Human Landing System (HLS) Option A

Attachment J-1
Statement of Work (SOW)

Statement of Work Change Log

Version	Description of Changes	Date

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1. INTRODUCTION

The Human Landing System (HLS) Statement of Work (SOW) describes the work to be performed per the CLIN structure below associated with the work to be performed including the completion of the design, HLS hardware fabrication and test, coordination with commercial launch vehicle provider(s), launch vehicle integration, certification and launch of the HLS integrated lander, and the initial crewed HLS lunar landing demonstration mission; and the development of the requirements and preliminary design for subsequent sustaining missions. In the event of a conflict between the SOW and the contractor's Performance Work Statement (PWS), the SOW takes precedence.

Table 1-1 HLS CONTRACT CLIN STRUCTURE

CLIN	DESCRIPTION
001	**Base: 2024 HLS Design and Development**
002	**Base: 2026 HLS Design**
003	**Base: IDIQ for 2024 Long Lead Items**
004	**Base: IDIQ - Special Studies**
005	**Option A: 2024 HLS DDT&E and Demonstration Mission**. 2024 mission Design, Development, Test and Evaluation and flight demonstration (excepting detachable docking adapter work, if proposed, to be performed under CLIN009)
008	**Option A: IDIQ - Special Studies**. Special studies, analysis, and/or support tasks as initiated by written direction from the Contracting Officer
009	**Option A: Docking System**. Work on a detachable docking adapter, if proposed, for the 2024 demonstration mission.
010	**Option A: Sustaining Requirements and Preliminary Design.** Includes work to achieve a Sustaining SRR and Sustaining CR. The period of performance for this CLIN is start of Option A through January 31, 2023, anticipated to coincide with the start of Option B. Note that procurement of long lead flight items for the Sustaining demo should be planned to be acquired under Option B and are not allowed under Option A.

1.1 Background

The President's Space Policy Directive (SPD)-1 instructs NASA 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. Beginning with missions beyond low-Earth orbit, the United States will lead the return of humans to the Moon for long-term exploration and utilization, followed by human missions to Mars and other destinations." Additionally, on March 26, 2019, Vice President Mike Pence announced, "It is the stated policy of this administration and the United States of America to return American astronauts to the Moon within the next five years." The Human

Landing System (HLS) is a key capability of NASA's strategy to accomplish the return to the Moon referenced in SPD-1. The HLS will deliver a crew from lunar orbit to the lunar surface, provide capabilities for surface extra-vehicular activities, and then return the crew to lunar orbit to enable their return to Earth. In order to meet these goals and directives, NASA seeks to develop the HLS utilizing public-private engagements that will reduce the cost of developing the HLS, reduce the time required for the development cycle, and enhance U.S. competitiveness in the global space industry.

To enable these engagements NASA will: specify the minimum NASA HLS requirements allowing the contractor to tailor their design to best address their commercial interests; launch on industry-procured, commercial launch vehicles; utilize of commercial practices, standards, specifications, and processes; and utilize a collaborative approach with inline NASA subject matter expertise, as requested by the contractors, as well as insight. Each of these items represent a significant change in how NASA has traditionally worked with industry. These changes are being made to promote shared benefit between the public and commercial entities.

1.2 Definitions

The following definitions apply to the entirety of the Statement of Work:

- **Integrated Lander:** Any and all combinations of contractor elements (e.g. Ascent Element), including potentially a single element, which is integrated at any time crew are onboard.
- **Supporting Spacecraft**: Any contractor spacecraft that is not otherwise the Contractor's HLS Integrated Lander, Launch Vehicle, or AADA, but that is otherwise required for the Contractor to execute its demonstration mission or any portion thereof in performance of this contract, including, but not limited to, rendezvous, proximity operations, docking and undocking (RPODU), propellant transfer, and orbital maneuvering and transfer.
- **AADA**: Not considered a separate spacecraft. Considered part of Gateway when integrated with Gateway. Considered part of Integrated Lander when connected when crew are present and not docked to Gateway.
- **HLS**: All objects, vehicles, elements, integrated systems, systems, subsystems, or components thereof that are designed, developed, and utilized by the contractor, its teammates, subcontractors, and suppliers in performance of this contract, and which collectively comprise the contractor's Integrated Lander (or elements thereof), all Supporting Spacecraft, all launch vehicles necessary for launch and delivery of the contractor's Integrated Lander (or elements thereof) and its Supporting Spacecraft, and the contractor's Active-Active docking adapter (AADA) (if required for performance of the contractor's crewed demonstration mission).

1.3 Roles and Responsibilities

The roles and responsibility of the HLS contractors and the Government will reflect the stated desire to leverage commercial products and processes to the maximum extent practical and will rely on a Government-Industry collaborative approach. To that end, the HLS contractors will be responsible for all activities associated with the design, development, manufacture, test,

system verification, and system demonstration of the HLS with the following primary exceptions:

- The Government will have a shared responsibility for validating that the content of the contractor proposed milestone reviews are in compliance with the applicable acceptance criteria.
- The Government will have a shared responsibility for the HLS Safety and Engineering Review Panel (HSERP) as described in Section 7.1.
- The Government will have responsibility for approving all changes in contract requirements and for approving acceptance of deliverables, as required by corresponding Data Types.
- The Government will have responsibility for approving verification closures of NASA HLS requirements.
- The Government will have responsibility for Certification of Flight Readiness.
- The Government will have responsibility for critical Artemis mission Go/No Go calls during on-orbit crewed and lunar surface operations
- The Government will have responsibility for software Independent Verification and Validation (IV&V)

2. SCOPE

This Statement of Work (SOW) summarizes the work required for the design, development, manufacture, test, launch, demonstration, engineering support, and operations of the initial Human Landing System demonstration mission and requirements development and design for a sustainable Human Landing System through the Sustainability System Requirements Review and Continuation Review. Unless otherwise noted, the Statement of Work applies to all CLINs in the HLS Appendix H contract. This SOW applies to all work to meet NASA requirements and objectives for the HLS as documented in HLS-RQMT-002, *Human Landing System (HLS) Contractor System Requirements Document (CSRD)* and HLS-RQMT-002-ANX 0X, *HLS CSRD Annex – Technical Authority Agreements* [-0X is a unique identifier for a specific contractor].

The use of the words “shall”, “will”, “should”, and “may” are as defined:

a. **Shall** – Requirement: Shall is used to indicate a requirement, meaning it must be implemented, and its implementation verified.

b. **Will** – Fact: Will is used to indicate a statement of fact, declaration of purpose, or expected occurrence.

c. **Should** – Expectation: Should denotes a statement of best practice or intent.

d. **May** – Possible: May specified what is allowable or possible.

3. CONTRACT DOCUMENTATION

3.1 Applicable Documents

The following documents include specifications, standards, and other special publications. The documents listed in this section are applicable to the extent specified herein.

Table 3-1 APPLICABLE DOCUMENTS

Document No., Revision	Release/Effective Date	Document Title
HLS-RQMT-002, Rev D	TBD	*Human Landing System (HLS) Contractor System Requirements Document*
HLS-RQMT-002-ANX-0X	TBD	*HLS CSRD Annex – TA Agreements*
NPR 8580.1, Rev A.	Aug 1, 2012	*NASA National Environmental Policy Act Management Requirements*
NASA-STD-8739.8	May 5, 2005	*Software Assurance Standard*
SAE AS9100, Rev D	Sep 20, 2016	*Quality Management System – Requirements for Aviation, Space and Defense Organizations*
NASA-STD-8719.14, Rev B	Apr 25, 2019	*Process for Limiting Orbital Debris*
NPR 8621.1, Rev D	July 6, 2020	*NASA Procedural Requirements for Mishap and Close Call Reporting, Investigation and Recordkeeping .*
NID 8020.109, Rev A	July 9, 2020	*Planetary Protection Provisions for Robotic Extraterrestrial Missions*
HLS-PLAN-003, Rev A	July 21, 2020	*Safety and Mission Assurance Plan*
HLS-PLAN-013, Baseline	Nov 21, 2019	*HLS Planetary Protection Plan*
HLS-PLAN-004, Baseline	Dec 19, 2019	*Human Landing System (HLS) Configuration and Data Management Plan*
JSC 27472, Rev D	Aug 2019	*Requirements for Submission of Data Needed for Toxicological Assessment of Chemicals to be Flown on Manned Spacecraft*
NPR 7150.2, Rev C	Aug 2, 2019	*NASA Software Engineering Requirements*

3.2 Reference Documents

The following documents contain supplemental information to guide the user in the application of this document.

Table 3-2 REFERENCE DOCUMENTS

Document No., Revision	Document Title
NASA-STD-3001, NASA Space Flight Human Systems Standards Volume 2, Rev B	*Human Factors, Habitability, and Environmental Health*

NASA-STD-3001: NASA Space Flight Human Systems Standard Volume 1, Rev A	*Crew Health*
NPR 8715.7, Rev B	*Expendable Launch Vehicle Payload Safety Program*

4. PROGRAM MANAGEMENT

The contractor shall perform the management functions to assure accomplishment of all activities described in this SOW including delivery of the data required by this contract. The contractor shall report and document the performance of this work in the SOW and fulfill the requirements of associated Data Requirements Description (DRD) as outlined in Data Procurement Document (DPD) 1701 (Attachment J-2). The contractor shall determine the data restriction that applies to each data deliverable and mark or transmit the data restriction in accordance with section 2.3.3 of the DPD.

4.1.1 Technology Reports

The contractor shall provide NASA with technical information concerning any invention, discovery, improvement, or innovation made by the contractor in the performance of work under this contract in accordance with Technology Reports (DRD 1701CD-001).

4.1.2 Final Scientific and Technical Report

The contractor shall prepare and submit a Final Scientific and Technical Report summarizing the results of the entire contract effort, including recommendations and conclusions based on the experience and results obtained, in accordance with Final Scientific and Technical Report (DRD 1701MA-006).

4.1.3 Technical Direction

a. Performance of the work under this contract is subject to the written technical direction of the Contracting Officer Representative (COR), who shall be specifically appointed by the Contracting Officer in writing in accordance with NASA Federal Acquisition Regulations (FAR) Supplement 1842.270. ‘‘Technical direction’’ means a directive to the contractor that approves approaches, solutions, designs, or refinements; fills in details or otherwise completes the general description of work or documentation items; shifts emphasis among work areas or tasks; or furnishes similar instruction to the contractor. Technical direction includes requiring studies and pursuit of certain lines of inquiry regarding matters within the general tasks and requirements in Section C of the contract.

b. The COR does not have the authority to, and shall not, issue any instruction purporting to be technical direction that—

   1. Constitutes an assignment of additional work outside the statement of work;
   2. Constitutes a change as defined in the Changes clause of the contract;
   3. Constitutes a basis for any increase or decrease in the total estimated contract cost, the fixed fee (if any), or the time required for contract performance;
   4. Changes any of the expressed terms, conditions, or specifications of the contract.

c. Interferes with the contractor's rights to perform the terms and conditions of the contract.

d. All technical direction shall be issued in writing by the Contracting Officer's Representative.

e. The Contractor shall proceed promptly with the performance of technical direction duly issued by the COR in the manner pre-scribed by this section of the Statement of Work and within the COR's authority. If, in the contractor's opinion, any instruction or direction by the COR falls within any of the categories defined in paragraph (b) of this section of the Statement of Work, the contractor shall not proceed but shall notify the Contracting Officer in writing within 5 working days after receiving it and shall request the Contracting Officer to take action as described in this section of the Statement of Work. Upon receiving this notification, the Contracting Officer shall either issue an appropriate contract modification within a reasonable time or advise the contractor in writing within 30 days that the instruction or direction is—

   1. Rescinded in its entirety; or

   2. Within the requirements of the contract and does not constitute a change under the Changes clause of the contract, and that the contractor should proceed promptly with its performance.

e. A failure of the contractor and Contracting Officer to agree that the instruction or direction is both within the requirements of the contract and does not constitute a change under the Changes clause, or a failure to agree upon the contract action to be taken with respect to the instruction or direction, shall be subject to the Disputes clause of this contract.

f. Any action(s) taken by the contractor in response to any direction given by any person other than the Contracting Officer or the Contracting Officer's Representative shall be at the contractor's risk.

4.1.4 NASA Insight

The contractor shall develop and implement an approach establishing an effective working relationship between NASA and the contractor providing NASA insight into the contractor's approach. The contractor will allow NASA insight into contractor activities. The details of the approach shall be documented in the Insight Implementation Plan in accordance with Insight Implementation Plan (DRD 1701MA-001) and the contract section H Government Insight Clause.

a. The interactions between the contractor and the Government shall provide NASA sufficient insight into the activities associated with the HLS design, development, analysis, manufacture, integration, test, verification, certification, and operation, to include schedules, performance metrics, risks and management processes, while still allowing the contractor and sub-tier vendors to maintain the efficiencies and effectiveness of its normal commercial processes.

b. The contractor shall provide access to the Government's HLS insight team enabling technical insight into the design, development, manufacture, test, verification, and operation of the HLS .

c. The Government has identified engineering areas which are of particular interest to them and where insight is required. This is not an all-inclusive list; based upon the contractor design solution and identified risks, other areas of insight may be requested. The following initial areas for government insight have been identified:

1. System Safety.
2. Systems Engineering and Integration (SE&I).
3. Reliability.
4. Human Systems Integration.
5. Test.
6. Materials and Processes.
7. Guidance, Navigation, and Control.
8. Propulsion.
9. Structures and Mechanisms.
10. Environmental Control and Life Support Systems (ECLSS).
11. Interfaces, element-to-element (if applicable), GFE interfaces, and external vehicle interfaces.
12. Thermal Systems.
13. Avionics, including Electrical, Electronic, and Electromechanical Parts.
14. Software, including Independent Verification and Validation.
15. Hardware and Software Quality Assurance.
16. Mission Operations, including flight plans, flight rules, crew and flight control team training and communications and navigation networks.
17. Communications.
18. Launch Vehicle and Launch Site Operations, including spacecraft-to-launch vehicle integrations, spacecraft handling procedures, launch commit criteria, and ground operation and range safety analysis.
19. Supporting spacecraft needed to achieve the mission, including propellant storage and propellant transfer vehicles. Also, includes launch vehicle upper stages that perform critical operations above and beyond insertion of a payload into a desired orbit or trajectory.
20. Mission Design .
21. Relevant Environments.

d. The contractor shall provide a method of sharing, reporting, collecting, recording and accessing program information between NASA, HLS contractor, and safety critical sub-tier vendors with the Program enabling real-time collaborative access to a single source of management information, product information and technical data.

e. The contractor shall provide a team of Configuration and Data Management personnel to enable efficient and effective retrieval of data, analyses, reports, models, and documents from the contractor information technology (IT) systems.

4.1.5 Integrated Master Schedule and Schedule Risk Assessment (SRA)

The contractor shall develop and maintain an Integrated Master Schedule (IMS) (DRD 1701MA-003) that contains the logically networked tasks and milestones by Work Breakdown Structure (WBS) beginning with contract award to the completion of the contract. In addition to the design, development, manufacture, and test of the HLS, the IMS shall include any launch vehicle design modifications, ground systems modifications, design reviews, launch integration reviews and launch readiness reviews.

The contractor shall conduct a probabilistic Schedule Risk Assessment (SRA) report to be presented at Critical Milestone Reviews, and as directed by NASA per Integrated Master Schedule (IMS) (DRD 1701MA-003). The SRA will predict the probability of meeting the scheduled completion dates contained within the IMS. The SRA assessment shall be accomplished using a standard probabilistic management tool with monte-carlo functionality.

The contractor shall provide a separate IMS and SRA in accordance with Integrated Master Schedule (DRD 1701MA-003) for the sustaining requirements and preliminary design efforts in conjunction with the milestone reviews supporting CLIN 010.

4.1.6 Risk Management

a. The contractor shall implement a risk management process throughout the contract lifecycle that is documented in a configuration-controlled HLS Risk Management Plan in accordance with Risk Management Plan (DRD 1701MA-004).

b. The contractor shall provide a configuration-controlled risk report that is captured and managed throughout the contract lifecycle that indicates which safety, performance, and schedule risks present threats to mission success while identifying the appropriate risk approach for handling the risks in accordance with the Risk Reports – Initial Demo (DRD 1701MA-005) and is monitored regularly through insight. Likewise, for the sustaining integrated human landing system design and development effort, the contractor shall document safety, performance, and schedule risks while identifying the appropriate risk approach for handling the risks in accordance with the Risk Reports – Sustaining (DRD 1701MA-008).

4.1.7 Program Management Reviews

The contractor shall conduct monthly Program Management Review (PMR) meetings with NASA at mutually agreed upon locations (virtual meetings may be acceptable) including review packages. During the reviews, the contractor should present the following program status to include:

a. Integrated Schedule and Technical Status, to include:

   1. Schedule trends.

   2. Significant schedule technical variance.

b. Risk Management - The contractor shall provide a configuration-controlled risk report indicating which safety, performance, and schedule risks present threats to mission success and certification. Qualitative Risk Assessments (QRAs), Corrective Action Plans, software IV&V findings, and Project Impacts shall be addressed.

c. Technical Performance - Technical Performance Metrics, which includes design and performance margins and software metrics. The full list of the Technical performance metrics shall be mutually agreed upon by NASA and the contractor.

d. Accomplishments.

