NASA OFFICE OF INSPECTOR GENERAL

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The Honorable Richard Shelby
Chairman
Committee on Appropriations
United States Senate
Washington, DC 20510

The Honorable Patrick Leahy
Vice Chairman
Committee on Appropriations
United States Senate
Washington, DC 20510

The Honorable Jerry Moran
Chairman
Subcommittee on Commerce, Justice, Science, and Related Agencies
Committee on Appropriations
United States Senate
Washington, DC 20510

The Honorable Jeanne Shaheen
Ranking Member
Subcommittee on Commerce, Justice, Science, and Related Agencies
Committee on Appropriations
United States Senate
Washington, DC 20510

The Inspector General Act directs Offices of Inspector General (OIG) to review existing and proposed legislation relating to programs and operations at their agencies.[1] In addition, the Act requires OIGs to make recommendations to promote economy, efficiency, and effectiveness in the administration of an agency's programs and operations and keep Congress informed of the agency's progress in taking corrective actions based on those recommendations.[2]

In response to these two directives, we write to highlight an issue at NASA that we believe requires immediate action by Congress. Language in NASA's appropriation legislation requires the Agency to launch a satellite to Europa, a moon of Jupiter, in 2023 on the yet-to-be-completed Space Launch System (SLS) rocket.[3] However, because of developmental delays and, more significantly, NASA's plans to use the first three SLS rockets produced for its Artemis lunar program, an SLS will not be available until 2025 at the earliest. Consequently, if completed on its projected schedule, the approximately

[1] The Inspector General Act of 1978, as amended, 5 U.S.C. App. § 4 (a)(2) and (5).

[2] 5 U.S.C. App. § 2 (2) and (3).

[3] The SLS is a two-stage, heavy lift rocket that together with the Orion Multi-Purpose Crew Vehicle (Orion) will serve as the space flight system for NASA's lunar and Mars missions.

$3 billion dollar Europa spacecraft (known as "Europa Clipper") will need to be stored for at least 2 years at a cost of $3 to $5 million per month until an SLS becomes available. NASA recently added $250 million in Headquarters-held reserves to the project to address these storage and related personnel costs.

Congress could reduce risks to both the Europa mission and Artemis program while potentially saving taxpayers up to $1 billion by providing NASA the flexibility in forthcoming fiscal year (FY) 2020 appropriations legislation to determine the most cost effective and timely vehicle to launch the Europa Clipper mission in 2023 or whenever the satellite is completed.[4]

BACKGROUND

In 2011, the National Research Council (NRC) determined that an orbiter mission to Europa, one of Jupiter's 79 known moons, to confirm the presence of an interior ocean that could be suitable to sustain life should be NASA's second highest priority large-scale planetary science mission for the next decade.[5] Congress has taken a strong interest in the project and since FY 2013 has appropriated more than $2.04 billion for a Europa mission.

In addition to funding the Europa mission, Congress also added specific mission mandates over the years. In FY 2016, Congress directed NASA to launch the Europa orbiter in 2022 using the SLS.[6] The following year, Congress added a separate Europa Lander mission with a launch deadline of 2024 and directed NASA to use the SLS for both missions.[7] Most recently, in FY 2019 Congress delayed the launch dates for both missions by a year, stating in NASA's appropriations bill:

> $545,000,000 is for an orbiter and $195,000,000 is for a lander to meet the science goals for the Jupiter Europa mission as recommended in previous Planetary Science Decadal surveys: Provided further, that the National Aeronautics and Space Administration shall use the Space Launch System as the launch vehicles for the Jupiter Europa missions, plan for an orbiter launch no later than 2023 and a lander launch no later than 2025, and include in the fiscal year 2020 budget the 5-year funding profile necessary to achieve these goals.[8]

NASA's Management of the Europa Mission

In May 2019, we reported that despite robust early-stage funding a series of significant developmental and personnel resource challenges place the Clipper's current mission cost estimates and mandated 2023 target launch at risk.[9] In particular, we found the Clipper's initial cost estimate for its nine instruments increased 52 percent from May 2015 ($325 million) to June 2016 ($493 million). In our opinion, this significant cost increase was primarily due to overly optimistic cost and schedule estimates from the entities proposing the instruments and NASA's failure to sufficiently evaluate the

[4] This total includes the $250 million in Headquarters-held reserves and the NASA-estimated $700 million cost difference between an SLS and a commercial launch vehicle.

