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NASA'S MANAGEMENT OF THE GATEWAY PROGRAM FOR ARTEMIS MISSIONS

November 10, 2020

Report No. IG-21-004





Office of Inspector General

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RESULTS IN BRIEF

NASA's Management of the Gateway Program for Artemis Missions

November 10, 2020

IG-21-004 (A-20-008-00)

WHY WE PERFORMED THIS AUDIT

In March 2019, the Administration directed NASA to execute a plan to land humans on the Moon's South Pole by 2024, 4 years sooner than NASA's intended schedule. In response, the NASA Administrator announced that the return-to-the-Moon mission would be known as Artemis and the Agency would use innovative acquisition practices to help accelerate the timetable. The Artemis program includes two exploration missions to orbit the Moon in 2021 and 2023 using the Space Launch System rocket and Orion Multi-Purpose Crew Vehicle (Orion), both of which remain under development and have yet to be flown together. To conduct a lunar landing, the Agency must develop a Human Landing System, complete development of a new spacesuit, and conduct robotic exploration of the proposed landing sites. Moving forward, NASA also plans to build the Gateway—essentially, a small space station—to provide a staging location for additional lunar missions and future deep space operations.

Gateway's initial elements, scheduled to launch together in early 2024, consist of the Power and Propulsion Element (PPE), which powers and propels the spacecraft in orbit, and the Habitation and Logistics Outpost (HALO), which provides a docking location for the Orion capsule and living and working spaces for crewmembers. To date, NASA has spent over half a billion dollars and almost 3 years of design work on the PPE and HALO. To reduce the time needed to acquire these two Gateway elements, NASA modified its standard acquisition practices and instead used a fixed-price contract designed for commercial research and development and a sole-source award. Specifically, the Agency competitively awarded a contract to Maxar Technologies (Maxar) in May 2019 to develop the PPE and made a sole-source award to Northrop Grumman (Northrop) in July 2019 for the HALO. The Agency awarded these contracts before requirements were firm and before it decided whether to use the Gateway to support the planned 2024 Moon landing.

This report is one in a series of audits examining NASA's Artemis program. In this audit, we assessed to what extent the PPE and HALO are meeting schedule, cost, and performance goals. To complete this work, we reviewed the Gateway's schedule, funding documentation, and acquisition method. For PPE and HALO, we reviewed contract files, cost and budget documentation, performance updates, schedule data, and technical risks. We also reviewed HALO's sole-source documentation. In addition, we interviewed NASA, Maxar, and Northrop officials.

WHAT WE FOUND

The development schedules for both the PPE and HALO have been negatively impacted by the Agency's still-evolving Gateway requirements, including NASA's decision to co-manifest and launch the two elements on the same commercial rocket rather than separately as initially intended. Given this decision, the PPE is likely to launch at least 17 months behind its original date of December 2022 while HALO has 2 to 5 months of schedule risk, potentially moving its launch readiness date further into 2024. Compounding these issues is the 2024 lunar mandate that drove the accelerated development schedule in the first place and resulted in a lack of schedule margin in the Gateway Program. While NASA policies identify the need for sufficient schedule margin in development programs, we found Gateway officials had no guidance on suggested margins from the Human Exploration and Operations Mission Directorate (HEOMD)—organizationally where the Gateway Program is located—to factor into their schedules. With both the PPE and HALO

elements highly dependent on each other due to the decision to co-manifest the systems, coupled with an expected 10-month travel time to lunar orbit, the Gateway likely will not be in a position to support a 2024 lunar landing.

The decision to launch the PPE and HALO together, while avoiding the cost of a second commercial launch vehicle, has contributed to cost increases due to the redesign of several components, an elevated launch risk, and a longer duration flight to lunar orbit. In addition, due to the decision Maxar was forced to terminate its subcontract with Space Exploration Technologies Corp (SpaceX) for PPE launch services, even though Maxar had already paid SpaceX approximately \$27.5 million for this service, a portion of which was paid by NASA prior to the termination. Further, a co-manifested launch increases risk because together the elements may be too heavy for commercially available rockets or too long for the rocket's fairing, potentially impacting intended spacecraft mass, length, and other requirements. If it is able to address these risks, NASA may receive benefits from co-manifesting, such as avoiding a rendezvous in orbit by integrating both components on the ground before launch.

NASA selected Maxar in May 2019 to provide the PPE under a fixed-price contract because the Agency anticipated few design and development changes. However, the contract value has increased by \$78.5 million since the award, with more increases expected to accommodate additional evolving requirements and technical challenges. PPE has also experienced other contract management challenges, including the collapse of negotiations between Maxar and a subcontractor to provide its high-power electric propulsion system.

For HALO, the Agency awarded Northrop a sole-source contract in order to meet the 2024 goal. Despite NASA's standard requirement to definitize a contract's final terms, conditions, and costs within 6 months of issuance, the Agency did not definitize the contract with Northrop for 10 months due to the lack of defined requirements. Moreover, NASA and Northrop had only agreed to contract costs on a cost-reimbursable basis for a 7-month design phase. The Agency plans to spend over \$200 million on habitation design by January 2021, and we anticipate a significant increase in cost if NASA is unable to negotiate the 2021 to 2026 performance period as fixed-price. We also expect further schedule delays and cost increases for HALO due to additional undefined requirements, adjustments to projected budgets that removed a second U.S. habitat, and technical challenges.

In our judgment, NASA's acceleration of the acquisition for both the PPE and HALO before fully defining the Gateway's requirements added significant costs to the projects' development efforts and increases the risk of future schedule delays and additional cost increases.

WHAT WE RECOMMENDED

To increase the efficiency and effectiveness of NASA's Gateway Program, we recommended NASA's Associate Administrator for HEOMD: (1) baseline the Gateway requirements and specifications in contract modifications prior to updating and awarding the PPE and HALO fixed-price contracts; (2) ensure PPE and HALO delivery and launch dates are realistic by including sufficient schedule margin in their development schedules; (3) develop a HEOMD policy that establishes a reasonable amount of recommended schedule margin by phase of program or project; (4) confirm at selection the launch system provider for the co-manifested PPE and HALO will meet spacecraft mass, length, and other requirements; (5) work with the contractors to obtain a credit for the amount already spent on launch services under the PPE contract; (6) take action to enforce NASA policy to definitize contracts within 6 months of award; (7) definitize the remaining development and delivery portion of the HALO contract by Preliminary Design Review plus 3 months; and (8) ensure the maturity of system requirements are fully understood before selecting the acquisition method and contract type for future acquisition strategies supporting Artemis and Mars missions.

We provided a draft of this report to NASA management who concurred with our recommendations and described planned actions to address them. We consider the proposed actions responsive to our recommendations and will close the recommendations upon their completion and verification.

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Acronyms

ABC	Agency Baseline Commitment
CDR	Critical Design Review
EM	Exploration Mission
FAR	Federal Acquisition Regulation
FY	fiscal year
HALO	Habitation and Logistics Outpost
HEOMD	Human Exploration and Operations Mission Directorate
HLS	Human Landing System
ISS	International Space Station
JPL	Jet Propulsion Laboratory
KDP	Key Decision Point
NextSTEP	Next Space Technologies for Exploration Partnerships
NFS	NASA FAR Supplement
OIG	Office of Inspector General
PCA	Program Commitment Agreement
PDR	Preliminary Design Review
PPE	Power and Propulsion Element
ROSA	Roll Out Solar Array
SAA	Space Act Agreement
SLS	Space Launch System
SRB	Standing Review Board

INTRODUCTION

In March 2019, the Administration announced an accelerated goal for NASA to land humans on the Moon's South Pole by 2024.¹ NASA's plans for its Artemis lunar exploration program are extremely ambitious and include completing two exploration missions to orbit the Moon in 2021 and 2023 using the Space Launch System (SLS) rocket and Orion Multi-Purpose Crew Vehicle (Orion), both of which remain under development and have yet to be flown together. As we previously reported, these programs face significant cost, schedule, and performance issues.² All told, total Artemis program costs are projected to reach \$86 billion by 2025.³ Moreover, NASA must acquire a significant number of new systems and capabilities to enable a lunar landing. Among other things, the Agency must develop a Human Landing System (HLS) (for which NASA awarded design contracts to three companies in April 2020), complete development of a new spacesuit for astronaut exploration of the Moon's surface and spacewalks, and conduct robotic exploration of the proposed lunar landing sites. Moving forward, NASA also plans to build and launch the Gateway—essentially, a small space station placed in an orbit around the Moon.

The Gateway provides a staging location for lunar missions and deep space operations and, according to NASA, is essential to support sustained Artemis operations. Scheduled to launch in early 2024, the initial Gateway elements consist of the Power and Propulsion Element (PPE), which powers and propels the spacecraft in orbit, and the Habitation and Logistics Outpost (HALO), which provides a docking location for the Orion capsule and living and working spaces for crewmembers staying less than 30 days. To date, NASA has spent over half a billion dollars and almost 3 years of design work on these elements.

To reduce the time needed to acquire Gateway elements, NASA is modifying its standard acquisition practices by using a commercially focused research and development contract and a sole-source award. With this approach, the Agency is moving forward with development before requirements are firm. To this point, several key mission parameters have changed after the Gateway contracts were awarded. In particular, NASA officials are reconsidering the use of the Gateway to support the proposed 2024 Moon landing. In addition, PPE and HALO will no longer launch separately and instead will launch together in 2024 on the same commercial rocket, which has yet to be chosen. Moreover, a second U.S. habitat was removed from the configuration with functions being shifted to the remaining elements due to projected funding reductions. As requirements are adjusted and further defined, the overall cost and the time needed to complete the development of the PPE and HALO will likely increase.

¹ Vice President Pence remarks at the fifth meeting of the National Space Council, Huntsville, Alabama (March 26, 2019).

² NASA Office of Inspector General (OIG), *NASA's Management of Space Launch System Program Costs and Contracts* (March 10, 2020, IG-20-012) and *NASA's Management of the Orion Multi-Purpose Crew Vehicle Program* (July 16, 2020, IG-20-018).

³ We calculated this amount starting with fiscal years (FY) 2012 through 2020 obligations. Cost projections from FYs 2021 through 2025 are based on the FY 2021 President's Budget Request and includes the development and production costs of the SLS, Orion, and Exploration Ground Systems Programs, which during this period mainly supports Artemis missions.

This report is one in a series of audits examining NASA’s Artemis program. Given the importance of the Gateway to NASA’s overall exploration plans, in this audit we assessed to what extent the PPE and HALO are meeting schedule, cost, and performance goals.

Background

In December 2017, the Administration announced Space Policy Directive 1 which directed NASA to lead an integrated program with private sector and international partners for a return of astronauts to the Moon, with later missions to Mars and beyond.⁴ This significantly changed NASA’s strategic goals from the previous 8 years, which were focused on an asteroid retrieval mission and follow-on missions to Mars in the 2030s. Originally estimated to take until 2028 to complete a return Moon landing, the timeline was accelerated in 2019 when the NASA Administrator announced the mission would be known as Artemis and that innovative acquisition practices would be implemented to help accelerate the timetable.⁵

The first planned flight to the Moon was initially known as Exploration Mission (EM)-1, with all subsequent flights utilizing the EM and number designations. Artemis replaced the EM naming convention, and therefore the first mission to the Moon’s orbit—now anticipated for late 2021—is Artemis I. The second mission and first crewed flight—Artemis II—would also orbit the Moon and prepare the way for Artemis III in late 2024. In the third mission, the Orion capsule would dock in orbit with either the Gateway with an attached HLS or directly with the HLS in lunar orbit to transport astronauts to the lunar surface. Prior to the astronauts’ arrival, NASA intends to explore the lunar landing area with robotic systems. Subsequent Artemis missions will include a longer-term presence on the Moon that incorporates ground infrastructure and surface transportation.