4.1.8 Artemis Tests, Reviews and Technical Interchange Meetings

a. The contractor shall support the planning and development of data products for quarterly Artemis reviews conducted by the Government at the mission level. The contractor shall plan to support with two (2) contractor personnel, either in attendance or virtually at these reviews.

b. The contractor shall provide support to the integrated Artemis Technical Integration Meetings (TIMs) to identify and resolve integration issues. The contractor shall plan to support with two (2) contractor personnel for four (4) two-day TIMs per quarter. Virtual attendance is acceptable for these meetings.

c. The contractor shall provide support to the Artemis integrated training Technical Readiness Review (TRR) at approximately L-18 months, the Artemis integrated training Operations Readiness Review (ORR) conducted prior to the L-12 month start of formal crew and flight controller training and the Artemis Joint Flight Operations Review (JFOR) conducted no later than L-5 months. The contractor shall plan to support the TRR, ORR, and JFOR consistent with DRD 1701OP-002, *Integrated Operations Training*, and DRD 1701OP-003, *Mission Operations and Mission Systems Plan*.

4.1.9 Support to the Artemis-3 Mission

a. NASA will, at its sole discretion, select one contractor to perform its initial demonstration flight, with a target goal of 2024, and the other contractor will perform their demonstration mission at a later date. This may result in the second contractor incurring unforeseen expenses (e.g., storage, staffing, etc.). To accommodate this situation, NASA will effectuate any necessary contractual changes, as well as any corresponding requests for equitable adjustment, according to the terms and conditions of FAR 52.243-1 Changes—Fixed Price (Aug 1987) Alternate 1 (Apr 1984).

b. The contractor shall ensure that the HLS Integrated Lander and the docking adapter, if required, have completed all checkouts to support an Artemis 3 SLS/Orion Flight Readiness Review with a potential 60-day lunar orbit loiter period.

4.1.10 Docking System

If required for the contractor's concept of operations for the initial demonstration mission, the contractor shall develop, design, produce and launch a capability that enables HLS docking to transport the crew from either Gateway or Orion.

a. For docking with the Gateway, contractors shall include development of an IDSS- and GDSS-compliant Active-Active Docking Adapter (AADA) or equivalent approach for successful docking by integrating a solution into their design, as well as delivery and attachment of the adapter to Gateway.

b. For docking with Orion contractors shall include development of a passive docking system or equivalent approach for successful docking, as well as delivery and attachment of the system on HLS. If the use of the adapter flown during the first contractor mission is successful and if the second contractor mission architecture supports an adapter, the first contractor's adapter will remain attached to Gateway, and the Government will take ownership of the adapter after completion of the demonstration mission. Upon transfer of ownership, the contractor shall deliver an Active-Active Docking Adapter Acceptance Data Package in accordance with DRD 1701SE-008 at the Post Mission Assessment Review. That adapter could then be used for subsequent missions by both awarded contractors for docking to Gateway. In this scenario, the second contractor's adapter would become a flight spare, to be delivered to the Government prior to the end of Option B (if awarded and subsequently exercised) or Option A (if Option B is not exercised).

4.2 Export Controls

The contractor shall perform an export control assessment for all data deliverable items shown in DPD 1701 (Attachment J-2). Due to the additional overhead in storing and handling International Traffic in Arms Regulations (ITAR) and Export Administration Regulations (EAR) materials, the contractor should only mark data that has been specifically identified under this designation and is not to globally mark all data as ITAR and/or EAR by default.

4.2.1 International Traffic in Arms Regulation

If a product is determined to contain information controlled by the International Traffic in Arms Regulations, the following statement shall be included on the product cover page:

International Traffic in Arms Regulations (ITAR) Notice

This document contains information which falls under the purview of the U.S. Munitions List (USML) as defined in the International Traffic in Arms Regulations (ITAR), 22 CFR§120-130, and is export-controlled. It shall not be transferred to foreign persons in the U.S. or abroad without specific approval of a knowledgeable NASA export control official, and/or unless an export license or license exemption is obtained/available from the Directorate of Defense Trade Controls, United States Department of State. Violations of these regulations are punishable by fine, imprisonment or both.

4.2.2 Export Administration Regulations

If a product is determined to contain information controlled by the Export Administration Regulations and which requires a license or exception prior to export, the following statement shall be included on the product cover page:

Export Administration Regulations (EAR) Notice

This document contains information within the purview of the Export Administration Regulations (EAR), 15 CFR §730-774, and is export-controlled. It may not be transferred to foreign persons in the U.S. or abroad without specific approval of a knowledgeable export control official, and/or unless an export license or license exception is obtained/available from the Bureau of Industry and Security, United States Department of Commerce. Violations of these regulations are punishable by fine, imprisonment or both.

4.2.3 Public Release

For Export Control purposes, if a product has been determined by the contractor and the Government to be suitable for public release, it shall be so labeled by the contractor.

4.3 Indefinite Delivery Indefinite Quantity (IDIQ) Special Studies Task Orders

In accordance with the task ordering procedures in this contract, the contractor shall perform HLS-related tasks such as special studies, analysis, and/or support tasks as initiated by written direction from the Contracting Officer. Content may include but is not limited to: evaluation of HLS use cases, extensibility studies of HLS technology, trade studies, and capability assessments.

4.4 HLS Integrated Lander and Active-Active Docking Adapter (AADA) Final Design Documentation and Software

The contractor shall deliver a Final Design Data Package for the HLS Integrated Lander in accordance with Integrated Lander Final Design Data Package (DRD 1701CM-001) in conjunction with the Post Mission Assessment Review.

If the contractor's design requires an Active-Active Docking Adapter (AADA), the contractor shall provide Active-Active Docking Adapter (AADA) Final Design Data Package at the Post Mission Assessment Review in accordance with DRD 1701CM-002.

4.5 Environmental Compliance and National Environmental Policy Act (NEPA) Documentation

The contractor shall ensure that all operations, activities, equipment, and facilities under this contract are in compliance with all applicable Federal, state, and local environmental laws, statutes, regulations, and ordnances. Unless otherwise stated in this contract, the contractor shall be solely responsible for compliance with aforementioned environmental requirements including environmental permits. The contractor shall be considered an independent entity responsible for its own actions for the purposes of environmental compliance and permitting matters.

Shall contractor activities trigger the need for NEPA documentation during the performance of the contract, the contractor shall be responsible for complying with NPR 8580.1, *NASA National Environmental Policy Act Management Requirements*, and providing documentation and supporting rationale to NASA throughout the NEPA process, as required by the Contracting Officer.

4.6 Government-Provided Resources

NASA is making a variety of Government-provided resources available to the contractor for use on this contract. Some of these resources are required for use by the contractor during performance, while others are optional. As a general overview, NASA is making the following items available under this contract:

Table 4-1 GOVERNMENT PROVIDED RESOURCE REQUIREMENTS

Type of Resource	Listed in Contract	Special Agreement Required	Property-specific contract clauses that apply
GFP	Attachment J-3	No**	52.245-1 (ALT I) 52.245-9 1852.245-73 1852.245-75 1852.245-76 1852.245-78 *Contractor Use of Government Furnished Equipment, Property, or Information*
NASA On-Site Resources*	N/A	Yes – GTA	1852.245-71, if applicable 1852.245-82, if contractor will be operating on-site *Use of Government Resources*

If added anew during contract performance, the cost is the responsibility of the contractor.
****New OGFPAs are required for GFP added anew during contract performance, and the terms of all OGFPAs will apply to the GFP that they respectively cover.***

4.6.1 Government Furnished Equipment/Government Furnished Property (GFE/GFP)

For the solicitation, the listing of mandatory and enumerated optional GFP is in Attachment I.

The list of Government Furnished Equipment/Government Furnished Property (GFE/GFP) requested by the contractor and agreed to by the Government is in the *To-Be-Provisioned GFP List* (Attachment J-3). Upon contract award, the OGFPAs will be subject to formal review and approval by the HLS program manager and Contracting Officer. Once the final terms and conditions of the provision of the GFE/GFP have been finalized by the Parties (such as delivery date), and any funding has been secured from the appropriate NASA organization if needed, the approved OGFPA will become an attachment to the contract authorizing the Contractor to proceed with the OGFPA(s). NASA will also update the *GFP Provisioned List* (found in Attachment J-3) for any GFE/GFP furnished to the contractor. NASA has indicated

in the *To-Be-Provisioned GFP List* (Attachment J-3) which GFE/GFP items may be consumed during performance ("Consumable Property"). Items not consumed shall be returned to NASA at the end of performance. The GFE/GFP items are provided to the contractor at no cost and are provided subject to the specific property contract clauses indicated in Table 4-1.

The contractor may inquire at the NASA Centers to determine the availability of any additional GFP requested during contract performance. The Contractor shall submit an *OGFPA* through the Contracting Officer's Representative to document the agreement between NASA and the Contractor to potentially provide one or more of these requested items of GFE/GFP subject to Contracting Officer approval.

Any items provided to the contractor shall be included in the *GFP Provisioned List* (Attachment J-3) prior to delivery of the GFE/GFP. If not consumed during contract performance, the GFE/GFP shall be returned to NASA. These items are provided subject to the specific property contract clauses indicated in the table above. Additionally, the contractor shall develop a Government Property Management Plan in accordance with Government Property Management Plan (DRD 1701LS-001).

The contractor assumes the risk of, and shall be responsible for, any loss of GFE/GFP upon its delivery to the contractor as GFP. The contractor is responsible for the cost of replacement or purchase of these items, if needed. These items are provided "as-is."

4.6.1.1 Integration of Government Furnished Property/Equipment

In accordance with contract H clause *Contractor Use of Government-Furnished Equipment, Property, or Information* clause, *(g) Contractor Responsibility*, the contractor shall be responsible for the integration of any Government Furnished Property/Equipment into their integrated HLS design.

4.6.2 Government Task Agreements and GFP and other Government Resources Available to the Contractor while Working On-site at a NASA Facility

In accordance with contract H clause *Use of Government Resources* and 1852.245–82 *Occupancy Management Requirements,* the contractor may elect to perform a portion of the work required under this contract using the property, facilities, assets, services, or other specialized resources uniquely available on-site ("on-site resources") from a NASA Center, Component Facility, or the Jet Propulsion Laboratory (JPL) (any one of which is a "Performing Organization"). Such proposed requests must be within the scope of the contract and are subject to the availability of those resources and the Performing Organization's ability and willingness to provide them. The contractor shall limit requests for the use of on-site resources to only those Performing Organization facilities, services, or other resources that are unique or not otherwise reasonably available commercially. The contractor shall document its planned use of on-site resources through the execution and submission with proposal of one or more *Government Task Agreements (GTAs)*. During contract performance, the Parties may agree to execute additional GTAs if they mutually determine such agreements are necessary to respond to new or changed circumstances that arise during performance. The contractor is responsible

for the cost of any GTA. During contract performance, the contractor shall formally request Government Task Agreements in writing to the Contracting Officer's Representative identifying the tasks to be performed, facilities required, and the start and end dates for the task agreement. The contractor is responsible for the cost of all GTAs added anew during contract performance (i.e., the GTA was not included in the contract proposal). These on-site resources are provided subject to the specific contract clauses indicated in the table above.

In accordance with FAR 52.245-1(h)(1) the contractor shall be liable for property lost, damaged, destroyed or stolen by the contractor or their employees when determined responsible by a NASA Property Survey Board. The official accountable recordkeeping, financial control, and reporting of the property subject to this clause shall be retained by the Government and accomplished within NASA management information systems prescribed by the installation Supply and Equipment Management Officer (SEMO) and Financial Management Officer.

Contractor use of Government property provided to the contractor under a GTA for use at an off-site location requires advance approval of the Contracting Officer and notification of the Industrial Property Officer.

The contractor shall not bring to the installation for use under this contract any property owned or leased by the contractor, or other property that the contractor is accountable for under any other Government contract, without the Contracting Officer's prior written approval.

The contractor shall be responsible for any loss of or damage to Government property as a result of the contractor's actions while operating pursuant to a GTA. In accordance with 52.245-1 paragraph (d)(2)(iii), all Government resources used by the contractor while operating pursuant to a GTA are provided "as-is."

4.6.3 Collaboration

In accordance with contract H clause *Use of Government Resources*, the contractor may elect to use the NASA personnel that NASA is making available for use during the performance of this contract. During contract performance, the contractor shall document its collaboration requests in writing to the Contracting Officer or Contracting Officer's Representative (COR). The contractor shall request specific areas of technical subject matter expertise (e.g., engineering, operations, or safety) and the duration and amount of the requested resources, but the contractor shall not request specific equivalent personnel (EPs) by name or title. NASA has the sole authority to determine whether it will provide any portion of the collaboration resources requested by the contractor. During contract performance, NASA reserves the right to unilaterally change its approach to collaboration at any time, including the right to modify the specific EPs offered to the contractor and the amount, type, and/or duration of their support, and including the right to cease collaboration at any time. At all times during collaboration, the EPs remain employed by, and under the supervisory control of, NASA or the NASA support contractor, as appropriate. While collaborative communication between the contractor and provided EPs is expected in furtherance of the EPs' advisory roles, the contractor shall not direct or supervise the work of EPs. NASA will use reasonable efforts to ensure equitable

resources are provided to all HLS contractors in support of their respective collaboration approaches but makes no guarantees that identical resources will be provided. Specific resources will be narrowly tailored to a contractor's unique development approach and associated needs and objectives.

4.6.4 Government-Furnished Information

This is Government-Furnished information (GFI), such as technical data packages, that will be furnished to the contractor for performance of the contract and will not be returned to the Government. During contract performance, the contractor should inquire at NASA Centers to determine the availability and cost of these items and execute an *Optional GFE/GFP Agreement* to document the agreement between NASA and the contractor about the provision of GFI. This request should be made in writing to the Contracting Officer's Representative.

4.7 Security Clearances

The contractor shall have two employees that possess, or have the capability to obtain, Top Secret/ Sensitive Compartmented Information (TS/SCI) security clearances.

4.8 Cybersecurity and Project Protection

4.8.1 Definitions

As used in this section (4.8), the following definitions apply:

Covered contractor system means any IT system, OT system, or Mission system; that is owned, or operated by or for, the contractor, its subcontractors, or its suppliers; that processes, stores, accesses, or transmits any data and information; as part of the performance of this contract.

Data and information means technical data (as that term is defined in the contract's *Rights in Data – General (Deviated)* clause) and/or information incidental to contract administration, such as financial, administrative, cost or pricing, or management information.

Information Technology (IT) system means: any services, equipment, or interconnected system(s) or subsystem(s) of equipment; either contractor-owned or to which NASA may or will take legal title in accordance with this contract; that are used by the contractor, in the performance of this contract, for the automatic acquisition, storage, analysis, evaluation, manipulation, management, movement, control, display, switching, interchange, transmission, or reception of data and information. An IT system may include computers, ancillary equipment (including imaging peripherals, input, output, and storage devices necessary for security and surveillance), peripheral equipment designed to be controlled by the central processing unit of a computer, software, firmware and similar procedures, services (including cloud computing and help-desk services or other professional services which support any point of the life cycle of the equipment or service), and related resources.

Mission system means any of the following: a space vehicle; instruments developed for, and used in, space flight programs and projects; critical technical facilities specifically developed or significantly modified for space flight systems; launch systems. A mission system can also include components, sensors, avionics, and communications equipment designed and

engineered for the Human Landing System vehicle and ground systems that are in direct support of space flight operations.

Operational Technology (OT) system means hardware and software that is physically part of, dedicated to, or essential in real time to the performance, monitoring, or control of physical devices and processes. This includes but is not limited to a mission control system or center.

Privacy controls means the administrative, technical, and physical safeguards employed within a system or an organization to manage privacy risks and to ensure compliance with applicable privacy requirements.

Radio Frequency Interference means any event that is observed as an increase in spacecraft receiver noise floor, degradation, disruption, or inability to receive commands, associated with safe and purposeful spacecraft operations. Examples include changes in or loss of Position Navigation Timing (PNT) signals that threaten the accuracy of a sufficient PNT solution, or signals that threaten the loss of or interference with the operator's positive control of the spacecraft. This may also include spectrum interference, jamming, or signal spoofing.

Security controls means the safeguards or countermeasures employed within a system or an organization to protect the confidentiality, integrity, and availability of the system and its information and to manage information security risk.

Space system means all of the IT systems, OT systems, and Mission systems that, throughout the entire period of contract performance, collectively enable and support the contractor's performance of this contract.

Space vehicle means the portion of a space system that operates in space (e.g., launch vehicles, launch vehicle upper stage components, and spacecraft).

System Security Plan means, individually, the contractor's cybersecurity plan for a discrete IT system, OT system, or Mission system that the contractor will use in the performance of this contract (e.g., "System Security Plan for [contractor]'s IT system"), and collectively, refers to the single document that contains all of these individual plans.

4.8.2 Contractor Use of NASA Systems

For the purposes of effectuating collaboration, Government Task Agreements, or similar contractual mechanisms, NASA may grant access to one or more systems that are owned, operated by, or operated on behalf of NASA (e.g., an internal NASA network at a NASA Center). To the extent that NASA has facility-specific security requirements that apply to these scenarios, before being granted such access, the contractor shall comply with such requirements specified by the applicable NASA Center and/or facility. At a minimum, all contractor personnel requiring physical or logical access to any such NASA system at any NASA Center and/or facility shall complete NASA's IT Security Awareness training prior to being granted physical or logical access and shall repeat this training annually thereafter if the personnel continues to require such access.

