Report
regarding
NASA Human Landing System Program

pursuant to

Explanatory Statement
accompanying
FY 2022 Consolidated Appropriations Act (P.L. 117-103)

April 2022

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The Explanatory Statement accompanying the FY 2022 Consolidated Appropriations Act (P.L. 117-103) includes the following direction for NASA:

> *Human Landing System (HLS)* -The agreement provides not less than $1,195,000,000 for HLS, including no less than the requested amount for the Lunar Lander office. With these funds, in addition to enabling a human landing during the Artemis III mission, NASA is expected to make real investments in development that promote competition for the sustainable lander phase rather than additional studies. The agreement urges NASA to enable a routine cadence of human transportation services to and from the Moon with multiple providers, as practicable. Within 30 days of enactment of this Act, NASA is directed to deliver a publicly available plan explaining how it will ensure safety, redundancy, sustainability, and competition in the HLS program within the resources provided by this Act and included in the fiscal year 2023 budget request.

In response to this direction included in the Explanatory Statement accompanying the FY 2022 Consolidated Appropriations Act (P.L. 117-103), the following report constitutes NASA's plan regarding how the Human Landing System (HLS) program will ensure the above-described goals within the resources provided by P.L. 117-103.

Introduction

The United States is going back to the Moon, and NASA recognizes the need to achieve this monumental feat by fostering the commercial development of expertise and technologies required for safe, sustainable, and human-rated landing systems. NASA's HLS program will use a combination of management and acquisition approaches to reach the Nation's goal of sustainable lunar exploration this decade and beyond.

NASA appreciates the continued support of the Committees on Appropriations as demonstrated by the full funding of NASA's FY 2022 requested budget for the HLS program in P.L. 117-103. In recognition of Committee recommendations, NASA has continued to evolve and refine its HLS program planning to achieve safety, redundancy, sustainability, and competition.

With prior-year appropriations for HLS, NASA has made significant progress toward enabling a human landing system for the Artemis III mission. Despite the challenges presented by the COVID-19 pandemic, the HLS program has nonetheless accomplished all planned work and milestones, including major reviews of Design and Construction Standards and the Certification Baseline Review for the Artemis III lander. Additionally, NASA has established formal organization (control boards, internal/external working groups) and management standards (and associated formal documentation) that will enhance planning and control for the Artemis III mission.

NASA awarded a contract for the full development of an initial lander capability to SpaceX in April 2021 (Appendix H, Option A of the NextSTEP-2 Broad Agency Announcement (BAA)). Following lengthy delays caused by unsuccessful bid protests of this award, work resumed in late 2021, and this provider has successfully achieved initial requirements for scheduled milestone payment(s). The objective of Option A is to facilitate the rapid development and demonstration of a U.S. landing system that will deliver the first American crew to the surface of the Moon in more than 50 years. The Option A contract scope of work includes both an uncrewed and crewed lunar landing demonstration. The uncrewed demonstration will prove out landing capabilities prior to the crewed mission with astronauts. During the Artemis III mission, the HLS will first dock with Orion in lunar orbit to receive the crew, after which it will safely descend to the lunar surface with two astronauts for approximately a six day stay. During this time, the crew will perform lunar surface extra-vehicular activity, conduct science objectives, and collect materials from the surface. The HLS will then ascend from the surface to lunar orbit for rendezvous and docking with Orion. Figure 1 illustrates the Artemis III mission Concept of Operations.