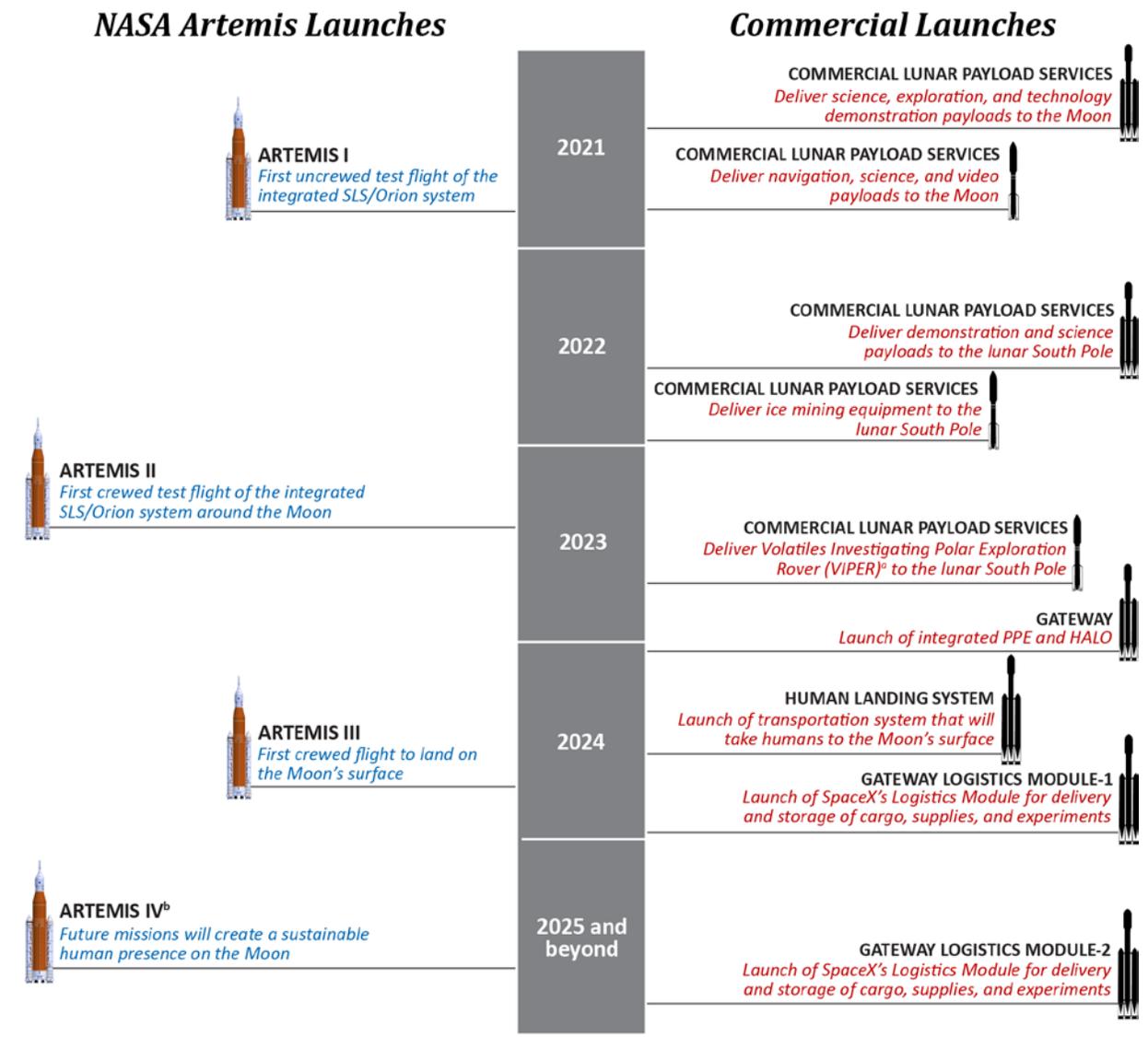
NASA’s plan to land astronauts on the Moon by 2024 relies heavily on the maturity of the SLS/Orion system. In addition, NASA will use commercial launch vehicles to transport both the Gateway and HLS into the Near Rectilinear Halo Orbit.⁶ Figure 1 shows the mission schedule for the Artemis exploration missions as well as commercial launches in support of a lunar landing.

⁴ Space Policy Directive 1 was signed by President Trump and directs the NASA Administrator to “lead an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the solar system and to bring back to Earth new knowledge and opportunities.”

⁵ NASA renamed its planned lunar exploration missions the Artemis program to signify the return of U.S. astronauts to the Moon by 2024. In Greek mythology, Artemis—the twin sister of Apollo—is the goddess of the Moon.

⁶ Near Rectilinear Halo Orbit is an orbit around the Moon with a 7-day cycle, taking the Gateway as close to the lunar surface as approximately 1,600 kilometers (1,000 miles) and as far away as about 68,260 kilometers (42,415 miles). Consequently, the lunar lander can efficiently depart the Gateway to travel to the lunar surface approximately every 7 days.

Figure 1: Timeline of NASA Artemis and Related Commercial Launches



Source: NASA Office of Inspector General (OIG) depiction of NASA program information.

Note: SpaceX is Space Exploration Technologies Corporation.

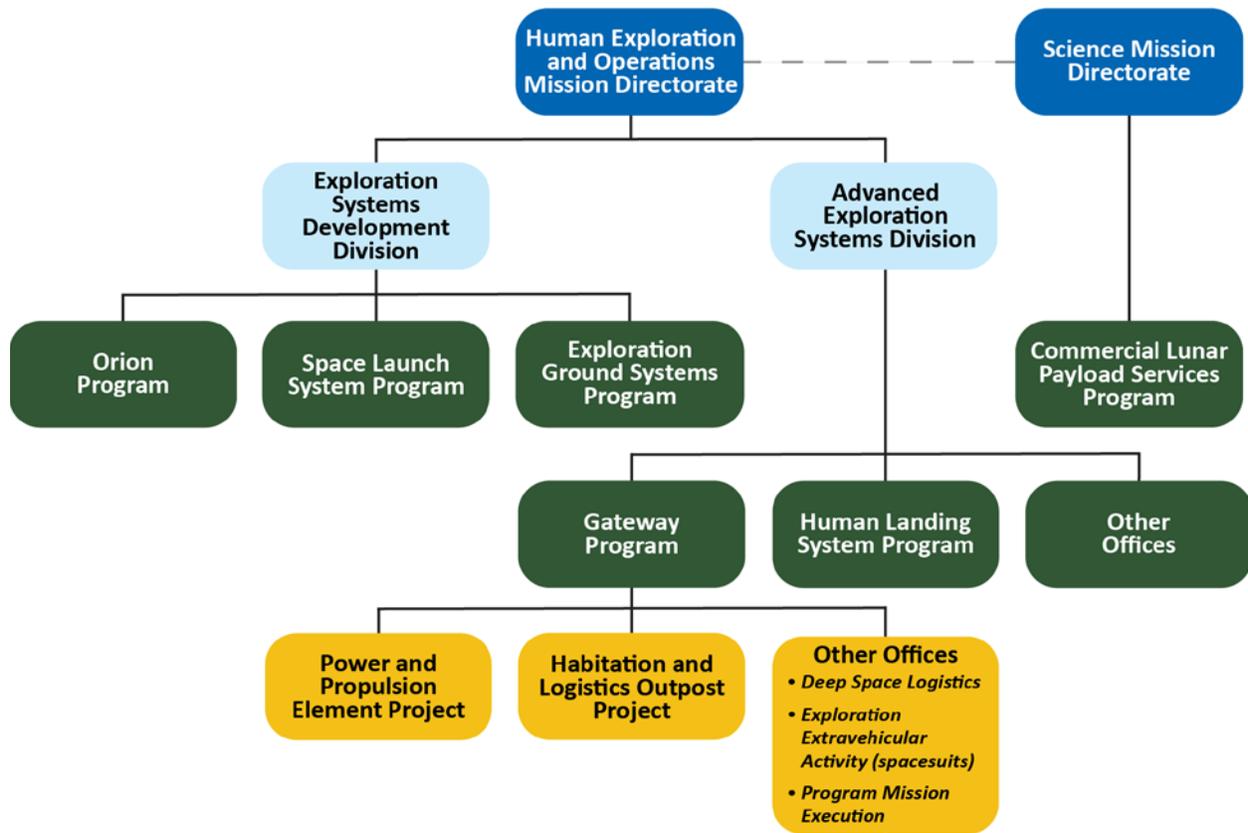
^a As NASA's first mobile robotic mission to the Moon, VIPER is expected to analyze water ice on the Moon's surface and subsurface at varying depths and temperature conditions. This data would inform future landing sites under the Artemis program by helping to determine locations where water and other resources can be harvested to sustain humans for extended lunar expeditions.

^b Artemis IV is scheduled to launch in March 2026 (as of August 2020).

Artemis Organizational Structure

Falling under the Human Exploration and Operations Mission Directorate (HEOMD), NASA’s Advanced Exploration Systems Division is responsible for managing development of the Gateway, HLS, and spacesuits. The Exploration Systems Development Division, also under HEOMD, includes the Orion, SLS, and Exploration Ground Systems Programs. Upon her appointment in June 2020, the new Associate Administrator for HEOMD established a systems engineering and integration function within the Directorate to integrate all Artemis elements. Figure 2 provides the Artemis mission’s organizational structure, while Appendix B provides NASA’s approach for managing the Gateway Program.

Figure 2: Artemis Program Organizational Structure (September 2020)



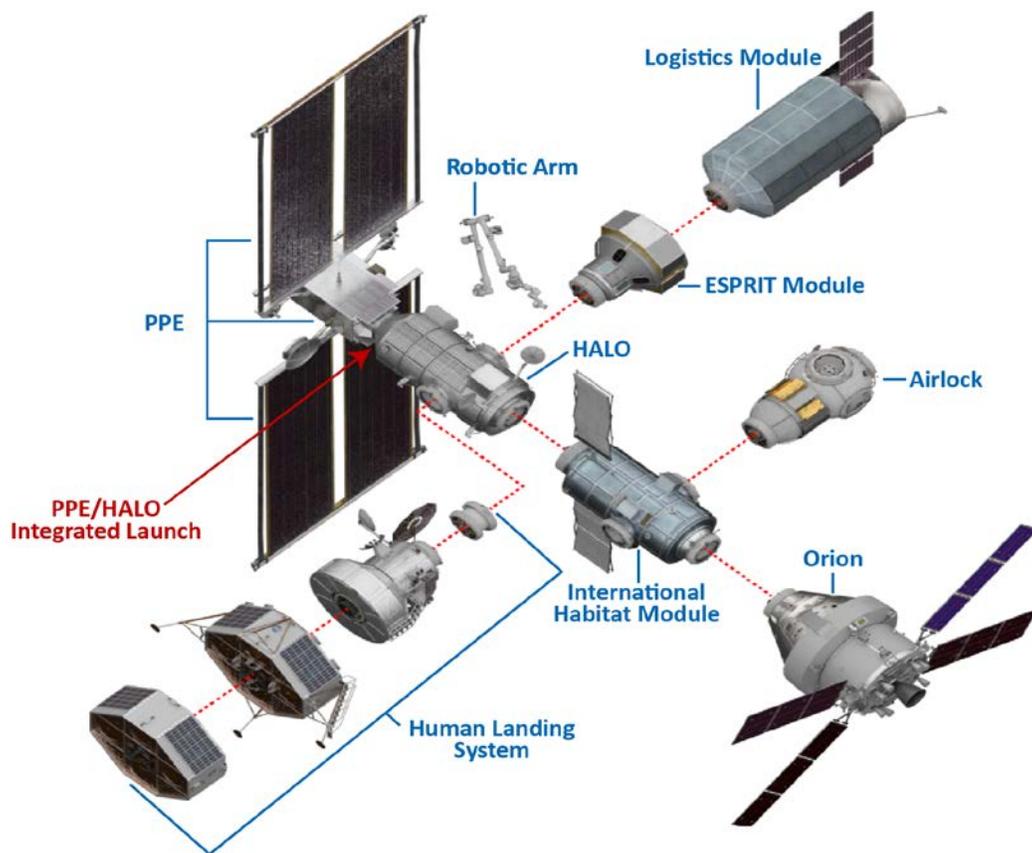
Source: NASA OIG presentation of Agency information.

Gateway Program

For the Artemis III mission in 2024, NASA is attempting to have the Gateway’s initial elements—PPE and HALO—available to potentially dock with a spacecraft as well as to serve as a resupply and communications platform. For Artemis missions IV and beyond, NASA plans to add additional capabilities, providing an orbiting home base for Moon expeditions and future Mars missions. Under its current plans, the Gateway will serve as an aggregation point for vehicles in orbit, support the HLS, extend crewed mission duration in the lunar vicinity, serve as a communication hub for surface elements and payloads, and support scientific research with domestic and international payloads.