4.8.3 Cybersecurity for Covered Contractor Systems

a. System Security Plan. In accordance with DRD 1701MA-011 and the requirement for an "IT Security Plan" within contract clause NFS 1852.204-76, the contractor

shall provide a System Security Plan to describe its approach to cybersecurity on all covered contractor systems. The contractor shall select and implement, or provide a plan to implement, a subset of controls from NIST SP 800-53 that, in the contractor's assessment, when implemented within the covered contractor systems, collectively ensure end-to-end cybersecurity during all phases contract performance.

b. **Third Party Audit**. The contractor shall have a third-party cybersecurity audit performed on all of its covered contractor systems (including those of its subcontractors) at least once, and possibly twice, during contract performance, as follows: (1) At any point during contract performance, so long as the audit occurs after all of the contractor's covered contractor systems are either operational or otherwise sufficiently mature to undergo a meaningful audit, but no later than one hundred and twenty (120) calendar days before the commencement of HLS Flight Operations (as defined in section 9 of this SOW); and (2) NASA may direct the contractor to get a second audit if, prior to the commencement of HLS Flight Operations, but after the first audit occurs, the contractor makes, in NASA's assessment, material changes to its HLS hardware or software. The primary purpose of the audit is to provide independent assessment and assurance to NASA that, prior to the start of HLS Flight Operations (as defined in Section 9 of this SOW), the contractor has achieved the required level of cybersecurity. Following the completion of any such audit, the contractor shall provide an audit report authored by the third-party auditor to NASA as soon as is reasonably practicable.

   The contractor shall ensure that its proposed timing of the initial third-party audit is clearly reflected in other HLS contract documents as is appropriate, such as but not limited to the contractor's IMS (DRD 1701MA-003).

c. **NASA Inspection.** In accordance with paragraph (d) of contract clause NFS 1852.204-76, upon request of the Government, the contractor shall facilitate timely Government access to the Contractor's and subcontractors' facilities, installations, operations, documentation, databases, and personnel used in performance of the contract to the extent required to carry out a program of IT inspection. This inspection may include actions such as vulnerability testing, investigation and audit to safeguard against threats and hazards to the integrity, availability, and confidentiality of NASA Electronic Information or to the function of IT systems operated on behalf of NASA, or may be for the purpose of preserving evidence of computer crime. The Government may use a covered Government support contractor to perform this inspection in whole or in part, but will notify the contractor ahead of time if it plans to do so and will ensure that the appropriate measures are put in place to ensure protection of the contractor's proprietary data that may be accessed during this inspection.

4.8.4 Information Technology Security Management Plan

In accordance with DRD 1701MA-009, the contractor shall provide an Information Technology Security Management Plan.

4.8.5 Project Protection Plan

In accordance with DRD 1701MA-010, the contractor shall provide a Project Protection Plan.

4.9 Organizational Conflict of Interest (OCI) Plan

The contractor shall prepare and submit an Organizational Conflict of Interest (OCI) Plan in accordance with DRD 1701MA-007.

4.10 Changes, Waivers, and Deviations to Technical Requirements

The contractor shall prepare and submit requests to change, waive and deviate from HLS technical requirements to the Contracting Officer's Representative, who will ensure that the request is entered in the HLS Change Management System. The requests shall be developed in accordance with HLS-PLAN-004, *Human Landing System (HLS) Configuration and Data Management Plan*.

5. MILESTONE REVIEWS

The HLS Program Office has defined major milestone reviews for the HLS Program in order to be able to assess programmatic and technical progress and performance at key decision points in the development and operational lifecycle phases, with the ultimate goal of certifying the lander for crewed operations to and from the lunar surface and assessing the likelihood of mission success. Additionally, supporting spacecraft that are required in the contractor's concept of operation to successfully complete the mission shall be included in the scope of the review for mission success. These spacecraft could include propellant storage and/or propellant transfer vehicle, as well as launch vehicle upper stages that perform critical operations above and beyond insertion of a payload into a desired orbit or trajectory.

For each review, the contractor shall address verification, validation and certification of any heritage hardware and software for its intended use on HLS, in addition to new hardware and software.

5.1 Contractor Proposed Reviews

Additional Critical Milestone Reviews should be proposed based on the contractor's Program Management and Systems Engineering requirements at the HLS system and lower level reviews.

5.1.1 Program Review Plan and Detailed Review Plans

a. The contractor shall prepare and submit a comprehensive Program Review Plan, that encompasses the entire lifecycle of the HLS. The contractor shall develop detailed Review Plans for each contractor-led milestone review. The Program Review Plan and the detailed Review Plans for individual reviews, or equivalents, shall be developed in accordance with Review Plan (DRD 1701MA-002) and Technical and Readiness Reviews (DRD 1701LV-005).

b. The contractor shall provide to the Government a Review Plan, in accordance with DRD 1701MA-002, for each contractor-led review 30 calendar days prior to the start of review activities as defined by the contractor in the Comprehensive Review Plan. Review data packages shall be delivered to the Government 20 calendar days prior to the start of review activities as defined by the contractor in the Comprehensive Review Plan. Data will be delivered by electronic means to NASA. Changes in the as-presented data package from the advance package delivered prior to the review shall be identified.

5.2 Critical Milestone Reviews

The Critical Milestone Reviews will be conducted to assess the contractor deliverables and programmatic and technical performance during the current period of performance.

a. The contractor shall participate and provide a single point of contact for participation in the Review Board for Government-led reviews at a NASA specified location. The contractor can bring in additional technical leads as the contractor single point of contact deems necessary for a successful review.

b. Review data packages shall be delivered to the Government for review 20 calendar days prior to the Review Board meeting. Data will be delivered by electronic means.

c. The contractor shall provide support to the HLS Program for Artemis integrated design and flight readiness reviews (e.g., Gateway/Orion reviews, SLS/Orion flight readiness reviews, etc.) and operations reviews during the execution of the mission (e.g., Lunar Orbit Checkout, etc.), as needed.

d. Data Requirements Descriptions (DRDs) identified as deliverable for Critical Milestone Reviews (Critical Design Review, Flight Readiness Review (FRR), Design Certification Review, Post Mission Assessment Review (PMAR), Sustaining System Requirements Review (SRR), and Sustaining Continuation Review (CR) identified in Data Procurement Document (DPD) 1701 (Attachment J-2) will be identified as reviewable documents, as part of the review data package at the associated Government-led review regardless of the data type assigned to the document.

    1. Supporting and/or reference materials may be delivered to provide context to the review deliverables.

    2. In addition to the listed DRD deliverables, the contractor may deliver other data and documentation for the review to provide evidence the contractor's design meets the review criteria. These deliverables will be considered reviewable documents for the review.

    3. A listing of reference and/or supporting documents and any other reviewable documents, in addition to the specified DRD deliverables, shall be delivered to the Government 20 calendar days prior to the delivery of the data review package. The listing shall include a mapping of documents to DRD deliverables for supporting and reference documents and review criteria for additional reviewable documents/data.

e. The contractor shall respond to the assigned review actions assigned in accordance with the Board-approved closure plan.

5.3 Contractor Life-Cycle Reviews

a. The contractor may hold life-cycle reviews at the HLS level or below for the purpose of verification, validation, qualification and/or certification of systems and subsystems. For these reviews, NASA will participate as reviewers and board observers. Additionally, for HLS-level reviews and software reviews, NASA will serve as a Board Member. The contractor-led Review Boards will be chaired by the contractor.

b. The contractor shall respond to discrepancies and comments generated by NASA authorized reviewers for system-level and software reviews.

c. In addition to the critical milestone reviews, all contractor reviews shall be included in the Integrated Master Schedule.

5.4 2024 HLS Demonstration Critical Milestone Reviews

5.4.1 Critical Design Review (CDR)

a. Objective: The Program CDR demonstrates that the maturity of the design is appropriate to support proceeding with full-scale fabrication, assembly, integration, and test. CDR determines that the technical effort is at appropriate Technology Readiness Levels and is on track to complete the flight and ground system development and mission operations to meet mission performance requirements within the identified schedule constraints. The CDR should be completed prior to the Design Certification Review.

b. Table 5-1 shows the Acceptance criteria and applicable products for the Critical Design Review.

Table 5-1 CDR ACCEPTANCE CRITERIA AND PRODUCTS

Acceptance Criteria	Applicable Products
The detailed design is expected to meet the requirements with adequate margins at an acceptable level of risk.	Design Data Book – Initial Demo Integrated System Performance Analysis – Initial Demo Risk Reports – Initial Demo
Interface control documents are appropriately matured to proceed with fabrication, assembly, integration and test, and plans are in place to manage any open items including docking systems.	HLS Integrated Lander System Specification – Initial Demo Design Data Book – Initial Demo

Acceptance Criteria	Applicable Products
The program schedule estimate is credible and within program constraints.	Integrated Master Schedule Schedule Risk Assessment
High confidence exists in the product baseline, and adequate documentation exists and/or will exist in a timely manner to allow proceeding with fabrication, assembly, integration, and test.	Design Data Book – Initial Demo Assembly, Integration and Test Plan – Initial Demo
The product verification and product validation requirements and plans are complete or in progress at appropriate maturity.	Detailed Verification Objectives – Initial Demo Verification Closure Notices Verification, Validation, and Certification Plan HLS Integrated Lander System Specification – Initial Demo
The testing approach is comprehensive, and the planning for system assembly, integration, test, and launch site and mission operations is sufficient to progress into the next phase.	Assembly, Integration and Test Plan – Initial Demo Flight Software Simulator Integrated Operations Training Missions Operations and Mission Systems Plan
Adequate technical margins exist to complete the development within schedule and known risks	Integrated Systems Performance Analysis – Initial Demo Design Data Book – Initial Demo
Risks to mission success are understood and credibly assessed and plans and resources exist to effectively manage them.	Risk Reports – Initial Demo Reliability Prediction Analysis (SOW 7.3.2)
Safety and Mission Assurance (SMA) (e.g.,, safety, reliability, maintainability, quality, software assurance and safety, and EEE parts) have been adequately addressed in system and operational designs and any applicable SMA products (e.g., PRA, system safety analysis) meet requirements, are at the appropriate maturity level for this phase of the program's life-	System Safety Assessment Reports – Initial Demo PRA (NASA generated using contractor data) Human Error Analysis Reports and Analyses – Initial Demo Orbital Debris Assessment Reports (ODARs) and End of Mission Plan (EOMP) Micrometeoroid Orbital Debris Report (MMOD) Planetary Protection Data (Initial Pre-Launch)

Acceptance Criteria	Applicable Products
cycle, and indicate that the program safety/reliability residual risks will be at an acceptable level.	
TBD and TBR items are clearly identified with acceptable plans and schedule for their disposition, including docking system.	Applies to all Products
Engineering test units, life test units, and/or modeling and simulations have been developed and tested per plan.	Design Data Book – Initial Demo Integrated Systems Performance Analysis – Initial Demo Assembly, Integration and Test Plan – Initial Demo Integrated Operations Training
Material properties tests are completed along with analyses of loads, stress, fracture control, contamination generation, etc.	Design Data Book – Initial Demo Integrated Systems Performance Analysis – Initial Demo Insight Implementation Plan (Reference)
EEE parts have been selected, and planned testing and delivery will support build schedules	Design Data Book – Initial Demo Integrated Systems Performance Analysis – Initial Demo
The operational concept has matured, is at a CDR level of detail, and has been considered in test planning	Mission Operations and Mission Systems Plan Integrated Systems Performance Analysis – Initial Demo Assembly, Integration and Test Plan– Initial Demo Integrated Operations Training
Manufacturability has been adequately included in design of the HLS and docking system.	Design Data Book – Initial Demo
The software has matured, adequate testing is planned, and delivery will support build schedules.	Software Plan Software Verification, Validation, and Certification Plan Resource and utilization constraints (e.g., CPU, memory); how the software will adapt to changing margin constraints; performance estimates Input and output data and formats identified

Acceptance Criteria	Applicable Products
	Algorithms exist sufficient to satisfy their requirements Software IV&V findings dispositions (NASA provided) Software test procedures
Launch Vehicle and Supporting Spacecraft Status	Presentation Only—Should include status on primary and backup launch vehicle options and the status on support spacecraft such as propellant storage, propellant transfer, and/or upper stage vehicles that provide transportation capabilities beyond the standard for orbit insertion.

5.4.2 Design Certification Review (DCR)

a. Objective: The DCR ensures that the qualification and verifications demonstrate design compliance with the functional and performance requirements and human spaceflight certification. This milestone should be completed at first HLS launch – 9 Months (L-9).

b. Table 5-2 contains the Acceptance criteria and applicable products for the DCR.

Table 5-2 DCR ACCEPTANCE CRITERIA AND PRODUCTS

Acceptance Criteria	Applicable Products
Verification results satisfy all requirements. (e.g. functional, performance, design & construction standards, human spaceflight certification)	Detailed Verification Objectives – Initial Demo Verification Closure Notices System Safety Assessment Report (SSAR) – Initial Demo
Docking System interfaces with the HLS are verified	Detailed Verification Objectives – Initial Demo Verification Closure Notices
Launch vehicle interfaces with the HLS are verified	Launch Vehicle/Spacecraft Interface Control Document (ICD) and Verification Matrix – Initial Demo Launch Vehicle Mission Specific Drawings
Waivers and deviations to requirements are approved by HLS Program	Detailed Verification Objectives – Initial Demo Verification Closure Notices HLS Integrated Lander System Specification – Initial Demo Design Data Book – Initial Demo HLS GNC Simulator Specification

Acceptance Criteria	Applicable Products
Any requirement that has not been verified, or approved for a deviation or waiver, is noted with a mitigation plan and schedule.	Detailed Verification Objectives – Initial Demo Verification Closure Notices Integrated Master Schedule Risk Reports – Initial Demo
Safety and Mission Assurance (SMA) (e.g.,, safety, reliability, maintainability, quality, software assurance and safety, and EEE parts) have been adequately addressed in system and operational designs and any applicable SMA products (e.g., PRA, system safety analysis) meet requirements, are at the appropriate maturity level for this phase of the program's life-cycle, and indicate that the program safety/reliability residual risks will be at an acceptable level.	System Safety Assessment Reports – Initial Demo PRA (NASA generated using contractor data) Human Error Analysis Reports & Analyses–Initial Demo Micrometeoroid Orbital Debris (MMOD) Report Planetary Protection Data (Initial Pre-Launch)
The pedigrees of the test articles directly traceable to the production unit of the HLS and the docking system.	Design Data Book – Initial Demo
Test procedures and environments used comply with those specified in design to specification including docking system.	Design Data Book – Initial Demo Detailed Verification Objectives – Initial Demo Verification Closure Notices Assembly, Integration and Test Plan – Initial Demo Flight Software Simulator
Design changes in the CI resulting from the verification process (as run – test, etc.) have been incorporated and/or appropriately addressed (successfully retested as required).	Detailed Verification Objectives – Initial Demo Verification Closure Notices Design Data Book – Initial Demo HLS Integrated Lander System Specification – Initial Demo
Verify the approach is compliant with requirements relative to SMA and reliability.	Detailed Verification Objectives – Initial Demo Verification Closure Notices

Acceptance Criteria	Applicable Products
The program schedule estimate is credible to meet delivery to and checkout at Lunar NRHO or LO dates.	Integrated Master Schedule Schedule Risk Assessment Risk Reports – Initial Demo
All issues and concerns raised during the DCR process are documented, discussed and provided with a plan for resolution and implementation.	DCR Board Actions
Verify the software approach is compliant with software requirements.	Software Plan Software Verification, Validation, and Certification Plan Project Protection Plan Threat Summaries Candidate Protection Strategy Implementation

5.4.3 Post-Test Review of Uncrewed Lunar Landing Test

Objective: The Post-Test Review of the Uncrewed Lunar Landing Test presents evidence that the contractor successfully landed on the lunar surface meeting the requirements defined in the Statement of Work, Section 6.7. The Review topics and objectives are listed in Table 5-3.

Table 5-3 POST UNCREWED LANDING TEST REVIEW

Review Topics	Review Objectives
Mission Performance Summary	Achieved lunar landing site between 84°S and 90°S, within 100m (3-sigma) of target landing site Achieved 2 hours of state-of-health telemetry transmission (TBR) back to earth after landing
Anomaly Identification and Closure Plans	List of in-flight/ground anomalies Closure Plan(s) for in-flight anomalies
Post-Test Analyses	Mission Performance Evaluation Report (DRD 1701-SE016) Test performance within prediction Validation of external interfaces, if applicable Understanding of boundary conditions tested
Risks	Identification of risk reduction achieved due to Uncrewed Lunar Landing Test

Lessons Learned	Lessons Learned documented

5.4.4 Flight Readiness Review(s) (FRR)

Objective: The FRR examines tests, demonstrations, analyses, and audits that determine the system's readiness for a safe and successful flight or launch and for subsequent flight operations. The FRR also ensures that all flight and ground hardware, software, personnel, and procedures are operationally ready. The FRR should be completed by two (2) weeks before launch of each HLS element.

Table 5-4 lists the Acceptance criteria for the Flight Readiness Review(s):

Table 5-4 FRR ACCEPTANCE CRITERIA

Acceptance Criteria
The flight vehicle, launch vehicle, and support spacecraft (such as propellant storage, propellant transfer, and/or upper stage vehicles that provide transportation capabilities beyond the standard for orbit insertion) are ready for flight
The hardware is deemed acceptable safe for flight; Hardware integration testing has been successfully completed
Certification that flight operations can safely proceed with acceptable risk
Class A-C software (per NPR 7150.2C, NASA Software Engineering Requirements) is deemed acceptably safe for flight, has successfully completed software integration testing, and is ready to support flight, flight operations, and lunar surface operations
Interfaces have been checked and demonstrated to be functional
The Program has demonstrated compliance with applicable NASA requirements, standards, processes, and procedures
TBD and TBR items are resolved
Open Items and Waivers have been examined and residual risk from these is deemed to be acceptable
The flight environmental factors are within constraints
All open safety and mission risk items have been addressed, and the residual risk is deemed acceptable
Supporting organizations are ready to support flight, to include trained operations personnel
Software components meet the criteria defined in NASA-HDBK-2203, NASA Software Engineering Handbook, or an accepted alternate standard. NASA software IV&V findings dispositioned.

