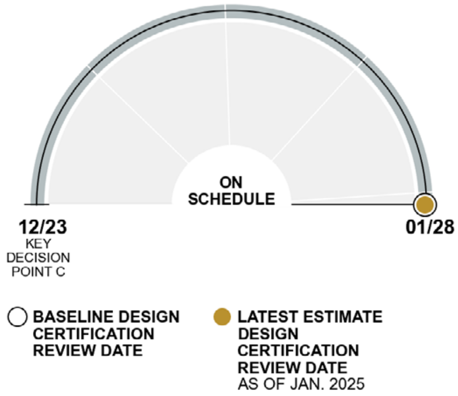
Project Summary

SLS Block 1B is operating within the original cost and schedule baselines approved by NASA in December 2023. These baselines include a committed design certification review in January 2028, ahead of the planned Artemis IV mission in September 2028, and a life-cycle cost of approximately $4.9 billion.

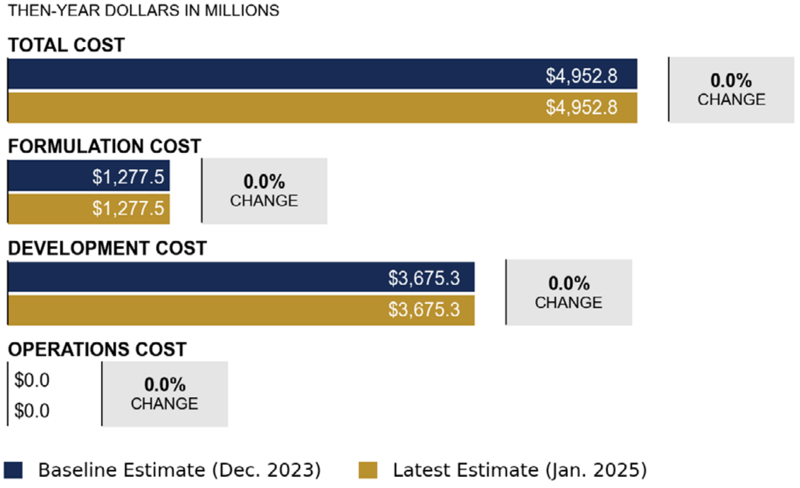
According to NASA officials, the program is encountering difficulties manufacturing both the EUS and core stage needed for Artemis IV. Program officials attributed these problems to several issues, including delays to earlier Artemis flights and delayed deliveries of parts and materials.

The SLS program completed manufacturing of some flight hardware for Artemis IV, including the engines for both the core stage and the EUS. However, development of the facilities needed to test and qualify the integrated SLS Block 1B software and avionics remains a top program risk. Continued challenges could delay qualification testing, the design certification review, and the Artemis IV launch date.

Schedule Performance



Cost Performance



Cost and Schedule Status

SLS Block 1B is currently operating within the original cost and schedule baselines that NASA approved in December 2023—a committed design certification review date of January 2028, ahead of the planned Artemis IV mission in September 2028, and a life-cycle cost of approximately $4.9 billion. The design certification review is a final review to demonstrate that a system fulfills all functional, performance, physical, and safety requirements. As of February 2025, NASA had spent over $3.4 billion developing the SLS Block 1B.

The SLS Block 1B baseline does not include the cost of system elements common with SLS Block 1, such as the core stage and solid rocket boosters. The costs for these elements are captured in the annual 5-year production and operations estimate for the SLS program.

According to NASA officials, the program is encountering difficulties manufacturing the EUS and core stage needed for Artemis IV on time and within established costs. Program officials attributed these problems to several issues ranging from the continuing impacts of delays to earlier Artemis flights, to delayed deliveries of materials and parts from suppliers and subcontractors. Program office officials stated that they and Boeing, the prime contractor for SLS Block 1B, are actively engaging with subcontractors and parts suppliers and increasing their presence at the supplier facilities.

As of February 2025, the program had no margin between the planned contractor delivery dates for the EUS and core stage and the date that Exploration Ground Systems needs these elements to support Artemis IV. NASA officials stated that ongoing manufacturing issues with the SLS core stage for Artemis III and Artemis IV are likely to become the activities that drive the Artemis IV schedule.

Technology and Design

A top program risk is the development of the EUS System Integration and Test Facility-Qualification (SITF-Q) needed to test and qualify the integrated SLS Block 1B software and avionics. The EUS SITF-Q is a complex facility and as of January 2025, delayed deliveries of wiring harnesses and avionics components, as well as component redesigns, were impacting its development schedule. There is a risk that continued late deliveries could delay qualification testing, the design certification review, and the Artemis IV launch date. Officials reported that Boeing developed and implemented a 5-phased Build and Checkout Plan that was completed in April 2025, demonstrating technical and schedule progress and risk burn down.

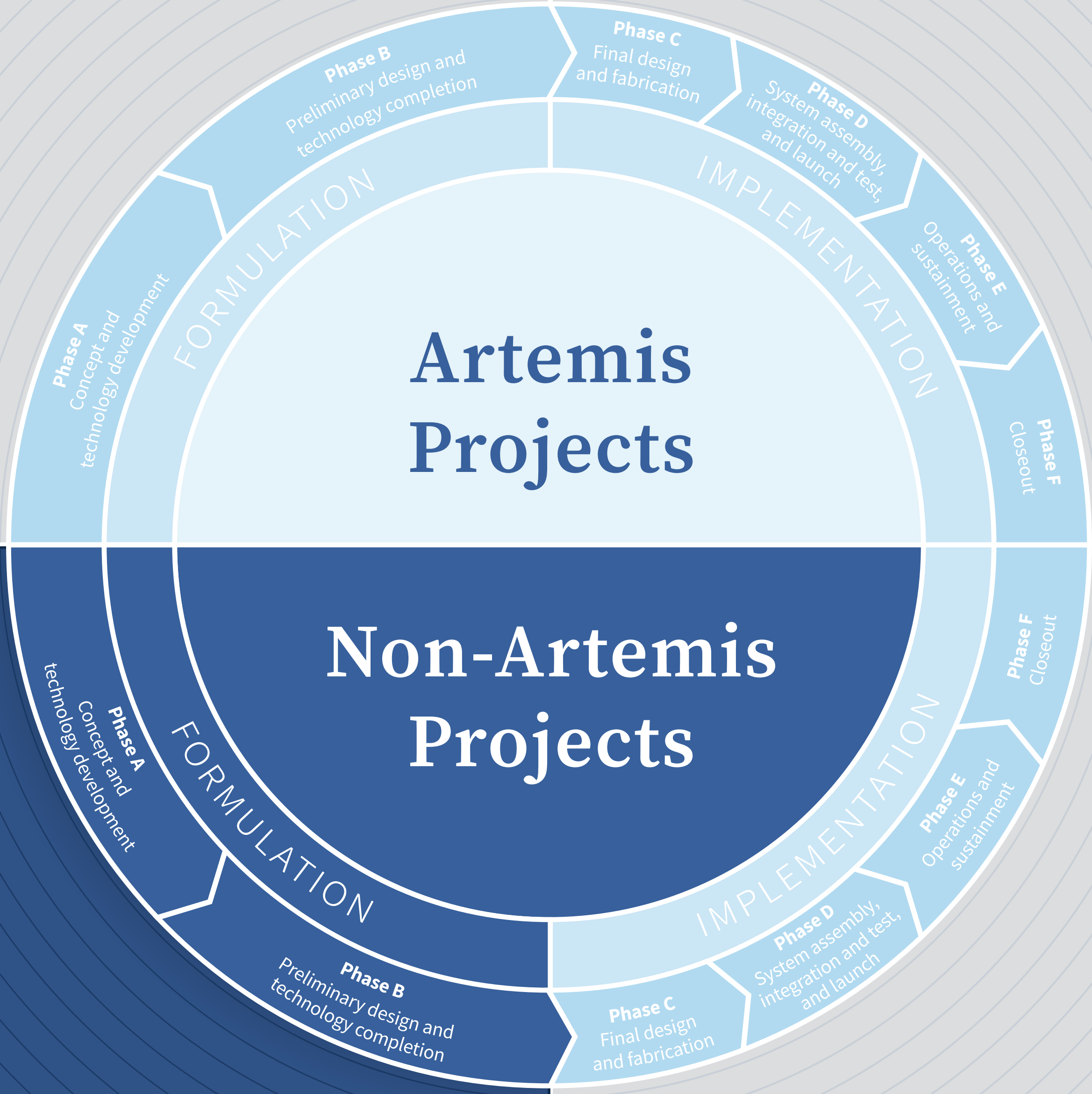
The program has been tracking a SLS Block 1B flight computer performance risk. The risk is that due to the increased in-space radiation exposure time during the EUS phase of flight as compared to the SLS Block 1 ascent trajectory and flight time, the SLS Block 1B flight computers could experience radiation-induced issues. Program officials informed us that flight software algorithms have been developed to mitigate potential flight computer radiation-induced issues.

The SLS program has completed manufacturing of some flight hardware for Artemis IV, but development continues for new hardware needed for SLS Block 1B. The four RS-25 engines required for the core stage and four RL-10 engines required for EUS are complete and in storage. The program has also completed casting of the 10 solid rocket booster segments. Development continues on capability upgrades required for SLS Block 1B. For example, the universal stage adapter and the payload adaptor, which attach the Orion vehicle to the EUS, are undergoing structural testing.

Since June 2024, the SLS program successfully completed developmental testing of the Autonomous Flight Safety System in a pod mounted to an airplane. This system will autonomously terminate the SLS Block 1B's flight, if necessary, to protect the public. The results of these tests will inform the design of the SLS program's Autonomous Flight Safety System.

Project Office Comments

SLS Block 1B project officials provided technical comments on a draft of this assessment, which were incorporated as appropriate.



- Demonstration Rocket for Agile Cislunar Operations **(DRACO)**
- Earth System Observatory (**ESO**) - Surface Biology and Geology- Thermal Infrared (**SBG-TIR**)
- Mars Sample Return **(MSR)**
- United States Deorbit Vehicle **(USDV)**

Source: GAO analysis of NASA data. | GAO-25-107591

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Demonstration Rocket for Agile Cislunar Operations (DRACO)

DRACO is a technology demonstration of nuclear thermal propulsion managed jointly between NASA and the Defense Advanced Research Projects Agency (DARPA). NASA will fund and manage the overall development and fabrication of the nuclear thermal rocket engine. Nuclear thermal propulsion uses a nuclear reactor to combust rocket propellant and potentially delivers at least twice the performance as traditional chemical propulsion. Nuclear thermal propulsion could reduce transit time and the amount of mass required for fuel for potential future missions to Mars and deep space destinations.

Source: DARPA. | GAO-25-107591

Project Information

NASA Lead Mission Directorate: **Space Technology**

NASA Lead Center: **Marshall Space Flight Center**

International Partners: **None**

Launch Location: **Cape Canaveral, FL**

Launch Vehicle: **Vulcan Centaur**

Mission Duration: **2 months**

Requirement Derived from: **Moon to Mars Campaign**

Next Major Project Event: **N/A**

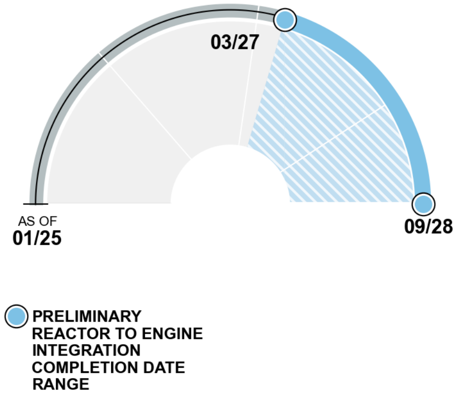
Project Summary

NASA officials told us that on April 2, 2025, DARPA ended the DRACO project. They stated that advances in the commercial launch market, the cost and challenges of the planned demonstration, and a change in priorities at the Department of Defense led to the decision. Officials said NASA is assessing its closeout responsibilities and future plans.

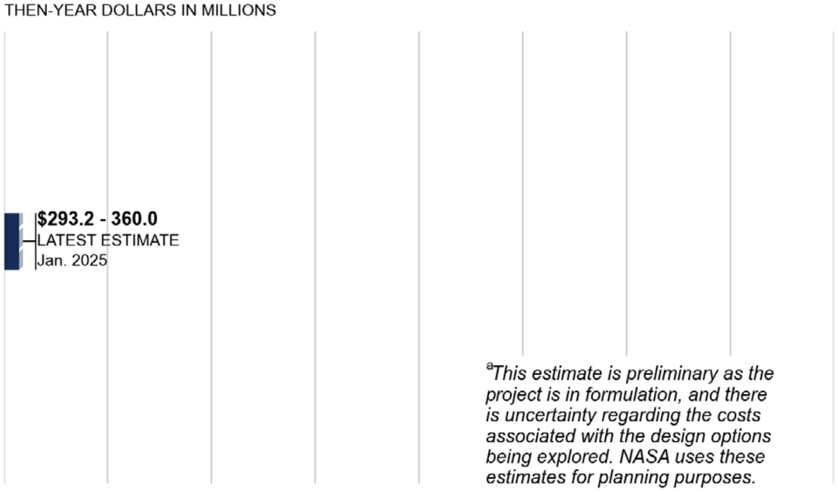
The DRACO project was rescoping from its former plans to conduct an in-space demonstration of nuclear thermal propulsion. Instead, it planned to deliver a flight-ready nuclear thermal reactor engine with the option for a follow-on flight demonstration. The rescope was driven by significant program challenges revealed during the preliminary design review.

Project officials said that the preliminary design review had revealed that it was not possible to achieve the original plan within the original cost and schedule estimates.

Preliminary Schedule



Preliminary Cost[a]



[a]This estimate is preliminary as the project is in formulation, and there is uncertainty regarding the costs associated with the design options being explored. NASA uses these estimates for planning purposes.

Project Office Comments

DRACO project officials provided technical comments on a draft of this assessment, which were incorporated as appropriate.

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Earth System Observatory – Surface Biology and Geology – Thermal Infrared (SBG-TIR)

SBG-TIR is an instrument that will capture temperature and emissivity data that will help map wildfires, identify volcanic hot spots, and improve agricultural efficiency and urban planning. SBG-TIR is managed through a partnership between NASA and Agenzia Spaziale Italiana (ASI). NASA will contribute the SBG-TIR instrument and manage the ground antenna network during operations. ASI will contribute the visible near infrared (VNIR) camera, spacecraft, and launch vehicle and will conduct mission operations. Delivery of the integrated SBG-TIR instrument and VNIR camera, which together comprise the payload, represents NASA's key project milestone.

Source: NASA. | GAO-25-107591

Project Information

NASA Lead Mission Directorate: **Science**

NASA Lead Center: **Jet Propulsion Laboratory**

International Partners: **Agenzia Spaziale Italiana (Italy)**

Launch Location: **Kourou, French Guinea**

Launch Vehicle: **Vega-C (ASI provided)**

Mission Duration: **3 years**

Requirement Derived from: **2017 Earth Science Decadal Survey**

Next Major Project Event: **Key decision point C (To be determined)**

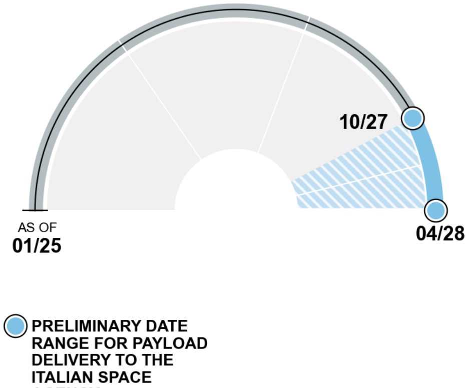
Project Summary

In May 2024, NASA decoupled the launch schedules of SBG-TIR from the SBG Visible and Short-Wave Infrared spacecraft, citing a constrained budget environment. NASA now manages the projects separately without requiring mission operations to overlap.

The project successfully completed its two-part preliminary design review in January 2025. The project addressed several concerns after its first preliminary design review in November 2024. For example, it worked with ASI on an approach to reduce the high number of ground station contacts required to downlink data collected by SBG-TIR.

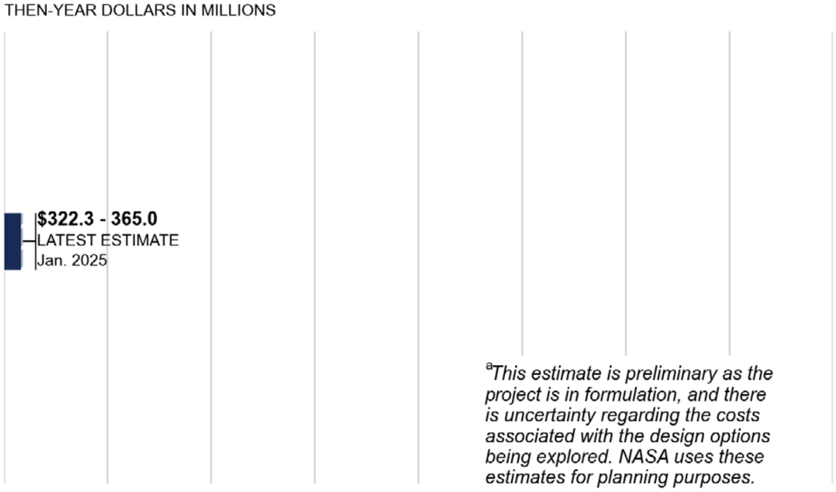
Project officials also noted that there is a risk if the schedules for delivering and integrating the NASA-provided TIR instrument and the ASI-provided VNIR camera and spacecraft are not closely aligned, the project may discover incompatibilities later in the development process. This could lead to potentially costly redesigns and delays. The project is mitigating this risk by finalizing the interface technical requirements for the components and starting to use configuration control.

Preliminary Schedule[a]



[a] *The schedule range represents the management agreement dates.*

Preliminary Cost[a]



[a] *This estimate is preliminary as the project is in formulation, and there is uncertainty regarding the costs associated with the design options being explored. NASA uses these estimates for planning purposes.*

Project Office Comments

In commenting on a draft of this assessment, project officials stated that the project closed technical trades related to the TIR instrument and the instrument met the Jet Propulsion Laboratory's guidelines for mass and power margins. In addition, they noted that the project has closed the action items from the key decision point B decision memo, including the use of a dual-polarization X-band spacecraft telecommunications system to reduce the required number of ground contacts per day. Project officials also provided technical comments on this draft, which were incorporated as appropriate.

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Source: Jet Propulsion Laboratory. | GAO-25-107591

Mars Sample Return (MSR)

The MSR program is a joint endeavor between NASA and the European Space Agency. It plans to collect Martian samples gathered by the Mars Perseverance Rover and bring them safely back to Earth for study and analysis. NASA's planned contributions include the Sample Retrieval Lander; the Mars Ascent Vehicle; and the sample Capture, Containment, and Return System. The European Space Agency's planned contributions include the Earth Return Orbiter. This mission is planning the first launch from the surface of another planet and the first international, interplanetary relay effort.

Project Information

NASA Lead Mission Directorate: **Science**

NASA Lead Center: **NASA Headquarters**

International Partners: **European Space Agency**

Launch Location: **Eastern Range, FL (Sample Retrieval Lander) and French Guiana (Earth Return Orbiter)**

Launch Vehicle: **TBD**

Mission Duration: **5 years**

Requirement Derived from: **2011 Planetary Science Decadal and 2022 Planetary Science and Astrobiology Decadal Survey**

Next Major Program Event: **Preliminary design review (fiscal year 2026)**

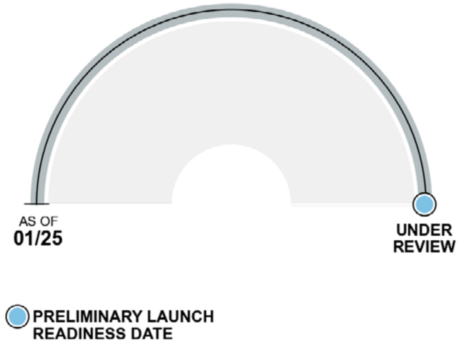
Project Summary

In April 2024, the NASA Science Mission Directorate responded to the findings of a September 2023 independent review board report noting the program would not be able to achieve its mission within the planned budget or sooner than 2040. The program sought input from industry and the NASA community on ways to adjust the mission architecture to ensure program costs would be less than $11 billion and that samples would be returned to Earth in the 2030s. NASA reported receiving 12 study reports.

After reviewing the study reports, NASA announced in January 2025 that it would pursue a revised, NASA-led effort using heritage technology as well as consider a commercial approach for landing on Mars. The program plans to select one of the two landing options after the preliminary design review planned for fiscal year 2026. NASA's current estimate states that samples could be returned as early as 2035 with total life-cycle costs under $11 billion.

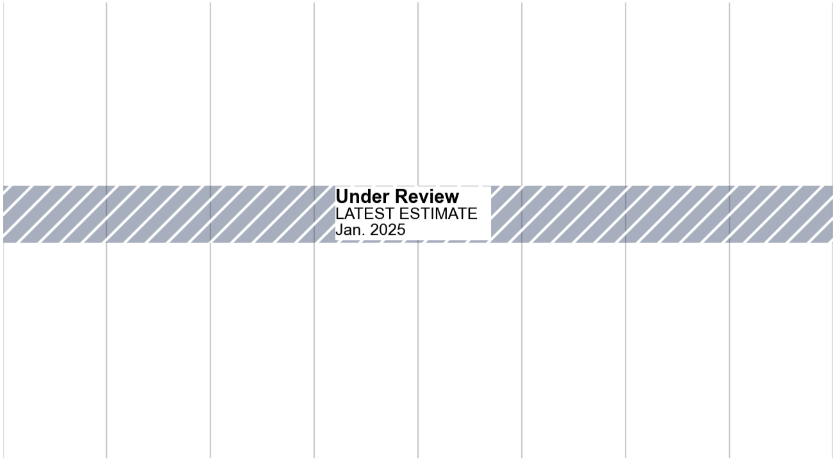
According to officials, the heritage-based landing architecture will not require additional technology development. During fiscal year 2025, the program plans to continue incorporating the architecture modifications and preparing for the preliminary design review, including maturing the design. Further, the program will align budget requirements to the newly scoped effort and continue to research commercial delivery options to develop a sufficient understanding for making a decision at the preliminary design review. To improve oversight in response to a recommendation from the independent review board, the lead office for the MSR program was transferred from the Jet Propulsion Laboratory to NASA headquarters.