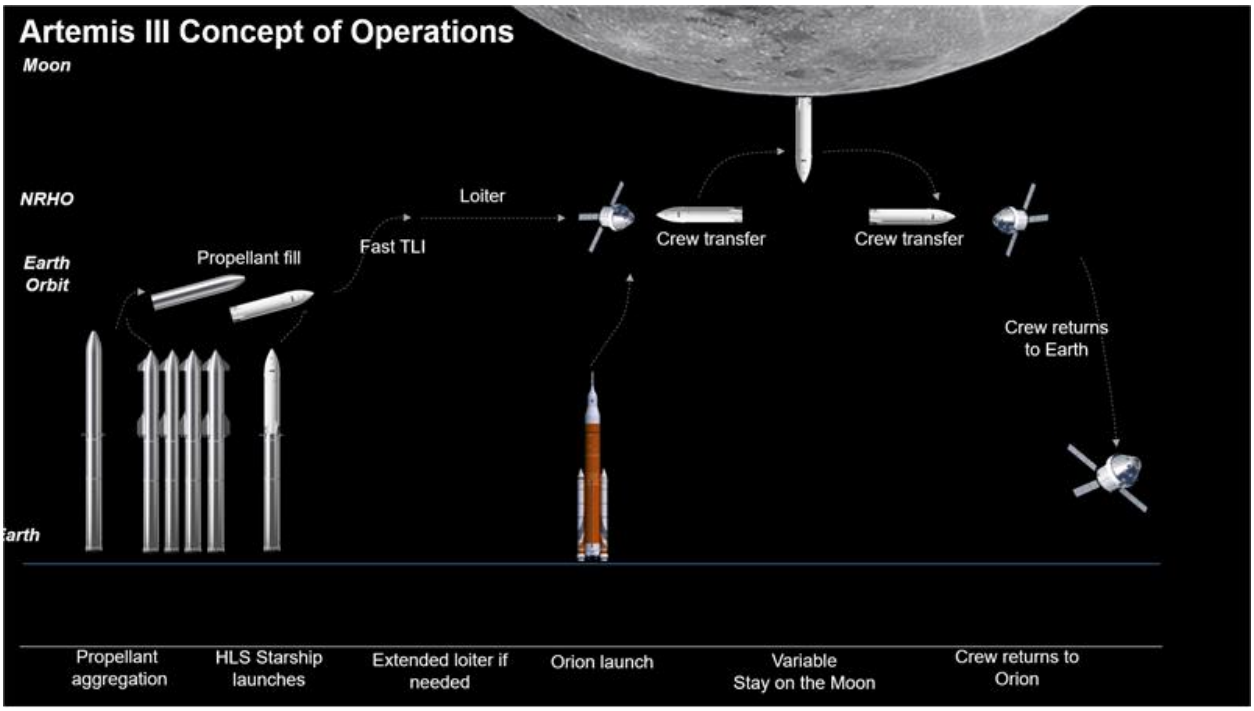

Figure 1 – Artemis III Concept of Operations

Subsequent to the Option A contract award, NASA further developed its requirements for a sustainable HLS capability and engaged with multiple additional providers from the U.S. aerospace industrial base. Through the "Appendix N" contract awards made in September 2021, five providers have worked with NASA to mature system concepts and achieve risk reduction. This provider input, along with NASA's own continued evolution of its HLS requirements, has resulted in a highly-refined set of sustaining lander requirements, including increased crew size,

increased lunar descent and ascent mass, and longer stays on the lunar surface with additional EVA capability.

Updated HLS Acquisition Strategy

On March 23, 2022, NASA announced an update to the next phase of its HLS acquisition strategy, separating sustaining lander development and demonstration from regularly recurring transportation services. This strategy provides maximum support for competition and empowers NASA to expedite award(s) for sustaining lander development. Under this approach, NASA will utilize the flexibilities built into SpaceX's Appendix H, Option A contract to solicit for a proposal from SpaceX to add the "Option B" scope of work; Option B calls for SpaceX to evolve the Artemis III Starship design into a lander that fully meets NASA's sustainable lander requirements. In addition, NASA will seek proposals from non-SpaceX industry providers for a separate, near-term competition for sustainable lander development and demonstration. These parallel paths will support redundancy and competition, and bolster industry readiness prior to NASA's future competition for the Sustaining Lunar Transport (SLT) services contract.