Acceptance Criteria
Responsible spectrum manager(s) concur that all necessary spectrum certification(s) and authorization(s) have been obtained
Hazardous operations have been tested.

5.4.5 Lunar Orbit Checkout Review (LOCR)

Objective: To determine the readiness of the HLS vehicle to perform the initial demonstration mission, perform crew transfer to the HLS, and to provide an HLS Program commitment for the launch of the Orion Crew Vehicle, the contractor shall perform a Lunar Orbit Checkout Review to examine the health and status of the HLS Integrated Lander. This review shall be accomplished prior to NASA approval to approach and dock to the Crew Staging Vehicle for the purpose of crew transfer. The review will be conducted early enough to allow NASA multi-program commitment to the Orion Crew launch. Using the Acceptance Criteria listed in Table 5-5, the Lunar Orbit Checkout Review will include a summary of Integrated Lander performance in flight, a detailed review of any off-nominal performance in which criteria listed in Table 5-5 are not met and a detailed review of specific high-priority checkout objectives that must be accomplished prior to proceeding into approach with either Gateway or Orion and additional high-priority checkouts that must be accomplished prior to departure from Gateway or Orion. Additionally, if the contractor's concept of operations uses the Gateway vehicle, as the crew staging vehicle for the HLS mission, a successful docking with Gateway, at a minimum, is required prior to Orion Crew launch.

The contractor will deliver details of all non-critical checkout criteria post mission as part of the Post Mission Assessment Review (PMAR).

Table 5-5 below shows the acceptance criteria for this review.

Table 5-5 LUNAR ORBIT CHECKOUT REVIEW ACCEPTANCE CRITERIA

Acceptance Criteria
Power • Power system checkout data shall demonstrate that the Integrated HLS vehicle's power generation, energy storage, bus electrical component operational and health status (bus voltages, currents, power flows, etc.) are within nominal performance predictions. • Critical Checkout Objective: Data shall demonstrate the HLS will maintain charge/re-charge states adequately to accomplish stated mission objectives. • Status of power related measurements shall demonstrate that parameters values are within acceptable levels and the sensors are measuring in a healthy manner.

Acceptance Criteria
Environmental Control and Life Support System (ECLSS) • ECLSS checkout data shall demonstrate that the ECLSS system parameters are within model predictions given the measured HLS environmental state. o The parameter assessments shall include, but are not limited to, cabin pressurization control, appropriate gas concentrations, cabin temperature and humidity control, trace contaminant measurements, cabin air circulation, health of carbon dioxide removal system, air particulate control, and venting. • Status of ECLSS related measurements shall demonstrate that parameters values are within acceptable levels and the sensors are measuring in a healthy manner.
Communications • Critical Checkout Objective: Communication checkout data shall demonstrate that the Integrated HLS has established communication with the ground and Gateway (if applicable) and HLS is transferring data appropriately considering various orientations. • Status of communication-related parameters shall demonstrate that values are within acceptable levels
Integrated Avionics • Integrated Avionics checkout data shall demonstrate that the Integrated HLS avionics system parameters are within operating parameters and the sensors are measuring in a healthy manner. Include measurements for radiation environment.
Thermal • Thermal system checkout data shall demonstrate that the Integrated HLS thermal system parameters are within model predictions given the measured HLS environmental state. o The parameter assessments shall include, but not limited to, HLS control within acceptable temperature ranges, capability to transfer heat and radiate appropriately, and capability to support other HLS systems within limits for the expected mission duration. • Status of thermal system related measurements shall demonstrate that parameters values are within acceptable levels and the sensors are measuring in a healthy manner.
Propulsion, to include main propulsion system (MPS) and reaction control system (RCS) • The MPS and RCS checkout data shall demonstrate that the MPS and RCS parameters are within model predictions given the measured HLS environmental state. o The parameter assessments shall include, but not limited to, tanks pressurization and venting control, propellant conditioning, boil off, slosh,

Acceptance Criteria
engine/engines/thruster readiness and conditioning, and pneumatic/helium system health. • Critical Checkout Objective: the HLS shall demonstrate the ability to reorient and translate in support of rendezvous, landing and return operations. • Status of propulsion system related measurements shall demonstrate that parameters values are within acceptable levels and the sensors are measuring in a healthy manner
Aggregation of HLS Lander Elements and Docking with Gateway, if applicable • Data shall demonstrate successful aggregation of lander elements and is functioning as expected. • For Gateway missions, successful docking with Gateway is required to successfully complete this review and support Orion Crew Vehicle launch decisions. • Status of measurements related to the successful aggregation of the lander elements successful shall demonstrate parameters are within acceptable levels and sensors are measuring in a healthy manner.
Guidance and Control of Integrated Lander • Guidance and Navigation control data shall demonstrate that the Integrated HLS guidance and navigation control parameters are within model predictions given the measured HLS on orbit state. o The parameters assessments shall include, but not limited to, ability to establish location state and track, update navigation states, establish actuators health, and related avionics health. • Critical Checkout Objective: demonstrate the accuracy of the Guidance and Navigation Control data required to achieve MPS and RCS control modes. • Critical Checkout Objective: demonstrate that on external command (from Orion/Gateway or the ground) HLS can establish closing and opening rates and the ability to abort motion with a target rendezvous vehicle per preflight modelling. • Status of navigation and control related measurements shall demonstrate that parameters values are within acceptable levels and the sensors are measuring in a healthy manner.
Flight/Crew Safety and Mission Success • Across all consumable sets, demonstrate the HLS has sufficient resources to accommodate a minimum duration mission and return to Gateway or Orion. • Validate the status of failure tolerant systems and subsystems. Hazard controls that may have required on-orbit/in-flight verification shall be statused. • The assessment shall also include a review of any in-flight failures and anomalies (both hardware and software) that have occurred, including their resolution.
Crew Health and Medical

Acceptance Criteria
• Readiness of the integrated vehicle and HLS to safely support crewed flight operations shall be demonstrated by assessing vehicle telemetry for habitable conditions and relevant HLS data for safe operations. • Hazard controls that may have required on-orbit/in-flight verification shall be statused. • Assessment shall also include a review of any in-flight failures and anomalies (both hardware and software) that have occurred, including their resolution and residual risk to crew health and safety
Software • Software data shall demonstrate that the integrated HLS software parameters are within operating parameters and the software monitoring data are measuring in a healthy manner.

The final areas of testing required to meet the intent of this review and the specific information required to meet Critical Checkout Objectives in flight to meet the intent of this review will be finalized at Design Certification Review.

5.4.6 Post Mission Assessment Review (PMAR)

Objective: The Post Mission Assessment Review examines the success of the mission. The contractor shall provide a thorough post-flight summary of the mission. The summary shall include an assessment of HLS-Initial Capability performance, identification and closure (or closure plan) for in-flight anomalies, and the contractor's assessment of the overall mission success for the Artemis 3 mission. The PMAR shall be held no later than Mission Completion + thirty (30) days.

The primary and secondary objectives for the Artemis 3 demonstration mission are:

Primary Objectives

a. The transport of two (2) crew members from Gateway or Orion to the lunar surface and their safe return to Gateway or Orion.
b. Completion of one (1) or more lunar surface extravehicular activity excursions.
c. Safe disposal of the Human Landing System, including separation from Gateway or Orion.

Secondary Objective

a. Return of a lunar sample to Gateway or Orion

The Primary and Secondary Objectives listed above form the basis for defining mission success, as documented in the "Mission Success Determination" contract clause.

Table 5-6 contains the review topics and applicable products, to be delivered, for the Post Mission Assessment Review.

Table 5-6 PMAR REVIEW TOPICS

Review Topics	Applicable Products
Mission Performance Summary	Initial Mission Performance Evaluation Report (DRD 1701SE-016)
Anomaly Identification and Closure Plans	List of In-Flight/Ground Anomalies Closure Plan(s) for In-flight Anomalies
Final Documentation	Integrated Lander Final Design Data Package (DRD 1701CM-001) Final Scientific and Technical Report (DRD 1701MA-006) Active-Active Docking Adapter (AADA) Acceptance Data Package (ADP) (DRD 1701SE-008), if applicable Active-Active Docking Adapter (AADA) Final Design Data Package (DRD 1701CM-002), if applicable

5.5 Sustainability HLS Critical Milestone Reviews

5.5.1 Sustaining System Requirements Review (SRR)

a. Objective: The HLS Sustaining SRR examines the functional and performance requirements defined for the sustainable human landing system and ensures that the requirements with the selected concept will satisfy the mission and can be certified for human spaceflight. The Sustaining SRR should be completed by Authority to Proceed (ATP) + 8 months.

b. Table 5-7 shows the acceptance criteria and applicable products for the Sustaining SRR.

Table 5-7 SUSTAINING SRR ACCEPTANCE CRITERIA AND PRODUCTS

Acceptance Criteria	Applicable Products
The functional and performance requirements defined for the system, including external interfaces, are responsive to the parent requirements and	HLS Integrated Lander System Specification - Sustaining

Acceptance Criteria	Applicable Products
represent achievable capabilities.	
The functional and performance requirements defined for the docking system are responsive to the parent requirements and represent achievable capabilities.	HLS Integrated Lander System Specification - Sustaining
The maturity of project plans is sufficient to proceed.	Review Plan (Reference) Assembly, Integration and Test Plan - Sustaining Risk Management Plan SMA Plan Integrated Operations Training Mission Operations and Mission Systems Plan
Approaches have been determined and documented for how all requirements will be verified and validated, and the system will be certified for human spaceflight.	Verification, Validation, and Certification Plan - Sustaining
Major risks have been identified and technically addressed and viable mitigation strategies have been defined.	Risk Reports - Sustaining (Monthly Risk Report deliverable will be utilized to assess risk posture)
Adequate technical margins exist to complete the development within schedule and known risks	Integrated Systems Performance Analysis - Sustaining Design Data Book - Sustaining
TBD/TBRs items are clearly identified with acceptable plans and schedule for their disposition	Applies to all Products
Software management and control plan meets the intent of NPR 7150.2C, NASA Software Engineering Requirements.	Software Plan Software IV&V Findings Dispositions

Acceptance Criteria	Applicable Products
The proposed system architecture, inclusive of the flight system, supporting spacecraft that provide propellant storage and/or transfer, and logistics modules, is credible and responsive to the program requirements and constraints, including resources.	Design Data Book - Sustaining Integrated Systems Performance Analysis - Sustaining
The mission can likely be achieved within schedule with acceptable risk.	Integrated Master Schedule (Initial) Schedule Risk Assessment (SRA) Risk Reports - Sustaining (Monthly risk report deliverable to be utilized to assess Program risk)
Launch vehicle(s) has been identified that has adequate performance and capacity to deliver HLS to lunar NRHO or lunar orbit depending on architecture.	Launch vehicle option(s) with performance analysis (Presentation Only – No Deliverable)
NASA is given access to processes, activities, and data throughout the project life cycle	Insight Implementation Plan (Baseline)
Standards have been agreed to between NASA and the contractor	Agreed-to standards for execution

5.5.2 Sustaining Continuation Review (CR)

a. Objective: The HLS Sustaining CR demonstrates the design for a sustainable Human Landing System meets the system requirements, including human spaceflight verification, with acceptable risk. It will show that the correct design options have been selected, interfaces have been identified, and verification methods have been described. It will clearly define all testing, including checkout at NRHO or LO, required for human spaceflight certification. NASA will determine the agenda for the Continuation Review. The Sustaining CR should be completed by ATP + 18 months.

b. Table 5-8 shows the Acceptance criteria and applicable products for the Continuation Review.

Table 5-8 SUSTAINING CR ACCEPTANCE CRITERIA AND PRODUCTS

Acceptance Criteria	Applicable Products
The status of flow down of verifiable requirements and an adequate plan exists for timely resolution of open items. Requirements are traceable to HLS SRD.	HLS Integrated Lander System Specification - Sustaining
The status of flow down of verifiable requirements and an adequate plan exists for timely resolution of open items. Requirements are traceable to HLS SRD for the docking system.	HLS Integrated Lander System Specification - Sustaining
The program schedule is credible and within program constraints.	Integrated Master Schedule Schedule Risk Assessment
The design is expected to meet the requirements at an acceptable level of risk, inclusive of the flight system, supporting spacecraft that provide propellant storage and/or transfer, logistics modules, and the docking system.	Design Data Book - Sustaining Risk Report - Sustaining HLS Integrated Lander System Specification - Sustaining
Definition of the technical interfaces (both external entities and between internal elements) is consistent with the overall technical maturity, if not, an adequate plan exists for timely resolution of open items and provides an acceptable level of risk.	HLS Integrated Lander System Specification - Sustaining
The project risks are understood and have been credibly assessed, and plans exist to effectively manage them to achieve schedule.	Risk Report Integrated Master Schedule Schedule Risk Assessment (SRA)
SMA (e.g., safety, reliability, maintainability, quality, software assurance, and	System Safety Assessment Reports - Sustaining PRA (NASA generated)

Acceptance Criteria	Applicable Products
Electrical, Electronic, and Electromechanical (EEE) parts) have been adequately addressed in designs and any applicable SMA products (e.g., PRA, system safety analysis) meet requirements, are at the appropriate maturity level for this phase of the program's life-cycle, and indicate that the program safety/reliability residual risks will be at an acceptable level or if not, adequate plans exist for timely resolution of open items.	Human Error Analysis Reports and Analyses - Sustaining
Adequate technical margins exist to complete the development within schedule and known risks	Integrated Systems Performance Analysis - Sustaining Design Data Book - Sustaining
The operational concept is technically sound, includes (where appropriate) human systems, and includes the flow down of requirements for its execution	Mission Operations and Mission Systems Plan Integrated Operations Training Integrated Systems Performance Analysis - Sustaining Assembly, Integration and Test Plan - Sustaining
Technical trade studies are mostly complete to sufficient detail and remaining trade studies are identified, plans exist for their closure, and potential impacts are understood.	Presentation on Trade Study Results Status of Open Trades
TBD and TBR items are clearly identified with acceptable plans and schedule for their disposition.	Applicable to all Products
Status of analysis of the primary subsystems, highlighting performance and design margin challenges with a credible plan for closure in a timely manner and an achievable schedule.	Design Data Book - Sustaining Integrated Systems Performance Analysis - Sustaining Integrated Master Schedule Schedule Risk Assessment (SRA)

Acceptance Criteria	Applicable Products
Status of modeling and analytical results	Design Data Book - Sustaining Integrated Systems Performance Analysis - Sustaining
Manufacturability has been included in design.	Design Data Book - Sustaining
Status of software requirements and software plans including meeting the intent of NPR 7150.2C, NASA Software Engineering Requirements	Software Plan Software Test Plans Software Preliminary Design Resource and utilization constraints (e.g., CPU, memory); how the software will adapt to changing margin constraints; performance estimates IV&V findings dispositions
Launch Vehicle and Supporting Spacecraft Status	Presentation Only—Should include status on primary and backup launch vehicle options and the status on support spacecraft such as propellant storage, propellant transfer, and/or upper stage vehicles that provide transportation capabilities beyond the standard for orbit insertion.

6. ENGINEERING AND INTEGRATION

6.1 Engineering

The Engineering effort defines the tasks required to design, build, integrate, test, and certify the HLS Integrated Lander and includes the technical and management efforts of directing and controlling the integrated engineering effort for the design, development, manufacturing, integration, test, evaluation, verification, and validation of the HLS Integrated Lander to achieve a solution that satisfies HLS Integrated Lander requirements and otherwise balances performance, cost, schedule, and risk, to include docking adapter if applicable.

6.2 Engineering Management

The Engineering Management effort includes the technical and management efforts of directing and controlling the integrated engineering effort for the design, development, manufacturing, integration, test, evaluation, verification, and validation of the HLS Integrated Lander to achieve a solution that satisfies all HLS Integrated Lander requirements and otherwise balances performance, cost, schedule, and risk, to include docking adapter if applicable.

6.3 Requirements Development, Analysis, and Management

The contractor shall identify, derive, develop, and maintain requirements, including traceability and verification approach, necessary to implement a design that meets the NASA requirements

documented in HLS-RQMT-002, *Human Landing Systems (HLS) Contractor System Requirements Document (CSRD)* and HLS-RQMT-002-ANX-0X, *HLS CSRD Annex – Technical Authority Agreements* in accordance with HLS Integrated Lander System Specification – Initial Demo (DRD 1701SE-001). For sustaining integrated human landing system requirements, the contractor shall document in HLS Integrated Lander System Specification – Sustaining (DRD 1701SE-010).

6.3.1 Tracking and Traceability

The contractor shall define and deploy, by 1 month after contract award, a tool for requirements tracking and traceability that is capable of exporting requirements and the associated metadata into a Dynamic Object Oriented Requirements System (DOORS) format. If the contractor does not use DOORS for requirements tracking and traceability, Microsoft Excel format is acceptable.

a. The contractor shall provide remote electronic access to the requirements management tool and all levels of requirements data for Government-designated personnel or propose regular deliveries that meet the intent.

b. The contractor shall document the allocation of requirements in HLS-RQMT-002, *Human Landing Systems (HLS) Contractor System Requirements Document (CSRD)* and HLS-RQMT-002-ANX-0X, *HLS CSRD Annex – Technical Authority Agreements*, to lower level specifications, showing the traceability of all requirements including performance and design drivers--explicitly identifying any derived requirements—and shall maintain traceability of the requirements to the verification method and specific verification event or activity in accordance with HLS Integrated Lander System Specification – Initial Demo (DRD 1701SE-001). For sustaining integrated human landing system requirements, the contractor shall document in HLS Integrated Lander System Specification – Sustaining (DRD 1701SE-010).