Preliminary Schedule– Under Review



Preliminary Cost– Under Review

THEN-YEAR DOLLARS IN MILLIONS



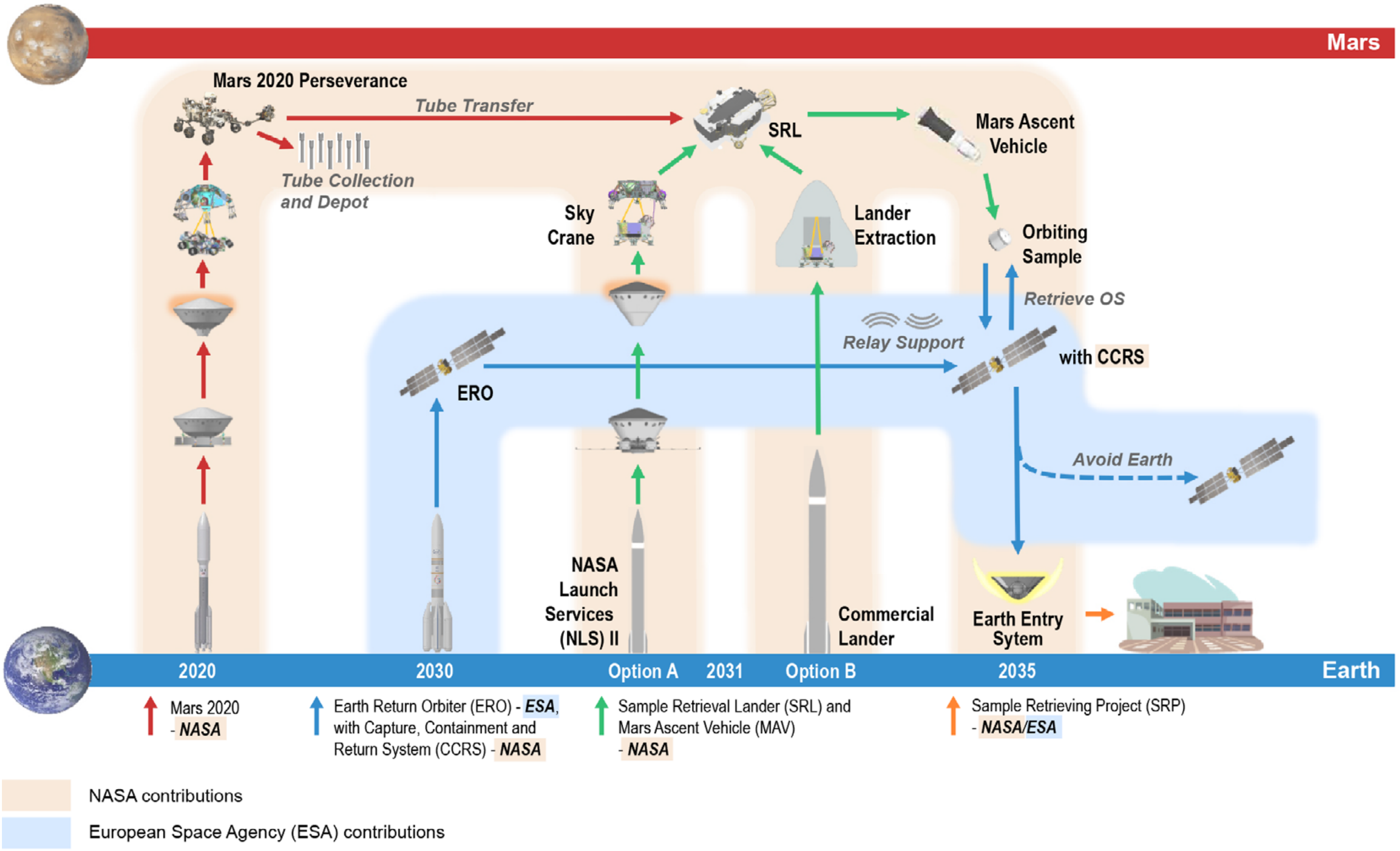
MSR Mission Architectures Under Consideration

NASA is considering two approaches for delivering the Sample Retrieval Lander to the surface of Mars. Both approaches would modify the architecture under development to, among other things, reduce the weight of the Mars Ascent Vehicle and lander. This would allow a Sky Crane landing system design to be used. Sky Crane was successfully deployed for the Perseverance and Curiosity rovers. As a second approach, NASA will also consider the capabilities and costs associated with using a commercial partner to bring the Sample Retrieval Lander to the surface of Mars.

According to the project, the Sample Retrieval Lander will be modified regardless of which option is used to land it. Other design changes include replacing the developmental Sample Transfer Arm with a spare arm procured for the Perseverance rover and using a radioisotope thermoelectric generator rather than solar arrays for power. Further, NASA is no longer pursuing development of a sample recovery helicopter that was included in the prior MSR architecture.

Once the lander is deployed, Perseverance—a NASA rover currently collecting samples on Mars—will deliver the samples to the lander. Sample tubes will be loaded into the Mars Ascent Vehicle, which will launch them into Martian orbit. The European Space Agency's Earth Return Orbiter will use a simplified, NASA-developed Capture, Containment, and Return system to collect the orbiting samples. The Earth Return Orbiter will then bring the samples near Earth and deploy the separate, NASA-developed Earth Entry System for their delivery.

Illustration of Two MSR Mission Approaches



Source: Jet Propulsion Laboratory. | GAO-25-107591

Project Office Comments

MSR program officials provided technical comments on a draft of this assessment, which were incorporated as appropriate.

United States Deorbit Vehicle (USDV)

The USDV is an uncrewed spacecraft that will deorbit the International Space Station (ISS) at the end of the station's operational status in 2030. The spacecraft is meant to safely deorbit the ISS through a controlled re-entry that minimizes risk to populated areas. NASA plans to launch the USDV 18 months before deorbiting and dock it at the ISS until deorbit. The USDV will execute a re-entry burn that will push the ISS through low-Earth orbit, initiating the process for the ISS to naturally re-enter Earth's atmosphere. Along with the ISS, the USDV is expected to break up as part of the re-entry process and fall into a remote part of the ocean.

Source: © 2024 Space Exploration Technologies Corp. | GAO-25-107591

Project Information

NASA Lead Mission Directorate: **Space Operations**

NASA Lead Center: **Johnson Space Center**

International Partners: **TBD**

Launch Location: **TBD**

Launch Vehicle: **TBD**

Mission Duration: **18 months**

Requirement Derived from: **Explanatory Statement, 168 Cong. Rec. S7819, S7947 (daily ed., Dec. 20, 2022), accompanying H.R. 2617, Consolidated Appropriations Act, 2023, which became Pub. L. No. 117-328**

Next Major Project Event: **System Definition Review (TBD)**

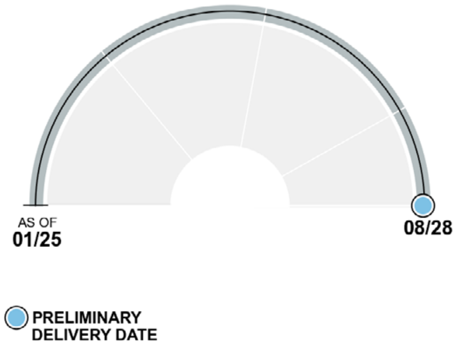
Project Summary

In June 2024, NASA awarded SpaceX a contract with up to an $843 million reported value to design, build, and deliver the USDV. The project anticipates delivery of the USDV in August 2028 with a cost of approximately $1.5 billion. According to project officials, this higher cost represents the total project life cycle including the USDV, the heavy launch vehicle, launch vehicle integration, among other things related to integration, testing, training, and operations. The project plans to refine this estimate after procurement of the launch vehicle. Project officials said that NASA is beginning detailed discussions with ISS international partners on the use of USDV for deorbit.

The USDV will have two components. One will be an existing SpaceX Dragon spacecraft that has a docking mechanism and rendezvous capabilities. The other will be a larger-than-usual Dragon trunk with a new propulsion capability including more propellant tanks and thrusters.

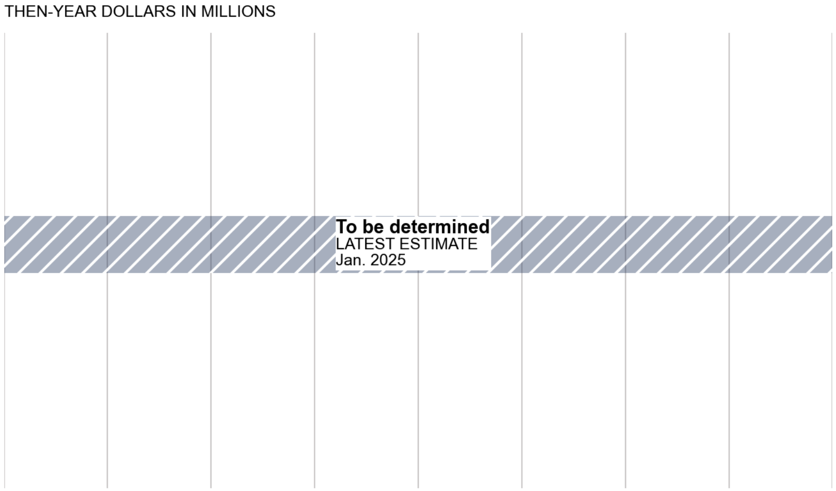
NASA identified several risks related to USDV's larger propulsion system. For example, the larger design affects how the thrusters interact and work when clustered together. NASA will perform necessary testing and analysis, including a large-scale Reactive Module Test, to ensure the propulsion system performs as expected and to verify the propulsion system performance and system interactions. According to project officials, using appropriate sizing for the Reactive Module Test is critical for understanding the propulsion system.

Preliminary Schedule[a]



[a] This date represents the contract's delivery date for production, assembly, integration, and test.

Preliminary Cost



Project Office Comments

USDV project officials provided technical comments on a draft of this assessment, which were incorporated as appropriate.

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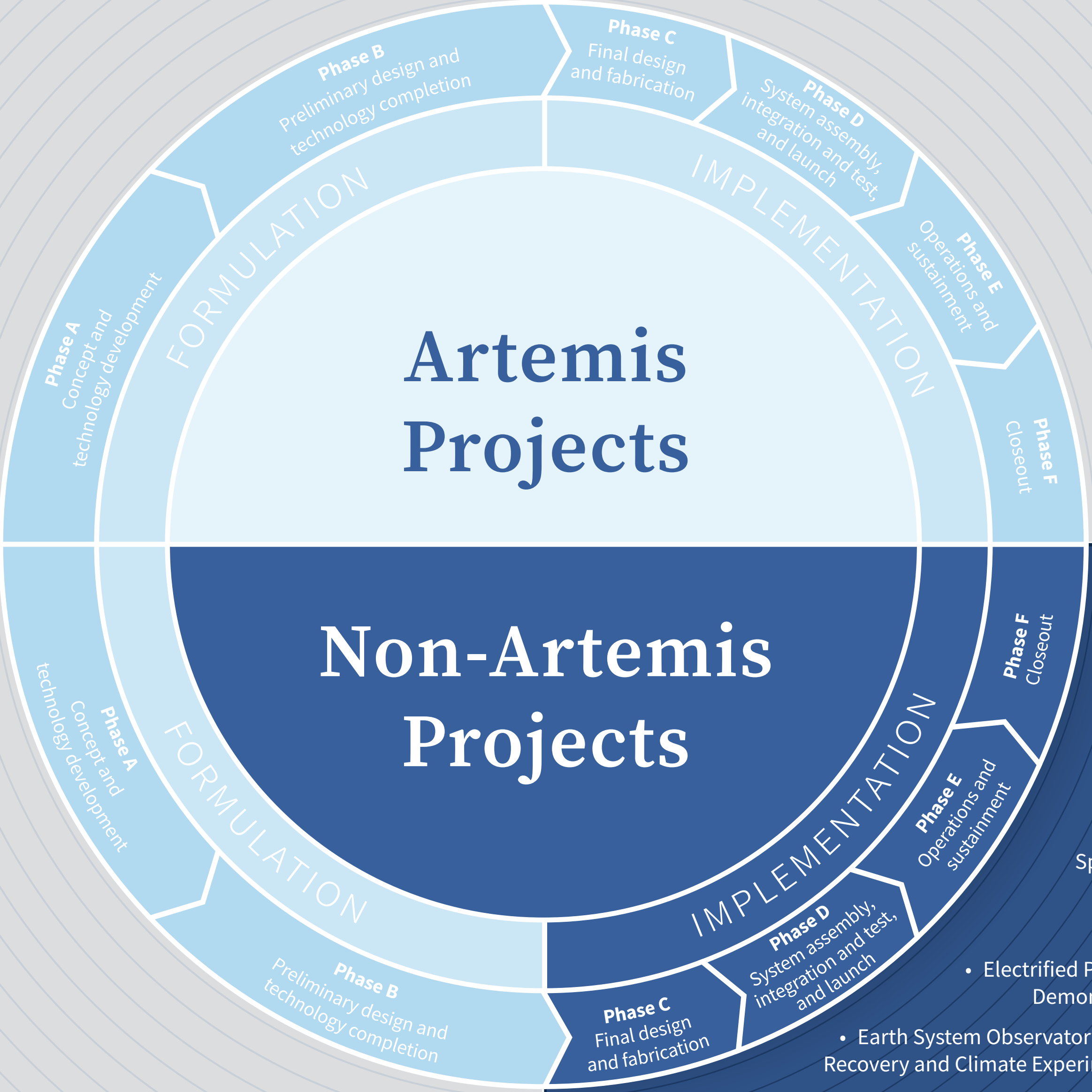

- Commercial Crew Program **(CCP)**
- Compton Spectrometer and Imager **(COSI)**
- Dragonfly
- Electrified Powertrain Flight Demonstration **(EPFD)**
- Earth System Observatory **(ESO)** - Gravity Recovery and Climate Experiment-Continuity **(GRACE-C)**
- Interstellar Mapping and Acceleration Probe **(IMAP)**
- Low Boom Flight Demonstrator **(LBFD)**
- MUlti-slit Solar Explorer **(MUSE)**
- Near Earth Object **(NEO)** Surveyor
- NASA – Indian Space Research Organisation Synthetic Aperture Radar **(NISAR)**
- Nancy Grace Roman Space Telescope **(Roman)**
- Spectro-Photometer for the History of the Universe, Epoch of Re-ionization and Ices Explorer **(SPHEREx)**

Source: GAO analysis of NASA data. | GAO-25-107591

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Source: NASA. | GAO-25-107591

Commercial Crew Program (CCP)

CCP oversees the development of crew transportation systems by commercial companies to carry NASA astronauts to and from the International Space Station (ISS). The program is working with Boeing and SpaceX to design, develop, test, and operate crew transportation systems. NASA must certify that these crew transportation systems meet its standards for human spaceflight before the companies can fly crewed missions to and from the ISS. NASA certified SpaceX in November 2020.

Timeline

09/14 Transportation capabilities phase contract awards

03/19 SpaceX uncrewed test flight

12/19 Boeing uncrewed test flight-1

05/20 SpaceX crewed test flight

11/20 SpaceX final certification and first post-certification flight

05/22 Boeing uncrewed test flight-2

06-09/24 Boeing crewed test flight

01/25 GAO review

Fall 2025 Boeing final certification

2020-2030 Post-certification operational missions

Project Information

NASA Lead Mission Directorate: **Space Operations**

NASA Lead Center: **Kennedy Space Center**

Commercial Partners: **Boeing and SpaceX**

Launch Location: **Boeing–Cape Canaveral Space Force Station, FL; SpaceX–Kennedy Space Center, FL**

Launch Vehicle: **Boeing–Atlas V; SpaceX–Falcon 9**

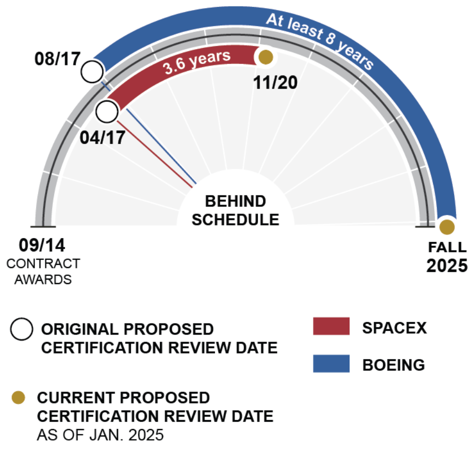
Requirement Derived from: **NASA Strategic Plan**

Project Summary

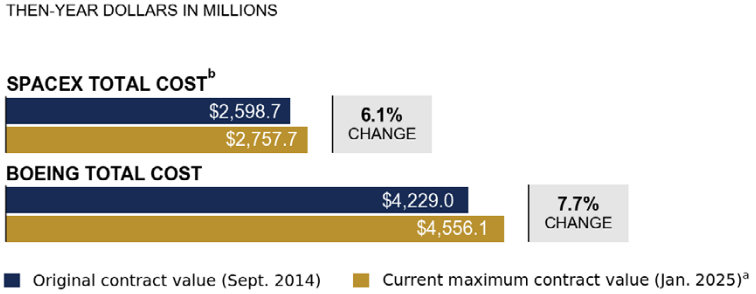
CCP and Boeing are working to certify Boeing's crew transportation system to fly service missions to the ISS after Boeing's crewed flight test returned to Earth without crew in September 2024. Five thrusters failed during the crewed flight test, which CCP's program manager said affected vehicle control of Boeing's Starliner spacecraft. NASA decided to return the Starliner uncrewed due to uncertainty about the Starliner's ability to safely execute the deorbit burn. The CCP program manager said the deorbit burn is controlled by the flight computer and cannot be stopped after a certain point if there are significant failures.

CCP is not planning for another crewed flight test before Boeing's certification review. The CCP program manager said that Boeing's next flight will be the first post-certification, or service, mission. However, they said Boeing's service missions may be cargo or crewed missions. As of November 2024, CCP reported that that it had not yet assessed the effect of Boeing's crewed flight test on Boeing's path to certification.

Schedule Performance



Cost Performance[a]



[a] *As reported by NASA as of January 2025 and includes contract costs for development, operations, and special studies*

[b] *SpaceX completed development and completed all six post-certification missions in its original contract by September 2023. We consider the cost of subsequent SpaceX post-certification missions to be an increase in scope and not cost growth on the original contract. Therefore, SpaceX's costs will not change after September 2023.*

Cost and Schedule Status

CCP and Boeing are working to certify Boeing's crew transportation system to fly service missions to the ISS after Boeing's crewed flight test returned to Earth without crew in September 2024. As of November 2024, CCP reported that it was in the process of conducting post-flight reviews of Boeing's crewed flight test. The program reported that it had not yet assessed the effect of Boeing's crewed flight test on Boeing's path to certification, which is planned for fall 2025.

CCP is not planning for another crewed flight test before Boeing's certification review. The CCP program manager said that Boeing's next flight will be the first post-certification, or service, mission. They said that after the crewed flight test, Boeing's crew transportation system must be certified before it can conduct another flight.

NASA is planning for Boeing to complete the six service missions that NASA previously ordered, depending on the ISS lifetime. The CCP program manager said these missions may be cargo or crew missions.

Integration and Test

CCP reported that Boeing met about 90 percent of its fight test objectives for the crewed flight test. These objectives included manually arming the launch abort system and establishing effective and reliable in-cabin communication with crew. However, Boeing's crewed flight test had multiple in-flight anomalies, or issues that posed increased risk to mission success or crew safety. For example, thruster failures and helium leaks in the service module of the Starliner spacecraft were classified as in-flight anomalies. The service module provides propulsion on-orbit and in abort scenarios, radiators for thermal control, and solar panels to charge batteries.

Thruster failures. As the Starliner approached the ISS, five of its 28 service module reaction control thrusters failed. These thrusters are used for attitude control, crew and service module separation, and service module disposal. The CCP program manager explained that when the thrusters failed, it affected the Starliner's ability to maintain vehicle control. The CCP program manager said that the Starliner's rendezvous and proximity operations were the most intense portion of the mission for the thrusters, and that the crewed flight test had more aggressive rendezvous operations than Boeing's second uncrewed flight test.

Operation of four of these five thrusters was eventually recovered and the Starliner docked with the ISS as planned. However, NASA decided to return the Starliner to Earth uncrewed due to uncertainty about the Starliner's ability to safely execute the deorbit burn. The CCP program manager said the deorbit burn—which is typically controlled by the flight computer—must be successfully completed to safely return the vehicle.

The program believes the most likely root cause of the thruster failures was excessive heat generation by the Starliner's thrusters. The CCP program manager said that there are hardware and operational solutions that could be used to keep temperatures within boundaries. For example, a hardware solution that is being considered is to add thermal barriers between thrusters. An operational solution could be changing which thrusters fire and when.

The CCP program manager said that CCP's certification process missed the thruster issue, and the program is trying to figure out why. Specifically, the program set up an investigation team to identify any lessons learned with their initial certification approaches that could have prevented the propulsion system anomalies that occurred during Boeing's crewed flight test.