Although similar in design in many respects to the International Space Station (ISS), the Gateway with all elements attached will be much smaller, approximately one-sixth the size—a habitable area comparable to a studio apartment while the ISS is more like a 6-bedroom house. Astronauts will visit for up to 3 months instead of crew living onboard continuously. The Gateway will include living quarters (or habitation modules), payload accommodations both internally and externally for science and research, and docking ports for spacecraft. When no astronauts are present, scientific experiments and investigations may continue to operate without the crew present. As shown in Figure 3, the Gateway will include an element to provide power and propulsion, habitation capabilities, a robotic arm to inspect vehicles or install science payloads, and a module for cargo deliveries. The Orion crew capsule will be able to dock with the Gateway.

Figure 3: Gateway Planned Configuration



Source: NASA OIG presentation of Agency information.

For the following Gateway elements, NASA has awarded contracts to several U.S. companies (see Table 1).

- *Power and Propulsion Element.* The PPE is the foundation of the Gateway and provides 60-kilowatt power generation, solar electrical and chemical propulsion, and communications capabilities. The PPE will be three times more powerful than current satellite platforms while requiring less propellant, allowing the Gateway to move more mass around the Moon. In May 2019, NASA contracted with Maxar Technologies (Maxar) to provide this first element of the Gateway.

- *Habitation and Logistics Outpost.* The HALO provides the Gateway with initial living and working space and additional life support systems for Orion to be later supplemented by another pressurized habitation module with crew accommodations and advanced research and experimentation facilities. In July 2019, the Agency contracted with Northrop Grumman (Northrop) to provide this element. Initially, NASA planned to launch the PPE in December 2022 and HALO in December 2023 and integrate the two elements in orbit. However, in February 2020 NASA announced plans to integrate the elements on the ground at Kennedy Space Center and launch the PPE and HALO systems together in a co-manifested payload through a commercial launch service provider in November 2023. NASA made this decision in order to reduce risk by avoiding a first-time on orbit integration and save the cost of a second launch vehicle and service module, a strategy that also gained more time for PPE development. During the course of this audit, the launch date slipped 2 months to January 2024.
- *Human Landing System.* The HLS Program will design and develop the lunar lander to ferry astronauts from either the Orion or Gateway to the Moon’s surface. Although NASA has not yet determined whether the lunar lander will utilize the Gateway for the planned 2024 Artemis III mission, the lander will dock with the Gateway for future missions. While not part of the Gateway Program, the HLS will be integral to the sustained presence of the Gateway as the astronaut’s sole transportation method between their living and research habitat in lunar orbit and the Moon’s surface. In April 2020, NASA contracted with three companies to undertake a design study: Blue Origin, Dynetics Incorporated (Dynetics), and Space Exploration Technologies Corporation (SpaceX). NASA plans to complete its reviews of the companies’ designs by December 2020.
- *Logistics Modules.* NASA plans to build and add two logistics modules to the Gateway in 2024 and 2026, both of which will launch to the Gateway and are scheduled to remain for 6 to 12 months at a time before being disposed of in space. These modules are for delivery and storage of cargo, science experiments, and supplies, and will be transported by SpaceX under the Gateway Logistics Services contract.

NASA is also in discussions with international partners—specifically, the European Space Agency, Japan Aerospace Exploration Agency, and Canadian Space Agency—to build other Gateway elements and capabilities, as noted below and shown in Figure 3 and Table 1.

- *International Habitat Module.* The International Habitat Module will provide complete life support systems, crew accommodations, and additional research facilities. The International Habitat will also add capability to perform expanded research and extend mission duration for the crew beyond 30 days, as well as provide additional docking ports for future expansion. Both the European Space Agency and Japan Aerospace Exploration Agency are partners for the development of this module, planned for launch in late 2025.
- *Robotic Arm.* The robotic arm is a smart mechanical arm that will be attached to a Gateway module by 2026 to berth and inspect vehicles as well as perform external visual inspections of the Gateway and install science payloads. The Canadian Space Agency will provide the arm, known as Canadarm3, which is an evolution of the mechanical arm they provided for the ISS. This next-generation robotic system will be designed to maintain, repair, and inspect visiting spacecraft to the Gateway, relocate Gateway modules, and assist astronauts during spacewalks and experiments. Canadarm3 is designed to work autonomously, but could also be operated by Earth-bound flight controllers or by Gateway crew during spacewalks.

- *ESPRIT Module.* The ESPRIT Module will provide additional operational capability, to include refueling for the PPE and increased habitable volume. NASA has negotiated with the European Space Agency to provide this module and hopes to launch it in late 2027.
- *Airlock.* The airlock is a set of doors to allow astronauts and equipment to enter and leave the spacecraft by equalizing pressure within the chamber. The airlock will enable extravehicular activities—astronaut “spacewalks” and other activity outside of the spacecraft—and additional docking capabilities. NASA is considering Russia’s space agency as a partner for providing the airlock with plans to integrate it into the Gateway in 2028.

Table 1: Gateway Opportunities for International Partner Contributions

Gateway Element	U.S. Contractor/ Contributing Partner	Anticipated Launch Year
PPE	Maxar Technologies	2024
HALO	Northrop Grumman	2024
Logistics Module (1)	SpaceX	2024
International Habitat Module	European Space Agency and Japan Aerospace Exploration Agency	2025
Logistics Module (2)	SpaceX	2026
Robotic Arm	Canadian Space Agency	2026
ESPRIT	European Space Agency	2027
Airlock	Russia’s space agency (potentially)	2028

Source: NASA OIG presentation of Agency information.

Acquisition Strategies for Procuring Commercial Gateway Elements

NASA has the authority to use a variety of acquisition strategies for the design, development, and purchase of space flight systems, with most traditionally bound by the Federal Acquisition Regulation (FAR). The FAR outlines contract vehicles used for the acquisition of goods and services, such as cost-reimbursement and fixed-price contracts. In cost-reimbursement contracts, the Agency agrees to pay all allowable costs the contractor incurs in delivering the service or product. Such contracts are often used in space flight development projects when the government does not fully know the requirements of the project, changes are likely, and estimated costs are difficult to identify. For NASA projects, cost-reimbursement contracts are common for development of spacecraft. In fixed-price contracts, the contractor agrees to deliver a product or service at an agreed-upon price. NASA generally uses fixed-price contracts when it can clearly define costs and risks, for example when purchasing commercially available items such as the third generation of NASA’s Tracking and Data Relay Satellites, or in the later phases of the Commercial Crew Program.

For the PPE acquisition, NASA chose a fixed-price contract using FAR Part 35 and NASA FAR Supplement (NFS) 1835.016 relating to research and development contracting and the use of Broad Agency Announcements. These announcements are used to acquire basic and applied research in addition to Announcements of Opportunity using NFS 1872 but are normally not used for acquiring a specific

system or to procure hardware.⁷ As such, the use of FAR Part 35 and Broad Agency Announcements are designed for commercial companies to conduct research only and not for the acquisition of an end-item. NASA decided to use this approach to leverage commercial capabilities and the NASA Chief of Procurement granted an exception to the “research only” clause to allow for the eventual purchase of the PPE after a successful demonstration.

Similar to the PPE award, for the HALO acquisition NASA utilized FAR Part 35 and NFS 1835.016 relating to research and development contracting and the use of Broad Agency Announcements to enter into a fixed-price contract. However, rather than compete the project, NASA decided to sole source the award to Northrop under its existing prototype-driven Next Space Technologies for Exploration Partnerships-2 (NextSTEP-2) Broad Agency Announcement contract under which considerable development work had already taken place for a habitation module.⁸ Like the PPE award, NASA chose to take advantage of the flexibilities afforded under NFS 1835.016 and deviated from the “research only” clause to allow the HALO’s end product to be acquired by NASA. For the first 10 months of HALO work, the contract with Northrop was undefinitized, meaning the final terms, conditions, and costs were not formally agreed upon. When NASA finalized the contract with Northrop in June 2020, they chose to utilize FAR Part 16 to definitize a 7-month period under a cost-plus-incentive-fee structure to cover work through the initial design phase only.⁹ This design phase will continue until just after the preliminary design is complete and NASA has determined that the HALO meets all requirements with acceptable risk and within cost and schedule constraints. In the meantime, NASA and Northrop will negotiate the terms for the remaining period of performance under a fixed price that includes final design work, fabrication, delivery, and sustainment in orbit.

Not covered by the FAR are Space Act Agreements (SAA), which NASA can enter into as “other transactions” under the National Aeronautics and Space Administration Authorization Act of 2010.¹⁰ These “other transactions” are categorized as either reimbursable, nonreimbursable, funded, or international. SAAs establish a set of legally enforceable promises between NASA and another party requiring a commitment of Agency resources including personnel, funding, services, equipment, expertise, information, or facilities. The purpose of SAAs is to enhance NASA’s ability to advance cutting-edge science and technology, reduce administrative burden, and stimulate industry to undertake new and at times commercially risky endeavors. For example, SAAs were successfully used to develop commercial spacecraft for delivering crew and cargo to the ISS. Moreover, the cost savings were substantial since in the case of cargo development the companies contributed approximately 50 percent of the required funding. In our previous work, we found that NASA put unnecessary limitations on

⁷ FAR Part 35, *Research and Development Contracting* (2019); NFS 1835.016, *Research and Development Contracting—Broad agency announcements* (March 2020); and NFS 1872, *Acquisition of Flight Investigations* (March 2020).

⁸ NextSTEP is a partnership model between NASA and the private sector that seeks commercial development of deep space exploration capabilities to support more extensive human space flight missions in and beyond cislunar space, the space near Earth that extends just beyond the Moon. There have been two NextSTEP announcements, one in 2014 and the other in 2016. The first NextSTEP sought proposals from U.S. industry for concept studies and technology development for advanced propulsion, habitation, and small satellites. NextSTEP-2 included all U.S. and non-U.S. institutions and covered areas such as prototypes for habitation systems, power and propulsion system studies, and HLS studies and demonstrations.

⁹ NASA chose to follow FAR Part 16.304, *Cost-plus incentive-fee contracts*, for the 7-month definitization period and plan to utilize FAR Part 16.403, *Fixed-price incentive contracts*, for the remainder of the HALO period of performance. A cost-plus-incentive-fee contract is a cost-reimbursement contract that provides for an adjusted fee based on whether the contractor is meeting certain cost, performance, or schedule metrics. Similarly, a fixed-price incentive contract provides for an adjusted fee but is under a fixed-price contract structure.

¹⁰ National Aeronautics and Space Administration Authorization Act of 2010, Pub. L. No. 111-267, 124 Stat. 2805 (2010).

usage of SAAs such as not allowing the identification of space flight safety requirements.¹¹ As a result, we had noted that NASA’s program managers were reluctant to use SAAs since they cannot communicate particular requirements to the commercial companies. NASA officials told us that when making the decision on an acquisition strategy for the Gateway, they considered using SAAs but decided that FAR contracts were more suitable and provided extra protections to the government.

Projected Funding Requirements of the Gateway

Between fiscal years (FY) 2015 and 2025, NASA is expected to spend \$3.8 billion on the Gateway Program and additional support items such as habitation prototypes and extravehicular spacesuit development. The first two contracted elements of the Gateway Program—PPE and HALO—make up \$1.5 billion (over 40 percent) of the total through FY 2025, which includes vehicle launch costs. However, both the PPE and HALO are expected to be completed and launched by early 2024; therefore, funding for 2024 and 2025 will be dedicated to the sustainment of those two elements and other projects, such as the logistics modules and spacesuits. From FY 2015 through FY 2025, the PPE and HALO, including prototype development, comprise 47 percent of the total Gateway Program and support costs. Table 2 provides the amount NASA has obligated for support of the Gateway Program from FY 2015 through August 20, 2020, and the requested President’s budget from FY 2021 through FY 2025.

¹¹ NASA OIG, *NASA’s Use of Space Act Agreements* (June 5, 2014, IG-14-020).