6.3.2 Concept of Operations (ConOps)

The contractor shall prepare and submit a Concept of Operations (ConOps) documenting how the system will be used, operated, and maintained during all life-cycle phases so that their designs, development, integration, and tests will accommodate the needs, goals, objectives, missions, and operational philosophy of the stakeholders. The ConOps shall specify the uses, capabilities, and functions of the Human Landing System, inclusive of the flight system, supporting spacecraft that provide propellant storage and/or transfer, logistics flights, including interaction with other vehicles and Government entities. The ConOps for the initial demonstration mission shall be developed in accordance with Concepts of Operations (ConOps) – Initial Demo (DRD 1701SE-009), while the sustaining ConOps will be documented in accordance with Concepts of Operations (ConOps) – Sustaining (DRD 1701SE-015).

6.4 Interface Definition, Allocation, Verification and Control

Using the results of the analyses and allocations of technical parameters performed in support of the efforts described in Section 6.3.1.b, the contractor shall specify all interfaces not

explicitly defined by Government specifications. The contractor shall define, document, verify, and control these interfaces for the duration of the contract as per Sections 6.4.1 and 6.4.2.

6.4.1 External Interfaces

a. The contractor shall define, document and maintain the interface requirements internal to the HLS Integrated Lander systems for which the contractor is contractually responsible. The external and internal interface requirements for the hardware and software shall be defined in Interface Requirements Documents (IRD). The contractor shall provide the analysis, definition and support necessary to define these interface requirements.

b. The contractor shall perform all systems analyses and systems engineering to develop specifications, drawings and models defining and characterizing all of the external interfaces for the HLS Integrated Lander System. The external interfaces include, but are not limited to, Gateway/Orion, Extravehicular Activity (EVA) suits, Mission Systems, Ground Systems, and Launch Vehicle. The contractor shall deliver these specifications, drawings, and models to the HLS Program to support interface development, analyses and verification.

   1. The design of each external interface shall be documented in an Interface Control Document (ICD). The Interface Control Documents will be reviewed during Design Reviews and throughout the lifecycle through the Insight Implementation Plan.

   2. These documents will be developed in concert with external entities, which could be NASA, as required by the interface.

   3. For Ground Systems, Service Level Agreements (SLA), or equivalent, should be developed for all communication system links.

c. The contractor shall verify and maintain the interfaces defined for the duration of the contract including:

   1. Test and evaluation of the interfaces between the HLS Integrated Lander and other external simulators on the ground to demonstrate the integrated performance of the HLS Integrated Lander System.

   2. Performance of analyses and tests and documentation of results in reports and engineering data demonstrating the designed interfaces between the HLS Integrated Lander System and external systems/elements meet the appropriate IRDs.

   3. The contractor shall develop, deliver, and sustain an HLS Flight Software Simulator in compliance with DRD 1701OP-001 and an Avionics Emulator and accompanying Acceptance Data Package in compliance with DRD 1701SE-007 and HLS Integrated Lander GNC Simulator Specification (DRD 1701SE-006).

6.4.2 Interfaces with NASA On-Site Resources and GFP

a. Critical for testing to verify the Gateway interface, NASA will provide a Gateway/Orion Simulator/Emulator that can be used for the HLS Integrated Lander development and verification testing. The simulator/emulator is expected to provide a

high-level emulation of the avionics/command and data handling (C&DH) interface with the docking port.

1. The contractor shall perform all systems analyses and systems engineering to develop specifications and drawings defining and characterizing all of the interfaces.
    a. These interfaces shall be documented in Interface Control Documents (ICDs). These ICDs will be developed in concert with other entities, which could include NASA, as dictated by the interface.
2. The contractor shall verify and maintain the interfaces defined for the duration of the contract including:
    a. The contractor shall perform analyses and tests and provide reports and engineering data demonstrating the designed interfaces between the HLS Integrated Lander System and interfacing elements.
    b. Test and evaluation of the interfaces between the HLS Integrated Lander System and interfacing element simulators to demonstrate the integrated performance of the HLS Integrated Lander System with the interfacing elements prior to integration.
    c. Physical and functional integration of interfacing elements with the HLS Integrated Lander System and validation of external interface performance after integration into the HLS Integrated Lander System.

b. NASA will work with Lander supplier to mutually define an interface that documents the detailed implementation of utilities provided by the HLS Integrated Lander to the Exploration Extravehicular Activity (xEVA) System. NASA will require CAD models of HLS Integrated Lander structural interface for NASA-provided "hard-mounted" xEVA Servicing, Performance and Checkout Equipment (SPCE) and a physical copy of the structural interface NASA-provided "hard-mounted xEVA SPCE flight equipment will be installed in Lander. Intention is for NASA to use this during buildup of Design Verification Test (DVT) and Flight hardware to minimize risk/likelihood of encountering structural misalignments/geometry conflicts during later checkouts with Lander prototype/flight vehicles. Critical to verifying xEVA interfaces, NASA requires extensive and timely collaboration to ensure interface integrity, to include:
    1. Physical access to any early prototypes of the Lander-side structural interface for NASA-provided "hard mounted" xEVA SPCE. Joint debrief of findings to be conducted within 2 weeks of fitcheck completion (may be done at conclusion of fitcheck process as NASA's logistics allow).
    2. Physical access to the flight vehicle to support physical fitcheck and interface functionality of the NASA-provided "hard mounted" xEVA SPCE Verification and Validation (V&V) Unit. Joint debrief of findings to be conducted within 2 weeks of fitcheck completion (may be done at conclusion of fitcheck process as NASA's logistics allow).

3. Physical access to the flight vehicle to support delivery, installation and checkout of the NASA-provided "hard mounted" xEVA SPCE flight units. Joint debrief of findings to be conducted within 2 weeks of fitcheck completion (may be done at conclusion of fitcheck process as NASA's logistics allow).

4. Physical access to the flight vehicle to support stowage fitchecks of the loose equipment transferred by the flight crew to the HLS Integrated Lander prior to Lunar Descent (Exploration Extravehicular Mobility Unit (xEMU) Suits and xEVA Lunar Surface Geology Tools). Joint debrief of findings to be conducted within 2 weeks of fitcheck completion (may be done at conclusion of fitcheck process as NASA's logistics allow).

6.5 HLS Mission Design

The contractor shall, in accordance with the shared integrated mission design with the government, develop, validate and verify: a) specific trajectories to deliver the HLS from launch vehicle separation to the entry point of the selected lunar orbit, b) the orbit maintenance and attitude control trajectory maneuver strategy for the HLS during orbital phases of operation, c) descent to the lunar surface and d) ascent from the lunar surface and safe return of the crew to Gateway or Orion.

a. The contractor shall develop, verify and validate specific integrated trajectories in accordance with joint trajectory design, simulation, and modeling interface agreements.

b. The contractor shall perform integrated trajectory design which covers the development of the nominal and off-nominal transfer trajectories for all of the mission phase events, including margin design policy development and design as well as re-optimization or redesign of the nominal trajectory throughout the flight mission in response to changes to the nominal flight path.

c. The contractor shall perform Mission and Fault Management (M&FM) Design, Analysis, and Test to integrate and assess design information, interfaces, requirements, and compatibility as an element of the integrated mission design.

d. Whether the contractor opts to dock with and retrieve the crew from the Orion Crew Vehicle or Gateway, the contractor shall be responsible for launching all other logistics items with the HLS elements. This includes both government-furnished logistics in Table 8: *Crew and GFP Descent Mass* of the HLS Contractor System Requirements Document, HLS-RQMT-002, as well as contractor-provided logistics (including those needed to satisfy Orion or Gateway IRD requirements).

e. To enable end-to-end mission design and systems engineering and integration assessments, the contractor shall notify NASA of their intent to fly secondary payloads no later than:

   1. Launch – 9 months for the Uncrewed Lunar Landing Test

   2. Launch – 18 months, for the initial demonstration mission, for the specific launch that will deploy the secondary payloads.

f. For missions docking with Gateway, HLS modules, including reusable modules, shall depart Gateway no later than 7 days after the crew departs Gateway for return to Earth.

6.6 Design, Analysis and Trades

a. The contractor shall perform all engineering analyses necessary to develop a design solution that meets all of the HLS system requirements and lower level requirements. The contractor shall document the results of all analyses performed and these analyses shall be available for review by the HLS Insight Team throughout the lifecycle through the Insight Implementation Plan.

b. The contractor shall develop, implement, and maintain a plan in accordance with Software Plan (DRD 1701SW-002), and shall manage, develop, test, and integrate all software according to this plan. Subcontractor effort can be included in this plan or have its own plan.

c. The data related to integrated performance of the spacecraft or vehicle systems shall be documented and reported in the Integrated System Performance Analysis (ISPA)-Initial Demo (DRD 1701DE-002). For the sustaining HLS, the contractor shall develop a sustaining ISPA in accordance with Integrated System Performance Analysis – Sustaining (DRD 1701DE-004).

d. For purposes of communication and engineering completeness, the contractor shall develop a Design Data Book which provides a complete understanding of the HLS and each of the subsystems in accordance with Design Data Book- Initial Demo (DRD 1701DE-001). For the sustaining HLS, the contractor shall develop a sustaining Design Data Book in accordance with Design Data Book – Sustaining (DRD 1701DE-003).

e. The contractor shall provide the NASA Insight Team access to CAD models, drawings and data that define vehicle configuration, outer mold line, and interface features, to include packaging, for integrated operational analysis.

f. The contractor shall provide the NASA access to source code, software models, software design, software requirements, software build data, software configuration data, and software test data that define HLS Integrated Lander software configuration, access to all software/hardware interfaces, and operational plans.

g. The contractor shall provide engineering models and data in accordance with Engineering Design Models, Structural Dynamic and Loads Models, and Thermal Math Models (DRD 1701DE-005) for NASA to perform cross-program integrated analyses.

6.6.1 Modeling and Simulation

The contractor shall develop and deliver to NASA an HLS Integrated Lander GNC simulator and other relevant descriptive information that defines the simulator's capabilities for mathematically simulating the HLS Integrated Lander GNC operation and response to operating conditions in accordance with HLS Integrated Lander GNC Simulator Specification – Initial Demo (DRD 1701SE-006), and in accordance with HLS Integrated Lander GNC Simulator Specification – Sustaining (DRD 1701SE-014) for the sustainable HLS design and development efforts.

6.7 Uncrewed Lunar Landing Test

The contractor shall perform a successful uncrewed landing test on the lunar surface including HLS systems and/or subsystems necessary to demonstrate precision landing capabilities, at a scale representative of the planned Initial crewed demo landing, providing safety and risk mitigation prior to the crewed demonstration mission. To be considered successful, the uncrewed flight test shall achieve a lunar landing site between 84°S and 90°S, within 100m (3-sigma) of target landing site and transmit state-of-health telemetry back to earth for 2 hours (TBR) after landing. The specific landing site will be coordinated with NASA after Option A award. The contractor is encouraged to utilize Mission Control Center-Houston (MCC-H) capabilities to be consistent with a Test-Like-You-Fly philosophy.

6.7.1 Flight Test Readiness Review (FTRR) for Uncrewed Lunar Landing Test

The contractor shall conduct a Flight Test Readiness Review before execution of the Uncrewed Lunar Landing Test. The contractor shall address the following criteria, at a minimum:

a. Flight vehicle, launch vehicle, and support spacecraft are deemed safe and are ready for the test flight and can safely proceed with acceptable risk.

b. Class A-C software (per NPR 7150.2C, NASA Software Engineering Requirements) is deemed acceptably safe for an uncrewed test flight, has successfully completed software integration testing, and is ready to support flight, flight operations, and lunar surface operations.

c. Interfaces have been checked and demonstrated to be functional.

d. Demonstration of compliance with applicable NASA requirements, standards (or accepted alternate standards), processes, and procedures.

e. TBD and TBR items are resolved.

f. Open Items and Waivers have been examined; Flight rationale is acceptable.

g. Flight Environmental Factors are within constraints.

h. All open safety and risk items have been addressed and residual risk is deemed acceptable.

i. Supporting organizations are ready to support flight, to include trained operations personnel.

j. Software components meet the criteria defined in NASA-HDBK-2203, NASA Software Engineering Handbook, or an accepted alternate standard.

k. Responsible spectrum manager(s) concur that all necessary spectrum certification(s) and authorization(s) have been obtained.

l. Hazardous operations have been tested.

6.8 Assembly, Integration and Test (AI&T)

The contractor shall be responsible for implementation of a full assembly, integration, and test program for the HLS Integrated Lander system and lower level assemblies, ensuring the

performance and readiness of the HLS Integrated Lander system for the flight demonstration operations.

The contractor shall conduct data reviews following completion of test events to ensure that the test data verifies required performance/functionality and to review all anomalies.

6.8.1 Assembly, Integration and Test Plan

a. The contractor shall prepare, submit, and implement a HLS Assembly, Integration, and Test (AI&T) Plan – Initial Demo (DRD 1701SE-005). For the sustainable Human Landing System, the contractor shall develop and submit a HLS Assembly, Integration, and Test (AI&T) Plan – Sustaining (DRD 1701SE-013). The AI&T Plan(s) shall include the following elements:

   1. Definition of the overall strategy for testing the HLS Integrated Lander System and lower level assemblies, to include the Lunar Orbit Checkout Review testing.
   2. Include the test approach, types of tests, pass/fail criteria, decision process, software versions used for the test, and control milestones for proceeding to the next test.
   3. Summarize all tests and analyses that will be performed at each level, to include integrated hardware and software testing.
   4. Describe how the integration and test program will be managed and staffed.
   5. Include a schedule for test execution including the location and types of tests for the HLS Integrated Lander system and lower level assemblies.
   6. Describe plan for informing NASA of testing anomalies and mishaps (Reference Section 7.7)

b. The contractor shall ensure that the Assembly, Integration and Test Plan and Verification, Validation and Certification Plan are consistent and provide a complete set of activities necessary to ensure readiness of the HLS Integrated Lander System and lower level assemblies to certify the system to perform the crewed flight demonstration. The following testing areas shall be specifically addressed in the Assembly, Integration and Test Plan:

   1. Testing to support HLS System Certification, which shall include on-orbit checkout of the HLS Integrated Lander.
   2. Human-in-the-Loop (HITL) Test Strategy .
   3. Hardware and software in the loop test strategy, including end-to-end test approach and software stress test approach.

c. The contractor, as part of the Insight Implementation Plan, shall allow the Government to observe testing.

d. The contractor shall identify, track and resolve any integration or test problems through the initial demonstration mission.

e. The contractor shall accommodate NASA presence in AI&T activities, such as assembly and integration activities, software testing, integrated functional tests and pre- and post-test reviews, environment testing along with pre- and post-test reviews.

6.9 Verification, Validation and Certification

Validation is the process that shows that the correct requirements and architecture have been defined and meet the mission objectives. Verification shows how the requirements are met by the system. In addition to the contractor's verification, validation and certification efforts, the Government will also conduct independent verification, validation and certification efforts.

6.9.1 Verification, Validation and Certification Planning

The contractor shall develop and implement a plan for verification of the HLS in accordance with Verification, Validation and Certification (VV&C) Plan – Initial Demo (DRD 1701SE-002). For the sustainable integrated Human Landing System efforts, the contractor shall document their plan for verification in accordance with Verification, Validation, and Certification (VV&C) Plan – Sustaining (DRD 1701SE-011). The VV&C Plan shall include:

a. The overall approach for verifying and validating the requirements in HLS-RQMT-002, *Human Landing Systems (HLS) Contractor System Requirements Document (CSRD)* and HLS-RQMT-002-ANX-0X, *HLS CSRD Annex – Technical Authority Agreements* including the management and technical approach.

b. The verification methods, verification activities, verification reporting, discrepancy reporting, verification roles and responsibilities for the HLS Integrated Lander System and Subsystem levels that roll up to the requirements in HLS-RQMT-002, *Human Landing Systems (HLS) Contractor System Requirements Document (CSRD)* and HLS-RQMT-002-ANX-0X, *HLS CSRD Annex – Technical Authority Agreements*.

c. References to applicable plans, specifications, procedures, and reports that define the technical aspects of the verification program.

d. Any limitations in the ability to verify any performance requirement along with a risk assessment of the limitations in verifying those requirements.

e. The definition of tests and analyses that collectively demonstrate that the hardware complies with the HLS Integrated Lander system- and subsystem-level requirements.

f. The definition of tests and analyses that collectively demonstrate that the software complies with the HLS Integrated Lander system- and subsystem-level requirements.

g. The definition of the integrated hardware and software testing that demonstrate the integrated systems comply with the HLS Integrated Lander system- and subsystem-level requirements.

h. The contractor shall develop, document, and implement detailed success criteria for each of the Program-level verification/validation requirements in Detailed Verification Objectives (DVOs) – Initial Demo as defined in DRD 1701SE-003, or DRD 1701SE-012 for Detailed Verification objectives (DVOs) – Sustaining, to confirm the deliverable product is in compliance with requirements and is ready for a particular use, function, or mission.

i. For each analysis activity, the contractor will include in the Verification, Validation and Certification Plan objectives, a description of the mathematical model, assumptions on which the model is based, required output, criteria for assessing the acceptability of

the results, the interaction with related test activity and requirements for reports, and the process for validating the HLS Integrated Lander System for each level in the test program.

6.9.2 Software Verification and Validation

The contractor shall develop, implement, and maintain a plan for software verification, validation, and certification of all HLS software in accordance with the Software Verification, Validation and Certification Plan (DRD 1701SW-001). The Subcontractor effort can be included in this plan or have its own plan.