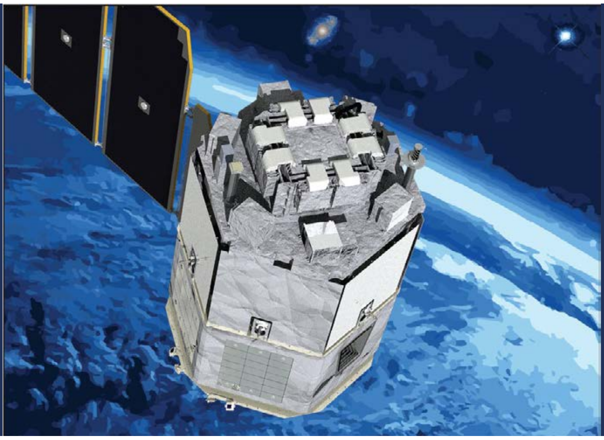
Helium leaks. The Starliner experienced a small helium leak before launch and several helium leaks during the crewed flight test. Helium is used to open the thruster propellant valves. According to the CCP program manager, the helium leak identified before launch was believed to be stable and the spacecraft had sufficient margin to account for multiple helium leaks. CCP reported there were six other leaks during the flight test, including two before docking with the ISS and four after docking with the ISS. CCP reported that the helium leaks did not require in-flight management.

The program believes that the likeliest cause of the helium leaks was degradation of the Starliner's helium seal due to extended oxidizer exposure. The CCP program manager said oxidizer and propellant permeates the helium seal which caused degradation and possible leakage of the seal. This issue is different than the service module valve issues that led Boeing to postpone its second uncrewed flight test in 2021.

According to the CCP program manager, the helium seal is a heritage design that has flown many times, including Boeing's two uncrewed flight tests. They said there was a small helium leak on Boeing's second uncrewed flight test, but that leak did not correlate to what was seen on the crewed flight test. To address the helium leak issue, Boeing and its suppliers are searching for an alternative helium seal to replace the existing seals. They are also determining what additional qualification testing would be needed for the alternative seals.

Project Office Comments

In commenting on a draft of this assessment, CCP officials noted that they made significant progress regarding Boeing's crewed flight test post-flight activities and continued to work to certify Boeing's crew transportation system. Once certified, they said NASA plans to conduct crew transportation missions to the International Space Station by alternating missions between the two providers. They said CCP has demonstrated the benefits of crew rotation missions, innovation, and cost effectiveness through its partnerships with industry and use of competition. CCP officials also provided technical comments on this draft, which were incorporated as appropriate.



Source: University of California, Berkeley. | GAO-25-107591

Compton Spectrometer and Imager (COSI)

COSI is a space telescope that will perform wide-field imaging and surveys of the gamma-ray radiation sources in space to answer questions about the structure and evolution of the galaxy. Specifically, the telescope will study the origin of antimatter in the Milky Way, element formation in supernovae, and the extreme environments of black holes and gamma-ray bursts. The project is managed by the University of California, Berkeley under NASA's Explorers Program.

Project Information

NASA Lead Mission Directorate: **Science**

NASA Lead Center: **Goddard Space Flight Center**

International Partners: **Agenzia Spaziale Italiana (Italy)**

Launch Location: **Cape Canaveral Space Force Station, FL**

Launch Vehicle: **Falcon 9**

Mission Duration: **24 months**

Requirement Derived from: **2010 Astrophysics Decadal Survey**

Next Major Project Event: **System Integration Review (Sept. 2026)**

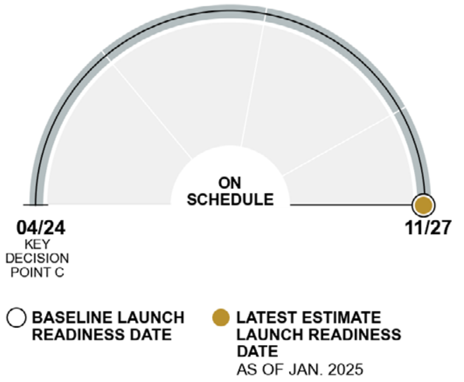
Project Summary

In April 2024, COSI established cost and schedule baselines of $273 million and November 2027, respectively. The project is currently operating within these baselines. The project held its critical design review in December 2024 and successfully passed the review.

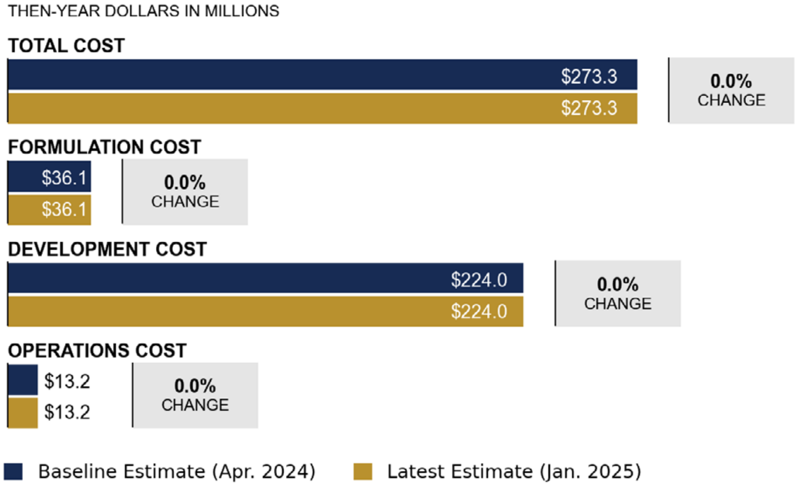
The project is tracking a risk of germanium detector delivery delays, which would delay instrument integration and testing. The germanium detectors collect high-energy radiation data for the instrument. Officials said that Lawrence Berkeley National Lab could fall behind in germanium detector production due to supplier issues and personnel changes. The project is pursuing the purchase of detectors from another supplier as a backup to keep the project on schedule. As of February 2025, the detector delivery remains behind schedule.

In 2024, the project delayed testing for approximately 6 months because it moved testing to a different facility at the Goddard Space Flight Center. The lab that was used to test the cryocooler—officials said that this is the system that keeps the detectors cold—had to be moved and reassembled in another building. This move affected the test schedule of components and programming of the cryocooler's microchip. The component needed to be tested in this lab, which was completed in December 2024. The risk of delays has been largely mitigated.

Schedule Performance



Cost Performance



Project Office Comments

COSI project officials provided technical comments on a draft of this assessment, which were incorporated as appropriate.

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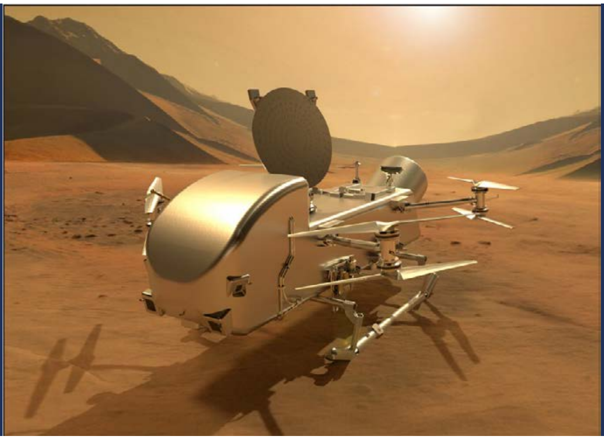


Dragonfly

Dragonfly is a rotorcraft lander that will visit Titan—Saturn's largest moon—and fly like a drone to sample and examine dozens of sites and search for the building blocks of life. It will explore organic dunes and the deposits of an impact crater where liquid water and complex organic materials key to life once existed together for possibly tens of thousands of years. It will also investigate how far prebiotic chemistry has progressed. This mission is the first time that NASA will fly an eight-bladed rotorcraft and take advantage of Titan's dense atmosphere to gather science on another planetary body. It will fly its entire science payload to new places for repeated and targeted access to surface materials.

Source: Johns Hopkins University Applied Physics Laboratory. | GAO-25-107591

Timeline

Project Information

NASA Lead Mission Directorate: **Science**

NASA Lead Center: **Marshall Space Flight Center**

International Partners: **Centre National d'Etudes Spatiales (France); Japan Aerospace Exploration Agency; German Aerospace Center**

Launch Location: **Kennedy Space Center, FL**

Launch Vehicle: **Falcon Heavy**

Mission Duration: **10 years**

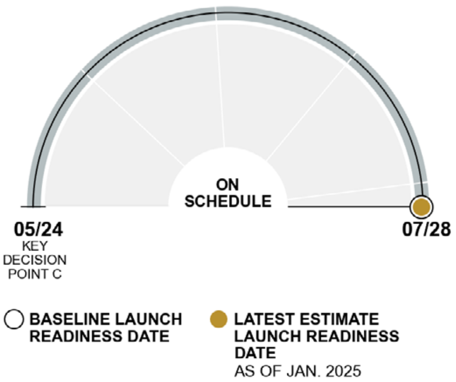
Requirement Derived from: **2011 Planetary Science Decadal**

Project Summary

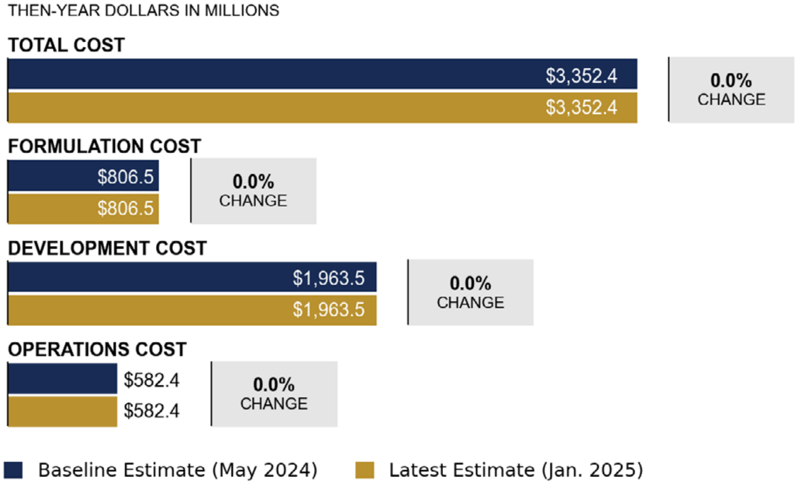
In May 2024, the Dragonfly project entered the implementation phase and formally established a baseline life-cycle cost of $3.4 billion and a July 2028 launch readiness date. According to the project, the fiscal year 2025 budget will be challenging due to funding constraints. Dragonfly will reassess its cost reserves following the critical design review (CDR), which began in April 2025.

The project continues to make progress on the rotorcraft lander and its instruments. Dragonfly is continuing to mature its design as it works toward its CDR. As of March 2025, the project completed almost all of the planned subsystem and instrument CDRs. Project officials said they plan to complete the remaining by Dragonfly's CDR. While the project continues to make progress on the designs of its subsystems and instruments, it faces cost and schedule challenges that it is working to resolve within its current resources.

Schedule Performance



Cost Performance



Cost and Schedule Status

The Dragonfly project entered the implementation phase and established its cost and schedule baselines in May 2024. NASA set a baseline life-cycle cost of $3.4 billion and a July 2028 launch readiness date. This is $852 million more than the top end of the project's preliminary cost estimate and 13 months later than its preliminary schedule estimate. Prior to setting this baseline, the project had replanned several times. One of the replans occurred after the project's March 2023 preliminary design review and resulted in the new July 2028 launch readiness date. Then, in December 2023, NASA directed the project to proceed with implementation development work, but it did not set a project cost or schedule baseline due to funding uncertainties. In May 2024, the agency set the project's cost and schedule baselines after it presented a plan that fit within NASA's funding constraints.

According to the project, its fiscal year 2025 budget will be constrained. NASA recognized in the beginning of the implementation phase that Dragonfly had limited reserves for fiscal year 2024 and 2025. The project is managing fiscal year 2025 costs while investigating options to improve its reserve posture. Dragonfly will assess its reserve needs as part of the CDR process in April 2025.

Technology and Design

The project is making progress toward its CDR, which began in April 2025. As of March 2025, the project completed 23 of 26 planned subsystem and instrument CDRs. The project plans to complete all of the remaining subsystem and instrument CDRs by the project-level CDR.

The project continues to make progress in developing its subsystems and instruments, but it is tracking several risks that may affect the schedule. For example, according to project documentation, a contractor may not be able to meet Dragonfly's need dates for pumps and fans. If the pump assembly is not delivered on time, it will severely impact progress in preparation for lander delivery and flight system integration. If the fans are delivered late, they will not be present for an important test during the lander integration and test, which is a critical test for the thermal system. The project is also concerned that the lander's battery temperature cannot be held within the specified temperature limits, which may degrade battery capacity and impact flight performance. The project is evaluating thermal model predictions to ensure that it has sufficient temperature margin.

The project made multiple changes to the lander design. For example, project officials said they redesigned the lander to use a three bladed rotor rather than two to mitigate vibration loads that are transmitted through the arms to all equipment inside the lander. Project officials said that this brought down the magnitude of loads and helped complete the vehicle design. They also said that they changed the blade angle to recover the flight performance lost by going to three blade rotors. Project officials said that they added a fin to the back of the lander on either side of the lander's nuclear energy source to improve the aerodynamic control.

Similarly, when the project made the decision to use a three bladed rotor design, the details on how the lander is packaged and accommodated inside the aeroshell needed to be updated. The aeroshell is part of the Entry Descent and Landing Assembly which includes the backshell and heatshield to protect the lander. The lander is attached to the backshell via a mechanism that includes the separation devices and guiderails to avoid any recontact during separation of the two flight elements during Titan arrival. Project officials noted that all of these features were previously in place, but changes in the lander's physical layout required that these be reassessed and the accommodations updated, resulting in schedule pressures.

The project is tracking a risk that the lidar may not be delivered on time. Part delays, staffing issues, and cost challenges threaten the delivery schedule. The lidar is a critical sensor that needs to be integrated early in the integration and test process. Project officials said that it is being developed and built at the Goddard Space Flight Center, with the Dragonfly project office collaborating on the development schedule and helping obtain parts. Project officials said that there is no viable commercial lidar they can use, and NASA does not have other lidar options that are mature enough to meet Dragonfly's requirements. If delivery of the lidar is delayed, it could delay Dragonfly's integration and test schedule and possibly its launch.

Project Office Comments

Dragonfly project officials provided technical comments on a draft of this assessment, which were incorporated as appropriate.

Source: GE Aerospace and magniX. | GAO-25-107591

Electrified Powertrain Flight Demonstration (EPFD)

EPFD is a technology demonstration project overseeing the commercial development of hybrid electric-powered aircraft. The program is working with two industry partners—GE Aerospace (GE) and magniX—to mature Electrified Aircraft Propulsion technologies for commercial aircraft through ground and flight demonstrations. These technologies can lead to lower operating costs, improve fuel efficiency, and reduce noise emissions. GE is developing a megawatt-class powertrain system for single-aisle aircraft carrying about 150 passengers, while magniX is developing a hybrid commuter aircraft for transporting approximately 45 passengers.

Timeline

Formulation

- **06/20** Formulation start
- **09/21** Contract awards
- **2022** GE system requirements review
- **2022** GE preliminary design review
- **2023** magniX system requirements review
- **2024** magniX preliminary design review
- **2024** GE critical design review
- **10/24** Key decision point C

Implementation

- **01/25** GAO review
- **2026** magniX critical design review
- **05/28** magniX first electrified flight

Project Information

NASA Lead Mission Directorate: **Aeronautics Research**

NASA Lead Center: **Virtual Project Office**

International Partners: **None**

Requirement Derived from: **Aeronautics Research Mission Directorate Strategic Implementation Plan**

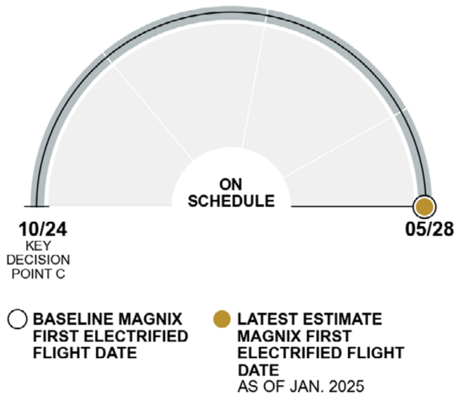
Project Summary

In October 2024, the EPFD project entered the implementation phase and formally established a baseline life-cycle cost of $655 million and a May 2028 first electrified flight date. The project is currently working within its cost and schedule baselines.

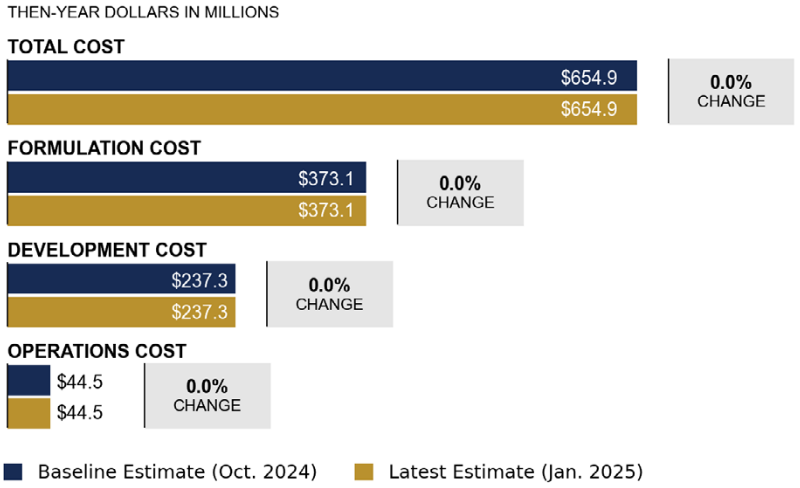
GE successfully completed its critical design review last year and has made progress maturing several of its critical technologies. The project is tracking a risk that GE's test schedule may be too aggressive. The project is coordinating with GE to prioritize what data can be provided to the project so that it can independently assess the data.

magniX successfully completed its preliminary design review last year. One of the key efforts for magniX is the design and development of its batteries, which will power the electric engines during flight. The project is tracking a risk that delays in maturing this system could lead to rework in the future.

Schedule Performance



Cost Performance



Cost and Schedule Status

In October 2024, the EPFD project entered the implementation phase and formally established a baseline life-cycle cost of $655 million and a May 2028 first electrified flight date. This cost baseline is approximately $185 million more than the highest preliminary cost estimate. Additionally, the first flight date is approximately 3.5 years after the preliminary schedule estimate.

These cost and schedule baselines cover the work being done by both GE and magniX. To generate the schedule baseline, NASA established top level milestones for each partner that project officials said are tied to demonstrating performance. Based on NASA's assessment of those schedules, the schedule baseline is tied to the magniX first electrified flight date, because NASA expects magniX to fly first. Both partners are working toward earlier first flight dates, but NASA anticipates that the first flights are more likely to occur in 2028.

One of the actions from the key decision point C meeting was direction for the project to pursue an alternate funding mechanism to fund the project beyond fiscal year 2025. The project is tracking a risk that GE and magnix's forecasted progress through fiscal year 2026 could limit availability to access project funds in future fiscal years. NASA awarded hybrid firm-fixed-price, cost-share contracts to GE and magniX in 2021. These contracts are firm-fixed-price until the critical design reviews. After these reviews, NASA and the industry partners will each fund 50 percent of the total contract costs through contract closeout, which includes flight demonstration. Project officials told us that they are working with NASA headquarters officials to find a solution by the spring of 2025.

Technology and Design

The EPFD project is categorized as a technology demonstration mission. As such, the project uses technology readiness level data to assess the maturity of critical technologies at various points in their life cycles but has additional flexibilities to determine when it will mature technologies. One of the project's objectives is for both industry partners to demonstrate a technology readiness level (TRL) of 6 through ground and flight demonstrations for their individual integrated powertrain system at the conclusion of the project. Achieving a TRL 6 involves demonstrating a representative prototype of the technology in a relevant environment.

GE Aerospace. GE completed its critical design review in April 2024 and is responding to several key action items from the review. Specifically, the independent review board identified eight requests for action associated with airworthiness, safety of flight, and technical risk. As of November 2024, GE closed one action, is in the final stages of closing five actions, and has two planned actions underway.

Since the critical design review, NASA reported that three of 10 critical technologies are at a TRL 6, with the seven remaining technologies at a TRL 5. Achieving a TRL 5 involves demonstrating a component of a system in a relevant environment. According to NASA documentation, there is a path forward to maturing all 10 technologies to a TRL 6 ahead of the flight demonstration, thereby reducing the risk of not achieving project success.

According to NASA documentation, NASA is tracking a risk that GE's test schedule may be too aggressive. This could reduce the time available for GE to assess and analyze test results. The project is coordinating with GE to prioritize what data can be provided to NASA for NASA to assess these data independently.

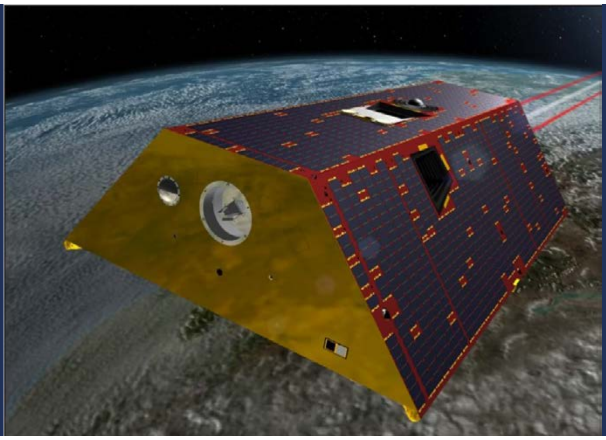
magniX. magniX completed its preliminary design review in February 2024 and is responding to key action items from the review. The independent review board identified nine requests for action associated with hazards, mitigations, and instrumentations, among others. As of November 2024, magniX had closed two actions, with planned actions underway to respond to the remaining seven. The next major milestone for magniX is the critical design review, which is scheduled for fiscal year 2026.