Table 2: Gateway Program Including PPE and HALO Breakouts with Past Obligations and Future Budget Requests (as of August 2020, Dollars in Millions)

Program/ Project	Obligations				FY 2021 President’s Budget Request					Total
	2015-2017	2018	2019	2020 ^a	2021	2022	2023	2024	2025	
Gateway Program	\$0.1	\$20.8	\$350.4	\$435.0	\$739.3	\$712.1	\$481.8	\$376.5	\$476.4	\$3,592.4
PPE	0	16.0	167.3	90.5	91.0	116.0	55.0	10.0	4.8	550.6
HALO	0	0	23.0	114.2	280.0	325.0	182.7	72.7	1.7	999.3
Logistics Element ^b	0	0	0	2.8	1.5	1.5	4.5	50.3	204.0	264.6
Program Mission Execution ^c	0	0	110.5	53.0	178.3	91.6	103.4	104.7	127.0	768.5
Spacesuits ^d	0.1	4.8	49.6	121.9	175.3	158.0	116.2	118.8	118.9	863.6
Mission Directorate Support ^e	0	0	0	0	13.2	20.0	20.0	20.0	20.0	93.2
Early Commercial Cislunar and Deep Space Developments	\$73.7	\$68.4	\$46.2	\$55.7	\$0	\$0	\$0	\$0	\$0	\$244.0
NextSTEP Phase 1 ^f	33.5	6.8	2.8	10.1	0	0	0	0	0	53.2
NextSTEP Phase 2 ^f	40.2	61.6	43.4	45.6	0	0	0	0	0	190.8
Totals by Year	\$73.8	\$89.2	\$396.6	\$490.7	\$739.3	\$712.1	\$481.8	\$376.5	\$476.4	\$3,836.4

Source: FY 2015 through August 20, 2020, are obligations from NASA’s accounting system and a prorated portion from NASA’s FY 2020 Spending Plan for Appropriations. FY 2021 through FY 2025 funding was obtained through the FY 2021 President’s Budget Request.

^a For the Gateway Program overall, FY 2020 includes obligations of \$382.4 million through August 20, 2020, and 1.5 months of prorated budget authority from the NASA FY 2020 Spending Plan equal to \$52.6 million. For this FY only, the project lines do not equal the overall Gateway Program line.

^b Logistics Element includes the logistics module(s) and commercial launch services for cargo delivery through the Gateway Logistics Services contract.

^c Program Mission Execution includes multiple support areas such as program management, Systems Engineering and Integration, Safety and Mission Assurance, Program Planning and Control, and common equipment. Specifically, common equipment includes the procurement of the NASA Docking System, S-band for communication, and other smaller common vehicle equipment to both PPE and HALO.

^d Funding for the extravehicular spacesuits will be transitioned to the Gateway Program beginning in FY 2021. From FY 2015 through FY 2020, the spacesuits were funded through the ISS Program and NASA’s Advanced Cislunar and Surface Capabilities area.

^e Mission Directorate Support is similar to a “tax” on the Gateway Program to assist in paying cross-Mission Directorate expenses at the headquarters level. This “tax” will not be charged to the Gateway Program until FY 2021. Mission Directorate Support estimates are based on prior year actuals and will be recalculated annually based upon the Mission Directorate Support services used by the Program.

^f The studies and prototypes developed under the NextSTEP Broad Agency Announcement were funded under NASA’s Advanced Exploration Systems Division.

Gateway Earth to Moon Contracts

Since May 2019, NASA has contracted with three U.S. companies in support of Gateway Program development for total contract values of \$7.7 billion with \$354 million of that amount obligated and \$223 million disbursed as of August 2020. As shown in Table 3, NASA has entered into two separate development contracts for the first two elements of the Gateway—PPE and HALO. The Agency has also provided a 15-year contract to SpaceX for logistics services to resupply the Gateway, but has not yet selected a launch service provider for the integrated PPE and HALO. Further, NASA is currently developing the spacesuits for the 2024 mission in-house and is in the process of identifying viable contractors for production of spacesuits for future lunar missions.

Table 3: Gateway Contracts (as of August 2020)

Contract	Contractor	Deliverables	Contract Type and Performance Period	Contract Value as of August 3, 2020	Obligated Amount and Percentage	Additional Information
PPE	Maxar	Design, develop, test, manufacture, and demonstrate the power and propulsion element	Contract Type: firm-fixed-price with indefinite-delivery, indefinite-quantity portion Performance Period: 5/23/2019 to 2/28/2026	\$453,573,559	\$223,495,810 49%	Rebaselining efforts underway
HALO	Northrop	Design, develop, test, and manufacture the habitation module; only design portion on contract	Contract Type: sole-source, firm-fixed-price then cost-plus-incentive-fee Performance Period: 7/31/2019 to 12/31/2020	\$240,409,181	\$130,881,176 54%	Work performed on undefinitized contract 10 months as firm-fixed-price; definitization only through the preliminary design as cost-plus
Logistics Services	SpaceX	Delivery of cargo to and from the Gateway to support crewed missions	Contract Type: firm-fixed-price, indefinite-delivery indefinite-quantity Performance Period: 3/25/2020 to 3/25/2035	\$7,000,000,000	\$323,952 0.005%	Includes multiple missions to and from the Gateway over a 15-year period; awardees are paid by mission and SpaceX, the first commercial provider selected, has only been guaranteed two missions under this contract
Launch Services	To be selected	Launch capability for the co-manifest of the PPE and HALO elements	To be selected	Not yet awarded	Not yet awarded	Launch Services Program at Kennedy Space Center is currently requesting information from potential contractors
Spacesuits	To be selected	Produce the exploration Extravehicular Mobility Unit and associated equipment and tools	To be selected	Not yet awarded	Not yet awarded	Currently designed and developed in-house for the 2024 mission; contract will cover suits for missions beyond 2024

Source: NASA OIG presentation of Agency information.

Note: A firm-fixed-price contract provides a set price that does not change even if the contractor's costs increase during performance. Using a cost-plus approach, NASA approves all designs, manages all development and schedules, and owns the vehicle once delivered by the contractor. While this process gives NASA maximum control over the contractor's design and final product, the majority of the cost, schedule, and outcome risks are borne by the federal government. An indefinite-delivery, indefinite-quantity contract refers to NASA's ability to issue an undefined number of task orders for services up to a specified amount of money.

Power and Propulsion Element

In May 2019, NASA awarded a firm-fixed-price contract (with indefinite-delivery, indefinite-quantity portion) to Maxar for a potential value of \$375 million to develop and demonstrate power, propulsion, and communications capabilities for NASA's Gateway. Maxar planned to utilize a modified version of its already proven 1300-class spacecraft platform, used primarily for communication satellites. The original contract provided for Maxar to launch the PPE into orbit in December 2022 and demonstrate the system for a year. The contract also contained an option by which NASA could elect to take ownership of the PPE after it has flown for a year. In mid-2019, Maxar teamed with Blue Origin, Dynetics, and The Charles Stark Draper Laboratory, Inc. to design, build, and operate the PPE spacecraft. By August 2020, total contract value had risen to over \$453 million. In addition, because the PPE would no longer launch separately, NASA began examining how the Agency could take ownership of the PPE prior to integration with the HALO and prior to launch.

Depiction of the Maxar 1300 Class Spacecraft Platform



Source: Maxar.

Habitation and Logistics Outpost

In 2015, under NextSTEP-2, NASA awarded Northrop (previously Orbital Science Corporation) and five other contractors a 4-year, firm-fixed-price contract to develop a full-size, ground-based deep space habitation prototype unit for initial habitation capabilities. In July 2019, after the Administration announced a revised goal to land humans on the Moon by 2024, NASA announced a Justification for Other Than Full and Open Competition to sole source the award for the HALO (also referred to as Minimal Habitation Module) to Northrop.¹² NASA deemed Northrop the only contractor from the NextSTEP-2 participants that could meet Gateway requirements and the 2024 schedule. Northrop's HALO design is based on its Cygnus spacecraft used for ISS cargo missions. Initially, HALO will serve as the initial crew cabin for the 2024 lunar landing, to include staging spacesuits for the moonwalks. Ten months after the contract was awarded with \$53 million obligated to Northrop, NASA revised its plan and added the co-manifested launch, concurrently updated its acquisition strategy, and subsequently definitized only the design portion of the contract—a 7-month period of performance—as a cost-plus-incentive-fee.¹³ During this period, Northrop completed both a System Requirements Review and a System Definition/Design Review.¹⁴

¹² A Justification for Other Than Full and Open Competition is covered by FAR Subpart 6.3 and authorizes NASA to award a contract to a company as a sole source, foregoing the competitive process. Among other requirements, the sole-source contract should be in the best interest of the government and the anticipated cost should be determined to be fair and reasonable.

¹³ \$18 million of the \$53 million was obligated under previous prototype work for a cislunar habitat and before the HALO project was initiated.

¹⁴ System Requirements Reviews and System Definition/Design Reviews are events where NASA and the contractor ensure that the government's requirements are understood and have been allocated to all functional elements of the mission/system before moving forward with a preliminary design.

Figure 4: Northrop Grumman Ground Test Article at Johnson Space Center



Northrop's habitat prototype developed during NextSTEP-2, with an interior view to the left and exterior view to the right.

Source: NASA.

Logistics Services

In March 2020, NASA selected SpaceX as the first commercial provider under the Gateway Logistics Services contract to deliver pressurized and unpressurized cargo, science experiments, and other supplies to the Gateway. SpaceX will launch the mission using its Falcon Heavy rocket to transport the Dragon XL vehicle. The contract is a firm-fixed-price, indefinite-delivery, indefinite quantity over a 15-year period of performance, with a maximum contract value of \$7 billion. As of August 2020, NASA has obligated approximately \$324,000 to SpaceX for logistics services. NASA may select additional commercial logistics providers under this contract in the future, and each will be guaranteed at least two missions.

SpaceX Falcon Heavy Rocket at Kennedy Space Center's Launch Pad 39A



Source: SpaceX.

Spacesuits

NASA is currently designing, manufacturing, and certifying the Artemis III extravehicular spacesuits—for astronauts to use outside of the Gateway and other spacecraft—at Johnson Space Center. These suits will first be demonstrated in a space flight environment on the ISS in 2023. However, for Artemis missions beyond 2024 NASA is in the process of identifying a contractor to produce, assemble, test, sustain, and maintain a fleet of flight and training spacesuits and associated hardware. The suits will feature a new design to accommodate a broader range of sizes and improve fit, comfort, and mobility. Specifically, improvements include a highly mobile lower torso for walking and kneeling to eliminate the astronaut “bunny hopping” seen during the Apollo missions. The suit also includes an upgradable life support system to improve overall reliability, safety, and performance.

Ground Prototype of the New Exploration Extravehicular Mobility Unit



Source: NASA.

GATEWAY WILL LIKELY NOT BE AVAILABLE FOR A 2024 LUNAR LANDING DUE TO STILL-EVOLVING REQUIREMENTS

NASA officials have yet to decide whether they intend to use the Gateway to support the planned 2024 lunar landing. Nonetheless, as a result of schedule delays in both PPE and HALO development, the Gateway likely would not be available to support a 2024 landing. The development schedules for both elements have been delayed by the Agency's still-evolving Gateway requirements, including NASA's decision to co-manifest and launch the two elements together and NASA's revisions to the Gateway's technical specifications. Moreover, the contract value for the PPE has increased by \$78.5 million over a 14-month period since the fixed-price contract was awarded in May 2019, with more increases expected to accommodate additional evolving requirements and technical challenges. For HALO, the Agency sole sourced the award to Northrop to meet the accelerated 2024 lunar goal; however, NASA and Northrop have yet to agree on final contract costs beyond a 7-month design phase. In our judgment, NASA's acceleration of the acquisition for both the PPE and HALO before fully defining the Gateway's requirements added unexpected costs to the development efforts and increases the risk of future schedule delays and additional cost increases.