[5] NRC, *Vision and Voyages for Planetary Science in the Decade 2013-2022* (2011). The NRC's top priority was a robotic mission to Mars, known as the Mars 2020 rover mission, which is scheduled to launch in July or August 2020 to seek signs of past microbial life.

[6] Consolidated Appropriations Act, 2016, Pub. L. No. 114-113 (2015).

[7] Consolidated Appropriations Act, 2017, Pub. L. No. 115-31 (2017).

[8] Consolidated Appropriations Act, 2019, Pub. L. No. 116-6 (2019).

[9] NASA OIG, *Management of NASA's Europa Mission* (IG-19-019, May 29, 2019).

reasonableness of those estimates. NASA is addressing this issue by developing a framework to monitor individual instrument cost and schedule deviations, analyzing the impact various instrument combinations may have on the mission's science requirements, and evaluating the impact of de-scoping specific instruments. For example, in March 2019 the Associate Administrator for the Science Mission Directorate terminated development of an instrument designed to help determine the location, thickness, and salinity of Europa's subsurface ocean because it was exceeding its cost and schedule estimates. In its place, project managers are working to develop a less complex instrument that could still accomplish many of the same science goals.

We also found Clipper is competing for critical personnel with at least four other major projects managed by the Jet Propulsion Laboratory (JPL), resulting in the project operating below planned staffing levels and causing concern that the project may not have a sufficient workforce with the required skills at critical periods in its development cycle. This is a continuing challenge that both the OIG and Government Accountability Office (GAO) have reported on in the past.[10] However, since the release of our May 2019 report, Clipper's workforce has started to reach planned levels and the situation should improve as Mars 2020 development comes to fruition and technical personnel from that project become available. Nonetheless, in August 2019 the Clipper Standing Review Board (SRB) commented on the aggressive schedule required to achieve a 2023 launch and expressed a concern over workforce burn-out due to the need to make up for the lag in previous schedule performance.[11]

Lastly, we reported in May 2019 that although Congress directed NASA to launch the Clipper using an SLS, we found the rocket unlikely to be available by the mandated 2023 launch date. Consequently, NASA continued to maintain spacecraft capabilities to accommodate both the SLS and two potential commercial launch vehicles, the Delta IV Heavy and Falcon Heavy. The Agency also had not incorporated associated development and launch vehicle risks into the Clipper's joint cost and schedule confidence level (JCL) analysis—a tool NASA requires for projects costing $250 million or more used at Key Decision Point C (KDP-C) to help determine the likelihood a project will achieve its objectives within budget and on time—thereby prolonging risks that should be resolved prior to establishing the project's cost and schedule baseline.[12]

[10] In NASA OIG's audit, *NASA's Surface Water and Ocean Topography Mission* (IG-18-011, January 17, 2018), we reported that the mission's complex technical issues were exacerbated by the challenge of maintaining sufficient qualified staff. GAO similarly found in its report, *NASA: Assessments of Major Projects* (GAO-18-280SP, May 1, 2018), that three JPL managed projects—Europa Clipper, Mars 2020, and Surface Water and Ocean Topography—have encountered workforce challenges.

[11] The SRB is an independent advisory board chartered to assess programs and projects at specific points in their life cycle and provide the program, Decision Authority, and other senior management with a credible, objective assessment of how the program is progressing relative to Agency criteria and expectations. Composed of independent experts, the SRB provides assessments of the project's technical and programmatic approach, risk posture, and progress against the project baseline and offers recommendations to improve performance or reduce risk.