NASA reported that all 11 of magniX's critical technologies remain immature, with TRLs ranging from 3 to 5. But, according to NASA documentation, NASA and magniX agree on the technology assessment values and believe that there is a path forward to maturing all the technologies to a TRL 6 ahead of flight demonstration.

According to NASA documentation, development of the magniX energy storage system, or battery, is driving the design, integration, and installation schedule. Project officials told us that these batteries need to power the electric engines in the test flight, which is why both NASA and magniX are focused on their development. The project is tracking a risk that delays in maturing the battery system could lead to additional rework in the future.

Project Office Comments

EPFD project officials provided technical comments on a draft of this assessment, which were incorporated as appropriate.



Source: NASA. | GAO-25-107591

Earth System Observatory (ESO) – Gravity Recovery and Climate Experiment – Continuity (GRACE-C)

GRACE-C consists of two satellites that will continue more than 20 years of large-scale mass change observations used to assess drought and to understand sea level rise, Earth's energy imbalance, and ice mass loss. It is a successor to the GRACE (2002–2017) and GRACE-Follow On (2018–present) missions. The GRACE-C satellites use a laser system, called laser ranging interferometer, to precisely measure the distance between the satellites as they respond to Earth's gravitational pull, enabling monthly measurements of water and land mass.

Project Information

NASA Lead Mission Directorate: **Science**

NASA Lead Center: **Jet Propulsion Laboratory**

International Partners: **German Aerospace Center**

Launch Location: **TBD**

Launch Vehicle: **Falcon 9**

Mission Duration: **3 years**

Requirement Derived from: **Program Level Requirement Appendix**

Next Major Project Event: **System Integration Review (October 2025)**

Project Summary

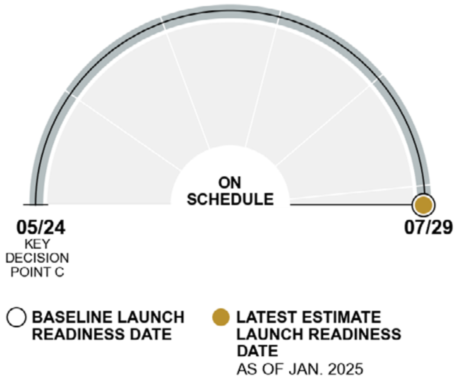
In May 2024, GRACE-C established cost and schedule baselines of $658 million and July 2029, respectively. This cost baseline is approximately $40 million more than the highest preliminary cost estimate. The project is currently working within its baselines.

According to officials, GRACE-C has no critical technologies because it is reusing much of the technology and design for the spacecraft and instrument from the previous iteration, GRACE-Follow On, with some changes due to obsolescence.

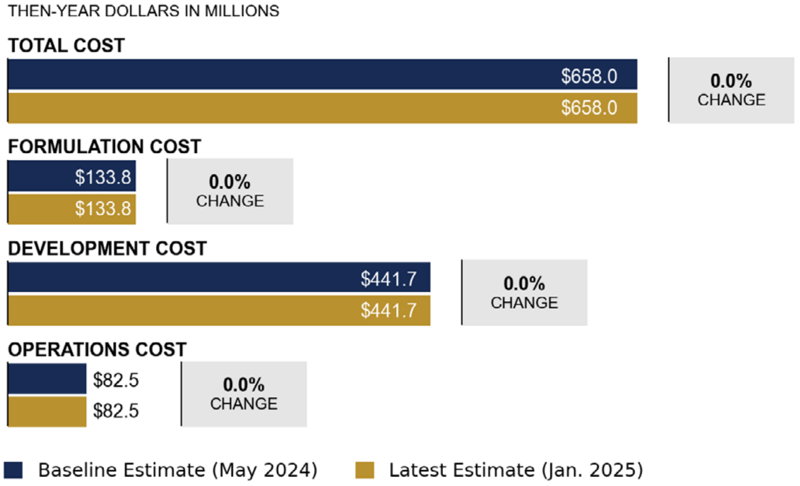
The project held and passed its preliminary design review in March 2024 and its critical design review in May 2025. At the critical design review, the standing review board's top concern was incompatibility with the Near Space Network ground terminals, which is a known issue for GRACE-Follow On and could affect GRACE-C if not resolved.

The top risk for the project is a delivery delay of the optical bench electronics due to issues with a redesign for redundancy, which would delay the delivery of the primary instrument. These electronics are developed by the German Aerospace Center and maintain alignment of specific satellite components.

Schedule Performance



Cost Performance



Project Office Comments

GRACE-C project officials provided technical comments on a draft of this assessment, which were incorporated as appropriate.

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Interstellar Mapping and Acceleration Probe (IMAP)

IMAP is a spinning spacecraft that will help researchers better understand the boundary where the heliosphere collides with interstellar medium, or material from the rest of the galaxy. The heliosphere is the bubble created by the solar wind—a constant flow of particles from our sun—and the boundary limits the amount of harmful cosmic radiation entering the solar system. IMAP includes 10 instruments and will reside in an orbit almost 1 million miles from Earth, where it will collect and analyze particles that make it through the boundary.

Source: NASA/Princeton/Patrick McPike. | GAO-25-107591

Timeline

Project Information

NASA Lead Mission Directorate: **Science**

NASA Lead Center: **Goddard Space Flight Center**

International Partners: **Polish Academy of Sciences (Poland), University of Bern (Switzerland), Imperial College of London (UK)**

Launch Location: **Cape Canaveral Space Force Station, FL**

Launch Vehicle: **Falcon 9**

Mission Duration: **2 years**

Requirement Derived from: **2013 Heliophysics Decadal Survey**

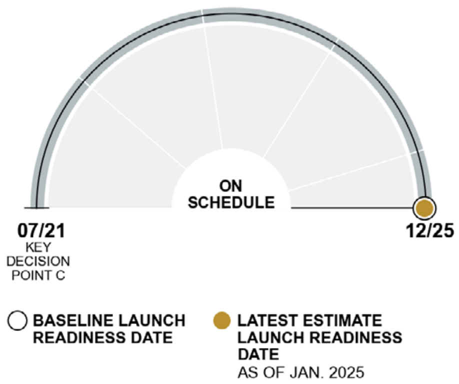
Project Summary

The IMAP project continues to operate within the cost and schedule baselines that NASA established in July 2021. The project adjusted its schedule within its baseline to accommodate instrument delivery delays and technical challenges. The project will use headquarters-held funding reserves to support the schedule adjustment and remain on track to launch by December 2025 and within its cost baseline.

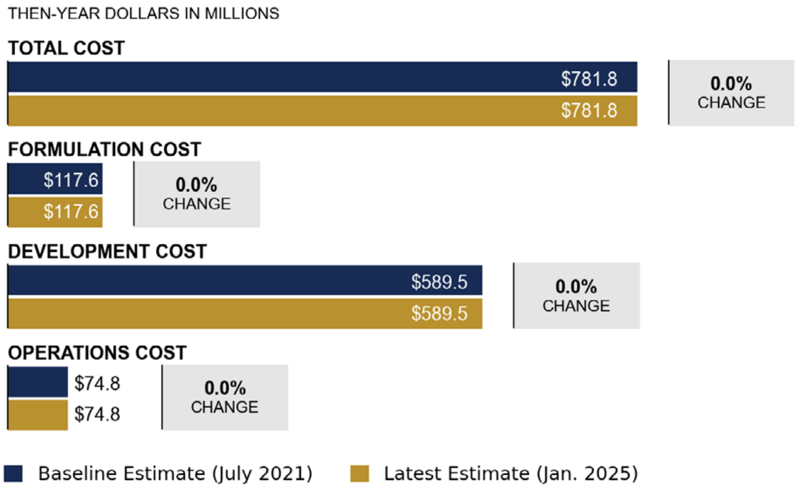
IMAP personnel successfully installed and integrated all of IMAP's instruments onto the spacecraft. The project is addressing an issue on the Compact Dual Ion Composition Experiment (CoDICE) instrument related to an electrical leak. Project officials stated they have a mitigation plan to address the issue.

The project completed shipment of the spacecraft to Marshall Space Flight Center in March 2025. The project shifted test sites to avoid conflicts with other NASA projects. Specifically, IMAP moved testing to Marshall Space Flight Center because testing facilities were unavailable at Goddard Space Flight Center. Following testing at Marshall, the spacecraft will be shipped to Cape Canaveral Space Force Station for the launch.

Schedule Performance



Cost Performance



Cost and Schedule Status

The IMAP project continues to operate within the cost and schedule baselines that NASA established in July 2021. In December 2024, the project adjusted its schedule due to instrument delivery delays and existing technical risks but remained on track to meet its launch date of December 2025. For example, project officials said that one instrument was delayed because a portion of the instrument required a change to a more robust material after unexpected issues occurred during vibration testing. As a result of the schedule adjustment, there were effects on the project's costs. Officials told us that in December 2024, NASA provided headquarters-held cost reserves to the project to address open technical risks and to complete remaining test activities within the cost baseline.

An IMAP official stated that the project paused the work of one of its teams in October 2024, to save funds while awaiting instrument deliveries. All major integration and test activities were paused for 3 weeks, and the project reported that releasing team members to complete other activities saved some project costs.

Instruments

IMAP personnel successfully installed and integrated all 10 of the project's instruments onto the spacecraft as of December 2024. The additional time provided by the schedule adjustment will allow the project to complete all instrument and system testing prior to launch. This will reduce the likelihood of a mission-critical issue arising on orbit. The project had previously been tracking several high-level instrument risks related to testing, but successfully closed many of them or reduced the potential impact of the risks. Specifically, if the instrument delays had continued, the project may have had to reduce testing, resulting in higher risk of issues after the spacecraft launched. This could have limited mitigation options and potentially increased risk to the mission.

The project is addressing a few remaining instrument issues. In particular, the project is addressing an electrical issue on the CoDICE instrument. Project officials stated that design changes between the engineering model and the flight model introduced pathways for an electrical leak in the instrument's high-voltage power supply. The project identified a mitigation and expects the rework to address the issue. However, it remains a high-level risk as the project is working to correct the issue.

Integration and Test

The IMAP team is working to complete its testing prior to moving to the launch site. For example, the project completed acoustic testing in December 2024. Acoustic testing is meant to ensure that the spacecraft can endure the noise during launch among other objectives. The project also has multiple test events scheduled for early 2025, including vibration and shock testing and thermal vacuum testing. Vibration and shock testing are meant to ensure that the spacecraft can survive the launch environment. Thermal vacuum testing ensures that the spacecraft can function in the extreme temperature variations in space.

The project has also shifted test sites to avoid conflicts with other NASA projects. Specifically, the IMAP project previously faced a risk of delays to its thermal vacuum testing due to facility availability at Goddard Space Flight Center. IMAP moved its testing to Marshall Space Flight Center to mitigate the risk. This mitigation cost approximately $2.4 million of project-held reserves to cover travel and shipping costs, within the cost baseline. The project completed shipment of the spacecraft to Marshall in March 2025 for the testing. Following the testing at Marshall, the spacecraft will be shipped to Cape Canaveral Space Force Station for launch.

Project Office Comments

In commenting on a draft of this assessment, IMAP project officials noted that IMAP successfully completed dynamic testing, including shock, vibration, and acoustic testing. Officials also stated that IMAP was successfully shipped to Marshall Space Flight Center for thermal vacuum testing. They also provided technical comments on a draft of this assessment, which were incorporated as appropriate.

Low Boom Flight Demonstrator (LBFD)

LBFD is a flight demonstration project that is developing the X-59 aircraft for the Quesst mission, which will provide data to help determine whether noise from supersonic flight—sonic boom—can be reduced to levels acceptable to the public for eventual commercial use in overland flight paths. After the aircraft transfer review, the project plans to transfer the flight demonstration aircraft to the other Quesst projects. NASA's Flight Demonstrations and Capabilities project will support community testing by the Commercial Supersonic Technology project that will gather community responses to the flights. It will also create a database to support the development of international noise standards, which are needed to open the market for supersonic flight.

Source: NASA. | GAO-25-107591

Timeline

Project Information

NASA Lead Mission Directorate: **Aeronautics Research**

NASA Lead Center: **Virtual Project Office**

International Partners: **None**

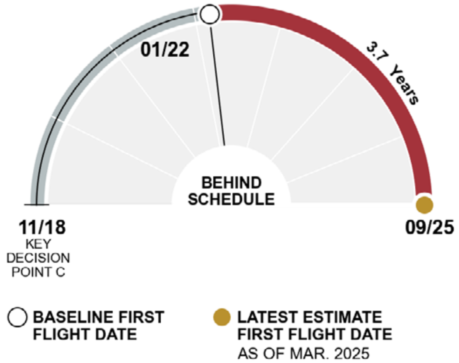
Requirement Derived from: **Aeronautics Research Mission Directorate Strategic Implementation Plan**

Project Summary

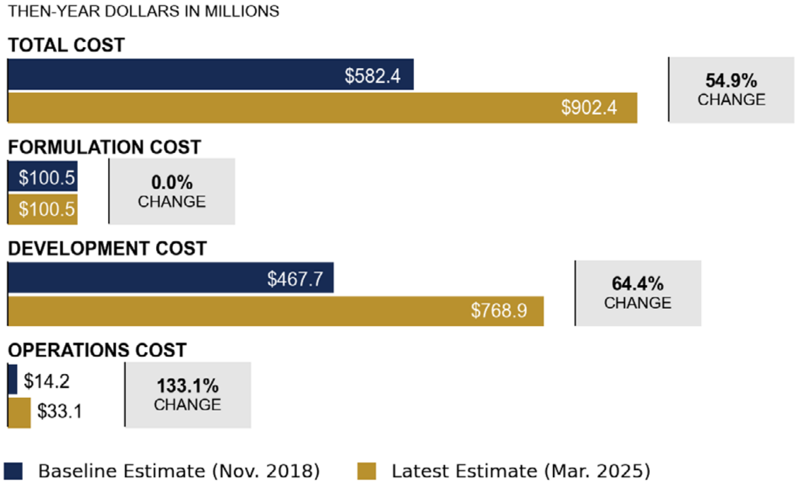
NASA set new cost and schedule estimates for the LBFD project following an 11-month delay to the project's first flight date. Schedule delays were driven by issues related to testing and staffing. For example, software testing led to delays because only one of two software testing facilities was fully available in 2024. According to NASA documentation, the contractor plans to continue to use its own funds to complete some work associated with related delays.

Project officials said they made significant progress by completing engine testing and a flight readiness review, which mark the beginning of integrated testing and the airworthiness process, respectively. If the project can complete its first flight by its estimated date of September 2025, then the greater Quesst mission should be able to support a 2031 international committee meeting that develops recommendations for aviation environmental standards with a complete set of community response data as planned. However, delays beyond this date could result in the Quesst mission delivering a partial dataset in support of the 2031 committee and delaying the complete dataset until 2034.

Schedule Performance



Cost Performance



Cost and Schedule Status

NASA reassessed the cost and schedule estimates for the LBFD project. The project's cost and schedule performance has continued to decline since the project rebaselined in January 2024. Since then, first flight was delayed by 11 months from October 2024 to September 2025. The project added approximately $64 million to the life-cycle cost to accommodate this delay. The contractor used its investment funds to complete some work associated with delays to first flight. According to NASA documentation, the reassessment assumes that the contractor will continue contributions through first flight.

Integration and Test

NASA reported that the major causes of the 11-month delay to first flight were issues with software testing, engine run tests, and flight test team staff:

- **Software testing.** According to project documentation, software testing delayed aircraft testing. Officials said the project had only one of two system integration laboratories fully available for software testing in 2024. Recovery work needed for components of the flight control computers affected the capability of the second laboratory, which reached full capability in early 2025. According to officials, the project could not minimize the effect of the software delays by shifting activities before the engine run tests because a firmware issue with the instrumentation system had to be resolved with the manufacturer first.
- **Engine run testing.** According to project documentation, engine run testing took longer than expected due to issues with the aircraft's subsystems and instrumentation systems. For example, the generator failed to turn on during one of the tests. According to officials, the generator is now operational after software and wiring updates.
- **Flight test staffing.** According to project documentation, contractor staffing challenges related to the transition from its production team to its flight test team contributed to delays. For example, prior to the transition, NASA identified a safety concern because the contractor had not identified a flight test lead and there were not enough engineers assigned to the project to complete testing on schedule. According to NASA documentation, the contractor acted quickly to address these concerns.

The project continues to work toward its first flight in September 2025. According to project officials, the completion of the engine run test and a flight readiness review represent the most significant accomplishment since the project rebaselined in January 2024. The engine run tests were the first set of integrated tests and represent the first time the project ran the engine while fully integrated with the other aircraft systems. Project officials said that the flight readiness review marks the beginning of the airworthiness process that validates the aircraft is ready for flight.

According to project officials, there are no major technical issues facing the project. Officials said the findings from integrated testing are typical for aircraft projects at this stage of testing. The project continues to carry some high risks, but officials said these risks may be reduced through further analysis and flight testing. For example, the project's top risk is that the aircraft's sonic boom will be too loud. Project officials said this risk is based on immature analysis and may be reduced through additional analysis.

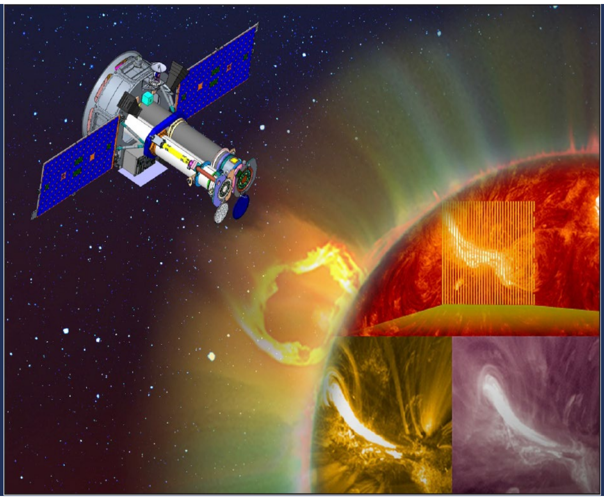
Other Issues to Be Monitored

The LBFD project is one of three projects in the Quesst mission. The mission has two goals: (1) develop an aircraft with technology to reduce the loudness of a sonic boom, and (2) fly the aircraft over up to five communities and gather data on public response to the noise. The LBFD project is responsible for the aircraft development and supports the acoustic validation phase along with two other projects, which will conduct the community response work.

There is a risk to the Quesst mission if the first flight of LBFD is further delayed. The Quesst mission plans to provide community response data to support the 2031 meeting of the Committee on Aviation Environmental Protection, an international group that makes recommendations about environmental aviation standards. However, officials said the estimated first flight of September 2025 adds risk to the mission due to the schedule compression of the acoustic validation phase that measures the aircraft's sonic boom. If first flight is beyond this date, the Quesst mission may not be able to support the 2031 meeting with the complete dataset as planned and instead provide a partial dataset. The next opportunity to support the committee meeting is in 2034.

Project Office Comments

LBFD project officials provided technical comments on a draft of this assessment, which were incorporated as appropriate.



MUlti-slit Solar Explorer (MUSE)

MUSE is a spacecraft that will observe the sun's extreme-ultraviolet radiation and obtain high-resolution images of the sun's atmosphere. Its goal is to understand the processes that heat the solar atmosphere and drive space weather events such as solar flares and eruptions. These events can impact the functioning of satellites, accuracy of global positioning systems, power grid on Earth, and safety of astronauts, among other things. The instrument on the spacecraft consists of an imager with a large field of view and a spectrograph, which will measure solar flares 35 to 100 times faster than current instruments. MUSE is based on the Interface Region Imaging Spectrograph spacecraft, but with some new parts to address obsolescence issues.

Source: NASA/Lockheed Martin Advanced Technology Center. | GAO-25-107591

Project Information

NASA Lead Mission Directorate: **Science**

NASA Lead Center: **Goddard Space Flight Center**

International Partners: **Italian Space Agency, German Aerospace Center, Norwegian Space Agency**

Launch Location: **TBD**

Launch Vehicle: **TBD**

Mission Duration**: 2 years**

Requirement Derived from: **2013 Space and Solar Physics Decadal Survey**

Next Major Project Event: **System integration review (Dec. 2025)**

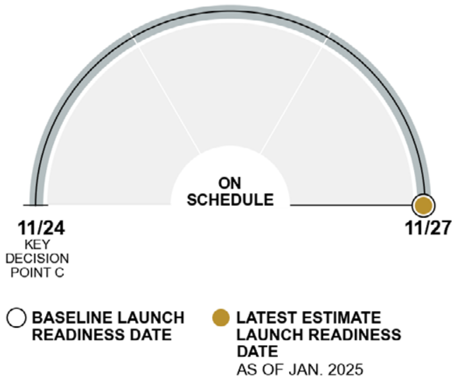
Project Summary

In November 2024, MUSE established cost and schedule baselines of $389.3 million and November 2027, respectively.