On March 31, 2022, NASA took an important step in executing this revised acquisition strategy by releasing a draft solicitation for its sustainable lander development and demonstration competition (Appendix P of the NextSTEP-2 BAA, hereafter referred to as the HLS Sustaining Lunar Development (SLD) procurement). Within this draft solicitation, NASA provided sustainable requirements for companies other than SpaceX interested in developing and demonstrating astronaut Moon landers. The provider awarded an SLD contract will be required to perform one uncrewed and one crewed demonstration landing. NASA will certify all sustainable landers prior to any crewed demonstration missions, ensuring astronaut safety and mission success. Combined, the SLD contract and SpaceX's Appendix H contract will facilitate multiple providers competing for NASA's future SLT contract.

Below, Figure 2 illustrates the current HLS acquisition approach, including: the SpaceX initial (Option A) and sustaining (Option B) capability demonstrations through the current Appendix H contract; the new competitive SLD procurement open to all potential providers other than SpaceX; and finally, the future SLT procurement for sustaining transportation services.

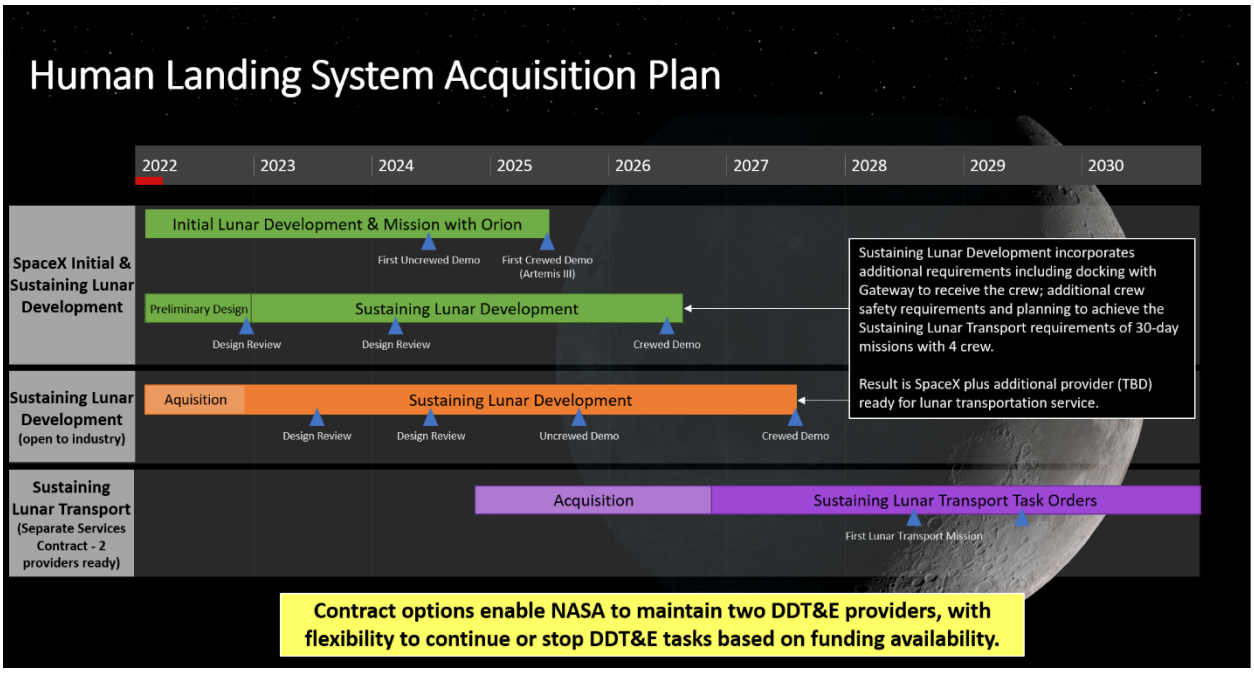

Figure 2 – Human Landing System Acquisition Plan

Together, these concurrent sustaining lander development efforts provide NASA with redundancy during the critical design and development phase. This development will enhance initial lander capabilities with features such as the ability to dock with Gateway for crew transfer, an increased crew size, increased mass to and from the lunar surface, additional extra-vehicular activity, and longer surface stays. The vehicles developed via Appendix H Option B and the SLD procurement will provide more capability than the vehicle developed via Option A, and collectively these procurements allow for the necessary testing of systems and processes before sustained lunar transportation efforts begin.