[12] KDP-C is the point in time when the Decision Authority—the responsible official who provides approval, which in this case is the NASA Associate Administrator—makes a final assessment of the preliminary design and a determination of whether the project is sufficiently mature to begin final design and fabrication. As part of the KDP-C review process, cost and schedule baselines—Management Agreement and Agency Baseline Commitment—are established against which the project is thereafter measured. The Management Agreement is regarded as a contract between the Agency and project manager and provides the parameters over which the project manager is accountable. The Agency Baseline Commitment contains the cost and schedule parameters NASA submits to the Office of Management and Budget and Congress.

NASA's Artemis Program Requires SLS

NASA's development of the SLS is integral to the Agency's efforts to pursue human exploration beyond low Earth orbit, with the rocket program representing the Agency's largest effort to develop space flight capabilities since launch of the first Space Shuttle in 1981. In October 2018, we reported that poor contractor performance by The Boeing Company and contract management practices by NASA have contributed to significant SLS cost and schedule overruns, which could impact both the Agency's planned human exploration missions and Europa Clipper target launch dates.[13]

In March 2019, the Vice President stated that the Administration was committed to landing humans on the Moon by 2024, 4 years sooner than planned in the President's FY 2020 budget request. In May 2019, NASA submitted a budget amendment requesting an additional $1.6 billion above the President's $21 billion FY 2020 request primarily for the Agency to accelerate development of a human lunar landing system and bolster development of the SLS and Orion for the lunar program known as Artemis.

In June 2019, NASA's Administrator said the Agency would need $20 to $30 billion in addition to current Agency appropriations over the next 5 years—an average of an additional $4 to $6 billion per year—to put the first woman and next man on the Moon by 2024. NASA's plan to accomplish this goal requires use of the first three SLS rockets. Artemis 1, which was planned to launch in 2020 but will likely be delayed until 2021, is designed as an uncrewed test flight of the integrated SLS and Orion spacecraft system to orbit the Moon. Planned to launch in the 2023 timeframe, Artemis 2 will be the first crewed flight of the SLS-Orion system. Finally, in 2024 NASA plans to launch Artemis 3 and return U.S. astronauts to the surface of the Moon.

EUROPA CLIPPER SLS MANDATE AND LAUNCH VEHICLE OPTIONS

In our May 2019 audit, we noted that although Congress mandated NASA use the SLS for the Clipper mission, up to that point the Agency had not formally selected the launch vehicle and that maintaining both SLS and commercial vehicle options created additional risks and uncertainties for an already challenging project. We also pointed out that the JCL conducted for the Clipper mission did not provide a reliable assessment of project cost and schedule because it did not include launch vehicle options and their associated risks. Although NASA did not concur with our recommendation to reassess the JCL with SLS and commercial launch vehicle risks prior to KDP-C and establishing the Agency Baseline Commitment, the Agency subsequently conducted such an analysis that showed that a commercial launch vehicle may be a better cost and schedule option than the SLS. However, due to the congressional directive, in August 2019 the Agency decided it was unable to select a commercial launch vehicle and instead established the Agency Baseline Commitment for the Europa Clipper mission based on a 2025 launch date using an SLS. In doing so, the Agency's senior leadership allocated $250 million in Headquarters-held reserve to cover storage, personnel, and other associated launch delay costs.

Our May 2019 report highlighted three main differences between launching the Europa mission on an SLS versus a commercial rocket: cost, transit time to Europa, and availability for a 2023 launch. The SLS is the most expensive launch vehicle option by a factor of three. In fact, the JCL analysis conducted by

[13] NASA OIG, *NASA's Management of the Space Launch System Stages Contract* (IG-19-001, October 10, 2018).

the SRB for Clipper showed the SLS would cost about $700 million more than a commercial vehicle option. Off-setting a small part of the higher cost is the fact that the SLS is powerful enough to carry Clipper directly to Europa in about 2.4 years whereas a commercial vehicle will need to use a planetary gravity assist trajectory for a transit time of at least 5.9 years.[14]