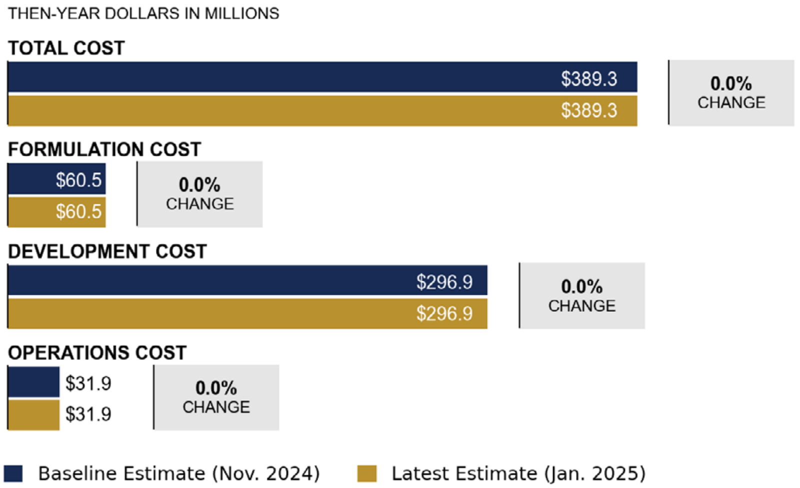
According to program documentation, the project is operating within its baselines and has sufficient cost and schedule reserves. MUSE successfully completed its preliminary design review in March 2024. As of November 2024, it had addressed all concerns raised by the standing review board, such as readiness for procurement of flight hardware and build activities that occur before the critical design review. The project will go through several sets of peer reviews before the critical design review, planned for April 2025.

Project officials told us that they are preemptively tracking risks associated with the reaction wheels. Reaction wheels are essential because they help orient telescopes in space. Officials stated that NASA experienced issues with this contractor's reaction wheels on prior missions, including the reaction wheels changing the direction of their rotation during a firmware update. These issues caused rework late in those projects' development. The MUSE project held a technical meeting with the contractor to begin addressing the concerns.

Schedule Performance



Cost Performance



Project Office Comments

MUSE project officials provided technical comments on a draft of this assessment, which were incorporated as appropriate.

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Near Earth Object (NEO) Surveyor

NEO Surveyor is a space-based telescope designed to search for NEOs such as asteroids and comets that are 140 meters or larger in diameter. By accomplishing this survey, the telescope will detect, track, catalog, and characterize NEOs to identify objects that could be potentially hazardous. The project aims to obtain detailed physical characterization data for individual objects that are likely to pose an impact hazard. It also aims to characterize the entire population of potentially hazardous NEOs to inform mitigation strategies. The NEO Surveyor continues work previously done under the NEO Camera project.

Source: NASA. | GAO-25-107591

Timeline

Formulation	06/20	Formulation start
	09/20	System requirements/ mission definition review
	09/22	Preliminary design review
	11/22	Key decision point C
Implementation	01/25	GAO review
	02/25	Critical design review
	07/26	System integration review
	06/28	Latest launch readiness date

Project Information

NASA Lead Mission Directorate: **Science**

NASA Lead Center: **Jet Propulsion Laboratory**

International Partners: **None**

Launch Location: **TBD**

Launch Vehicle: **Falcon 9**

Mission Duration: **5 years**

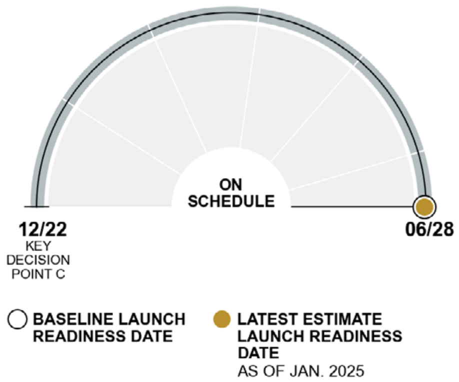
Requirement Derived from: **The George E. Brown, Jr. Near-Earth Object Survey Act, Pub. L. No. 109-155, § 321 (2005)**

Project Summary

The NEO Surveyor project continues to operate within the cost and schedule baselines set in December 2022. However, the project faces funding challenges with limited cost reserves in fiscal year 2025. The baseline funding profile for the project was approved, but the project did not receive funding from NASA headquarters for the amount of cost reserves expected in fiscal years 2023 and 2024. The project completed its critical design review in February 2025.

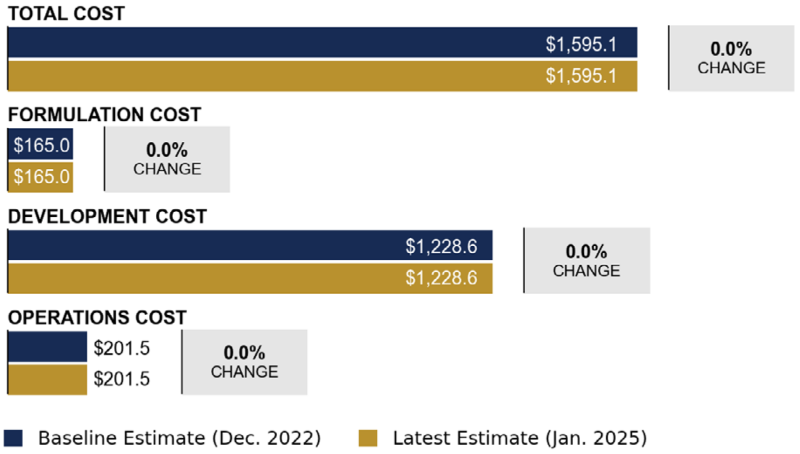
The project office is tracking multiple technical risks but is making progress on some risks and working on mitigation steps for others. For example, the project faces cost and schedule risks related to qualification testing of the spacecraft's propulsion tank. The project developed mitigation options and chose an alternate supplier that could deliver a qualified tank ahead of the need date. The project also started a thermal test that is important for the overall verification of the instrument enclosure to protect the telescope.

Schedule Performance



Cost Performance

THEN-YEAR DOLLARS IN MILLIONS



Cost and Schedule Status

While the NEO Surveyor project continues to operate within the cost and schedule baselines set in December 2022, the project faces funding challenges. The baseline funding profile for the project was approved, but the project did not receive funding from NASA headquarters for the amount of cost reserves expected in fiscal years 2023 and 2024. Due to the limited funding, the project deferred some contract costs into early fiscal year 2025 and NASA headquarters provided early funding for the year to assist with these deferred costs.

The project continues to track cost risks related to funding challenges as it proceeds through development. If the identified cost risks are realized, project costs in fiscal year 2025 will exceed the available reserves. In January 2025, the project reported the amount of project-held cost reserves is 16 percent, which is below the Jet Propulsion Laboratory's recommended 25 percent level for project-held reserves. According to project documentation, low reserves could affect the project's ability to maintain schedule. As a result, the project is developing options to mitigate risks.

The project completed its project-level critical design review in February 2025, after completing its subsystem reviews with minimal action items. NASA selected SpaceX as the launch services provider in February 2025.

Technology and Design

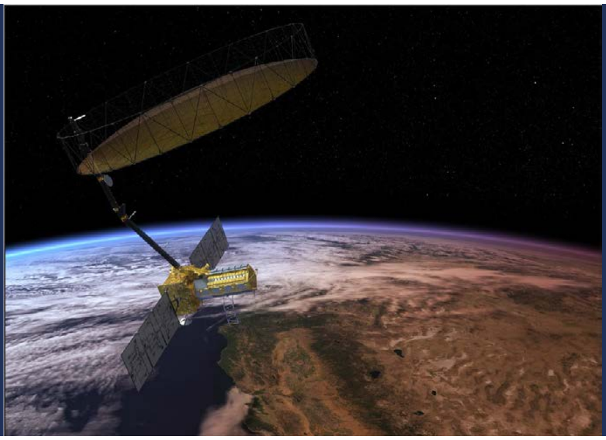
Delivery and integration of the propulsion tank is critical to the project schedule. The project originally planned to rely on the Space Launch System (SLS) program's qualification testing for their propulsion tank's diaphragm material. However, the SLS program's testing schedule slipped 18 months and now poses a risk to NEO Surveyor's schedule. Because of the risk of additional delays, the NEO Surveyor project developed mitigation options and chose an alternate supplier that could deliver a qualified tank ahead of the need date.

The project is conducting a complex series of tests to ensure the spacecraft and telescope can function in the expected thermal environment. This complexity poses a risk to cost and schedule if test replans are necessary. The project worked with the contractor and the Space Dynamics Laboratory to conduct early detailed temperature modeling ahead of the external thermal balance test. The external thermal balance test verifies the performance of the radiators and thermal shield. As of May 2025, the project had successfully completed thermal testing of the instrument enclosure, which keeps heat off the telescope, at the Johnson Space Center and delivered the hardware to the Space Dynamics Laboratory for integration with the flight telescope. The flight telescope is also undergoing thermal and optical testing at the Space Dynamics Laboratory.

The project also discovered workmanship issues with some subcomponents. For example, the spacecraft thruster valve had weld quality issues that needed to be corrected. This issue poses a risk to the spacecraft propulsion schedule as some components may need to be recalled for fixes. In addition, insulation damage on electrical harnesses had to be reworked.

Project Office Comments

NEO Surveyor project officials provided technical comments on a draft of this assessment, which were incorporated as appropriate.



Source: Jet Propulsion Laboratory - Graphics Dept. | GAO-25-107591

NASA–Indian Space Research Organisation (ISRO) Synthetic Aperture Radar (NISAR)

NISAR is a joint project between NASA and ISRO that will use a satellite to study the solid earth, ice masses, and ecosystems. It aims to address questions related to global environmental change, Earth's carbon cycle, and natural hazards such as earthquakes and volcanoes. The project will include the first dual frequency synthetic aperture radar instrument, with one radar provided by NASA and one provided by ISRO. The radars use different frequencies and will use advanced radar imaging to construct large-scale datasets of Earth's movements. ISRO will also provide the spacecraft and launch vehicle. NISAR represents the most complex science mission development undertaken jointly by NASA and ISRO.

Project Information

NASA Lead Mission Directorate: **Science**

NASA Lead Center: **Jet Propulsion Laboratory (JPL)**

International Partners: **Indian Space Research Organisation**

Launch Location: **Satish Dhawan Space Centre, India**

Launch Vehicle: **Geosynchronous Satellite Launch Vehicle Mark II**

Mission Duration: **3 years**

Requirement Derived from: **2007 Earth Science Decadal Survey**

Next Major Project Event: **Launch Readiness Date (June 2025)**

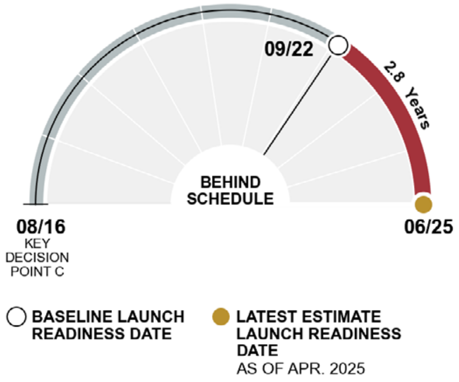
Project Summary

The NISAR project added $40.9 million to its previously rebaselined cost and delayed its planned launch by 8 months to June 2025. Repairs to the NISAR reflector, which is designed to transmit and receive signals to and from Earth's surface, delayed the launch date. Following the eclipse season, which runs from October through January, the launch was further delayed due to ISRO's launch schedule. NISAR is expected to launch no earlier than June 2025. NASA anticipates needing additional funding because of the delays.

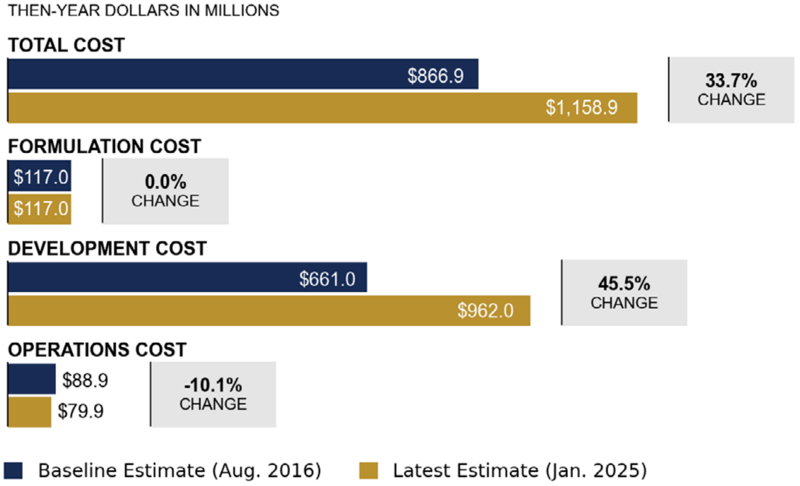
Early in 2024, a JPL analysis found discrepancies between the thermal model for the NISAR reflector and the thermal vacuum chamber test results. In March 2024, the project shipped the reflector from India back to the contractor in the U.S. The contractor applied reflective tape, among other precautionary measures, to mitigate temperature increases the reflector may be exposed to when it is deployed on-orbit. The reflector arrived back to ISRO at the end of October 2024 and integration and testing was completed in November 2024.

The NISAR launch date also depends on the launch pad schedule. Officials said that ISRO has launches planned before the NISAR launch, and changes to the launch pad schedule and maintenance time frames between launches can affect the NISAR launch date. As of April 2025, the spacecraft is in storage in India awaiting launch.

Schedule Performance – Under Review



Cost Performance – Under Review



Project Office Comments

NISAR project officials provided technical comments on a draft of this assessment, which were incorporated as appropriate.

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Nancy Grace Roman Space Telescope (Roman)

Roman, formerly known as the Wide-Field Infrared Survey Telescope, is an observatory designed to perform wide-field imaging and survey of the near-infrared sky. The Roman project plans to answer questions about the structure and evolution of the universe and expand our knowledge of planets beyond our solar system. The telescope has a primary mirror that is 2.4 meters in diameter, and its primary instrument will have a field of view that is 100 times larger than the Hubble Space Telescope's infrared instrument. The project plans to launch Roman to an orbit about 1 million miles from Earth. The project is also planning a guest observer program that may provide observation time to academic and other institutions.

Source: NASA/Goddard Space Flight Center. | GAO-25-107591

Timeline

Project Information

NASA Lead Mission Directorate: **Science**

NASA Lead Center: **Goddard Space Flight Center**

International Partners: **European Space Agency, Centre National d'Etudes Spatiales (France), Japan Aerospace Exploration Agency, Max Planck Institute (Germany)**

Launch Location: **Kennedy Space Center/Eastern Range, FL**

Launch Vehicle: **Falcon Heavy**

Mission Duration: **5 years (does not include on-orbit commissioning)**

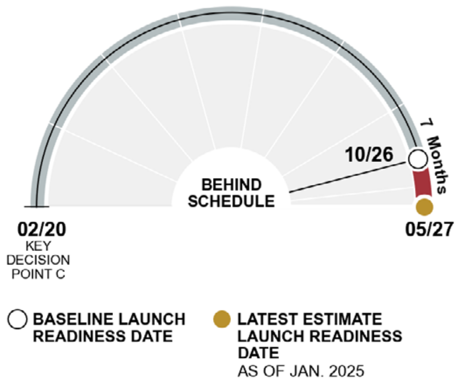
Requirement Derived from: **2010 Astrophysics Decadal Survey**

Project Summary

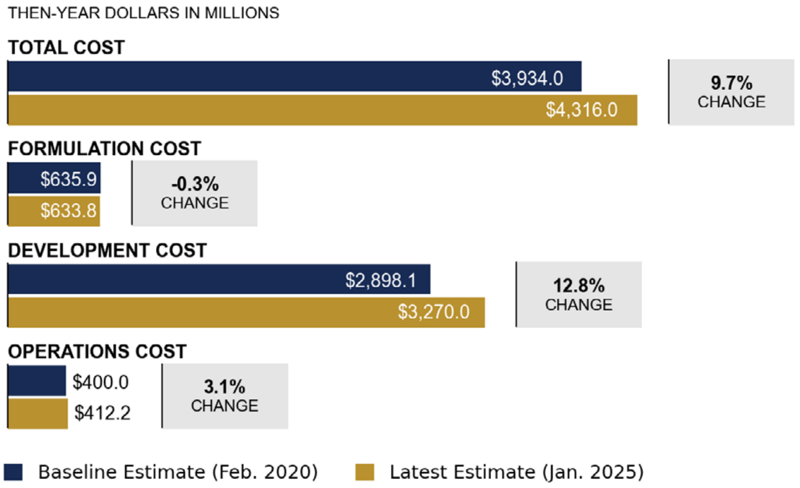
The Roman project continues to operate within its life-cycle cost of $4.3 billion and launch readiness date of May 2027. The Roman project was approved to enter the system assembly, integration and test, and launch phase—phase D—in March 2025. The project continues to execute according to its schedule.

All of the Roman components have been delivered to the Goddard Space Flight Center and the project is proceeding with integration and testing of these components. For example, the project integrated the Coronagraph Instrument (CGI) and the Wide Field Instrument to its instrument carrier. The project is continuing with integration and testing of the observatory.

Schedule Performance



Cost Performance



Cost and Schedule Status

The Roman project continues to operate within its revised cost and schedule commitments approved in the June 2021 replan. The replan set an estimated life-cycle cost of $4.3 billion and an estimated launch readiness date of May 2027, which is $382 million and 7 months above the original baselines, due to impacts from COVID-19. The project is working toward a launch as early as fall 2026.

The Roman project was approved to proceed with the system assembly, integration and test, and launch phase—phase D—in March 2025. NASA released headquarters-held cost reserves, increasing the project's cost reserves for phase D from 12.9 to about 20 percent which meets the amount required by the Goddard Space Flight Center procedural requirements. According to these requirements, the project needs to hold cost reserves equal to at least 20 percent of the estimated cost remaining during the system assembly, integration and test, and launch phase.[29]

Integration and Test

The project continues to make progress building, assembling, and testing key system components. All of the Roman components have been delivered to the Goddard Space Flight Center for integration. In August 2024, the project received the Wide Field Instrument, Roman's primary instrument, which is intended to measure light from a billion galaxies and perform a survey of the inner Milky Way. The instrument was integrated to the instrument carrier in December 2024.

NASA officials said that the spacecraft bus completed subsystem integration and structural qualification and electromagnetic interference testing. Propulsion system testing had previously shown an issue with the thruster intermittently failing to fire. According to officials, this issue has only occurred in non-flight configurations and has never occurred in a flight configuration. Although NASA officials said it is hard to repeat the issue to test it, they are conducting additional testing to ensure a thruster failure does not occur during operations.

Additionally, the project successfully completed some tests and is progressing with other testing. For example, the project completed radio frequency testing with all the networks that will support Roman during its mission. The project is also continuing with integration and testing of the observatory. Finally, the integration and testing of several components are in progress: the Outer Barrel Assembly that protects the optical system from stray light, the Solar Array Sun Shield that generates power and shields systems, and the Deployable Aperture Cover sunshade that protects the telescope lens while in transit and provides shade after deployment.

Coronagraph Instrument

In June 2024, the Jet Propulsion Laboratory transferred CGI to the Roman project at the Goddard Space Flight Center. CGI, a technology demonstration designed to perform high contrast imaging and spectroscopy to study the atmospheres of nearby exoplanets, is one of two instruments on the Roman observatory. It is managed separately from the Roman observatory and places no science requirements on Roman. A CGI official said that the post-delivery verification checks were completed successfully. CGI was integrated into the instrument carrier in October 2024 and post-installation measurements showed proper alignment.

A CGI official said that they are continuing to work on different aspects of CGI. For example, CGI is continuing to update the flight software for the instrument. Also, a CGI official said that the project and Jet Propulsion Laboratory leadership reviewed and accepted CGI residual risks driven by possible single point failures in the design accepted early in CGI's development. In addition, the CGI official said that they will continue to support the Roman project with integration and review activities. According to CGI officials, CGI has adequate budget reserves through the launch of Roman.

Launch Vehicle

In September 2024, the project successfully completed the preliminary design review for the SpaceX Falcon Heavy launch vehicle. NASA's Launch Services Program selected the Falcon Heavy for Roman in July 2022. The project was able to reduce the mass of the Roman observatory from 11,000 kg to 10,150 kg, which will enable SpaceX boosters to return to the launch site. Based on this, project officials report that the Launch Services Program received a credit from SpaceX, which will result in cost savings.

Roman project officials said they are working with the Launch Services Program and SpaceX to maintain the temperature of the instrument detectors at 23°C or below. The project is working with SpaceX and the Launch Services Program on a requirement to limit the temperature where the spacecraft connects to the launch vehicle to 23°C, and to provide temperature monitoring. Roman officials said they are not expecting any issues with adding this requirement.

Project Office Comments

Roman project officials provided technical comments on a draft of this assessment, which were incorporated as appropriate.

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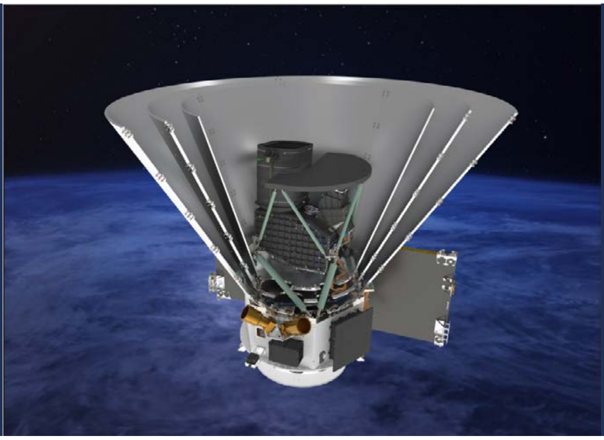
[29] NASA, Goddard Space Flight Center, *Funded Schedule Margin and Budget Margin for Flight Projects*, Goddard Procedural Requirements 7120.7B (Sept. 17, 2018).



Spectro-Photometer for the History of the Universe, Epoch of Reionization and Ices Explorer (SPHEREx)

The SPHEREx mission will use a telescope to probe the origin and destiny of the universe, explore whether planets around the other stars could harbor life, and explore the origin and evolution of galaxies. Every 6 months, SPHEREx will survey the entire sky in infrared light to create a three-dimensional all-sky map. Over the course of its 2-year mission, SPHEREx will gather data on more than 450 million galaxies and 100 million stars in the Milky Way.