6.9.3 Verification Closure Notices

The contractor shall prepare and submit Verification Closure Notices, with accompanying verification data, in accordance with Verification Closure Notices (VCNs) (DRD 1701SE-004).

6.10 Software Independent Verification and Validation (IV&V)

While NASA has responsibility for IV&V of Class A-C software, per NPR 7150.2C, NASA Software Engineering Requirements, the contractor shall provide sufficient data and access into the HLS software requirements, design, development, integration, test, verification, certification, processes, and operations.

6.11 Software IV&V Participation with Contractor Software Development Teams

The contractor shall allow NASA IV&V participation with software teams and in software and cybersecurity events conducted by the HLS contractor and subcontractor including developer-level system, software, and cybersecurity reviews.

6.11.1 Software IV&V Technical Interchange Meetings

The contractor shall conduct monthly Technical Interchange Meetings (TIMs) with NASA IV&V. The purpose of these TIMs will be to discuss the resolution and/or implementation of issues found by IV&V and also share status and discuss availability of contractor information and data made available through the NASA Insight Process including management information, product information and technical data.

6.11.2 NASA Software IV&V Access

The contractor shall provide the NASA IV&V Team access to source code, software models, software design, software requirements, software build data, software configuration data, and software test data that define vehicle software configuration, cybersecurity-relevant mission documentation, access to all software/hardware interfaces, and operational plans. The contractor shall provide a point of contact for NASA IV&V communications.

6.12 Mission Performance Evaluation Report and Data

The contractor shall deliver Mission Performance Evaluation Reports, both an Initial Report and a Final Report, providing post mission information relative to mission success, problems encountered, and recommendations for improvement in accordance with Post Mission Reports and Data (DRD 1701SE-016). The report shall contain a mission summary, In-Flight

Anomalies (IFAs), evaluation of HLS hardware performance and operations, and effects on overall system performance and operational characteristics. The initial delivery of the Mission Performance Evaluation Report will be included in the Post-Mission Assessment Review (PMAR) (see Table 5-5).

7. SAFETY AND MISSION ASSURANCE

The contractor shall provide the technical and management effort necessary to ensure the overall safety and protection of flight and ground personnel, general public, flight/ground hardware, the environment, other orbiting spacecraft and facilities through all phases of the project, including oversight of contracted efforts. The contractor shall provide the opportunity for NASA stakeholder participation, review and concurrence with access to all safety and mission assurance products, processes, and procedures. This includes participation in reviews that address safety, quality, and reliability of HLS hardware, software, operations, and associated interfaces.

The contractor shall develop, implement, and maintain a Safety and Mission Assurance (SMA) Plan in accordance with DRD 1701SA-002, Safety and Mission Assurance Plan.

The SMA Plan will cover the HLS contractor's SMA organizational structure, roles and responsibilities for implementing the HLS SMA requirements, key external interfaces, and a summary of the SMA tasks to be performed throughout the HLS Program life cycle.

7.1 System Safety

The contractor shall develop a System Safety Plan, which can be a component of the Safety and Mission Assurance Plan, that identifies a system for managing safety risks by identifying, assessing and analyzing hazards to eliminate, reduce, or control the hazards. The System Safety Plan shall contain details of the method of compliance specified in the System Safety Plan section in DRD 1701SA-002, including the software safety program that meets the intent of NASA-STD-8739.8, *Software Assurance Standard,* and the hazard risk matrix definitions listed in HLS-PLAN-003, *HLS Safety and Mission Assurance Plan*.

The HLS safety review process evaluates the safety of design development starting as early as possible. The contractor system safety team is expected to work with NASA to ensure the full scope of the hazard analysis is being addressed, including crew survival methods analysis.

The contractor shall perform and document a hazard analysis of the HLS Integrated Lander to identify potential hazards, associated controls and verifications over its entire mission flight phase (crewed and uncrewed). Hazards analyses shall be in accordance with DRD 1701SA-001, System Safety Assessment Report (SSAR) – Initial Demo for the initial demonstration mission and DRD 1701SA-006, System Safety Assessment Report (SSAR) – Sustaining for the sustaining mission. The analysis shall identify hazards, determine the methods used for controlling the hazards, support the program risk management process, and establish verification methods applicable to design, development, manufacturing and assembly, testing, inspection, integration, and flight (of subject systems) including any interfacing ground support equipment (GSE), facilities, and ground operations.

The HLS mission flight phase (starting with Lunar Orbit entry of any HLS element that poses a hazard to Gateway or Orion) hazard analyses shall be presented to the HLS Safety and Engineering Review Panel (HSERP) prior to scheduled milestone reviews as called out in DRD 1701SA-001 for the initial demonstration mission and DRD 1701SA-006 for the sustaining mission. The associated hazard analyses shall include reach back to prior ground and mission phases where hazard causes that manifest in the mission flight phase can occur.

Formal reviews using the HSERP will be utilized in support of design reviews through the Design Certification Review (DCR) with a final post-DCR review planned just prior to shipping Integrated Lander hardware for the initial demonstration mission. Formal HSERP reviews will also occur in conjunction with the Sustaining SRR and CR. The purpose of the reviews is to obtain NASA concurrence that the design is safe per the requisite level of design maturity. The contractor shall ensure at each review that all hazardous conditions or other safety issues have been identified and controls identified appropriate to the hazard level.

a. At the Critical Design Review (CDR) safety review meeting, the contractor shall present the design and operations scenario for an initial design maturity; all identified hazards and hazard causes; the evaluation for the means of eliminating, reducing or controlling the associated risk; the safety verification methods; identify the likelihood and severity for each unique hazard cause and provide a list of Failure Tolerance Exemptions (e.g., Exemption As and Bs). This content is captured in the CDR SSAR and the associated hazard reports.

b. At the Design Certification Review (DCR) safety review meeting, the contractor shall present the final design and operations scenario; all identified hazards, hazard causes, and critical items; the means for eliminating, reducing, or controlling the risk has been defined and implemented; verifications have been completed or a closure plan, utilizing a Safety Verification Tracking Log (SVTL), including estimated closure date (ECD) and constrained operations, are concurred with by the SERP. The content is captured in the DCR SSAR and associated hazard reports.

c. Post-DCR, formal approval of the hazard reports is complete when the verification tracking list shows that all open verifications have been successfully completed. The contractor shall keep the SVTL up to date. The contractor shall deliver the hazard control verification data prior to shipping hardware to the launch site.

d. The completion of the appropriate safety analysis and the Program acceptance of the residual risk is a component of the success criteria for the engineering milestone reviews, including the Flight Readiness Review (FRR).

The contractor shall provide the opportunity for NASA participation, review and understanding with access to all safety products, processes, and procedures. This includes participation in the launch site safety reviews, ground and payload safety working group (PSWG) as a NASA payload safety representative and a NASA launch vehicle safety representative for each NASA mission under this contract. The HLS contractor is expected to initiate and support the PSWG process as defined in NPR 8715.7, *Expendable Launch Vehicle Payload Safety Program*.

The contractor shall take into account the hazards identified by the Cross Program Hazard Analyses; supporting spacecraft such propellant depots, propellant transfer vehicles, and/or

upper stages that provide guidance or services in addition to those to achieve orbit; logistics modules; and Lunar EVA Suits Hazard Analysis that will be transferred to the HLS Integrated Lander. The HLS Program will develop cross-program hazards and coordinate with the HLS Integrated Lander contractor by providing the list of these transfers that the contractor shall address in its integrated lander hazard analyses.

The hazard analysis shall be linked to a structured methodology for identifying potential failures such as a fault tree analysis (FTA) and pertinent failure modes and effects analysis/critical items list (FMEA/CIL), if used by the contractor, entries to show the interrelationship of hazards to system and subsystem failure mechanisms. This information shall be provided at each milestone review.

The contractor shall capture and document all engineering analyses, trade studies, risk assessments, presentation briefings, and any associated supporting hazard analyses data that is in addition to the documented hazard reports.

The safety data for flight, launch, transport and ground phases shall be archived and made available when requested by the NASA stakeholder.

7.2 Industrial Safety, Health and Environmental Protection

If the contractor performs work on U.S. Governments sites, the contractor shall develop and provide the following:

a. An On-Site Safety, Health, and Environmental (SHE) Plan shall be developed and implemented. Specific On-Site SHE Plan requirements are dependent upon which Government facility work is being performed. The contractor and the Contracting Officer shall determine specific requirements for the Plan based on the Government site being used.

b. All on-site mishap close calls and safety statistics, including trend items, shall be reported to the Contracting Officer. Specific reporting requirements shall be determined by the contractor and the Contracting Officer based on which Government facility work is being performed.

c. Sufficient information and technical data to enable NASA or its agent to complete its National Environmental Policy Act analysis in accordance with NPR 8580.1, *National Environmental Policy Act Management Requirements*, and Executive Order 12114.

7.3 Reliability and Maintainability

7.3.1 Reliability and Maintainability Plan

The contractor shall provide a plan to describe how reliability and maintainability (R&M) tasks and activities will be performed. The R&M Plan may be a stand-alone document or included as a component of the program SMA Plan in accordance with DRD 1701SA-002, Safety and Mission Assurance Plan. In addition, the contractor shall provide a description of any planned in-space/lunar surface maintenance required to meet the initial demonstration mission and subsequent sustaining missions.

7.3.2 Reliability Analysis

The contractor shall perform a Reliability Prediction Analysis in accordance with their Reliability Plan and provide the final Reliability Prediction Analysis at the Critical Design Review. If there are any updates post CDR, an updated Reliability Prediction Analysis shall be provided at DCR. The results shall be compared to the reliability allocation for the HLS Integrated Lander. Reliability-informed approaches (including associated results) used in lieu of compliance to single failure tolerance shall be presented to the HLS Safety and Engineering Review Panel (HSERP) prior to each scheduled milestone review.

7.3.3 NASA Advisories and Government Industry Data Exchange Program (GIDEP) Failure Experience Data (FED) Processing

The contractor shall establish a system to receive, investigate, report, and exchange information involving safety or parts and materials problems. The contractor shall designate a NASA Advisory and GIDEP FED [hereafter referred to as Alerts] Coordinator within its organization with responsibility to review incoming Alerts for impact to the HLS and take actions on Alerts as appropriate to assure proper disposition. The contractor shall provide the Alert coordinator's name and contact information to the Program Manager/Contracting Officer's Technical Representative and NASA Marshall Space Flight Center (MSFC) SMA Alert Coordinator within 30 days after contract award. The contractor shall review all GIDEP Notices and designated Alerts to determine if they affect the contractor's products/and or services provided to the Government. The contractor is responsible for stating whether or not each GIDEP Notice and Alerts affects the subcontractor's products and services provided to the Government. The contractor shall document contractor-initiated Alerts and provide notification to the NASA Marshall Space Flight Center (MSFC) SMA Alert Coordinator.

7.3.4 Problem Assessment System (PAS)

The contractor shall define and implement an effective closed loop Problem Assessment System (PAS) Plan to identify, record, track, analyze, resolve, report, and disposition identified safety critical and mission critical problems that threaten or potentially could threaten mission success.

7.3.5 NASA Probabilistic Reliability Analysis (PRA) Data

The NASA-generated Artemis mission PRA is dependent on contractor reliability data sets and an understanding of HLS operations at the subsystem level. The Contractor shall provide access to the data necessary for NASA PRA analysts to develop the Artemis mission PRA. To ensure the PRA model accurately reflects the contractor's HLS design and operations, the contractor shall support quarterly Technical Interface Meetings (TIMs) with emphasis on supporting the review milestones where PRA results will be presented by NASA.

7.4 Software Assurance

The contractor shall establish and maintain a Software Assurance program that meets the intent of NASA-STD-8739.8, *Software Assurance Standard*. The contractor's Software Assurance

Planning shall be addressed in the SMA Plan in accordance with SMA Plan (DRD 1701SA-002).

The contractor shall maintain software assurance records in accordance with its Software Assurance Plan and shall make them available in accordance with the Insight Implementation Plan.

The contractor shall identify their Software Verification and Validation Plan and document in accordance with Software Verification, Validation and Certification Plan (DRD 1701SW-001).

7.5 Quality Assurance

The contractor shall meet the intent of SAE AS9100, *Quality Management System – Requirements for Aviation, Space and Defense Organizations*, for all activities performed under this contract. The contractor Quality Assurance Plan shall be in accordance with DRD 1701SA-002. Initial submittal of this document may be submitted as one package; or this plan may be incorporated in a more comprehensive Safety and Mission Assurance (SMA) Plan.

The contractor shall allow a NASA insight team member to participate on contractor Material Review Boards or equivalent allowing insight into non-conformances associated with safety critical subsystems and to inform Program risk posture.

7.6 Micrometeoroid Orbital Debris (MMOD) and Orbital Debris Assessment Reports (ODAR)

The contractor shall assess the risk to HLS spacecraft and crew resulting from damage or penetration of HLS components from micrometeoroid and orbital debris impacts during various mission phases. MMOD Analyses will provide feedback verification that the HLS flight system design meets HLS protection requirements. The MMOD analysis shall be prepared in accordance with DRD 1701SA-004, Micrometeoroid Orbital Debris (MMOD) Report.

The contractor shall assess its design as it relates to orbital debris generation during all phases of the mission, including launch, surface operations, and disposal. As the design matures the contractor shall prepare the ODAR products defined in NASA-STD-8719.14, *Process for Limiting Orbital Debris*. ODARs and End of Mission Plan (EOMP) product submissions shall be in accordance with DRD 1701MP-001, Orbital Debris Assessment Reports (ODARs) and End of Mission Plan (EOMP).

7.7 Anomaly Investigation and Corrective Action

An anomaly is an unexpected event, hardware or software damage, departure from established procedures or performance, or a deviation of system, subsystem, or hardware or software performance outside intended design or expected performance specification limits.

a. The contractor shall notify the Government of reportable HLS anomalies within 24 hrs. of identification. Reportable HLS anomalies are those that:

    1. Could potentially and negatively affect HLS certification, post certification performance, hazards, hazard controls, or verifications; or

2. Are unexplained or could not be duplicated.
3. Occur in flight or in testing of flight hardware and software for the required Uncrewed Lunar Landing Test and the initial HLS mission. Development testing is excluded from this requirement.

b. The contractor shall determine the scope of the anomaly investigation and shall conduct and control the investigation. The Government may designate representatives to observe and participate in the contractor's investigation. The contractor shall accommodate Government representation to the contractor's investigation.

c. The contractor shall be responsible for identifying the cause(s) of the anomaly and implementing corrective action(s). The contractor shall provide the Government access to any findings and any proposed corrective actions. If the contractor implements any changes to the HLS design that could negatively affect certification, post certification performance, hazards, controls, or verifications of the HLS, the contractor shall notify the Government of the change.

d. If the Government decides to conduct its own investigation of any anomaly, the contractor shall provide personnel support and data, as necessary, to support the Government anomaly investigation.

7.8 Mishap Preparedness and Reporting

The contractor shall assess its mishap and close call reporting process when NASA personnel or property are involved, at non-NASA government facilities, in-flight, and in-space, as defined in NPR 8621.1D, *NASA Procedural Requirements for Mishap and Close Call*. The contractor Mishap Preparedness and Contingency Plan shall be in accordance with DRD 1701SA-003, Mishap Preparedness and Contingency Plan.

7.9 Planetary Protection

The HLS Program is proceeding with the Mission Category II-L. HLS-PLAN-013, *HLS Planetary Protection Plan* is available to the contractor as an applicable document for additional guidance. The contractor shall provide the requested planetary protection data to NASA in accordance with DRD 1701SA-005, Planetary Protection Data.

7.9.1 Planetary Protection Extended Mission Data

If there are changes that impact Planetary Protection not addressed in the Post-Launch Data, the contractor shall submit Extended Mission Data to describe those changes.

8. HUMAN HEALTH AND MEDICAL

The contractor will use human-centered design and human systems integration practices to protect the health and safety of the crew, reduce human error and enable the crew to operate the system in an effective and efficient manner that meets or exceeds the intent of Appendix C in HLS-RQMT-002-ANX-0X *HLS CSRD Annex — Technical Authority Agreements.* The information contained within Appendix C has been tailored from NASA-STD-3001, *NASA*

Space Flight Human Systems Standards Volume 2, Rev B: Human Factors, Habitability, and Environmental Health, and NASA-STD-3001: *NASA Space Flight Human Systems Standard Volume 1 Rev A: Crew Health*, to assist the contractor in focusing on areas specific to the initial Human Landing System demonstration mission.

8.1 Human Error Analysis

The contractor shall document the analytical approach in accordance with Human Error Analysis (HEA) Plan (DRD 1701HS-001). The results of the task and human error analyses shall be documented in accordance with Human Error Analysis (HEA) Reports and Analyses – Initial Demo (DRD 1701HS-002). The results of the task and human error analyses sustaining integrated human lander system design and development shall be documented in Human Error Analysis (HEA) Reports and Analyses – Sustaining (DRD 1701HS-003). As a key component for human rating a NASA spacecraft, this data is intended to provide NASA with insight into the contractor's approach to managing human error, and the design trades, decisions and system improvements the contractor made to reduce the frequency and negative effects of human error.

8.2 Human Factors Analysis

The contractor shall perform human factors analysis (e.g. worksite; usability; population; crew loads; handling qualities necessary for manual control for landing controls and piloting tasks), occupant protection analyses (acceleration, velocity and vibration on the crew), noise and ionizing/non-ionizing radiation analysis in support of hardware, software and operations development in accordance with Integrated Systems Performance Analysis (ISPA) – Initial Demo (DRD 1701DE-002), and Integrated Systems Performance Analysis (ISPA) – Sustaining (DRD 1701DE-004) for sustaining integrated lander design and development efforts.