Schedule Delays for the Gateway Have Pushed Anticipated Launch Date into Mid-2024 with No Schedule Margin

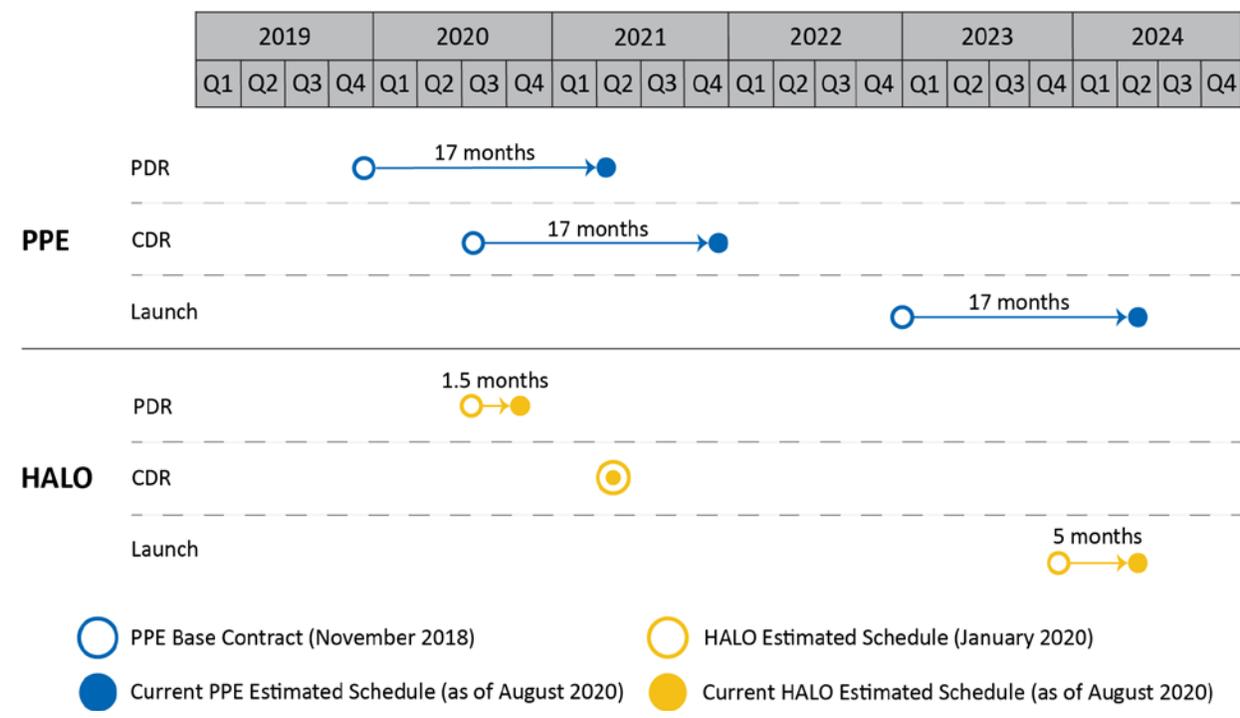
Both PPE and HALO have experienced development delays that have pushed the anticipated launch date from late 2023 to mid-2024 at best. Moreover, due to NASA's decision to integrate the systems on the ground to enable a co-manifested launch, PPE and HALO are now dependent upon each other's schedules to meet a launch date (see Figure 5). Specifically, the PPE's original launch of December 2022 was delayed 11 months to accommodate the co-manifested launch, and schedules showed an additional 6 months of risk for a possible launch of 17 months later than the original date of December 2022. Concurrently, NASA has delayed the project's Preliminary Design Review (PDR) and Critical Design Review (CDR).¹⁵ According to NASA's estimated schedule as of late August 2020, the PPE was scheduled to be shipped from Maxar's facility in California in February 2024, with an additional 2 to 3 months required for transit to Kennedy Space Center, integration with the HALO, and launch preparation. To address the schedule slip, NASA and Maxar are implementing several contracting initiatives to save

¹⁵ The PDR is one of a series of checkpoints in the design life cycle of a complex engineering project before hardware manufacturing can begin. As the review process progresses, details of the vehicle's design are assessed to ensure the overall system is safe and reliable for flight and meets all NASA mission requirements. A CDR demonstrates that a program or project design is sufficiently mature to proceed to full-scale fabrication, assembly, integration, and testing and is considered a key step in the development process because it often reveals shortcomings that must be addressed before the spacecraft design is finalized and manufacturing begins.

2 to 4 months in the propellant tank development with a goal of delivering the PPE in October 2023, but it remains to be seen if these actions will speed development.

For HALO, NASA has continued evolving the habitation’s design requirements for nearly a year and currently anticipates a 1.5-month delay in PDR while additional requirements related to the co-manifest launch are finalized. Even though HALO’s schedule shows that it remains on track to meet the early 2024 launch date, it includes 2 to 5 months of schedule risk, which would likely move the launch date further into 2024. With the decision to launch the PPE and HALO together, both elements are highly dependent upon each other and the earliest the co-manifested systems can launch is May 2024. If the PPE/HALO is not launched until May 2024, and based on an expected 10-month travel time to lunar orbit, the Gateway will not be in position to support a 2024 Moon landing. Without the Gateway, NASA will not have a staging location and communications platform in lunar orbit and will need to land astronauts on the Moon using a pre-positioned HLS and Orion.¹⁶

Figure 5: Original and Current PPE and HALO Schedules as of August 2020



Source: NASA OIG presentation of Agency information.

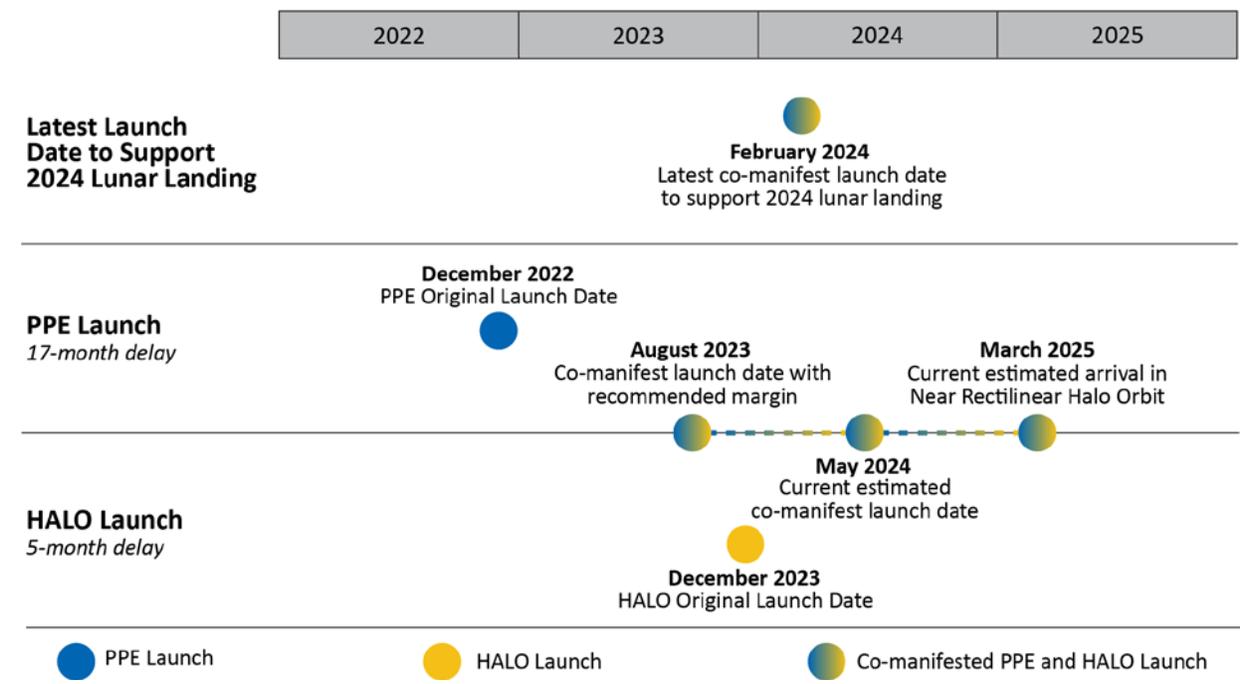
Note: With the HALO production contract yet to be definitized, the earliest project schedule with each date available was used as a baseline for this figure. PDR is Preliminary Design Review and CDR is Critical Design Review. See footnote 15 for a description of both reviews.

¹⁶ After the PPE and HALO are integrated on the ground and launched together, the co-manifested vehicle must rely on Solar Electric Propulsion to arrive at its lunar orbit, a relatively slow method of transportation compared to chemical propulsion. Prior to the decision to co-manifest, the PPE was scheduled to launch separately a year earlier and the HALO was to use a chemical propulsion transfer vehicle to reach the PPE in Near Rectilinear Halo Orbit. This transit would have taken between 14 and 120 days, depending upon the transit method.

Compounding the schedule challenges is the lack of any schedule margin in the Gateway Program to support a 2024 lunar landing. Space flight projects routinely encounter technical difficulties during development that cause delays, and therefore it is a best practice to build extra time or margin into the schedule. While NASA policies identify the need for sufficient schedule margin in development programs, the 2024 lunar mandate drove an accelerated development schedule that did not allow for standard schedule margins. Moreover, Gateway officials had no HEOMD guidance on suggested margins to build into their schedule.¹⁷ For example, NASA’s Jet Propulsion Laboratory (JPL) provides specific guidance on standard schedule margins by each phase of the program for non-human-rated space flight programs and projects.¹⁸

According to the JPL guidance, with an anticipated launch date of May 2024, the program should have approximately 6 months of schedule reserves. Further, because it will take approximately 10 months for the co-manifested PPE and HALO to reach Near Rectilinear Halo Orbit for the Gateway to support a lunar landing in 2024, the latest possible launch would need to be February 2024. The gap between the “need by” launch date of February 2024 and current estimated launch date of May 2024 represents a negative schedule margin of 3 months (see Figure 6). Therefore, to follow the intent of JPL’s non-human-rated guidance on schedule margin, the Gateway Program must compensate for a shortage of 9 months of schedule in order to meet the required launch date—a feat which, in our judgement, is likely impossible.

Figure 6: Negative Schedule Reserves for Co-manifested Launch



Source: NASA OIG presentation of Agency information.

¹⁷ Even though NASA/SP-2010-3403, *NASA Schedule Management Handbook* (January 2010) emphasizes that adequate schedule margin is critical to project success, the handbook leaves the calculation to the discretion of the Program or Project Manager.

¹⁸ JPL guidance states that schedule margin should be included at the following rates: 1 month for every year between PDR and the System Integration Review (a milestone that ensures elements and subsystems are on schedule to be integrated into the system); 2 months for every year between the System Integration Review and hardware shipment; and 1 week for every month between hardware shipment and launch.

Schedule Delays and Associated Cost Increases Are Primarily the Result of Evolving Gateway Requirements

After awarding the PPE and HALO contracts, work on both systems was delayed significantly through 2019 and 2020 given the decision to co-manifest the elements and because major system requirements and specifications changed or were not yet determined. PPE uses a firm-fixed-price contract and has experienced increased costs, technical challenges, management issues due to an accelerated timeline, required modifications and rebaseline of the contract, and a key subcontractor dropping out. For its part, HALO was awarded as a sole-source undefinitized contract with only its design phase definitized 10 months later as a cost-plus-incentive-fee due to anticipated future design changes. In addition, both systems have been negatively affected by COVID-19 virus-related Center closures and work restrictions.

Challenges in Co-manifesting the PPE with HALO

One significant requirement change that affected the schedule and could increase cost is NASA's decision to co-manifest the PPE with the HALO for an early 2024 launch, NASA's first time attempt at integrating and launching a system of this magnitude. Instead of launching separately and docking together in orbit as originally planned, both PPE and HALO will be integrated on the ground at Kennedy Space Center and launched together. Co-manifesting the PPE and HALO allows NASA to avoid the cost of an additional commercial launch. Further, it reduces technical risk by allowing for integration and testing on the ground prior to launch. However, it has also contributed to cost increases due to technical changes to the PPE, an elevated launch risk, and potential performance shortfalls primarily due to the increased mass of both elements that slows the electric propulsion transit to a lunar orbit.

Because the February 2020 requirement change to co-manifest PPE and HALO was NASA's decision, 10 months into the contract, Maxar was forced to terminate its subcontract with SpaceX for PPE launch services, even though Maxar had already paid SpaceX approximately \$27.5 million. Because a portion of this amount was for a milestone NASA paid Maxar for, and Maxar planned to also use the rocket for non-NASA purposes, NASA and Maxar will need to determine what this cancellation will actually cost the government. Ultimately, potential savings from reducing two rocket launches to one will be measured against this cost, along with the cost of the Gateway elements and launch vehicle modifications needed to meet the co-manifested requirements. In addition, since the procurement for the co-manifested rocket will be made using NASA's Launch Services Program, it is possible that the Agency could award the contract to the same company that Maxar was going to use and in effect pay twice for the same service (partial payment on the scrubbed PPE launch plus full payment on the co-manifested launch).