Source: NASA/Jet Propulsion Laboratory-California Institute of Technology. | GAO-25-107591

Timeline

Project Information

NASA Lead Mission Directorate: **Science**

NASA Lead Center: **Jet Propulsion Laboratory**

International Partners: **Korea Astronomy and Space Science Institute**

Launch Location: **Vandenberg Space Force Base, CA**

Launch Vehicle: **Falcon 9**

Mission Duration: **25 Months**

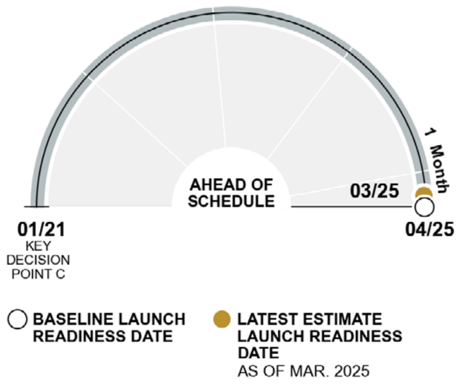
Requirement Derived from: **2010 Astrophysics Decadal Survey**

Project Summary

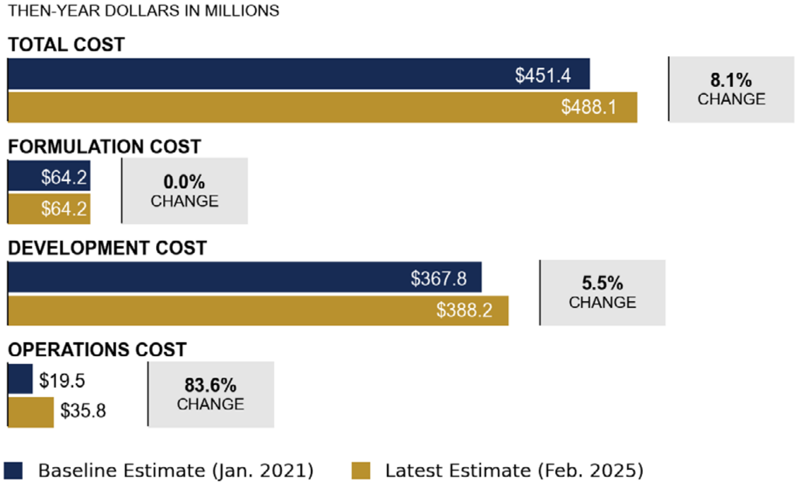
The SPHEREx project continues to operate within its revised January 2024 cost baseline. The project has used headquarters-held reserves to align with laboratory guidance reserve levels while addressing the project's technical challenges discovered during testing and experiencing institutional rate increases.

SPHEREx successfully launched in March 2025, approximately 1 month ahead of its baseline launch readiness date. The project had been addressing challenges as it prepared for launch and operations. These challenges include network access and software challenges impacting data collection and transmission, mobility hardware issues, and thermal controls that affect data imaging. Additionally, the project cited staff burnout, as a result of workforce reduction, as a concern they were tracking that could lead to mission disruption as it approached mission operations.

Schedule Performance



Cost Performance



Cost and Schedule Status

The SPHEREx project has maintained its cost baseline since it was revised as part of the key decision point D in January 2024. The project used reserves as necessary to address technical challenges. In August 2024, the project received $5.1 million in headquarters-held reserves. Of this, $4.5 million was used to meet Jet Propulsion Laboratory guidance for minimum reserves after the project had experienced prolonged technical challenges and institutional rate increases. The remainder was allocated to contract monitoring and oversight during operations.

SPHEREx launched on March 11, 2025, which is 1 month before its April 2025 baseline launch readiness date. In anticipation of the launch, the project completed its operational readiness review in December 2024. It also delivered the observatory to the launch site and completed standalone integration activities in January 2025.

Integration and Test

In February 2025, SPHEREx demonstrated readiness for launch with acceptable risk, after the project had addressed several technical challenges prior to launch and had mitigation plans in work for remaining risks. For example, the project experienced challenges while testing the Near Space Network—which it needs to downlink data—with the project’s ground systems. The challenges were related to new software development, network configuration and a lack of automation at the ground stations. According to project documentation, as of February 2025, all network modifications were implemented or executing on schedule, and the network was prepared for the SPHEREx launch.

The project also successfully addressed challenges with its instrument control electronics that manage the spacecraft and collect, package, and transmit data back to Earth. These challenges posed a technical risk that could lead to inaccurate data readings or render the system non-responsive, posing a risk to the project’s ability to meet its baseline mission. As of January 2025, the project addressed the challenges by uploading updated software and adding thermal protection. If the instrument faces these challenges in orbit, the project believes it will be able to reload the software and resume the survey.

SPHEREx continued to mitigate challenges as it prepared for launch. For example, in June 2024, the project experienced a decontamination heater failure, which required a workaround. According to project documentation, the primary heater failed, and there is concern that the backup heater could also fail. This could result in the telescope absorbing ice and impairing the thermal imaging device’s performance. The project determined that if the backup heater fails in orbit, it can use Earth’s heat—by pointing toward Earth—to warm its optical surfaces and remove any ice. The project has allocated time during operations for this process to occur. The project determined that this challenge had been addressed during its operational readiness review.

The project successfully completed testing of the reaction wheels, which are used to orient the telescope in space, in December 2024. As of January 2025, the project was working to obtain 1 year of post-launch support from the manufacturer in case of further anomalies. Between December 2023 and October 2024, the project experienced multiple anomalies with its reaction wheels. The anomalies included a significant cyber vulnerability and the wheels becoming unresponsive or malfunctioning at high speeds or due to voltage fluctuations. Project officials explained that a waiver was originally used to defer the reliability analysis requirement because the wheels were considered high heritage, meaning that the technology was previously used in space. However, anomalies occurred in post-delivery testing and the wheels were found to have less spaceflight experience than was originally understood.

The anomalies required a series of hardware, software, and firmware rework, which was completed in September 2024. Officials stated that the manufacturer accomplished all rework under warranty at no cost, but the project paid for expenses associated with additional analyses and overseeing the rework.

Operations

The project also cited severe staff burnout as a major risk that could lead to inefficient early mission operations. According to the project, key personnel were lost in the Jet Propulsion Laboratory workforce reduction, which resulted in the remaining staff working dual roles with heavy workloads to complete testing and prepare for launch. Project documentation stated that if the burnout continued, it could lead to critical errors due to reduced capacity to check work and delay operational timelines.

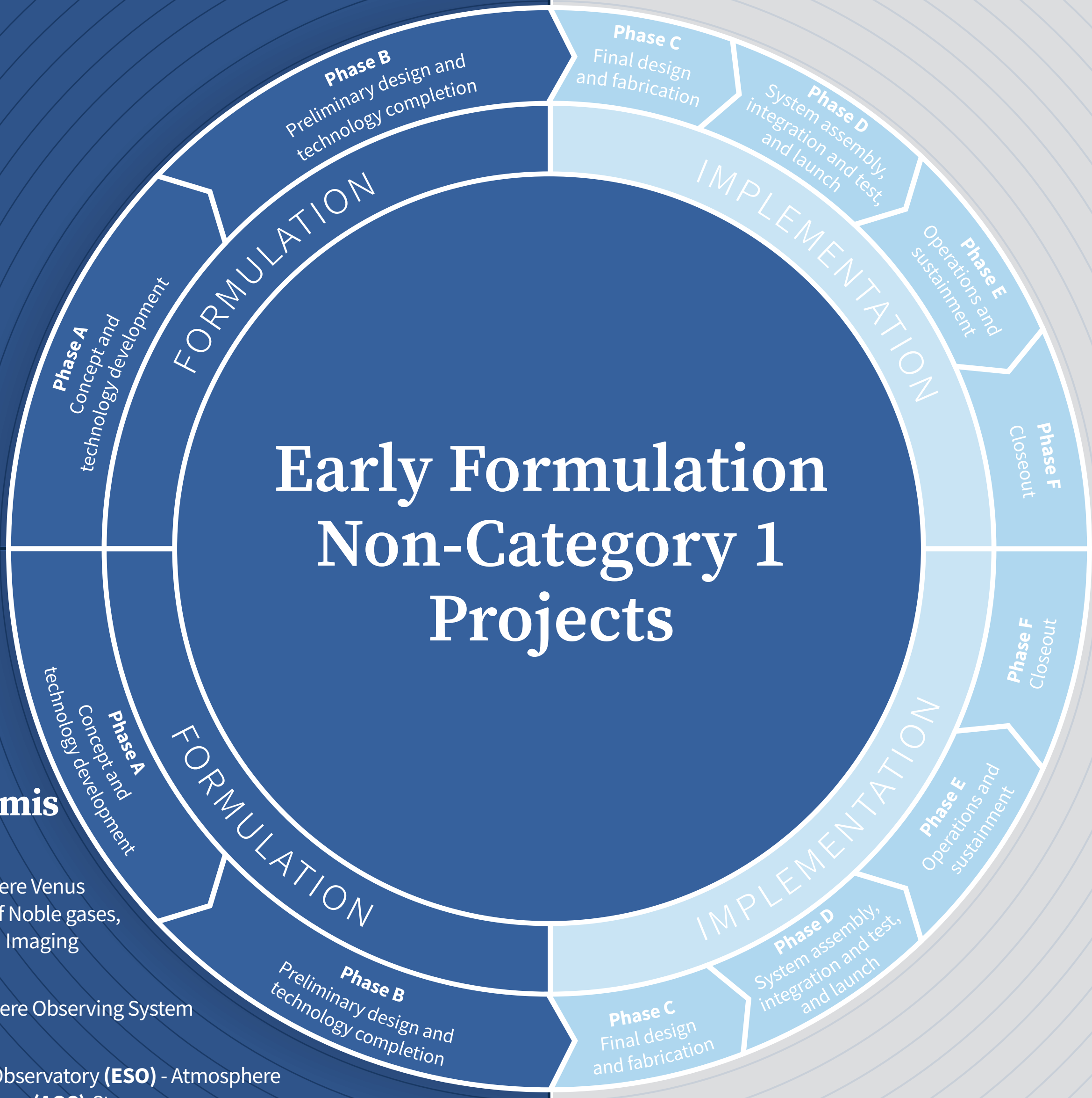
Project Office Comments

The SPHEREx project office was provided with a draft of this assessment and did not have any technical corrections or comments.

Artemis Projects

- Gateway – Deep Space Logistics **(DSL)**

Early Formulation Non-Category 1 Projects



Non-Artemis Projects

- Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging **(DAVINCI)**
- ESO - Atmosphere Observing System **(AOS)**-Sky
- Earth System Observatory **(ESO)** - Atmosphere Observing System **(AOS)**-Storm
- ESO - Surface Biology and Geology (**SBG)**-Visible and Short Wave Infrared **(VSWIR)**
- HelioSwarm
- Landsat Next
- Sustainable Flight Demonstrator **(SFD)**
- UltraViolet EXplorer **(UVEX)**
- Venus Synthetic Aperture Radar **(VenSAR)**
- Venus Emissivity, Radio Science, InSAR, Topography, and Spectroscopy **(VERITAS)**

Source: GAO analysis of NASA data. | GAO-25-107591

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Source: NASA. | GAO-25-107591

Gateway – Deep Space Logistics (DSL)

Project that will execute commercial end-to-end services to provide the Gateway with cargo deliveries, supplies, stowage, and trash disposal prior to crew arrival to maximize the length of crew stays on the Gateway.

Source: NASA/GSFC. | GAO-25-107591

Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging (DAVINCI)

Spacecraft and deep atmosphere probe to measure the composition and environmental properties of Venus's atmosphere and surface to understand how its evolution diverged from Earth's, and to determine whether it ever had oceans of liquid water.

EARTH SYSTEM OBSERVATORY

AOS

ATMOSPHERE OBSERVING SYSTEM

Source: NASA. | GAO-25-107591

Earth System Observatory (ESO) – Atmosphere Observing System – Storm (AOS-Storm)

The AOS-Storm spacecraft will measure aerosol and clouds at different times of day to understand precipitation and storm development and enable more accurate predictions of severe weather.

Earth System Observatory (ESO) – Atmosphere Observing System - Sky (AOS-Sky)

The AOS-Sky spacecraft is being reformulated to use remote sensing techniques to measure rain and clouds to improve weather and air quality predictions.

Source: NASA. | GAO-25-107591

Earth System Observatory (ESO) – Surface Biology and Geology – Visible and Short-Wave Infrared (SBG-VSWIR)

The SBG-VSWIR spacecraft will collect new global mapping measurements over oceans, coasts, and land to answer questions about natural resources including critical minerals, agriculture, water quality, wildfire fuel, and water resources.

Source: NASA. | GAO-25-107591

HelioSwarm

HelioSwarm will help improve our understanding of the dynamics of the sun, the sun-Earth connection, and the constantly changing space environment. The mission is a constellation or “swarm” of nine spacecraft that will measure fluctuations in the magnetic field and the motion of the solar wind. It will also provide critical insights into the fundamental physics governing space and laboratory plasmas to help better understand fusion energy and plasma materials processing. This mission will provide information to help protect astronauts, satellites, and communications signals such as GPS.

Source: NASA. | GAO-25-107591

Landsat Next

A constellation of three Earth-observing satellites, developed by NASA and operated by the U.S. Geological Survey, to provide enhanced land imaging capabilities to continue the data record.

Source: NASA. | GAO-25-107591

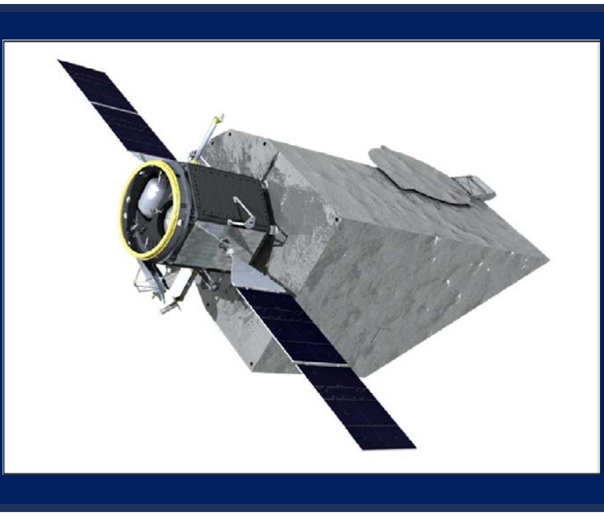
Sustainable Flight Demonstrator (SFD)

Flight demonstration project that will develop and flight-test ultra-efficient airframe technology on a full-scale demonstration aircraft to inform industry decisions associated with the next generation of commercial aircraft.

Source: ©2023 The Boeing Company. | GAO-25-107591

UltraViolet EXplorer (UVEX)

A wide-field survey space telescope that will provide a deep view of the ultraviolet sky, conduct a detailed study of galaxies recently discovered by the James Webb telescope, and enable follow-up observations of gravitational wave events and stellar explosions.



Source: UC Berkeley. | GAO-25-107591

Venus Synthetic Aperture Radar (VenSAR)

An instrument that collects synthetic aperture radar imaging and polarimetry, altimetry, and microwave radiation measurements of Venus's surface as part of the European Space Agency's EnVision Mission to Venus.

Source: ESA, with credits to NASA / JAXA / ISAS / DARTS / Damia Bouic / VR2Planets. | GAO-25-107591

Venus Emissivity, Radio science, InSAR, Topography, And Spectroscopy (VERITAS)

A spacecraft that will orbit Venus at a low altitude to create global, high-quality maps of the planet's surface and interior structure. The radar instrument will produce global topography and imaging. The spectrometer instrument will create a global map of rock type and study volcanic activity. The telecom system will study the planet's gravity field. The project will improve our understanding of how Venus became uninhabitable after starting out so Earth-like.

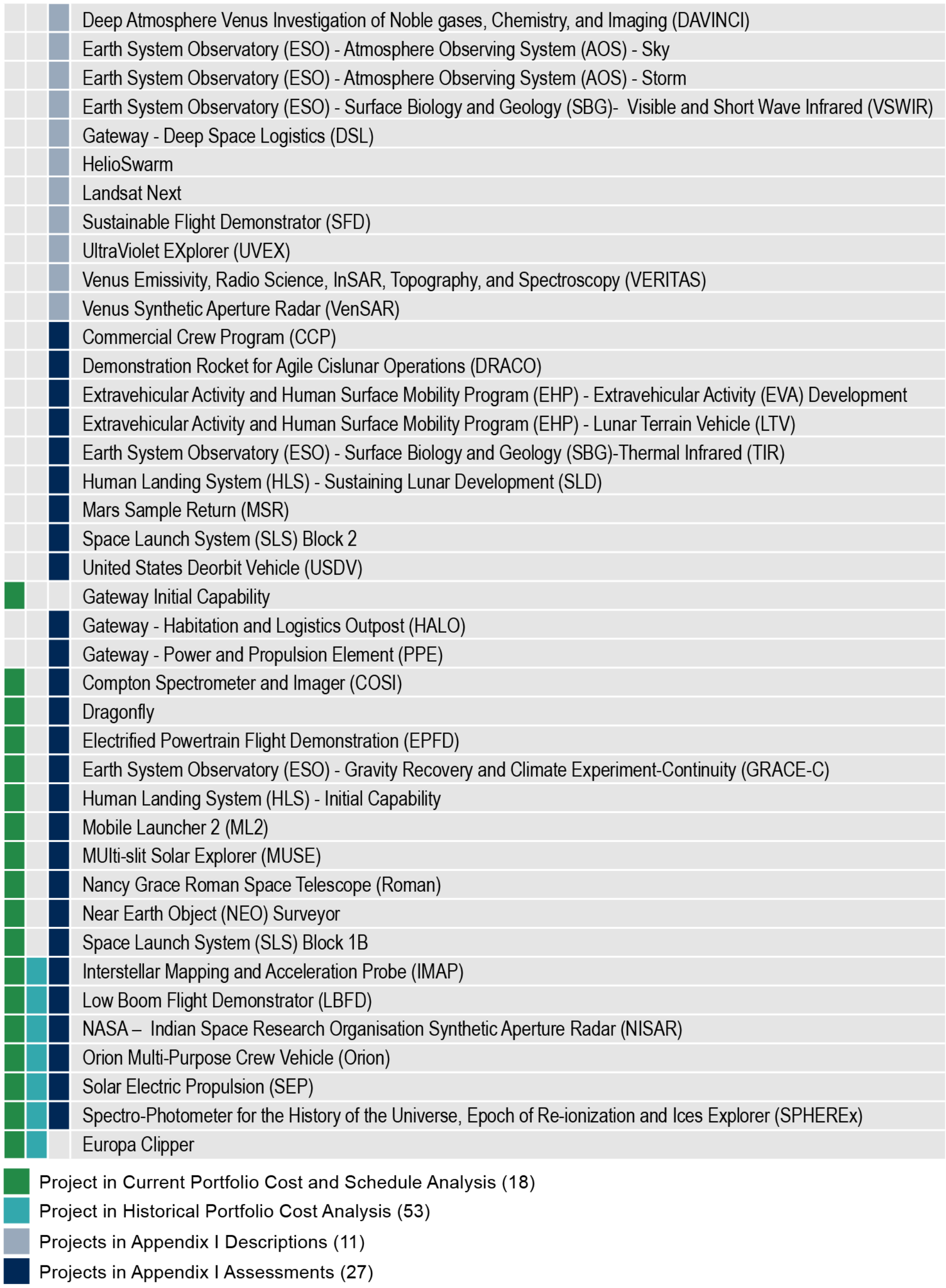
Source: Corby Waste. | GAO-25-107591

Appendix II: Objectives, Scope, and Methodology

This is our 17th annual report assessing selected large-scale National Aeronautics and Space Administration (NASA) programs and projects. When NASA determines that a project has an estimated life-cycle cost of over $250 million, we include that project in our annual review up through its launch date or the end of its development.

The objectives of our review were to assess the cost and schedule performance of NASA's major projects in development and assess the historical cost performance of NASA's major development projects included in our annual reports since 2009. We also generated individual project summaries. For a breakout of which projects are included in each objective and which have either an assessment or a description, see figure 8 below.