8.3 Displays and Controls

Since NASA is not imposing the usual design-to and verification standards for displays and controls layout; display and information navigation logic; colors and icons and symbols usage; units of measure; labeling style and placement; operational nomenclature for displays, controls, and equipment; and lighting on the contractor, the contractor shall provide NASA insight into the contractor's approach, plans, standards and data in order to assure that the final design will be sufficient to meet the requirements of the HLS Integrated Lander.

8.4 Toxicological Assessment of Chemicals to be Flown on Manned Spacecraft

The contractor shall deliver data on the chemicals used in vehicle and system design in accordance with JSC 27472 - *Requirements for Submission of Data Needed for Toxicological Assessment of Chemicals to be Flown on Manned Spacecraft*.

8.5 Decompression Sickness Protocol and Treatment

The contractor shall provide data and support to NASA in the development of an integrated Decompression Sickness (DCS) Protocol and Treatment Strategy across Gateway/Orion and the HLS.

8.6 Human Systems Best Practices

The contractor shall document how they have addressed best practices identified by child Human Systems Requirements that are marked as "should" in the HLS-RQMT-002-ANX-0X, *HLS CSRD Annex – Technical Authority Agreements* in accordance with the Verification, Validation, and Certification Plan (DRD 1701SE-002).

9. FLIGHT OPERATIONS AND OPERATIONS SUPPORT

9.1 Overview

HLS Flight Operations and operations support collectively span the Option A period of performance and include activities such as operational assessments in DDT&E; mission planning; operational product development; crew, flight controller, and Mission Management Team (MMT) training; and real-time mission execution.

9.2 Definitions

For purposes of this section (section 9), the following definitions apply.

Approach Ellipsoid means the region surrounding the target vehicle during rendezvous, proximity operations, docking, and undocking (RPODU) operations that the chaser vehicle shall not enter without NASA approval. The extent of the approach ellipsoid is to be specified in the Flight Rules.

Artemis Mission means NASA's Artemis III mission that begins with the launch of the crew aboard NASA's Orion Spacecraft, proceeds concurrently with the HLS mission, and ends with the crew's return to Earth.

Critical Event means any of the following events that occur during HLS Flight Operations: Launch of Integrated Lander element(s), RPODU with any Crewed Staging Vehicle (CSV) hatch opening and closing, critical burns for lunar descent and lunar ascent, all lunar surface operations, and aborts during any crewed operations. The Parties may amend and finalize the list of Critical Events within the Flight Rules and procedures.

HLS Flight Operations means the period of performance that begins with the first Earth launch of any element of the HLS Integrated Lander, includes the entirety of the HLS Mission, and concludes with the subsequent transition of the uncrewed HLS out of the CSV approach ellipsoid.

Flight Rules means the documentation defining pre-planned decisions for real-time flight operations.

HLS Mission (also defined in the "Mission Success Determination" contract clause) overlaps with but is distinct from HLS Flight Operations and means the period of performance that begins when the contractor has achieved, as determined solely by the Contracting Officer, all of the milestone acceptance criteria for the "Lunar Orbit Checkout Review" milestone, and ends: (i) Upon the safe return of the crew from the lunar surface to Gateway or Orion; or (ii) At the time the contractor ceases attempting to achieve, or is no longer capable of achieving, any of the primary objectives listed within this SOW.

MCC-H means NASA's Mission Control Center – Houston.

RPODU means rendezvous, proximity operations, docking, and undocking.

9.3 Mission Planning and Operations Product Development

The contractor shall perform and document (within DRD 1701-OP-003) its HLS mission planning using contractor-defined operations standards and processes.

The HLS mission planning responsibilities for which NASA is responsible are as follows:

a. The Artemis Mission Flight Rules;

b. Artemis mission design;

c. Artemis mission plan;

d. Operations support products; and

e. Lunar surface planning and operations product development.

For flight operations phases operating under either a Contractor-Led or Integrated Operations mode (as described in Section 9.5.3), the contractor shall develop the initial draft of joint procedures and submit it to NASA for review and approval. NASA will provide input and feedback and return it to the contractor for revision. The parties shall iterate in this manner until the document is approved by both parties.

For flight operations phases operating under a NASA-Led Operations mode (as described in Section 9.5.3), the contractor shall provide input and feedback to the initial draft of joint procedures developed by NASA within 30 days. The parties shall iterate in this manner until the document is approved by NASA.

Both NASA and the contractor have distinct responsibilities related to the development and certification of mission planning and operations products. Specifically, the contractor shall, in accordance with plans and schedules established in existing DRDs:

a. Provide any data, analysis, and all HLS plans and products and support necessary for development of the Artemis mission products (these products are expected to be within the scope of existing DRDs and are likely to include, but are not limited to, the timeline, joint operations procedures, joint flight rules, operations interface procedures, operational communication plan, operations management plan, contingency action plan);;

b. Support interface control document development to establish the required interfaces to NASA mission/ground systems necessary for development and certification of flight operations; and

c. Support working groups, panels, boards and testing required for NASA to timely develop and approve these plans, products, and mission systems interfaces.

9.4 Integrated Operations Training

The contractor shall develop the training capabilities (such as mockups and simulators) and products for, and conduct the training for, HLS Flight Operations using contractor-defined training standards and processes. Specifically, the contractor shall provision and/or support the following capabilities and activities in accordance with Integrated Operations Training (DRD 1701OP-002) and Flight Software Simulator (DRD 1701OP-001):

a. Full scale mockup(s), with increasing levels of fidelity over the project life to support crew systems training, operations and logistics, egress/ingress, depress/repress, in-space maintenance, fit checks, suit operations, and human in the loop (HITL) assessments including command/control interfaces, use of window(s), and surface slope mitigation for crewed operations;

b. High fidelity mission simulator to support dynamic event crew training, integrated Gateway/Orion and surface operations training, and lander simulations, including operations for orbital transfers and maneuvers, RPODU, lunar descent and landing, lunar surface operations, and lunar ascent. These facilities may include fixed-base and/or motion-base simulators.

c. Support the NASA Training System (i.e., Orion/Gateway) to HLS Training System(s) ICD development and establishment and maintenance of interfaces with Gateway/Orion, surface systems, and simulators to conduct integrated mission simulations;

d. Visualization tools supporting situational and spatial awareness training;

e. NASA crew and Flight Operations personnel participation with the contractor design and development team to obtain fundamental knowledge and training on vehicle systems;

f. Vehicle systems training, to include emergencies and crew vehicle interactions;

g. A minimum of 1 full-time equivalent contractor personnel support to working groups, panels, and boards required to develop and approve the training plans, schedules, and products required for training execution and certification of the crew and flight control teams;

h. Contractor personnel support for a minimum of five integrated simulations and a minimum of ten crew training events;

i. Training software, data, documentation, and supporting materials associated with each training capability; and

j. Maintenance and support strategy for contractor-developed and contractor-delivered hardware and software associated with HLS simulators and emulators.

NASA is responsible for the overall Artemis crew training plan, training for the NASA Artemis personnel supporting Artemis and HLS operations within the authorities defined below in section 9.5.1, and for maintaining NASA interfaces to HLS training systems.

Subject to NASA's final approval, the contractor shall develop and deliver a training plan and schedule in accordance with DRD OP-002, Integrated Operations Training.

NASA will certify all personnel proposed to be a member of the flight operations team at MCC-H. The contractor shall obtain certification by NASA for all contractor personnel proposed to be a member of the flight operations team. All contractor flight ops personnel at MCC-H conducting command and control of HLS shall further be certified by the contractor in accordance with DRD OP-002, Integrated Operations Training.

9.5 Mission Execution

9.5.1 NASA Responsibilities

NASA responsibilities for Artemis Mission execution include the following:

a. NASA Flight Control Team Roles

As part of NASA's Artemis Mission responsibilities and in support of HLS Flight Operations, NASA personnel will hold core real-time flight control roles, and could include the following:

Artemis Flight Director: Responsibilities include: overall Artemis mission safety and integration; coordination with the contractor regarding successful execution of the HLS mission plan; combined crew and vehicle safety and execution of the mission plan during integrated operations; authority for abort decisions and Go/No-Go calls during all crewed HLS phases within the authorities defined in Section 9.5.3.

Artemis CapCom: Primary responsibility for voice communications with the crew during all crewed mission phases for the Artemis mission.

Artemis Flight Surgeon: Responsible for all crew medical decisions during all crewed mission phases for the Artemis mission.

Artemis EVA Officer: Responsible for all xEVA operations inside the HLS (i.e. don, doff, ingress, and egress) and on the lunar surface.

b. Management of government-provided space communication assets and routing of forward and return communication links (command/data/voice, etc.) between MCC-H and government-provided space communication assets, if applicable.

c. MCC-H facility operations and interfaces with contractor control center(s).

9.5.2 Contractor Responsibilities

Contractor responsibilities to support Artemis Mission execution include the following:

a. Mission/ground systems interfaces as documented in the HLS-to MS IRD (HLS-IRD-004) and all applicable ICDs.

b. Communication links between MCC-H and any contractor mission operations site and/or commercial communication assets.

c. Processing and distribution of applicable telemetry/commands/voice/video for use, evaluation, and archiving within MCC-H.

d. Modifications to MCC-H tools, equipment, or facility software that are required to support whether the HLS flight control is co-located at MCC-H or distributed.

e. Integrated lander systems and subsystem engineering expertise and support to the flight control team during mission operations.

f. Contractor proposed lander flight operations positions.

9.5.3 Operational Modes

For all Operational Modes during HLS Flight Operations, the following **General Operational Rules** apply: (1) NASA maintains the right, and the Contractor shall effectuate NASA's ability, to fully monitor HLS performance at MCC-H (e.g., NASA monitoring real-time data); (2) the Contractor shall coordinate with NASA on all activities that impact the integrated Artemis mission; (3) at all times during HLS Flight Operations, the Flight Rules apply, and when there is a conflict between the Flight Rules and any other portion of the contract, including this Statement of Work, the Flight Rules govern; and (4) NASA personnel defined herein will maintain the roles and responsibilities specified herein.

The following Operational Modes during HLS Flight Operations are defined:

I. **Contractor-Led Operations:** Other than the authorities granted to NASA within the General Operational Rules, NASA has no authority to direct specific contract performance.

II. **Integrated Operations:** In addition to the authorities granted to NASA within the General Operational Rules, NASA also has the authority for abort decisions and Go/No-Go calls at Critical Events. The Contractor shall otherwise have operational decision-making authority and shall command and control all HLS vehicles.

III. **NASA-Led Operations:** In addition to the authorities granted to NASA within the General Operational Rules, NASA also has the authority for abort decisions, Go/No-Go calls at Critical Events, and operational decision-making. NASA shall direct the Contractor execution of command and control of HLS vehicles.

9.5.4 HLS Flight Operations Phases

The Contractor's performance requirements are delineated herein according to the HLS Flight Operations Phases defined in the table below. The phases are applicable to all HLS Flight Operations pertaining to individual HLS elements or to multi-element HLS configurations.

Table 9-1 DESCRIPTION OF HLS FLIGHT OPERATIONS PHASES

HLS Flight Operations Phase	Description
Uncrewed, Earth Launch	Earth launch, including pre-launch check out, of uncrewed HLS Integrated Lander elements.
Uncrewed, Outside Approach Ellipsoid	All uncrewed HLS flight operations after Earth launch, except when the HLS is in lunar orbit located within the CSV Approach Ellipsoid (or when the CSV is within the HLS Approach Ellipsoid, as applicable).
Uncrewed, Inside Approach Ellipsoid	Uncrewed HLS flight operations in lunar orbit when not docked with the CSV, and when HLS is located within the CSV Approach Ellipsoid (or when the CSV is within the HLS Approach Ellipsoid, as applicable).
Crewed, Inside Approach Ellipsoid	Crewed HLS flight operations in lunar orbit when not docked with the CSV, and when HLS is within the CSV Approach Ellipsoid (or when the CSV is within the HLS Approach Ellipsoid, as applicable).
Docked with CSV	Crewed HLS flight operations while docked with the CSV.
Crewed, Lunar Descent	Crewed HLS flight operations beginning with HLS exit from the CSV Approach Ellipsoid (or with CSV exit from the HLS Approach Ellipsoid, as applicable), and concluding with touchdown on the lunar surface.
Crewed, Lunar Surface, Dynamic	Dynamic crewed HLS flight operations on the lunar surface including, but not limited to, EVA-related operations.
Crewed, Lunar Surface, Quiescent	Quiescent crewed HLS flight operations on the lunar surface including crew sleep.
Crewed, Lunar Ascent	Crewed HLS flight operations beginning with HLS liftoff from the lunar surface and concluding with HLS entrance into the CSV Approach Ellipsoid (or with CSV entrance into the HLS Approach Ellipsoid, as applicable).

During each HLS Flight Operations Phase, the Parties shall employ one of the three Operational Modes defined above, with permissible phase-specific options indicated below. Implementation details shall be documented in the Mission Operations and Mission Systems Plan (DRD OP-003), In conducting real-time operations for each Phase, the Contractor shall either co-locate its flight control team together with NASA's flight control team at MCC-H, or else situate its team at a Contractor control center facility, forming a distributed team.

Table 9-2 HLS FLIGHT OPERATIONS PHASES AND OPERATIONAL MODES

HLS Flight Operations Phase	Operational Mode
Uncrewed, Earth Launch	Integrated
Uncrewed, Outside Approach Ellipsoid	Contractor-led
Uncrewed, Inside Approach Ellipsoid	Integrated OR NASA-led
Crewed, Inside Approach Ellipsoid	Integrated OR NASA-led
Docked with CSV	Integrated OR NASA-led
Crewed, Lunar Descent	Integrated OR NASA-led
Crewed, Lunar Surface, Dynamic	NASA-led
Crewed, Lunar Surface, Quiescent	Integrated OR NASA-led
Crewed, Lunar Ascent	Integrated OR NASA-led

10. LAUNCH VEHICLE PROCESSING, INTEGRATION, AND OPERATIONS

The contractor shall secure a commercial launch vehicle service for transportation of HLS module(s) or integrated landing system to lunar orbit, as well as all necessary launch slots and licenses in accordance with Contract H clause – Licenses, Permits, and Other Authorizations for a Launch or Reentry Service Operator. The proposed launch vehicles, by three (3) months prior to the FRR, must either:

a. Have been NASA Launch Services (NLS) II certified vehicle (reference NASA Policy Directive (NPD) 8610.7).

b. Have at least three (3) successful demonstrated launches of a common launch vehicle configuration prior to launching HLS elements.

As the integration and launch is one of the highest risk events of the mission, NASA will perform Launch Vehicle independent risk assessments with mitigation implementation for each NASA mission. In order to accomplish this task, NASA will work directly with the contractor and/or subcontractor in the performance of the following tasks:

a. Launch Vehicle (LV) fleet and LV mission specific hardware/software risk reduction through spacecraft separation

b. Launch vehicle to spacecraft mission integration insight

The HLS contractor shall ensure all tasks necessary to safely and reliably launch and deliver the spacecraft in accordance with NASA-defined mission objectives.

10.1 Launch Vehicle Insight

The HLS contractor shall work directly with NASA to provide an adequate level of insight into launch vehicle-related tasks and milestones in order to ensure reasonable steps have been taken that result in a high probability of mission success. This includes insight into any corporation, corporate divisions, subsidiaries, joint ventures, partner(s) and any other business entity actually performing launch vehicle manufacturing, management, spacecraft-to-launch vehicle

integration, testing, and launch. This also includes insight into certain major sub-contractor tasks and milestones (i.e., those subcontractors that perform major portions of manufacturing or integration of vehicle systems). Fulfillment of this could require HLS contractor execution of third-party data rights agreements with its suppliers, as well as rights to information developed under other programs, to provide adequate NASA insight on parts and services procured by the contractor. The HLS contractor shall obtain signed commitments to comply with the terms of the Insight Clause and Statement of Work requirements from any major subcontractor, or sub-tier contractor that will manufacture critical launch vehicle components (e.g., propulsion, avionics, flight controls, software, separation systems, etc.).

NASA insight is defined as gaining an understanding necessary to knowledgeably concur/non-concur with the HLS contractor's actions through interaction, watchful observation, documentation review, meeting attendance, reviews, tests, software IV&V, and compliance evaluations. The HLS contractor shall be responsible for directly notifying of meetings, reviews, or tests in sufficient time to permit meaningful Government participation.

NASA shall have insight into any launch vehicle fleet or vehicle changes or any changes that may affect the HLS missions.

The HLS contractor shall provide the data, documentation, drawings, software, analytical models, and support services as necessary to accommodate the requirements specified. The HLS contractor shall provide this information for launch vehicle systems, subsystems, materials, processes, and test equipment including, upon request, those used on non-NASA missions with findings specifically related to the NASA mission.