The 2019 JCL analysis performed by the SRB showed that Clipper is unlikely to be ready for a 2023 launch on the SLS. Given the alignment of Earth and Jupiter systems, the window of opportunity for an SLS launch in 2023 on a direct trajectory runs from July 4 through 26. Further, SLS development delays and commitment of at least the first three rockets to the Artemis program will result in unavailability of an SLS for a Clipper launch until at least 2025 and possibly later. Consequently, in August 2019 senior NASA officials approved a Management Agreement to complete development of Clipper with a launch readiness date of 2023, and established an Agency Baseline Commitment launch date in 2025 that requires the spacecraft be placed in storage until an SLS becomes available at an estimated cost of $3 to $5 million per month.[15]

The SRB's JCL analysis also showed Clipper more likely to be ready for a commercial vehicle launch opportunity in November 2023 (November 8 through 23) than the July 2023 SLS launch window. At the present time, two commercial options appear possible: a Delta IV Heavy, a rocket with a 12-year history of successful launches, and the Falcon Heavy, which in June 2019 successfully flew for a third time thereby meeting NASA's minimum requirements to be considered for the Europa mission.[16] However, given the lead time required, the Agency must begin the procurement process in the next few months if it is to ensure delivery of a commercial launch vehicle for a potential Clipper launch in late 2023.

CONCLUSION

NASA's renewed focus on returning humans to the Moon on an accelerated timetable means that an SLS will not be available to launch the Clipper mission to Europa before 2025 at the earliest.

Given all of the foregoing factors, we urge Congress to consider removing the requirement that NASA launch the Europa Clipper on an SLS and allow the Agency to decide whether to use an SLS or a commercial vehicle based on cost, schedule, vehicle availability, and impact on science requirements.

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[14] A gravity assist trajectory, also called a "slingshot" path, uses the gravity of a planet or other astronomical object to alter the path and speed of a spacecraft, thereby enabling a less powerful launch vehicle such as the Delta IV Heavy or Falcon Heavy to carry the same amount of mass to Europa as the SLS. As of August 2019, the Agency was still confirming the fidelity of calculations that showed the first iteration of the SLS could, in fact, fly Clipper on a direct trajectory to Europa compared to the next, more powerful version of the SLS that Clipper was originally slated to use. NASA is also evaluating whether a "kick-stage" on the Falcon Heavy could shorten the flight time to Europa compared to a baseline Falcon Heavy or Delta IV Heavy.

[15] The SRB provided the estimated monthly storage costs at KDP-C based on past science missions; specifically, estimates of $10 to $12 million per month to store the Geostationary Operational Environmental Satellites and $3 to $5 million per month for the Joint Polar Satellite System satellites. The SRB settled on the lower range and stated the figure would need to be recalculated in the future.

[16] NASA Policy Directive 8610.7D, *Launch Services Risk Mitigation Policy for NASA-Owned and/or NASA-Sponsored Payloads/Missions—Revalidated w/Change 2* (January 31, 2008) describes the launch vehicle certification, which includes three successful flights with at least two of those being consecutive without failure, of a common launch vehicle configuration and completion of extensive NASA technical evaluation, audits, and evaluation of vehicle documentation.

Please contact us if you have any questions about this letter.

Sincerely,

Paul K. Martin
Inspector General

cc: James Bridenstine
Administrator

Jim Morhard
Deputy Administrator

Steve Jurczyk
Associate Administrator

Kenneth Bowersox
Acting Associate Administrator for Human Exploration and Operations Mission Directorate

Thomas Zurbuchen
Associate Administrator for Science Mission Directorate

Identical Letter To:

The Honorable Roger Wicker
United States Senate

The Honorable Maria Cantwell
United States Senate

The Honorable Ted Cruz
United States Senate

The Honorable Krysten Sinema
United States Senate

The Honorable Nina Lowey
U.S. House of Representatives

The Honorable Kay Granger
U.S. House of Representatives

The Honorable José Serrano
U.S. House of Representatives

The Honorable Robert Aderholt
U.S. House of Representatives

The Honorable Eddie Bernice Johnson
U.S. House of Representatives

The Honorable Frank Lucas
U.S. House of Representatives

The Honorable Kendra Horn
U.S. House of Representatives

The Honorable Brian Babin
U.S. House of Representatives