Pending the successful award of both Option B and an SLD contract within the funds provided in NASA's FY 2023 budget request, NASA's updated approach to sustainable lander development efforts will result in additional flights to prove and demonstrate sustainable lander capabilities, with one crewed mission for SpaceX and both uncrewed and crewed missions for the SLD provider. The FY 2023 budget request includes sufficient funds to execute the work scope in FY 2023; outyear budgets will be informed by the firm fixed prices awarded by NASA for these sustainable development efforts. To maintain programmatic and budget flexibility, NASA plans to utilize contract option periods for fiscal years beyond FY 2023.

NASA has established an ambitious sustainable lander development schedule that precedes the SLT competition, with a goal of executing one demonstration mission per year following the initial Option A crewed landing under Artemis III. This cadence provides the Artemis campaign with valuable redundancy in sustaining capability readiness during the development phase and enables at least two providers, if successful, to compete for long-term sustaining services. Figure 3, below, depicts the planned HLS demonstration missions.

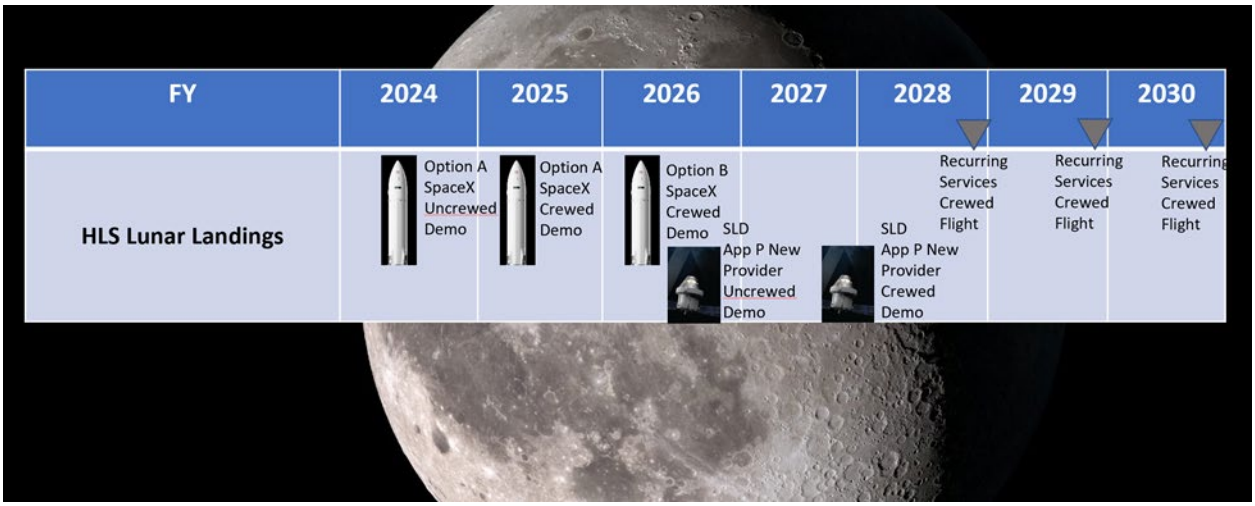

Figure 3 – HLS Lunar Landing Demonstration Mission Plan

Safety is a primary NASA value – a cornerstone in our culture – and a prominent priority in every assessment and decision made in program management. The HLS acquisition approach described above demonstrates a commitment to safety by supporting multiple providers and associated redundancy for the lunar campaign development phase, in addition to requiring an uncrewed demonstration of all human landing systems prior to the spacecraft performing crewed missions. Furthermore, NASA's initial Artemis III lander, the evolution of this lander under Option B, and any lander developed under the SLD contract will all undergo extensive safety requirement reviews and adjudication processes overseen by NASA. NASA's sustaining HLS requirements were also developed with significant input from NASA's safety and crew organizational disciplines, including new and updated Health and Medical requirements to ensure the campaign is safe for the crew commensurate with the additional requirements and Artemis campaign elements. The HLS development approach further demonstrates NASA's commitment to safety first by ensuring up-front requirements are well understood by the providers. By enabling the development of at least two sustainable lander capabilities, NASA is empowered to ensure that safety is a priority in its future selection of one or more SLT services providers.