10.1.1 Government Insight Areas

a. Interface requirements between spacecraft and the launch vehicle via Spacecraft-to-launch vehicle interface control documents/drawings including deviations, waivers and verifications
b. LV mission-unique hardware and software design analysis, manufacture, and test
c. LV Integrated spacecraft-to-launch/transit vehicle handling, mate, test, and closeout procedures and deviations
d. Launch countdown procedures and deviations that affect the spacecraft at the ICD integrated assembly level
e. LV anomaly resolutions that affect the integrated assembly
   Note: Anomaly resolutions affecting the integrated assembly also requires NASA approval
f. LV baseline vehicle design, analyses, models, and configuration management
g. LV production program reviews, plans, and schedules
h. LV production and systems test, and Material Review Boards
j. LV critical flight hardware pedigree
k. LV flight and ground software (Class A-C software per NPR 7150.2C, NASA Software Engineering Requirements)
l. LV Safety and Mission Assurance compliance evaluations (prime and subcontractors)
m. LV pre-ship reviews
n. LV design and qualification reviews
o. Major/critical LV problems and their resolutions

p. Major LV system and integrated systems tests
q. LV post-test data
r. LV failure analysis
s. LV/ground support equipment procedures
t. LV launch site support work schedules and plans
u. LV launch site vehicle preparations and closeout data
v. LV walk-down inspections
w. LV operations and procedure discipline
x. LV work practices and documentation
y. Conduct of HLS contractor-chaired Mission, Launch, and Flight Readiness Reviews
z. LV post-flight vehicle, tracking, and Range data
aa. LV post-flight anomaly investigations/close-outs
bb. Vehicle and GSE telemetry (test, pre-launch, and launch)
cc. Decisions/resolutions of action items as determined by joint NASA/HLS contractor mission integration teams
dd. Top-level LV test plans, requirements, and success criteria for integrated vehicle systems and for tests that verify the integrated vehicle interfaces
ee. Closeout of actions from NASA-chaired Mission and Flight Readiness Reviews
ff. LV Integrated spacecraft-to-launch/transit vehicle mate, test, and closeout as performed procedures and deviations impacting the spacecraft (e.g. handling, spacecraft power on, or mission unique requirements)

Note: * denotes insight and approval by the Government for these areas.

The HLS contractor shall provide for NASA attendance at any flight hardware and software reviews the HLS contractor or LV subcontractor performs at HLS contractor or subcontractor facilities. The HLS contractor shall make available directly to NASA any build paper, test results, nonconformance reports, discrepancy history, statistical process control, and failure analyses that are relevant to the reviews.

10.2 Launch Vehicle

The HLS contractor shall provide commercial launch vehicle transportation services to accomplish the mission. The HLS contractor shall be responsible for obtaining the support services, permits and licenses necessary to complete the launch service.

10.2.1 Launch Vehicle (LV) Preparation and Launch

The HLS contractor and/or subcontractor shall:

a. Provide access to all vehicle documentation in support of the NASA insight functions.
b. Provide access for at least two NASA personnel to consoles in the HLS contractor and/or subcontractor's launch control center that provide access to vehicle telemetry and voice nets (including countdown and major systems).

10.2.2 Telemetry Data and Communication

NASA will utilize LV telemetry data to verify the LV performance. The HLS contractor and/or subcontractor shall receive and record the full-rate telemetry data from the initiation of launch countdown through all mission phases for the launch vehicle through disposal. The HLS contractor shall measure and provide launch vehicle telemetry, in electronic format, and upon request, hard copy format, according to relevant DRDs.

The HLS contractor shall provide voice and video communications from the launch complex to the designated NASA Data Center during launch vehicle and spacecraft operations at the launch complex through Range Loss of Signal (LOS).

The HLS contractor shall implement the NASA provided console communications configuration for those consoles occupied by the NASA team within the contractor's launch control center. The HLS contractor shall validate this configuration with the designated NASA Data Center prior to launch vehicle testing and mission simulations.

10.2.3 Operational Support Services

The HLS contractor and/or subcontractor shall provide access for NASA personnel to the launch vehicle facilities.

10.2.4 Mission Integration and Analysis

The HLS contractor and/or subcontractor shall design, manufacture, test, and qualify for flight all hardware and software that is required to support the mission. The HLS contractor shall be responsible to perform the mission planning and analyses necessary to provide the data for launch vehicle and spacecraft integrated performance as listed in Attachment J-2, Data Procurement Document (DPD) 1701.

The HLS contractor shall prepare and submit required information in accordance with DRD 1701LV-001, Launch Vehicle/Spacecraft Interface Control Document (ICD) and Verification Matrix – Initial Demo, DRD 1701LV-002, Mission Specific Drawings, and DRD 1701LV-004 Performance and Guidance Accuracy Analysis (PGAA) to support NASA insight for the initial demonstration mission. For the sustaining integrated human landing system mission, 1701LV-006, Launch Vehicle/Spacecraft Interface Control Document (ICD) and Verification Matrix – Sustaining should be used instead of DRD 1701LV-001. The HLS contractor shall use SMC-S-016, Test Requirements for Launch Upper Stage and Space Vehicles, as a guideline when developing environmental qualification and acceptance criteria and related test and analysis.

The HLS contractor shall provide source code and mission constants' listings with appropriate requirement specifications to support NASA insight of mission software. The HLS contractor shall prepare a pre-flight control system and stability analysis report reports for the vehicle and mission unique software used for these missions.

NASA reserves the right to perform software Independent Verification and Validation (IV&V) on the LV. If requested, the HLS contractor shall deliver information directly to NASA to perform software IV&V of safety and mission critical items (including delivery of the models and the flight code).

10.3 Technical and Readiness Reviews

The HLS contractor is required to conduct and chair/co-chair reviews to include, but not limited to the mission-specific reviews defined in sections 10.3.1 - 10.3.6. All derived requirements from all system requirements must be identified and addressed in each of these reviews. NASA will have approval into the LV Mission Specific items in these reviews. The HLS contractor shall be responsible to prepare and submit required information in accordance with DRD 1701LV-005, Technical and Readiness Reviews.

10.3.1 Mission Specific Requirements Review (MSRR)

The contractor shall conduct an MSRR prior to the Mission Specific Preliminary Design Review (MSPDR) with NASA to review the mission specific design requirements for the following items:

a. System requirements' identification and definition to a level adequate to verify launch vehicle performance capabilities.

b. Design restrictions, limitations, and known violations.

c. Physical and mechanical interfaces (e.g., spacecraft to launch vehicle, payload envelope, and access provisions).

d. Electrical interfaces (e.g., launch vehicle to spacecraft, interfaces with electrical ground support equipment, pad electrical systems, ground batteries, telemetry, grounding, and power).

e. Functional interfaces (e.g., structures, structural loads, and vibration).

f. Avionics systems and interfaces (e.g., spacecraft avionics interfaces with launch vehicle, separation systems, telemetry interfaces, spacecraft command and telemetry, and radio frequency (RF)).

g. Software

h. Mass properties.

i. Environmental requirements (e.g., thermal, contamination, vibration, pressure, Electromagnetic Compatibility (EMC), shock, launch complex RF, and lightning).

j. Orbital requirements, launch vehicle performance, launch window injection, and deployment attitudes and rates.

k. Spacecraft/Launch Vehicle separation requirements (e.g., separation conditions, launch vehicle post-separation maneuver requirements, and telemetry).

l. Summary of the contractor's, and Launch Vehicle contractor if the contractor is procuring a launch service, systems engineering practices and processes.

10.3.2 Mission Specific Preliminary Design Review (MSPDR)

At not later than L-18 months, the contractor shall conduct a preliminary detailed design review prior to major commitment to drawings and design. Mission specific trade studies shall

be completed prior to the MSPDR. The contractor shall discuss analyses performed and their results along with comparisons to any similar proven designs. The contractor shall evaluate the safety of the design and its ability to meet safety requirements. The preliminary mission unique design shall be subject to NASA's approval. NASA reserves the right to withhold approval until all action items have been closed. As a minimum, the contractor shall provide verification of the following items at the MSPDR:

a. All system requirements have been allocated to the subsystem and component level and the flow down is adequate to verify system performance.

b. The design solutions being proposed are expected to meet the performance and functional requirements.

c. The design does not pose major problems that may cause schedule delays.

d. Overall system architecture has been established and all launch vehicle to spacecraft interfaces have been identified and are verifiable.

e. The design solution can be produced based on existing processes and techniques; if not, risk areas, which require unique and unproved processes, are identified and risk mitigation plans are established.

f. An acceptable operations concept has been developed.

g. Preliminary vehicle interfaces have been defined.

h. Preliminary plans are established for end-to-end testing methodologies.

i. 30% mission unique drawings released.

j. Software requirements and data dictionary are baselined, and software architecture and preliminary design released.

10.3.3 Mission Specific Critical Design Review (MSCDR)

At not later than L-12 months, the contractor shall conduct an MSCDR prior to design freeze and before significant fabrication activity begins. The contractor shall present a final detailed design using drawings, analyses, and evaluation testing that shows the design meets final performance and interface specifications, safety requirements, and mission objectives. The contractor shall provide selection criteria for the evaluation tests performed to prove validity. The mission specific critical design shall be subject to NASA's approval. NASA reserves the right to withhold approval until all action items have been closed. As a minimum, the contractor shall provide verification of the following items at the MSCDR:

a. All technical problems and design anomalies have been resolved without compromising system performance, reliability and safety.

b. The detailed design will meet performance, functional requirements, and schedule.

c. Software simulations and prototyping results do not present any potential mission risks.

d. All key subsystem and/or component engineering analyses are complete.

e. Integrated safety analysis identifying any remaining hazards and proposed resolution.

f. Launch vehicle/spacecraft compatibility test plans have been defined.

g. 90% mission unique drawings released.

h. Software detailed design is baselined, and software test plans released.

10.3.4 Systems Acceptance Review (SAR)

At not later than L-4 months, the contractor shall conduct a mission specific SAR after all items are complete to review the design, fabrication, qualification testing and analysis results of the mission specific items, such as special adapters, low-shock separation systems, unique payload fairing access doors to perform final cover removal or batter plug installation, special purge locations or gasses, fuel fill or vent capabilities, cryogenic management vent lines, etc. Additionally, as soon as feasible, the contractor shall conduct a Launch vehicle (LV) SAR to review the final results of the design, fabrication, qualification testing and analysis of the of the common launch vehicle configuration (CLVC) after the first successful flight of that common launch vehicle configuration. The review(s) shall incorporate any flight data available as part of the launch service. The review(s) will verify qualification, compliance, and systems-level compatibility using completed analyses, test, inspection, and demonstrations results. The systems acceptance shall be subject to NASA's approval. NASA reserves the right to withhold approval until all action items have been closed. The contractor is encouraged to hold the CLVC portion of the SAR separately from the mission specific items, and as early as possible after ATP to ensure NASA's LV risk assessment can be completed by L-6 months in accordance with the terms and conditions of this contract. As a minimum, the contractor shall provide verification of the following items at the review(s):

a. Results of the system acceptance reviews of the major suppliers or major subsystems;

b. Design changes that occurred subsequent to CDR or changes as a result of new flight data;

c. Summary of applicable component tests (test setups, test cases, results and significant anomalies), analyses, margins, or similarity assessments. Included in the summary is component qualification rationale (similarity, test, analysis) for all affected components that are new, changed or subject to new environments or functional requirements;

d. Qualification rationale for the system as a whole;

e. Methodology and results of current analyses;

f. System level engineering review of launch complex structural, mechanical, fluid, software, and electrical ground to vehicle interfaces.

10.3.5 Launch Vehicle Systems Readiness Review

The contractor shall conduct a Launch Vehicle Systems Readiness Review to demonstrate that the launch site and launch vehicle are ready to proceed with launch vehicle processing activities at the launch site.

10.3.6 Pre-Mate Readiness Review

At not later than spacecraft to LV mate minus 1 week, the contractor shall conduct a Pre-Mate Readiness Review to demonstrate the launch site and launch vehicle are ready for spacecraft mechanical and electrical integration. The contractor shall conduct a launch vehicle/site walk-down with NASA participation prior to or in conjunction with the Pre-Mate Readiness Review. The contractor shall present as a minimum:

a. Action item status, safety status, spacecraft mating plan, closure plan, spacecraft integration/launch site documentation, interface verifications, checkout and software status, nonconformance reports, launch site status, spacecraft readiness, and review of flight profile.

b. A detailed schedule showing all activities remaining to achieve an on-time launch.

10.3.7 Launch Readiness Review (LRR)

LVC will conduct/chair, and NASA LSP shall participate in an LRR one day prior to launch to verify all actions from the FRR are complete and final processing has been successfully completed. At the conclusion of this review, NASA will provide an "approval to proceed with launch countdown.

10.4 Launch Site Support

The HLS contractor and/or subcontractor's LV control center shall interface with the NASA Data Center. The HLS contractor shall participate in the development of joint operations products. This will include providing documentation for the ground system specifications and the standard interfaces with the NASA Control Center.

10.5 Launch Vehicle Preparation and Launch

The HLS contractor shall provide NASA access to all launch site LV meetings for the NASA mission related to the spacecraft integrated operations, including scheduling meetings, test briefings, and technical meetings. Upon request, the HLS contractor shall provide copies or access to schedules, test briefings, and other material presented at technical meetings. The HLS contractor and/or subcontractor shall conduct launch vehicle/launch site walk-downs with NASA participation.

The HLS contractor shall make provisions for NASA safety representative insight into integrated spacecraft/launch vehicle operations as well as launch vehicle processing.

10.6 Launch Site Payload Integration Support

The HLS contractor and/or subcontractor LV control center shall provide the necessary interfaces to the NASA Data Center/Spacecraft mission control center and other entities with the ability to monitor the spacecraft, as required for spacecraft mission success and safety.

The HLS contractor shall provide all services, equipment, and support required for the integration and launch of the spacecraft. Services shall include, as a minimum, the following:

a. Support integrated verification testing between the spacecraft and the LV

b. Preparation of the payload procedures for integrated vehicle/spacecraft operations as appropriate per DRD 1701LV-003, Launch Vehicle/Spacecraft Integrated Procedures.

APPENDIX A: ACRONYMS

AI&T	Assembly, Integration and Test
ANSI	American National Standards Institute
ATP	Authority to Proceed
BAA	Broad Agency Announcement
C&DH	Control and Data Handling
CAD	Computer Aided Design
CDR	Critical Design Review
CIL	Critical Items List
CLIN	Contract Line Item Number
CLVC	Common Launch Vehicle Configuration
CM	Configuration Management
CO	Carbon Monoxide
CO2	Carbon Dioxide
ConOps	Concept of Operations
COR	Contracting Officer's Representative
DCR	Design Certification Review
DCS	Decompression Sickness
DDT&E	Design, Development, Test and Evaluation
DOORS	Dynamic Object Oriented Requirements System
DPD	Data Procurement Document
DRD	Data Requirements Description
DVO	Detailed Verification Objective
DVT	Design Verification Test
EAR	Export Administration Regulations
ECD	Estimated Closure Date
EEE	Electrical, Electronic, and Electromechanical
EOMP	End of Mission Plan
EP	Equivalent Personnel
EVA	Extravehicular Activity
FED	Failure Experience Data
FMEA	Failure Modes and Effects Analysis
FRR	Flight Readiness Review
FTA	Fault Tree Analysis
FTRR	Flight Test Readiness Review

GFE	Government Furnished Equipment
GFI	Government Furnished Information
GFP	Government Furnished Property
GIDEP	Government Industry Data Exchange Program
GN&C	Guidance Navigation and Control
GSE	Ground Support Equipment
GTA	Government Task Agreement
HEA	Human Error Analysis
HITL	Human-In-The-Loop
HLS	Human Landing System
HSERP	HLS Safety and Engineering Review Panel
ICD	Interface Control Document
IDSS	International Docking System Standard
IDIQ	Indefinite Delivery Indefinite Quantity
IMS	Integrated Master Schedule
IRD	Interface Requirements Document
ISPA	Integrated System Performance Analysis
ITAR	International Traffic in Arms Regulations
IV&V	Independent Verification and Validation
JFOR	Joint Flight Operations Review
JPL	Jet Propulsion Laboratory
LOS	Loss of Signal
LRR	Launch Readiness Review
LV	Launch Vehicle
M&FM	Mission and Fault Management
MCC-H	Mission Control Center - Houston
MMOD	Micrometeoroid and Orbital Debris
MMT	Mission Management Team
MPCP	Mishap Preparedness and Contingency Plan
MSCDR	Mission Specific Critical Design Review
MSFC	Marshall Space Flight Center
MSPDR	Mission Specific Preliminary Design Review
MSRR	Mission Specific Requirements Review
NASA	National Aeronautics and Space Administration
NDS	NASA Docking System
NEPA	National Environmental Policy Act
NID	NASA Interim Directives

NLS	NASA Launch Services
NLT	No Later Than
NPR	NASA Procedural Requirements
NRHO	Near Rectilinear Halo Orbit
ODAR	Orbital Debris Assessment Reports
OGFPA	Optional Government Furnished Property Agreement
ORR	Operations Readiness Review
PAS	Problem Assessment System
PGAA	Performance and Guidance Accuracy Analysis
PMAR	Post Mission Assessment Review
PMR	Program Management Review
POC	Point of Contact
PWS	Performance Work Statement
R&M	Reliability and Maintainability
RCS	Reaction Control System
RF	Radio Frequency
RPOD	Rendezvous, Proximity Operations and Docking
RPODU	Rendezvous, Proximity Operations, Docking, and Undocking
SAR	System Acceptance Review
SE&I	Systems Engineering and Integration
SEMO	Supply and Equipment Management Officer
SHE	Safety, Health, and Environmental
SLA	Service Level Agreements
SMA	Safety and Mission Assurance
SOW	Statement of Work
SPCE	Servicing, Performance and Checkout Equipment
SPD	Space Policy Directive
SQA	Software Quality Assurance
SQR	Software Quality Report
SRR	System Requirements Review
SSAR	System Safety Assessment Report
SVTL	Safety Verification Tracking Log
TBR	To Be Resolved
TBD	To Be Determined
TIM	Technical Interchange Meetings
TPAD	Trajectory and Performance Analysis Document
TRR	Test Readiness Reviews

TS/SCI	Top Secret/Sensitive Compartmented Information
V&V	Verification and Validation
VV&C	Verification, Validation and Certification
VCN	Verification Closure Notices
WBS	Work Breakdown Structure
xEMU	Exploration Extravehicular Mobility Unit
xEVA	Exploration Extravehicular Activity