Figure 8: Projects Included in Individual GAO Analyses and Summaries



		▨	Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging (DAVINCI)
		▨	Earth System Observatory (ESO) - Atmosphere Observing System (AOS) - Sky
		▨	Earth System Observatory (ESO) - Atmosphere Observing System (AOS) - Storm
		▨	Earth System Observatory (ESO) - Surface Biology and Geology (SBG)- Visible and Short Wave Infrared (VSWIR)
		▨	Gateway - Deep Space Logistics (DSL)
		▨	HelioSwarm
		▨	Landsat Next
		▨	Sustainable Flight Demonstrator (SFD)
		▨	UltraViolet EXplorer (UVEX)
		▨	Venus Emissivity, Radio Science, InSAR, Topography, and Spectroscopy (VERITAS)
		▨	Venus Synthetic Aperture Radar (VenSAR)
		■	Commercial Crew Program (CCP)
		■	Demonstration Rocket for Agile Cislunar Operations (DRACO)
		■	Extravehicular Activity and Human Surface Mobility Program (EHP) - Extravehicular Activity (EVA) Development
		■	Extravehicular Activity and Human Surface Mobility Program (EHP) - Lunar Terrain Vehicle (LTV)
		■	Earth System Observatory (ESO) - Surface Biology and Geology (SBG)-Thermal Infrared (TIR)
		■	Human Landing System (HLS) - Sustaining Lunar Development (SLD)
		■	Mars Sample Return (MSR)
		■	Space Launch System (SLS) Block 2
		■	United States Deorbit Vehicle (USDV)
🟩			Gateway Initial Capability
		■	Gateway - Habitation and Logistics Outpost (HALO)
		■	Gateway - Power and Propulsion Element (PPE)
🟩		■	Compton Spectrometer and Imager (COSI)
🟩		■	Dragonfly
🟩		■	Electrified Powertrain Flight Demonstration (EPFD)
🟩		■	Earth System Observatory (ESO) - Gravity Recovery and Climate Experiment-Continuity (GRACE-C)
🟩		■	Human Landing System (HLS) - Initial Capability
🟩		■	Mobile Launcher 2 (ML2)
🟩		■	MUlti-slit Solar Explorer (MUSE)
🟩		■	Nancy Grace Roman Space Telescope (Roman)
🟩		■	Near Earth Object (NEO) Surveyor
🟩		■	Space Launch System (SLS) Block 1B
🟩	🟦	■	Interstellar Mapping and Acceleration Probe (IMAP)
🟩	🟦	■	Low Boom Flight Demonstrator (LBFD)
🟩	🟦	■	NASA – Indian Space Research Organisation Synthetic Aperture Radar (NISAR)
🟩	🟦	■	Orion Multi-Purpose Crew Vehicle (Orion)
🟩	🟦	■	Solar Electric Propulsion (SEP)
🟩	🟦	■	Spectro-Photometer for the History of the Universe, Epoch of Re-ionization and Ices Explorer (SPHEREx)
🟩	🟦		Europa Clipper

🟩 Project in Current Portfolio Cost and Schedule Analysis (18)
🟦 Project in Historical Portfolio Cost Analysis (53)
▨ Projects in Appendix I Descriptions (11)
■ Projects in Appendix I Assessments (27)

Source: GAO presentation of GAO methodology. | GAO-25-107591

Note: The historical portfolio cost analysis also includes 46 other projects that previously completed development.

To conduct our review, we developed several standard data questionnaires. NASA's Office of the Chief Financial Officer completed the questionnaires on project cost and schedule data. We used another questionnaire that was completed by project offices to gather general data and information on the projects, such as their category, their technology and design maturity, key schedule events, and development partners.[1] The information available on individual projects depends on where the project is in its life cycle. For example, for projects in an early stage of NASA's acquisition life cycle—called formulation—there are still unknowns about technology and design. We compared the current questionnaire data to questionnaire data from our prior reviews to analyze long-term trends.

To assess the cost and schedule performance of major NASA projects in development, we compared current development cost and schedule data we received from NASA for the 18 projects in development during our review to the projects' original baselines established at Key Decision Point (KDP) C.[2] The Commercial Crew Program has a tailored project life cycle and project management requirements, so we excluded it from these analyses. Most of the latest estimates for cost and schedule data were provided by NASA in response to our questionnaires and were as of January 2025. However, three projects provided updated data after those questionnaires were received. The Spectro-Photometer for the History of the Universe, Epoch of Re-ionization and Ices Explorer (SPHEREx) project updated its costs as of February 2025. The Low Boom Flight Demonstrator (LBFD) project updated its cost and schedule data as of March 2025. The NASA - Indian Space Research Organisation (ISRO) Synthetic Aperture Radar (NISAR) project updated its schedule data as of April 2025. We took additional steps to assess the quality and reliability of the data, such as checking to ensure the data summed to the totals provided and reviewing any changes since our last data collection. We

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[1] According to NASA's key project management policy, NASA designates a project as category 1 if the total life-cycle cost of the project is over $2 billion, the project includes significant radioactive material, or the project has a human spaceflight component. Projects with lower life-cycle cost estimates are category 2 or 3 depending on their cost and priority level. NASA, NASA Space Flight Program and Project Management Requirements, Procedural Requirements 7120.5F (Aug. 3, 2021).

[2] All cost and schedule original baseline data are documented at each project's KDP C. At least four other projects—Orion Multi-Purpose Crew Vehicle (Orion), Solar Electric Propulsion (SEP), NASA - Indian Space Research Organisation (ISRO) Synthetic Aperture Radar (NISAR), Low Boom Flight Demonstrator (LBFD)—have rebaselined, but we use the original baseline data when calculating cumulative overruns for the purposes of our analyses.

also followed up with the agency on any perceived errors or unexplained cost changes.

To examine longer-term trends for NASA's portfolio of major projects in development, we compared the original baseline development costs as well as the total cumulative development cost and schedule overruns for the portfolio for each year from 2015 through 2025.

To assess annual cost and schedule performance, we compared the cost and schedule performance data received from NASA during this review to the performance data presented in the prior year's report for all projects in development during our review.[3] This analysis identifies whether a project's latest development cost or schedule estimates have changed from our prior year report. Prior year report cost and schedule estimates were generally based on data collected early in the calendar year that we issued our report. All cost information in this report is presented in nominal then-year dollars for consistency with budget data. We did not assess the cost and schedule performance of projects in formulation because they have not yet established baselines.

To assess the historical cost performance of NASA's major development projects that have been included in our annual reports since 2009, we compared the development cost performance of projects included in our annual reports against statutory thresholds for NASA to notify congressional committees of cost overruns.[4] Since 2009, our annual reports have included projects for which NASA set baselines in response to a statute, which requires NASA to report cost and schedule baselines for all programs and projects that have estimated life-cycle costs of at least $250 million and that have been approved to proceed to implementation.[5] The statute also requires NASA to notify congressional committees when development costs are likely to exceed the baseline estimate by 15 percent or more, or a milestone is likely to be delayed by 6 months or more from the baseline estimate.[6] When development costs are likely to exceed the baseline estimate by more than 30 percent, the

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[3] GAO, *NASA: Assessments of Major Projects*, GAO-24-106767 (Washington, D.C.: June 20, 2024).

[4] 51 U.S.C. § 30104(d)(3).

[5] See 51 U.S.C. § 30104(c).

[6] Id. § 30104(d)(3).

statute provides that NASA may not expend additional funds on the program unless Congress reauthorizes it.[7]

We used these requirements for congressional notification and reauthorization as criteria to determine when a project's cost overrun is significant.[8] To determine if a project met the cost overrun threshold for congressional notification or reauthorization, we first reviewed the project's final development cost overrun as reported in our annual reports. We calculated the percent overrun from the original baseline and compared it to the statutory thresholds. If the cost overrun percentage reported in our annual assessments at development end met either of the statutory thresholds, we reviewed major program assessment reports and congressional notification letters and reports. This allowed us to collect additional evidence that NASA notified congressional committees or requested reauthorization.

We included 53 of the total 64 development projects included in our annual reports since 2009 in our historical cost analysis based on the following criteria:

- We included all 48 projects in our annual reviews that previously completed development (including SPHEREx and Europa Clipper that launched during our review). They are listed in appendix IV and include the following:
    - 45 projects that successfully completed development by completing the key schedule milestone that signals the end of development.[9]
    - Three projects were canceled prior to completing the key schedule milestone: (1) Radiation Budget Instrument; (2) On-orbit Servicing, Assembly, and Manufacturing (OSAM-1); and (3) VIPER. We

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[7] Id. § 30104(f). More specifically, NASA may not "expend additional funds, other than termination costs, unless Congress has subsequently authorized continuation of the program."

[8] For the purposes of our analysis, we did not identify projects that met the statutory threshold for notification based on schedule delays alone.

[9] While the majority of these 45 projects set a baseline at the start of implementation, some projects included in our 2009 annual report proceeded to implementation prior to enactment of the statutory requirement for NASA's congressional reporting of baselines and received baselines partway through development. See Pub. L. No. 109-155, § 103(b) (2005). Although setting a baseline late in development could have led to a higher cost baseline, understatement of final cost overruns, or both, we determined that their inclusion or exclusion did not change our overall findings.

decided to keep all three of these projects in our analysis. We highlighted in our report that these projects had been canceled to avoid additional overruns so as to not under-represent the significance of their overruns at project end.

- We included an additional five projects in this analysis that have not yet completed development but that are in their final phase of development (phase D). Our methodology for categorizing significant cost outcomes and reviewing reasons for those overruns was based on whether the project met the statutory threshold for congressional reauthorization. Four of the five projects in phase D met this criterion and were included in this analysis.

We reviewed the fifth project in phase D—the Interstellar Mapping and Acceleration Probe (IMAP)—that planned to launch later in 2025 to determine whether or not its status against the statutory threshold for reauthorization was likely to change prior to launch. We reviewed the current risks for IMAP and compared them to risks other projects realized that led to reauthorizations in phase D. The result of that analysis, the current cost and schedule reserves, and the close proximity of the launch date led us to conclude that there is low likelihood of this project experiencing such significant changes in percent cost overruns between now and development end that would lead to it reaching the statutory threshold for a reauthorization. As a result, we decided to include it in our analysis and note throughout that it is still in development.

- We did not include 11 projects in the early phase of development (phase C). We concluded that these projects are too early in development for us to be confident that their current cost performance against their baselines will not significantly change between now and development end.

To identify key factors that historical NASA major projects reported as drivers for cost overruns that met the statutory cost threshold for reauthorization and subsequent rebaselines, we reviewed documentary evidence in letters and reports to congressional committees, rebaseline memorandums, and major project assessment reports. We highlighted and categorized key reasons for overruns across the 12 projects that met the statutory threshold for reauthorization.

To show accumulated development cost overruns for the 53 projects included in our historical analysis, we analyzed cost overruns previously reported in our annual reports. To determine the categorization (i.e., category 1 or non-category 1) of major NASA projects included in our reviews, we used data collected from the project-provided questionnaires.

Project Profile Information on Each Individual Project Summary

This year, we developed 38 project summaries for projects with estimated life-cycle costs greater than $250 million.

We included 27 individual assessments for NASA projects and programs that have either passed key milestones or that NASA designated as a category 1 project.[10] We did not complete an individual assessment for Europa Clipper because it launched prior to January 2025. For each assessment, we included a description of the project's objectives; information concerning the lead NASA mission directorate, the NASA center, and international partners involved in the project, if applicable; the project's cost and schedule performance, when available; key project dates; and a brief narrative describing the current status of the project. We also provided a detailed discussion of project challenges for selected projects, as applicable.

We included 11 descriptions of projects that are early in formulation—or have not yet held preliminary design review as of January 1, 2025—and that NASA did not designate as category 1. We also developed an infographic of NASA's Artemis efforts, including a description of the first five missions.

To assess the cost and schedule changes of each project, we obtained data directly from NASA's Office of the Chief Financial Officer through our questionnaire. For the Commercial Crew Program, we obtained current cost and schedule data directly from the program. When applicable, we compared the level of cost and schedule reserves held by the project to the level required by the policy.

We also had NASA confirm preliminary estimates for the 19 projects in formulation as of January 2025. We included cost and schedule estimates for the early formulation projects that had selected a contractor or progressed to their preliminary design review phase. According to NASA's key project management policy, projects establish preliminary cost and schedule range estimates at KDP A.[11] At KDP B, these estimates are updated to be risk-informed range estimates with a joint

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[10] According to NASA's key project management policy, NASA designates a project as category 1 if the total life-cycle cost of the project is over $2 billion, the project includes significant radioactive material, or the project has a human spaceflight component. Projects with lower life-cycle cost estimates are category 2 or 3 depending on their cost and priority level. NASA, *NASA Space Flight Program and Project Management Requirements*, Procedural Requirements 7120.5F (Aug. 3, 2021).

[11] NASA*, NASA Space Flight Program and Project Management Requirements*.

cost and schedule confidence level. Estimates established at KDP A or B are preliminary and are not considered a formal commitment by the agency on cost and schedule for the mission deliverables.

To assess project schedules, we determined when NASA initiated the project, which is generally referred to as formulation start. Projects can be initiated in two basic ways: a direct assignment of a project or a competitive process, typically done through a broad agency announcement such as an announcement of opportunity. NASA refers to a project's start as KDP A or the beginning of the formulation phase. Projects selected as a result of a one-step announcement of opportunity enter formulation at KDP A. Projects selected as a result of a two-step announcement of opportunity process perform a concept development study and go through evaluation for down-selection, which serves as KDP B. The end of development is determined at KDP C and could be the projected or actual launch date, first flight date, or review date. The implementation phase includes the operations of the mission and concludes with project disposal.

Project Challenges Discussion on Each Individual Project Assessments

To assess the status, risk, and challenges for each project, we submitted a questionnaire to each project office. In the questionnaire, we requested information on the maturity of critical technologies, the number of releasable design drawings or other design stability data at project milestones, and international partnerships.[12] When applicable, we compared the level of maturity of critical technologies at preliminary design review and the percentage of design drawings released at critical design review against our best practices.[13] We also interviewed representatives from projects across multiple NASA centers to discuss the information on the questionnaires and the projects' statuses. We did not interview representatives for the Europa Clipper project that launched during our audit. We also conducted site visits at the Johnson Space Center, Kennedy Space Center, and Applied Physics Laboratory.

We then reviewed project documentation—including monthly status reports, schedules, risk assessments, and major project review

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[12] We did not collect this information for the Commercial Crew Program because we excluded it from the related portfolio analyses.

[13] GAO, *Technology Readiness Assessment Guide: Best Practices for Evaluating the Readiness of Technology for Use in Acquisition Programs and Projects [Reissued with revisions on Feb. 11, 2020.]*, GAO-20-48G (Washington, D.C.: Jan. 7, 2020); and *Best Practices: Capturing Design and Manufacturing Knowledge Early Improves Acquisition Outcomes*, GAO-02-701 (Washington, D.C.: July 15, 2002).

documentation—to corroborate any testimonial evidence we received in the interviews. These reviews allowed us to identify further challenges faced by NASA projects. The second page of each project assessment highlights key challenges that affected that project or could affect that project’s performance. For this year’s report, we identified challenges across the projects that we reviewed in the categories of cost and schedule, design, integration and test, launch vehicle, contractor performance, operations, and technology. These challenges do not represent an exhaustive or exclusive list and are based on our definitions and assessments, not those of NASA.

We conducted this performance audit from May 2024 to July 2025 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix III: Estimated Life-Cycle Costs and Launch Dates for Major NASA Projects in Development Assessed in GAO's 2025 Report

Table 3 shows the original cost and key schedule milestone baselines, set at a project's confirmation review, for six Artemis and Artemis-related projects in implementation. Implementation includes building, launching, and operating the system, among other activities. The table also includes the current key schedule milestone dates and life-cycle cost estimates for these six projects.

Table 3: Life-Cycle Cost and Schedule Estimates of Artemis and Artemis-Related Major NASA Projects in Development

Project name	Original baseline key schedule milestone date	Current key schedule milestone date	Original baseline life-cycle cost estimate (dollars in millions)[a]	Current life-cycle cost estimate (dollars in millions)
Gateway Initial Capability[b]	December 2027	December 2027	5,280.9	5,280.9
HLS – Initial Capability	February 2028	February 2028	4,878.0	4,878.0
ML2	September 2027	September 2027	1,873.1	1873.1
Orion[c]	April 2023	April 2026	11,283.5	14,495.0
SEP	December 2024	January 2029	335.6	402.4
SLS Block 1B	January 2028	January 2028	4,952.8	4,952.8

Legend: HLS: Human Landing System; ML2: Mobile Launcher 2; Orion: Orion Multi-Purpose Crew Vehicle; SEP: Solar Electric Propulsion. SLS: Space Launch System.

Source: GAO Analysis of NASA data. | GAO-25-107591

Note: Data for GAO's current assessment were collected as of January 2025. In addition, the Orion and SEP projects have rebaselined their estimates since their original baseline.

[a] All original baselines in the table are from the project's confirmation review.

[b] The Gateway Initial Capability's estimates include the cost and schedule of the PPE and HALO projects (which launch together), the launch vehicle, and portions of program mission execution essential for the launch.

[c] The cost estimate for Orion is under review and aligns to a launch date of September 2025. Until that review is complete, information presented above is based on the latest estimates that GAO received from NASA.

Table 4 shows the original cost and key schedule milestone baselines, as well as the current key schedule milestone dates and life-cycle cost estimates, for 13 non–Artemis major National Aeronautics and Space Administration (NASA) projects in implementation.

Table 4: Life-Cycle Cost and Schedule Estimates of Non–Artemis Major NASA Projects in Development

Project name	Original baseline key schedule milestone date	Current key schedule milestone date	Original baseline life-cycle cost estimate (dollars in millions)[a]	Current life-cycle cost estimate (dollars in millions)
CCP-Boeing[b]	August 2017	Fall 2025	4,229.0	4,556.1
CCP-SpaceX[b]	April 2017	November 2020	2,598.7	2,757.7
COSI	November 2027	November 2027	273.3	273.3
Dragonfly	July 2028	July 2028	3,352.4	3,352.4
EPFD	May 2028	May 2028	654.9	654.9
ESO-GRACE-C	July 2029	July 2029	658.0	658.0
Europa Clipper	September 2025	October 2024	4,250.0	5,167.9
IMAP	December 2025	December 2025	781.8	781.8
LBFD	January 2022	September 2025	582.4	902.4
MUSE	November 2027	November 2027	389.3	389.3
NEO Surveyor	June 2028	June 2028	1,595.1	1,595.1
NISAR[c]	September 2022	June 2025	866.9	1,158.9
Roman[d]	October 2026	May 2027	3,934.0	4,316.0
SPHEREx	April 2025	March 2025	451.4	488.1

Legend: CCP: Commercial Crew Program; COSI: Compton Spectrometer and Imager; EPFD: Electrified Powertrain Flight Demonstration; ESO-GRACE-C: Earth System Observatory-Gravity Recovery and Climate Experiment – Continuity; IMAP: Interstellar Mapping and Acceleration Probe; LBFD: Low Boom Flight Demonstrator; MUSE: Multi-slit Solar Explorer; NEO: Near Earth Orbit; NISAR: NASA - Indian Space Research Organisation (ISRO) Synthetic Aperture Radar; Roman: Nancy Grace Roman Space Telescope; SPHEREx: Spectro-Photometer for the History of the Universe, Epoch of Re-ionization and Ices Explorer

Source: GAO analysis of NASA data. | GAO-25-107591

Note: Data for GAO's current assessment were collected as of January 2025 with exceptions. SPHEREx cost data is as of February 2025, LBFD cost and schedule data are as of March 2025, and NISAR schedule data is as of April 2025. In addition, the LBFD and NISAR projects have rebaselined their estimates since their original baseline.

[a] All original baselines in the table are from the project's confirmation review.

[b] The Commercial Crew Program has a tailored project life cycle and project management requirements and did not establish a baseline. The cost values represent the original contract values and latest maximum contract values as reported by NASA.

[c] The NISAR project's cost and schedule are under review. Until these reviews are complete, information presented is based on the latest estimates that GAO received from NASA.

[d] The cost and schedule estimates for Roman include the related technology demo mission, the Roman Coronagraph Instrument.

NASA approved rebaselines for four major projects included in our review since they set their original cost and key schedule milestone baselines at their commitment reviews. Table 5 shows the latest approved rebaselined estimates for cost and key schedule milestone dates as well as the current estimates for cost and key schedule milestone dates for these projects.

Table 5: Approved Rebaseline and Current Life-Cycle Cost and Schedule Estimates for Major NASA Projects

Project name	Date of latest approved rebaseline	Latest approved rebaseline key schedule milestone date	Current key schedule milestone date	Latest approved rebaseline life-cycle cost estimate (dollars in millions)	Current life-cycle cost estimate (dollars in millions)
LBFD	January 2024	October 2024	September 2025	838.6	902.4
NISAR[a]	August 2022	October 2024	June 2025	1,118.0	1,158.9
Orion[b]	August 2021	May 2024	April 2026	13,811.0	14,495.0
SEP	March 2022	October 2028	January 2029	382.4	402.4

Legend: LBFD: Low Boom Flight Demonstrator; NISAR: NASA - Indian Space Research Organisation (ISRO) Synthetic Aperture Radar; Orion: Orion Multi-Purpose Crew Vehicle; SEP: Solar Electric Propulsion

Source: GAO analysis of NASA data. | GAO-25-107591

Note: Data for GAO's current assessment were collected as of January 2025 with exceptions. LBFD cost and schedule data are as of March 2025, and NISAR schedule data are as of April 2025.

[a] The NISAR project's cost and schedule are under review. Until these reviews are complete, information presented is based on the latest estimates that GAO received from NASA.

[b] The Orion project's costs are under review and align to a launch date of September 2025. Until these reviews are complete, information presented is based on the latest estimates that GAO received from NASA.

Appendix IV: Major NASA Projects and Programs in GAO's Annual Reports from 2009 to 2025 that Completed Development

Forty-eight National Aeronautics and Space Administration (NASA) major projects or programs were included in our annual reports from 2009 to 2025 whose development culminated in an event such as a launch, an achievement of minimum success criteria, or cancelation. See table 6 for a list of these 48 projects.