Moreover, both the PPE and HALO projects have identified an elevated risk relative to the co-manifested launch because the two elements joined together may be too heavy for commercially available rockets or too long for the rocket's fairing which provides the nose cone cover for the system during launch. At the onset of the HALO award, NASA envisioned the habitat would carry a metric ton of cargo for the astronauts, to include spacesuits for moonwalks, and to serve as living quarters for the crew transitioning to and from the lunar surface. According to Northrop officials, their effort to reduce the weight of the habitat focuses on eliminating a significant amount of cargo capability. However, as NASA and Northrop continue to identify potential solutions to reduce the mass and meet both weight and time frame requirements, HALO will not be able to deliver additional cargo as originally envisioned which will result in an earlier than planned resupply in orbit.

PPE Costs and Technical Challenges

Between February and July 2020, the PPE contract value increased by \$78.5 million and the period of performance was extended by 5 months, extending the design period through July 2020. Of the \$78.5 million in cost increases, \$51 million was related to six major technical and engineering changes from NASA-driven Gateway requirements changes, \$24 million to an increase in the task order value, and \$3.5 million for initial work on the co-manifested flight.¹⁹ Since its inception, PPE has undergone seven separate contract modifications to address NASA's changing Gateway requirements. Further, additional costs and extensions are expected given final contract modifications requiring additional technical changes will not be completed until fall 2020.

Immature requirements on the Gateway and its elements have resulted in a variety of interrelated technical issues that increase the risk of future schedule and cost increases. For example, NASA has directed Maxar to make significant technical upgrades using different electric thrusters and modifications to the power system. Many of these requirements were not built into the original schedule assumptions and, as a result, additional time and funding will be needed to test and integrate these systems. To gain 60 kilowatts, Maxar will use the new Roll Out Solar Array (ROSA) solar panels that consists of two solar arrays measuring approximately 8 by 20 meters with each array producing 32.5 kilowatts. While an earlier version of this array was demonstrated on the ISS in 2017, ROSA has not been used operationally. ROSA is also deployed differently during flight compared to other solar arrays, rolling up for launch instead of folding like an accordion. In addition, Maxar must add a power converter to provide 120-volts to the HALO. Based on their experience working on other development programs, NASA contracting officers stated they had not seen so many significant engineering change proposals in such a short time period (six major technical changes as of August 2020).

PPE Acquisition Approach and Contract Management Issues

Immature Gateway requirements have also resulted in contract management challenges for the PPE. In executing its acquisition strategy, NASA competitively selected Maxar with its commercial satellite bus—a proven system with over 100 missions to its credit.²⁰ NASA used a fixed-price contract under the FAR Part 35—typically selected for the purposes of research and development—because the Agency wanted to engage in a partnership with industry to fund the development and demonstration of advanced technologies to support both NASA and commercial applications. Further, the limited set of functional and performance requirements the Agency provided as part of this Broad Agency Announcement procurement were intended to allow contractor flexibility in system development. As such, the Agency anticipated PPE would ultimately undergo relatively few (if any) government-levied design and development changes during contract performance.²¹ Typically, fixed-price is used when requirements are firm, whereas a cost-type contract has been used for projects necessitating greater

¹⁹ The original task order value of \$12 million was spent within the first year on extensive studies related to the Gateway Program requirements changes.

²⁰ Although Maxar's initial contract took advantage of Maxar's extensive experience integrating with launch systems, this task was later removed from the contract and NASA's Launch Services Program took responsibility for launching both systems together. The Launch Services Program is seeking proposals for launch services with a target date of December 2020 to award a contract.

²¹ The NASA Associate Administrator for Procurement approved a deviation on using FAR Part 35 for the PPE in January 2018 in order to allow NASA to identify specific performance characteristics in the contract and to possibly purchase the PPE.

design and development of requirements. Modification of a fixed-price contract to accommodate requirement or design changes—inevitable in most new development programs such as the PPE—can prove costly.

NASA's decision to use a fixed-price contract for the PPE resulted in immediate challenges in contract management. For example, prior to NASA's award, Maxar's subcontractor Aerojet–Rocketdyne (Aerojet) had agreed to provide the high-power electric propulsion systems for the PPE. After award, Maxar's negotiations with Aerojet collapsed and Maxar was unable to definitize its subcontract with Aerojet. Maxar officials told us that Aerojet was unwilling to commit to a fixed-price because their power processing unit had development challenges. As a result, it became necessary for Maxar and NASA to generate an alternative approach with Maxar providing the electrical power components except for the government furnished electrical thrusters. Consequently, we expect the NASA/Maxar "work-around" approach to add additional costs as development efforts continue.

The program experienced additional contract management challenges as a result of the decision to co-manifest the PPE with HALO. NASA utilized a FAR Part 35 firm-fixed-price acquisition approach not anticipating requirement changes; however, the significant changes have caused PPE to rebaseline the contract. NASA and Maxar continue to evaluate the effects of the decision to co-manifest the two elements and the Gateway changes through numerous design analysis cycles, which they expect to conclude by early fall 2020. NASA officials stated the results of these design cycles for the co-manifested vehicle will ultimately lead to a rebaseline of the PPE contract, which may extend the schedule by 17 months from the initial timetable, increase costs, and further elevate program risk. Rebaselining the contract will include, but is not limited to, the following changes:

- *Significant technical changes to PPE's design and development.* PPE will need to increase its electric propulsion power and control capabilities to launch the co-joined PPE and HALO system into orbit. In addition, propellant tanks will need to be redesigned to support the increased load and orientation in the launch vehicle. These changes are expected to push the launch from early 2024 to mid-2024.
- *Removal of Maxar's launch vehicle requirement.* Maxar is experienced in this area, having conducted over 100 integrations and launches with its satellite system. However, the addition of new technologies and modifications needed for the integrated PPE and HALO launch creates an elevated risk to NASA and the launch service provider it selects. NASA also will assume additional risk as a first time integrator of this system.
- *Change to PPE ownership requirement.* NASA will take ownership of the PPE prior to integration with the HALO at Kennedy Space Center instead of after a planned 1-year on orbit demonstration that would have provided a "test ride before you buy." According to the original acquisition strategy, this approach would have significantly reduced NASA's risk of purchasing a system that did not meet its requirements. Instead, NASA must immediately assume this risk and associated costs.
- *Decrease in number of Maxar payment milestones.* As all payments with Maxar are tied to their milestones, any change requires a negotiation and addition of new milestones and requirements. Maxar provides NASA with detailed payment documents to verify completion of milestones. Currently, Maxar has 548 milestones coupled with additional milestones resulting from requirements changes. According to NASA procurement officials, the review and approval of milestones is extremely time consuming and burdensome. As a result, NASA and Maxar have

agreed during the rebaseline to decrease the number of Maxar payment milestones to reduce the administrative burden on both the Agency and contractor. In our judgement this is both appropriate and beneficial to both parties.

HALO Acquisition Approach and Undefined Requirements Result in Delayed Contract Definitization and Increased Costs

In July 2019, NASA issued a Justification for Other Than Full and Open Competition and awarded Northrop a sole-source, fixed-price, undefinitized contract for the HALO.²² NASA officials wrote they made the decision because in their view Northrop was the only contractor who could build the module on the timetable required and therefore using a non-competitive process avoided “unacceptable 12 to 18 month delays.” Despite NASA’s policy to definitize a contract within 6 months of issuance, the Agency did not definitize the contract with Northrop for 10 months due to factors including the co-manifested launch redirection and the evolution of requirements for HALO. However, according to Project officials, NASA has made substantial progress in defining requirements leading to an upcoming PDR relative to the time needed in other large human spacecraft development efforts.

Northrop used their Cygnus vehicle—which had completed numerous cargo delivery missions to the ISS and had already undergone 4 years of habitation technology development under a firm-fixed-price contract through NASA’s NextSTEP-2 award—to form the structure of the HALO. Although technically a preformulation activity designed to support operations in cislunar orbit, the intent of NextSTEP-2 was to advance the technology for and provide an actual prototype of a habitation module intended for that environment.²³ As such, Northrop had been working on the design of a habitation module since the NextSTEP-2 award in 2015—through which they were required to develop a full-size, ground prototype to include partial functionality for testing. However, NextSTEP activities were intended to allow contractors to advance early design concepts but without specific mission requirements. As a result, Northrop produced a mock-up rather than a true prototype. Consequently, NASA needed 10 additional months to define a HALO system that could meet Gateway requirements.

Further, according to procurement officials, when NASA modified the contract to Northrop in 2019 to reflect the new Gateway mission, the Agency could not finalize a contract price due to the lack of NASA-defined system and crew habitat requirements. As a result, between July 2019 and May 2020 Northrop worked on the design for the habitation module under an undefinitized contract action.²⁴ The Gateway Program did not approve the habitation’s system and crew requirements document until May 2020—nearly a year after Northrop had begun their HALO design activities under the Justification for Other Than Full and Open Competition and after NASA had already spent over \$50 million on the design. Despite approval of the requirements document, in June 2020 NASA only definitized the design phase of

²² NASA selected Northrop as a sole-source award by issuing a Justification for Other Than Full and Open Competition, covered under FAR Part 6. The contract remained undefinitized for 10 months out of an expected 17-month period of performance.

²³ The Trump administration canceled the asteroid retrieval mission, which was designed to bring an asteroid into cislunar orbit for examination by robotics and astronauts. To support this activity, the requirement of a habitation module for cislunar missions was part of NASA’s human exploration plans beyond low Earth orbit.

²⁴ According to the NFS, “undefinitized contract action” means a unilateral or bilateral contract modification or a delivery/task order in which the final price or estimated cost and fee have not been negotiated and mutually agreed to by NASA and the contractor. NFS 1843.70, *Undefinitized Contract Actions* (2016).

the HALO contract for the remaining 7-month period of performance through PDR for an additional \$187.3 million as a cost-plus-incentive-fee instead of the planned firm-fixed-price contract. NASA took this approach because several months of additional design changes were expected.²⁵ Including the costs spent during the early NextSTEP prototyping phase, the Agency will have spent over \$200 million on habitation design by 3 months past PDR. NASA procurement officials justified this unusual approach to a partial contract definitization as the result of an aggressive schedule to launch the HALO by late 2023 (a date that has since slipped to early 2024), which led to NASA's decision to sole source the award before fully defining the habitation module requirements and the ongoing co-manifesting changes.

NASA's experience has shown that the longer the government waits to finalize contract costs, the less incentive the contractor has to control its costs, creating a potential for wasted taxpayer dollars. NASA's current plan is to definitize the remainder of the contract with Northrop in early 2021 under a fixed-price-incentive-fee structure. If NASA is unable to negotiate the expected 2021 to 2026 period of performance as fixed-price, we anticipate a significant increase in costs during this period as Northrop continues to work under a cost-plus structure. NASA has already committed to spend over \$200 million on Northrop's contract for NextSTEP work, the early design portion of HALO, and initial purchases of material and long-lead items, but the Agency has not yet definitized the remaining work. Although Northrop's current work includes 3 months of work after the PDR is completed, NASA's best practice metrics show that 85 percent of a project's costs occur after PDR.²⁶ Moreover, the government is providing a substantial amount of equipment and services outside of this contract including the S-band radio system, research laboratories, and docking mechanisms.

We anticipate further schedule delays and cost increases due to additional undefined requirements, adjustments to projected budgets, and technical challenges. As of July 2020, over 50 requirements remain to be determined or resolved for areas such as the amount of storage needed. Moreover, given a projected reduction in funding for FYs 2021 through 2025, the Gateway Program made the decision to eliminate a second U.S. Habitation Module from its configuration, causing the HALO to accommodate medical and crew hygiene functions originally planned for the second module. HALO also continues to experience other technical challenges—including humidity control, especially when the crew is exercising; space needed for the layout of the crew's exercise area; and identifying a compatible lighting, video, and audio system—which may negatively affect HALO's schedule and cost.