The Committees on Appropriations have emphasized the importance of robust competition within the HLS program. This updated acquisition strategy for the next phase of the HLS program robustly supports multiple providers' development of unique sustaining human landing systems. These providers will then be capable of competing to provide crewed missions for NASA under a future SLT procurement. The envisioned result will enable a routine cadence of human transportation services to and from the Moon with multiple providers ready to compete for services.

Budget

The President's FY 2023 Budget Request for the NASA HLS program (released March 28, 2022) is shown in Figure 4. Supporting information for HLS is provided in NASA's FY 2023 Congressional Justification (found on: https://www.nasa.gov/budget pgs. 102-106).

HLS $M	FY23	FY24	FY25	FY26	FY27	FY23-FY27
FY23 PBR	1,486	1,864	2,246	2,168	2,538	10,302

Figure 4

In the FY 2023 President's Budget Request, NASA has requested $1.486B for the Human Landing System program, which will support development of the Artemis III SpaceX Starship lunar lander and the initial implementation of NASA's updated acquisition strategy for sustainable lunar lander development and demonstration. Outyear budgets will be informed by the firm fixed prices awarded by NASA for these sustainable development efforts. To maintain programmatic and budget flexibility, NASA plans to utilize contract option periods for fiscal years beyond FY 2023.

Management

NASA is confident that the Agency's management approach for the HLS program enhances the likelihood of success in technical, schedule, and cost objectives. NASA's management process is based on, and consistent with, NASA Space Flight Program and Project Management Requirements (defined in NASA Procedural Requirement NPR 7120.5F) – a disciplined, comprehensive structure for program management. This structure methodically develops plans and cost estimates, reviews them at Key Decision Points, and positions NASA to make an Agency Budget Commitment when plans and requirements are sufficiently mature. NASA has, and will continue to, set bold, ambitious mission schedules within its HLS solicitation. This approach supports lunar landing services coming online as quickly as possible and provides the Artemis campaign flexibility in its planning. NASA also continues to see advantages in combining the public-private partnership development model with NASA's evolved program and contract management approach as implemented through insight/oversight teams representing multiple NASA Centers and technical management disciplines, including Engineering, Crew, Safety, Flight and Ground Ops, Program and Business Management. Furthermore, NASA continues to benefit from synergies and improvements when compared to traditional approaches from the infusion of commercial space capabilities, interests, and motivations.

Summary

NASA welcomes the continuing review of NASA's HLS program plans and performance by the Committees on Appropriations, the support of which is key to enabling the safety and success of NASA's exploration objectives.

Responsible for the transportation of humans between lunar orbit and the lunar surface, NASA's HLS program is at the center of the Artemis campaign and the United States' robust civil space

program. The HLS program and Artemis more broadly will yield groundbreaking science and unprecedented strides in human exploration, empowering the United States and its partners to develop and utilize lunar surface resources while leveraging the Moon as a proving ground for future Mars missions.

NASA's investment in a flexible lunar exploration architecture through strategically designed and executed HLS procurements and resultant contracts as described in this report enables the safest and most affordable long-term approach to accessing the lunar surface. This approach acknowledges that NASA is one of many customers that has expressed an interest in purchasing lunar transportation services. Investments by the private sector are expected to grow as market opportunities are identified and activities expand from science and exploration to include resource utilization to the benefit of both public and private sectors.

Through Artemis, NASA and its international and commercial partners will establish a cadence of trips to the Moon to conduct science investigations, technology demonstrations, and establish a long-term presence to prepare for humanity's next giant leap – sending American astronauts on a round trip mission to Mars.