Table 6: Major NASA Projects and Programs Included in GAO's Annual Reports from 2009 to 2025 That Completed Development

Major project name	Year first included in GAO annual report	Date of development end	Result of development
Aquarius	2009	2011	Launched
Dawn	2009	2007	Launched
Double Asteroid Redirection Test	2018	2021	Launched
Europa Clipper	2016	2024	Launched
Exploration Ground Systems	2016	2022	Demonstrated initial capability
Gamma-ray Large Area Space Telescope	2009	2008	Launched
Glory	2009	2011	Launched but did not reach orbit
Global Precipitation Measurement Mission	2009	2014	Launched
Gravity Recovery and Climate Experiment Follow-On	2014	2018	Launched
Gravity Recovery and Interior Laboratory	2010	2011	Launched
Herschel	2009	2009	Launched
Ice, Cloud, and Land Elevation Satellite-2	2011	2018	Launched
Ionospheric Connection Explorer	2016	2019	Launched
Interior Exploration using Seismic Investigations, Geodesy, and Heat Transport	2014	2018	Launched
James Webb Space Telescope	2009	2021	Launched
Juno	2010	2011	Launched
Kepler	2009	2009	Launched
Landsat Data Continuity Mission	2009	2013	Launched
Landsat 9	2017	2021	Launched
Laser Communications Relay Demonstration	2018	2021	Launched
Lucy	2018	2021	Launched

Major project name	Year first included in GAO annual report	Date of development end	Result of development
Lunar Atmosphere and Dust Environment Explorer	2011	2013	Launched
Lunar Reconnaissance Orbiter	2009	2009	Launched
Magnetospheric Multiscale	2010	2015	Launched
Mars 2020	2015	2020	Launched
Mars Atmosphere and Volatile EvolutioN	2011	2013	Launched
Mars Science Laboratory	2009	2011	Launched
National Polar-orbiting Operational Environmental Satellite System Preparatory Project	2009	2011	Launched
On-Orbit Servicing, Assembly, and Manufacturing 1[a]	2018	2024	Canceled
Orbiting Carbon Observatory	2009	2009	Launched but did not reach orbit
Orbiting Carbon Observatory-2	2011	2014	Launched
Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer	2013	2016	Launched
Parker Solar Probe[b]	2011	2018	Launched
Plankton, Aerosol, Cloud, ocean Ecosystem	2017	2024	Launched
Psyche	2018	2023	Launched
Radiation Belt Storm Probes	2010	2012	Launched
Radiation Budget Instrument	2017	2018	Canceled
Solar Dynamics Observatory	2009	2010	Launched
Soil Moisture Active Passive	2011	2015	Launched
Space Launch System	2012	2022	Launched
Space Network Ground Segment Sustainment	2013	2021	Achieved minimum success
Spectro-Photometer for the History of the Universe, Epoch of Re-ionization and Ices Explorer	2020	2025	Launched
Stratospheric Observatory for Infrared Astronomy	2009	2014	Full operational capability
Surface Water and Ocean Topography	2014	2022	Launched
Tracking and Data Relay Satellite Replenishment (K&L)	2011	2013 (K) 2014 (L)	Launched

Major project name	Year first included in GAO annual report	Date of development end	Result of development
Transiting Exoplanet Survey Satellite	2015	2018	Launched
Volatiles Investigating Polar Exploration Rover	2021	2024	Canceled
Wide-field Infrared Survey Explorer	2009	2009	Launched

Source: GAO analysis of NASA data and previously issued GAO reports. | GAO-25-107591

[a] Previously known as Restore-L.

[b] Previously known as Solar Probe Plus.

Appendix V: Cumulative Development Cost and Schedule Performance for NASA's Current Portfolio of Major Projects

Table 7 shows the cumulative development cost and schedule overruns for the National Aeronautics and Space Administration's (NASA) current portfolio of major projects in development.

Table 7: Cumulative Development Cost and Schedule Overruns for NASA's Current Portfolio of 18 Major Projects in Development

			Changes from original baseline to current assessment		
Current performance status	**Project**	**Original baseline development cost estimate (then-year dollars in millions)**	**Development schedule delay (years)**	**Development cost overrun (then-year dollars in millions)**	**Development cost growth percentage**
First year estimate reported	COSI	224.0	0	0.0	0.0
	Dragonfly	1,963.5	0	0.0	0.0
	EPFD	237.3	0	0.0	0.0
	ESO-GRACE-C	441.7	0	0.0	0.0
	ML2	1,873.1	0	0.0	0.0
	MUSE	296.9	0	0.0	0.0
No variance expected from cost or schedule baselines	HLS–Initial Capability	2,339.0	0	0.0	0.0
	IMAP	589.5	0	0.0	0.0
	NEO Surveyor	1,228.6	0	0.0	0.0
	SLS Block 1B	3,675.3	0	0.0	0.0
Mixed cost and schedule performance	Europa Clipper	2,412.8	(0.9)	146.9	6.1
	SPHEREx	367.8	(0.1)	20.4	5.5
Overrunning original estimate	Gateway Initial Capability[a]	3,561.8	0	0.1	0.0
	LBFD	467.7	3.7	301.2	64.4
	NISAR[b]	661.0	2.8	301.0	45.5
	Orion[c]	6,768.4	3.0	3,217.0	47.5
	Roman[d]	2,898.1	0.6	371.9	12.8
	SEP	155.9	4.1	67.3	43.2
Totals		**30,162.4**	**13.1**	**4,425.8**	

Legend: COSI: Compton Spectrometer and Imager; EPFD: Electrified Powertrain Flight Demonstration; ESO-GRACE-C: Earth System Observatory-Gravity Recovery and Climate Experiment - Continuity; ML2: Mobile Launcher 2; MUSE: MUlti-slit Solar Explorer; HLS: Human Landing System; IMAP: Interstellar Mapping and Acceleration Probe; NEO: Near Earth Orbit; SLS: Space Launch System; SPHEREx: Spectro-Photometer for the History of the Universe, Epoch of Re-ionization and Ices Explorer; LBFD: Low Boom Flight Demonstrator; NISAR: NASA - Indian Space Research Organisation (ISRO) Synthetic Aperture Radar; Orion: Orion Multi-Purpose Crew Vehicle; Roman: Nancy Grace Roman Space Telescope; SEP: Solar Electric Propulsion.

Source: GAO analysis of NASA data. | GAO-25-107591

Note: Positive values indicate cost growth or launch delays. Values in parentheses indicate cost decreases or earlier than planned launch dates. Data were collected as of January 2025 with exceptions. SPHEREx cost data are as of February 2025, LBFD cost and schedule data are as of

March 2025, and NISAR schedule data are as of April 2025. Note that the values do not sum due to rounding.

[a] The Gateway Initial Capability program’s estimates include the cost and schedule of the PPE and HALO projects, which will launch together, the launch vehicle, and portions of program mission execution essential for the launch.

[b] The NISAR project’s cost and schedule are under review. Until these reviews are complete, information presented is based on the latest estimates that GAO received from NASA.

[c] The Orion project costs are under review. Until these reviews are complete, information presented is based on the latest estimates that GAO received from NASA.

[d] The cost and schedule estimates for Roman include the related technology demo mission, the Roman Coronagraph Instrument.

Appendix VI: Technology Readiness Levels for NASA Hardware and Software

Table 8: NASA Hardware Technology Readiness Levels (TRL)

TRL	Definition	Hardware description
1	Basic principles observed and reported.	Scientific knowledge is generated underpinning hardware technology concepts or applications.
2	Technology concept or application formulated.	Invention begins. Practical application is identified but speculative, and no experimental proof or detailed analysis is available to support the conjecture.
3	Analytical and experimental proof-of-concept of critical function or characteristics.	Research and development are initiated, including analytical and laboratory studies to validate predictions regarding the technology.
4	Component or breadboard validation in a laboratory environment.	A low fidelity system/component breadboard is built and operated to demonstrate basic functionality in a laboratory environment.
5	Component or brassboard validated in a relevant environment.	A medium-fidelity component or brassboard with realistic support elements is built and operated for validation in a relevant environment to demonstrate overall performance in critical areas. Performance predictions are made for subsequent development phases.
6	System/sub-system model or prototype demonstration in a relevant environment.	A high-fidelity prototype of the system/subsystems that adequately addresses all critical scaling issues is built and tested in a relevant environment to demonstrate performance under critical environmental conditions.
7	System prototype demonstration in an operational environment.	A high-fidelity prototype or engineering unit that adequately addresses all critical scaling issues is built and functions in the actual operational environment and platform (ground, airborne, or space).
8	Actual system completed and “flight qualified” through test and demonstration.	The final product in its final configuration is successfully demonstrated through test and analysis for its intended operational environment and platform (ground, airborne, or space). If necessary, life testing has been completed.
9	Actual system flight proven through successful mission operations.	The final product is successfully operated in an actual mission.

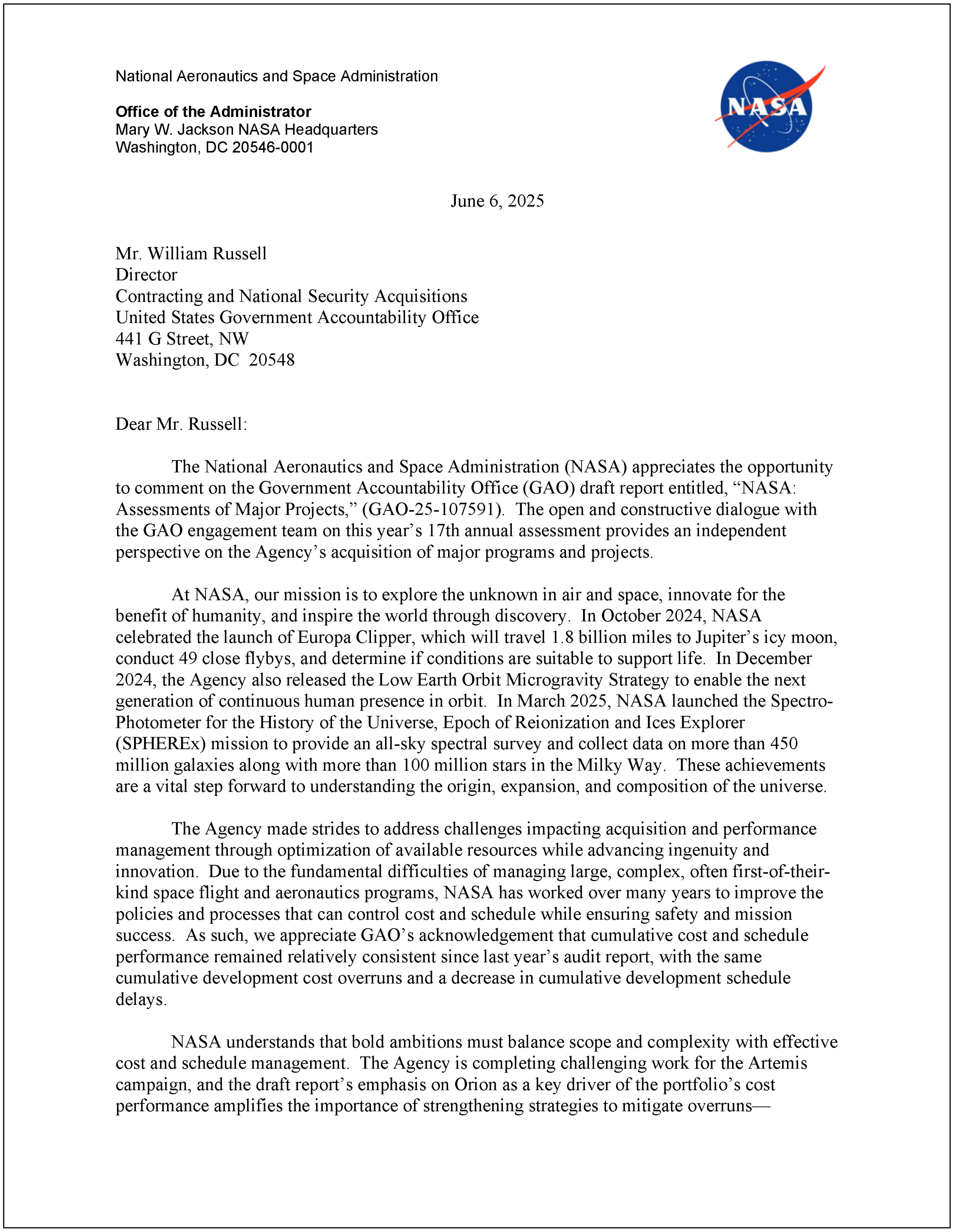
Source: GAO analysis and representation of NASA TRLs from NASA Procedural Requirements 7123.1C, Appendix E. | GAO-25-107591

Table 9: NASA Software Technology Readiness Levels (TRL)

TRL	Definition	Software description
1	Basic principles observed and reported.	Scientific knowledge is generated underpinning basic properties of software architecture and mathematical formulation.
2	Technology concept or application formulated.	Practical application is identified but speculative, and no experimental proof or detailed analysis is available to support the conjecture. Basic properties of algorithms, representations, and concepts defined. Basic principles are coded, and experiments are performed with synthetic data.
3	Analytical and experimental proof-of-concept of critical function or characteristics.	Development of limited functionality to validate critical properties and predictions using non-integrated software components occurs.
4	Component or breadboard validation in a laboratory environment.	Key, functionality critical software components are integrated and functionally validated to establish interoperability and begin architecture development. Relevant environments are defined and performance in the environment predicted.
5	Component or brassboard validated in a relevant environment.	End-to-end software elements implemented and interfaced with existing systems/simulations conforming to target environment. End-to-end software system tested in relevant environment, meeting predicted performance. Operational environment performance predicted.
6	System/sub-system model or prototype demonstration in a relevant environment.	Prototype implementations of the software demonstrated on full-scale, realistic problems. Partially integrated with existing hardware/software systems. Limited documentation available. Engineering feasibility fully demonstrated.
7	System prototype demonstration in an operational environment.	Prototype software exists having all key functionality available for demonstration and test. Well integrated with operational hardware/software systems demonstrating operational feasibility. Most software bugs removed. Limited documentation available.
8	Actual system completed and “flight qualified” through test and demonstration.	All software has been thoroughly debugged and fully integrated with all operational hardware and software systems. All user documentation, training documentation, and maintenance documentation completed. All functionality successfully demonstrated in simulated operational scenarios. Verification and validation are completed.
9	Actual system flight proven through successful mission operations.	All software has been thoroughly debugged and fully integrated with all operational hardware and software systems. All documentation has been completed. Sustaining software support is in place. System has been successfully operated in the operational environment.

Source: GAO analysis and representation of NASA TRLs from NASA Procedural Requirements 7123.1C, Appendix E. | GAO-25-107591

Appendix VII: Comments from NASA



National Aeronautics and Space Administration

Office of the Administrator
Mary W. Jackson NASA Headquarters
Washington, DC 20546-0001

June 6, 2025

Mr. William Russell
Director
Contracting and National Security Acquisitions
United States Government Accountability Office
441 G Street, NW
Washington, DC 20548

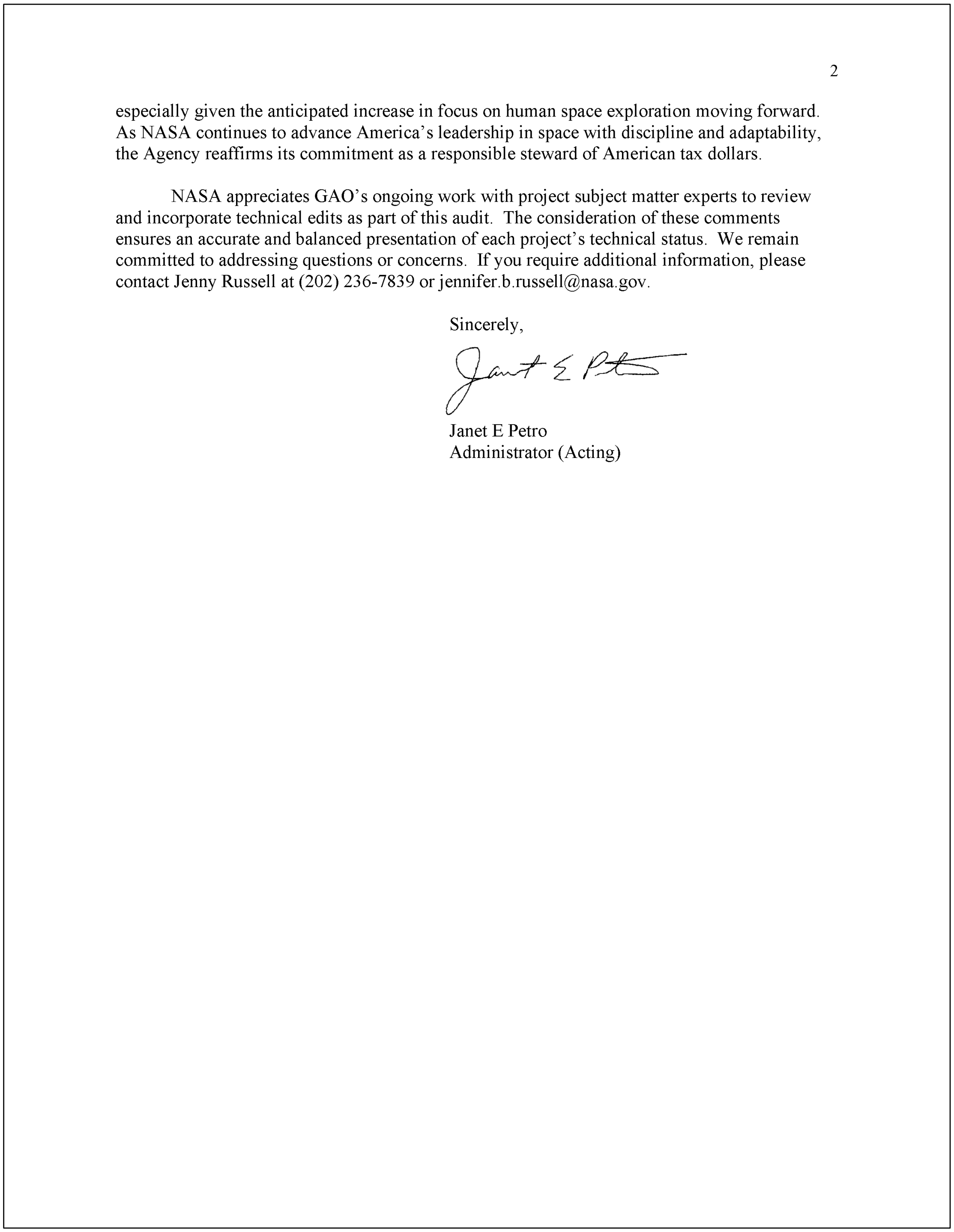
Dear Mr. Russell:

The National Aeronautics and Space Administration (NASA) appreciates the opportunity to comment on the Government Accountability Office (GAO) draft report entitled, "NASA: Assessments of Major Projects," (GAO-25-107591). The open and constructive dialogue with the GAO engagement team on this year's 17th annual assessment provides an independent perspective on the Agency's acquisition of major programs and projects.

At NASA, our mission is to explore the unknown in air and space, innovate for the benefit of humanity, and inspire the world through discovery. In October 2024, NASA celebrated the launch of Europa Clipper, which will travel 1.8 billion miles to Jupiter's icy moon, conduct 49 close flybys, and determine if conditions are suitable to support life. In December 2024, the Agency also released the Low Earth Orbit Microgravity Strategy to enable the next generation of continuous human presence in orbit. In March 2025, NASA launched the Spectro-Photometer for the History of the Universe, Epoch of Reionization and Ices Explorer (SPHEREx) mission to provide an all-sky spectral survey and collect data on more than 450 million galaxies along with more than 100 million stars in the Milky Way. These achievements are a vital step forward to understanding the origin, expansion, and composition of the universe.

The Agency made strides to address challenges impacting acquisition and performance management through optimization of available resources while advancing ingenuity and innovation. Due to the fundamental difficulties of managing large, complex, often first-of-their-kind space flight and aeronautics programs, NASA has worked over many years to improve the policies and processes that can control cost and schedule while ensuring safety and mission success. As such, we appreciate GAO's acknowledgement that cumulative cost and schedule performance remained relatively consistent since last year's audit report, with the same cumulative development cost overruns and a decrease in cumulative development schedule delays.

NASA understands that bold ambitions must balance scope and complexity with effective cost and schedule management. The Agency is completing challenging work for the Artemis campaign, and the draft report's emphasis on Orion as a key driver of the portfolio's cost performance amplifies the importance of strengthening strategies to mitigate overruns—



especially given the anticipated increase in focus on human space exploration moving forward. As NASA continues to advance America's leadership in space with discipline and adaptability, the Agency reaffirms its commitment as a responsible steward of American tax dollars.

NASA appreciates GAO's ongoing work with project subject matter experts to review and incorporate technical edits as part of this audit. The consideration of these comments ensures an accurate and balanced presentation of each project's technical status. We remain committed to addressing questions or concerns. If you require additional information, please contact Jenny Russell at (202) 236-7839 or jennifer.b.russell@nasa.gov.

Sincerely,

Janet E Petro
Administrator (Acting)

Appendix VIII: GAO Contact and Staff Acknowledgments

GAO Contact

William Russell, RussellW@gao.gov

Staff Acknowledgments

In addition to the contact named above, Kristin Van Wychen (Assistant Director); John Warren (Analyst-in-Charge); Tonya Woodbury (Analyst-in-Charge); Cassandra Ardern; John Armstrong; Paul Bauer; Dominique Belanger; Bonnie Binggeli; Tina Cota-Robles; Cassidy Cramton; Matthew T. Crosby; Lorraine Ettaro; Edward Harmon; Joy Kim; Meredith Allen Kimmett; Adie Lewis; John Ortiz; Jose A. Ramos; Carrie Rogers; Kimberly Schuster; Matt St. Geme; Juli Steinhouse; Filip Stojkovski; Ryan Stott; Tom Twambly; Tanya Waller; Alyssa Weir; Adam Wolfe; and Marvel Zhou made significant contributions to this report.

Appendix IX: Additional Source Information for Images and Figures

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Front cover banner graphics: The National Aeronautics and Space Administration (NASA) (Gateway Deep Space Logistics), Johns Hopkins University Applied Physics Laboratory (Dragonfly), NASA (Low Boom Flight Demonstrator)

Front cover: NASA/Kim Shiflett (Space Launch System Core Stage and Exploration Ground Systems Vehicle Assembly Building)

GAO analysis of NASA data (all cost performance figures),

GAO analysis of NASA data (all schedule performance figures), and

GAO analysis of NASA documentation (all timeline figures).

GAO (icons)

Related GAO Products

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