Given that NASA will likely be unable to use the Gateway to support the 2024 lunar landing, the use of full and open competition for HALO would have positioned the Agency to more thoroughly determine its requirements in preparation for a solicitation, and potentially reduce the costs of HALO development.

COVID-19 Restrictions Impacting Gateway Development

The COVID-19 virus is primarily affecting in-house laboratory and testing work for spacesuit development and, to a smaller extent, the PPE and HALO. For example, in April 2020 the Gateway Program reported that for several advanced-stage projects such as spacesuit development, the schedule

²⁵ The \$187.3 million includes \$152.3 million of the cost-plus-incentive-fee portion from June 2020 through December 2020, and \$35 million maximum value through indefinite-delivery, indefinite-quantity task orders.

²⁶ NASA's planned fixed-price cost for this contract is procurement sensitive. This 85 percent is based upon a metric NASA utilizes to assist with estimating costs on single build systems and has proven to be reliable by NASA's cost estimating software tools. These costs do not include support contractors or civil servant costs that support the habitation project. As of August 2020, the HALO contract costs comprise approximately 83.5 percent of total obligations under the HALO project, with the remaining contracts at 12 percent and civil servant costs at only 4.5 percent.

is projected to slip 1 day for every day that COVID-19 restrictions were in place. As of August 1, 2020, given 3 months of COVID-19-related work restrictions at Johnson Space Center, the Project anticipates a delay of spacesuit delivery from March 2023 to June 2023. However, this project is not on the Gateway's critical path. Other projects such as PPE and HALO—which are on the critical path—are mostly working on spacecraft designs, finalizing requirements and studies, and have not yet reached PDR. The Program is still assessing the overall effects of COVID-19-related delays on its subcontractors. Initial reports indicated HALO has a 1-month schedule delay due to slow negotiations related to COVID-19 with its subcontractors. Beyond this, NASA officials have not yet determined any significant effect on the Program except for spacesuit development. Nonetheless, as the pandemic's full effects are determined, given the lack of any schedule margin, COVID-19-related delays will likely have a direct impact on the Program's delivery dates. The Office of Inspector General continues to monitor the cost and schedule impacts of the virus on all NASA programs, but particularly the PPE and HALO projects as the schedules are already aggressive.

CONCLUSION

NASA's aggressive pursuit of landing humans on the Moon's South Pole by the end of 2024 faces multiple significant challenges. While the Gateway is key to the Agency's plans to maintain a sustainable human presence on the Moon, officials have yet to decide whether they intend to use the Gateway to support the planned 2024 landing. Nonetheless, to reduce the time needed to acquire Gateway elements, NASA is modifying its typical acquisition practices by using a commercially focused research and development contract and a sole-source award. However, given the time needed for developing, launching, and moving the Gateway into its lunar orbit, the earliest the system is projected to be available for Artemis missions is 2025.

The PPE launch is now potentially 4 months behind the expected launch date of January 2024—a timeline that has already slipped 2 months and does not support a human landing in 2024—and HALO can anticipate 5 months of schedule delays with no schedule margin to absorb additional delays. Moreover, for the PPE contract, the value has increased by \$78.5 million since the fixed-price contract was awarded in May 2019, with more increases expected by NASA as the project rebaselines to accommodate additional evolving requirements and technical challenges. For the HALO, without definitized costs, NASA runs the risk of significant cost growth. In our judgment, the Gateway's schedule delays and associated cost increases can largely be attributed to NASA's early acquisition for both the PPE and HALO in the midst of updating requirements to meet the 2024 lunar landing mandate and updated lunar architecture.

Looking ahead to the acquisitions of the future Artemis and deep space systems, NASA must decide which procurement strategies best support its objectives. This includes the type of contractual vehicle (Space Act Agreement, FAR contract), and whether sole sourcing or competition is needed to gain the desired system. Importantly, understanding the state of technology development and the level of maturity of requirements for each system will help inform decision makers on the best approach and produce a schedule and cost estimate that is feasible and realistic.

RECOMMENDATIONS, MANAGEMENT'S RESPONSE, AND OUR EVALUATION

To increase the efficiency and effectiveness of NASA's Gateway Program, we recommended NASA's Associate Administrator for Human Exploration and Operations Mission Directorate:

1. Baseline the Gateway requirements and specifications in contract modifications prior to updating and awarding the PPE and HALO fixed-price contracts.
2. Ensure PPE and HALO delivery and launch dates are realistic by including sufficient schedule margin in their development schedules.
3. Develop a HEOMD policy that establishes a reasonable amount of recommended schedule margin by phase of program or project.
4. Confirm at selection the launch system provider for the co-manifested PPE and HALO will meet spacecraft mass, length, and other requirements.
5. Work with the contractors to obtain a credit for the amount already spent on launch services under the PPE contract.
6. Take action to enforce NASA policy to definitize contracts within 6 months of award.
7. Definitize the remaining development and delivery portion of the HALO contract by PDR plus 3 months.
8. Ensure the maturity of system requirements are fully understood before selecting the acquisition method and contract type for future acquisition strategies supporting Artemis and Mars missions by describing the state of the program requirements in the acquisition strategy memorandum for each new acquisition.

We provided a draft of this report to NASA management who concurred with our recommendations and described planned actions to address them. We consider the proposed actions responsive to our recommendations and will close the recommendations upon completion and verification of the actions.

Management's comments are reproduced in Appendix C. Technical comments provided by management and revisions to address them have been incorporated as appropriate.

Major contributors to this report include Ridge Bowman, Space Operations Director; Kevin Fagedes, Project Manager; Susan Bachle; Scott Bruckner; Wayne Emberton; Tyler Martin; Lauren Suls; and Cedric Campbell.

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

Paul K. Martin
Inspector General

APPENDIX A: SCOPE AND METHODOLOGY

We performed this audit from March 2020 through October 2020 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.

This report is one in a series of audits examining NASA's Artemis program to include landing astronauts on the Moon by 2024. In this report, we assessed to what extent the PPE and HALO are meeting schedule, cost, and performance goals. Our review included interviews with officials at NASA Headquarters, Glenn Research Center, Johnson Space Center, Maxar Technologies, and Northrop Grumman.

To determine NASA's current plans for the Gateway and to assess costs for the entire Gateway Program, we reviewed NASA program, schedule, and funding documentation, such as: Gateway Formulation Authorization Document; Program Plan; Acquisition Strategy decision documents; Quarterly Program Manager's Review briefings; architecture briefings; integrated master schedules; cost and obligations data from NASA's accounting system; and NASA budget documentation, to include the FY 2021 President's Budget Request. We reviewed the acquisition method for procuring the Gateway Program elements, to include utilizing commercial contractors or international partners. We also reviewed federal and NASA policies and procedures for types of contracts and program and project management requirements. Further, we conducted interviews with the Director of Human Lunar Exploration Programs; Gateway Program Manager; Gateway Deputy Program Manager; and Gateway Program, Planning, and Control Manager.

To assess whether the PPE is meeting schedule, cost, and performance goals, we reviewed the contract file, cost and budget documentation, quarterly reviews for performance updates, schedule data, and top technical risks. Specifically, for the contract file review we analyzed the PPE base contract and the conformed version, each contract modification and associated negotiation documents, Independent Government Cost Estimates, and Acquisition Strategy decision documents. We conducted interviews with the program management team—PPE Project Manager; Deputy Project Manager; and Program, Planning, and Control lead—and the contract management team—Supervisory Contracting Officer, Contracting Officer, Contracting Officer Representative, and Alternate Contracting Officer Representative. We also conducted interviews with the Maxar contractor team, to include the Program Director, Project Manager, Deputy Project Manager, Director of Contracts, Contracts Administrator, and Finance Director.

To assess whether the HALO is meeting schedule, cost, and performance goals, we reviewed the sole-source documentation, contract file, cost and budget documentation, quarterly reviews for performance updates, schedule data, and top technical risks. Specifically, for the contract file review we analyzed the Justification for Other Than Full and Open Competition, base NextSTEP-2 contract, undefinitized contract modifications, HALO contract, Independent Government Cost Estimates, and Acquisition Strategy decision documents. We conducted interviews with the program management team—HALO Production Manager; Deputy Production Manager; and Program, Planning, and Control lead—and the contract management team—Procurement Manager, Contracting Officer, and Contracting Officer

Representative. We also conducted interviews with the Northrop contractor team, to include the Program Director, Project Manager, and contract lead.

Assessment of Data Reliability

We relied upon computer-generated data as part of performing this audit. We reviewed and analyzed NASA obligation and funding data for FYs 2015 through 2025 in NASA's financial accounting system for the entire Gateway Program; Gateway supporting projects, such as habitation prototypes and spacesuits; and each contract—PPE, HALO, Gateway Logistics Services, and HLS. We assessed the reliability of this financial data by (1) verifying the data with the NASA Office of Inspector General's Advanced Data Analytics Program, (2) reviewing data provided by the Gateway Program and NASA contracting officials for PPE and HALO, and (3) interviewing Agency officials knowledgeable about the data. We determined that the data was sufficiently reliable for the purposes of this report.

Review of Internal Controls

We assessed internal controls and compliance with laws and regulations necessary to satisfy the audit objective. Specifically, we assessed the extent to which NASA's contractors are meeting their schedule, cost, and performance goals for the development of the PPE and HALO for the Gateway, which are identified and discussed previously in this report. However, because our review was limited to these internal control elements and underlying principles, it may not have disclosed all internal control deficiencies that may have existed at the time of this audit. Our recommendations, if implemented, will correct the identified control weaknesses.

Prior Coverage

During the last 6 years, the NASA Office of Inspector General and Government Accountability Office have issued 11 reports of significant relevance to the subject of this report. Unrestricted reports can be accessed at <https://oig.nasa.gov/audits/auditReports.html> and <http://www.gao.gov>, respectively.

NASA Office of Inspector General

NASA's Management of the Orion Multi-Purpose Crew Vehicle Program (IG-20-018, July 16, 2020)

NASA's Development of Ground and Flight Application Software for the Artemis Program (IG-20-014, March 19, 2020)

Audit of NASA's Development of Its Mobile Launchers (IG-20-013, March 17, 2020)

NASA's Management of Space Launch System Program Costs and Contracts (IG-20-012, March 10, 2020)

2019 Report on NASA's Top Management and Performance Challenges (November 13, 2019)

NASA's Plans for Human Exploration Beyond Low Earth Orbit (IG-17-017, April 13, 2017)

NASA's Use of Space Act Agreements (IG-14-020, June 5, 2014)

Government Accountability Office

NASA: Assessments of Major Projects (GAO-20-405, April 2020)

NASA Lunar Programs: Opportunities Exist to Strengthen Analyses and Plans for Moon Landing
(GAO-20-68, December 19, 2019)

NASA Human Space Exploration: Persistent Delays and Cost Growth Reinforce Concerns over Management of Programs (GAO-19-377, June 19, 2019)

High Risk Series: Substantial Efforts Needed to Achieve Greater Progress on High-Risk Areas
(GAO-19-157SP, March 6, 2019)

APPENDIX B: MANAGEMENT OF THE GATEWAY PROGRAM

Discussed below is information on the Gateway Program’s life cycle and the approach NASA is utilizing to streamline program management processes in order to meet the goals of the Artemis mission.

Program Management and Life Cycle of the Gateway

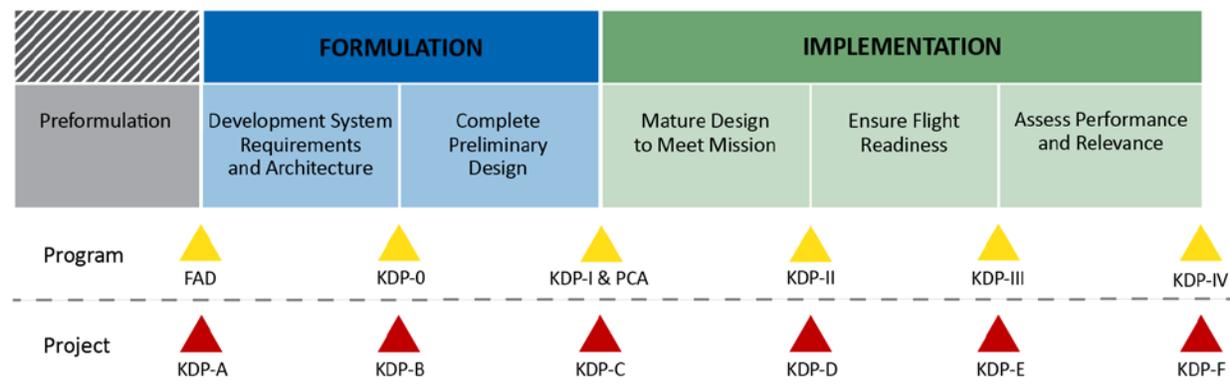
The Gateway Program follows NASA’s program life cycle for tightly coupled programs, which is divided into two main phases—Formulation and Implementation.²⁷ The program life cycle also consists of numerous activities, including preformulation, evaluation, and Key Decision Points (KDP) that allow managers to plan, assess, and review a program’s progress (see Figure 7).²⁸ Preformulation is where program teams develop concept studies to provide information on mission costs, risks, and feasibility. This culminates in a Formulation Authorization Document, which is issued by the Mission Directorate Associate Administrator, authorizes the formulation of a program, and sets program expectations for activities in the Formulation Phase. NASA approved the Gateway Program’s Formulation Authorization Document in April 2019. During the Formulation Phase, the program identifies how its mission supports NASA’s strategic goals and develops technological and preliminary project designs. KDP-0 also occurs during the Formulation Phase, at which point the program proves that it addresses critical NASA needs and associated projects are feasible. Once all required activities are completed, the program is approved for implementation at KDP-I with a Program Commitment Agreement (PCA) and transitions into the Implementation Phase.²⁹ As of August 2020, Gateway Program officials anticipate KDP-0 will occur in October 2020 and KDP-I in October 2021. The Implementation Phase is where mission development and operation program plans are executed and control systems are used to ensure they align with NASA’s strategic goals. During the later stages of the Implementation Phase, a program’s executed performance against expectations and strategic relevance to NASA is continually evaluated.

²⁷ Tightly coupled programs are programs with multiple projects that execute portions of a mission, where no single project is capable of implementing a complete mission. Individual projects may be managed at different NASA Centers, and the program may include contributions from other agencies or international partners.

²⁸ NASA Procedural Requirements 7120.5E, *NASA Space Flight Program and Project Management Requirements (Updated w/Change 18)* (August 14, 2012). A KDP is defined as the point in time when the Decision Authority—the responsible official who provides approval—makes a decision on the readiness of the program or project to progress to the next life-cycle phase. KDPs serve as checkpoints or gates through which programs and projects must pass during their development.

²⁹ A PCA is an agreement between the Mission Directorate Associate Administrator and the Decision Authority that authorizes program transition from Formulation to Implementation. The PCA documents program objectives, management and technical approach and associated architecture, technical performance, schedule, time-phased cost plans, safety and risk factors, internal and external agreements, life-cycle reviews, and all attendant top-level program requirements.

Figure 7: NASA Program Life Cycle (Tightly Coupled Program) with Program and Project Milestones



Source: NASA Procedural Requirements 7120.5E, *NASA Space Flight Program and Project Management Requirements (Updated w/Change 18)* (August 14, 2012).

Note: FAD is Formulation Authorization Document and PCA is Program Commitment Agreement.

Gateway Program Tailoring Certain Requirements

NASA is utilizing a tailored approach for the Gateway Program to streamline typical program management processes, to include reducing organizational overhead and meeting Artemis schedule goals. NASA policy for program and project management dictates certain requirements for oversight, life-cycle reviews, and other programmatic matters, while also providing the flexibility to adjust those requirements to fit the unique needs of a program or project. NASA has tailored requirements for several other programs, including the SLS, Orion, and Commercial Crew Programs. Major elements of the Gateway—such as PPE and HALO—serve as individual projects, each managed separately and with its own requirements.

Major adjustments include maintaining Agency Baseline Commitments (ABC) at the project level only and consolidating Standing Review Boards (SRB) to a single SRB at the program level.³⁰ NASA policy requires all tightly coupled programs and projects to document their life-cycle cost in an ABC at KDP-I and KDP-C, respectively.³¹ The Gateway Program is tailoring this requirement and is instead maintaining ABCs at the project level only and completing a PCA at the program level. Another tailored programmatic requirement identified by program officials is the number of SRBs. In lieu of standard NASA guidance that requires individual SRBs at the program and project level, the Gateway Program formed a single review board that covers both the program and all projects that fall under it. The NASA Associate Administrator approved these tailored requirements on August 20, 2019.

³⁰ An ABC establishes and documents an integrated set of project requirements, cost, schedule, technical content, and an agreed to Joint Cost and Schedule Confidence Level that forms the basis for NASA's commitment to the Office of Management and Budget and Congress. A SRB is an independent advisory board chartered to assess programs and projects at specific points in their life cycle and provide a credible, objective assessment of how the program is progressing against the baseline and offers recommendations to improve performance or reduce risk.

³¹ NASA projects must pass through KDP-C, including a final assessment of the preliminary design and a determination of whether the project is sufficiently mature, to receive management approval to proceed to the start of implementation. As part of the KDP-C review process, cost and schedule baselines are established against which the project is thereafter measured.

APPENDIX C: MANAGEMENT'S COMMENTS

National Aeronautics and
Space Administration

Headquarters
Washington, DC 20546-0001



November 9, 2020

Human Exploration and Operations Mission Directorate

TO: Assistant Inspector General for Audits

FROM: Associate Administrator for Human Exploration and Operations

SUBJECT: Agency Response to OIG Draft Report "NASA's Management of the Gateway Program for Artemis Missions" (A-20-008-00)

The National Aeronautics and Space Administration (NASA) appreciates the opportunity to review and comment on the Office of Inspector General (OIG) draft report entitled, "NASA's Management of the Gateway Program for the Artemis Missions" (A-20-008-00), dated October 1, 2020.

NASA remains committed to executing an efficient and effective Gateway Program as part of the Artemis Program. NASA appreciates the thoroughness of the OIG review. Implementing the associated recommendations will strengthen NASA's ability to plan and implement the complex missions that the Agency is undertaking while enhancing transparency.

In the draft report, the OIG makes eight recommendations addressed to NASA intended to increase the efficiency and effectiveness of NASA's Gateway Program.

Specifically, the OIG recommends the following:

Recommendation 1: Baseline the Gateway requirements and specifications in contract modifications prior to updating and awarding the PPE and HALO fixed-price contracts.

Management's Response: Concur. Major interface changes between the Power and Propulsion Element (PPE) and Habitation and Logistics Outpost (HALO) have been incorporated. Gaps in necessary functional requirements have been addressed. Top level, element level, system, and subsystem specifications have been updated and approved. Contractual modifications are underway for the PPE fixed-price contract, and the HALO will enter into a fixed-price contract following its Preliminary Design Review (PDR).

Estimated Completion Date: Spring 2021 timeframe (June 30, 2021).

Recommendation 2: Ensure PPE and HALO delivery and launch dates are realistic by including sufficient schedule margin in their development schedules.

Management's Response: Concur. Aggressive schedules have been laid out for the PPE and HALO elements to meet an early 2024 launch date. The Gateway Program will conduct probabilistic schedule risk analyses to help determine adequate schedule reserve based on the program's assessment of risk. Schedule margin opportunities are actively being worked for individual system component deliveries for each element and during the integrated buildup and test for the PPE and HALO. Schedule threats are actively managed with mitigation plans. Milestone payments are being aligned with scheduled completion of major tasks.

Estimated Completion Date: The baseline development schedules for PPE and HALO will be determined at Key Decision Point-C (KDP-C), for both projects, estimated to be conducted in September 2021.

Recommendation 3: Develop a HEOMD policy that establishes a reasonable amount of recommended schedule margin by phase of program or project.

Management's Response: NASA concurs. The Human Exploration and Operations Mission Directorate (HEOMD) will ensure that programs follow Agency requirements, outlined in NPR 7120.5E, NASA Space Flight Program and Project Management Requirements, according to life-cycle phases and that programs follow best practices described in the NASA Schedule Management Handbook, when practicable, as there are instances when external programmatic guidance is provided. The Gateway Program will conduct probabilistic schedule risk analyses to help determine adequate schedule reserve based on the program's assessment of risk and will be subject to evaluation by the HEOMD Associate Administrator.

Estimated Completion Date: Spring 2021 (June 30, 2021).

Recommendation 4: Confirm at selection the launch system provider for the co-manifested PPE and HALO will meet spacecraft mass, length, and other requirements.

Management's Response: Concur. The specifications in the launch system Request for Proposal (RFP) reflected interface and environment requirements (which includes mass, length, and other requirements) for the PPE/HALO integrated spacecraft.

Estimated Completion Date: Complete. The RFP released, on June 18, 2020, is structured to assure confirmation of this recommendation upon selection.

Recommendation 5: Work with the contractors to obtain a credit for the amount already spent on launch services under the PPE contract.

Management's Response: Concur with intent. NASA is currently negotiating the contractual modifications with Maxar that removes the launch service. However, NASA notes that under the Federal Acquisition Regulation (FAR), the Agency would not be requesting a credit but would seek to recover the maximum value during these negotiations.

Estimated Completion Date: Spring 2021 timeframe (June 30, 2021).

Recommendation 6: Take action to enforce NASA policy to definitize contracts within 6 months of award.

Management's Response: NASA concurs. HEOMD will work diligently with NASA Headquarters Office of Procurement (OP) and Center Procurement Offices to establish and maintain contract definitization schedules. HEOMD has established a 90-day contract procurement tracker to monitor major ongoing procurement actions to include contract definitization timeline and coordinate statuses with NASA Programs and Center Offices of Procurement. Contract Procurement Statuses are also reported as part of Directorate Program Management Council briefs on a quarterly basis. Prolonged definitization schedules will require explanation and resolution plans. OP also monitors the number and age of open undefinitized contract actions (UCAs) in the Agency as part of Baseline Performance Review. All UCAs over \$100K must be approved by the Head of Contracting Authority.

Estimated Completion Date: Spring 2021 (June 30, 2021).

Recommendation 7: Definitize the remaining development and delivery portion of the HALO contract by PDR plus 3 months.

Management's Response: Concur. NASA plans to enter into a fixed price, milestone-driven contract for the development and delivery of the HALO module following the successful completion of PDR in the spring 2021 timeframe.

Estimated Completion Date: Summer 2021 timeframe (June 30, 2021).

Recommendation 8: Ensure the maturity of system requirements are fully understood before selecting the acquisition method and contract type for future acquisition strategies supporting Artemis and Mars missions by describing the state of the program requirements in the acquisition strategy memorandum for each new acquisition.

Management's Response: NASA concurs. HEOMD will follow NASA acquisition policy guidance and the NASA FAR Supplement, including the requirements basis as a part of the acquisition and procurement packages for approval. HEOMD will ensure that the procurement strategy memoranda capture the decisions and the state of the program requirements for each new acquisition.

Estimated Completion Date: Spring 2021 (June 30, 2021).

We have reviewed the draft report for information that should not be publicly released. As a result of this review, we have not identified any information that should not be publicly released.

Once again, thank you for the opportunity to review and comment on the subject draft report. If you have any questions or require additional information regarding this response, please contact Kelly O'Rourke at kelly.e.o'rourke@nasa.gov or 202.358.1635.

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Kathryn L. Lueders

APPENDIX D: REPORT DISTRIBUTION

National Aeronautics and Space Administration

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Deputy Administrator
Associate Administrator
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Assistant Administrator for Procurement
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Non-NASA Organizations and Individuals

Office of Management and Budget
 Deputy Associate Director, Energy and Space Programs Division
Government Accountability Office
 Director, Contracting and National Security Acquisitions

Congressional Committees and Subcommittees, Chairman and Ranking Member

Senate Committee on Appropriations
 Subcommittee on Commerce, Justice, Science, and Related Agencies
Senate Committee on Commerce, Science, and Transportation
 Subcommittee on Aviation and Space
Senate Committee on Homeland Security and Governmental Affairs
House Committee on Appropriations
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House Committee on Oversight and Reform
 Subcommittee on Government Operations
House Committee on Science, Space, and Technology
 Subcommittee on Investigations and Oversight
 Subcommittee on Space and Aeronautics

(Assignment No. A-20-008-00)