



HUMAN LANDING SYSTEM PROGRAM

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Overview

- On April 30, 2020, NASA awarded 3 contracts for the Human Landing System Broad Agency Announcement
- Complete lander systems were proposed including launch vehicles for an end-to-end solution for 2024 and sustaining missions
- Base Period awards: May 2020-February 2021

The Broad Agency Announcement achieved the innovation from U.S. Industry it was designed to do.



\$579M
BASE PERIOD

HUMAN LANDING SYSTEM

NATIONAL TEAM



“INTEGRATED LANDER VEHICLE” (ILV)

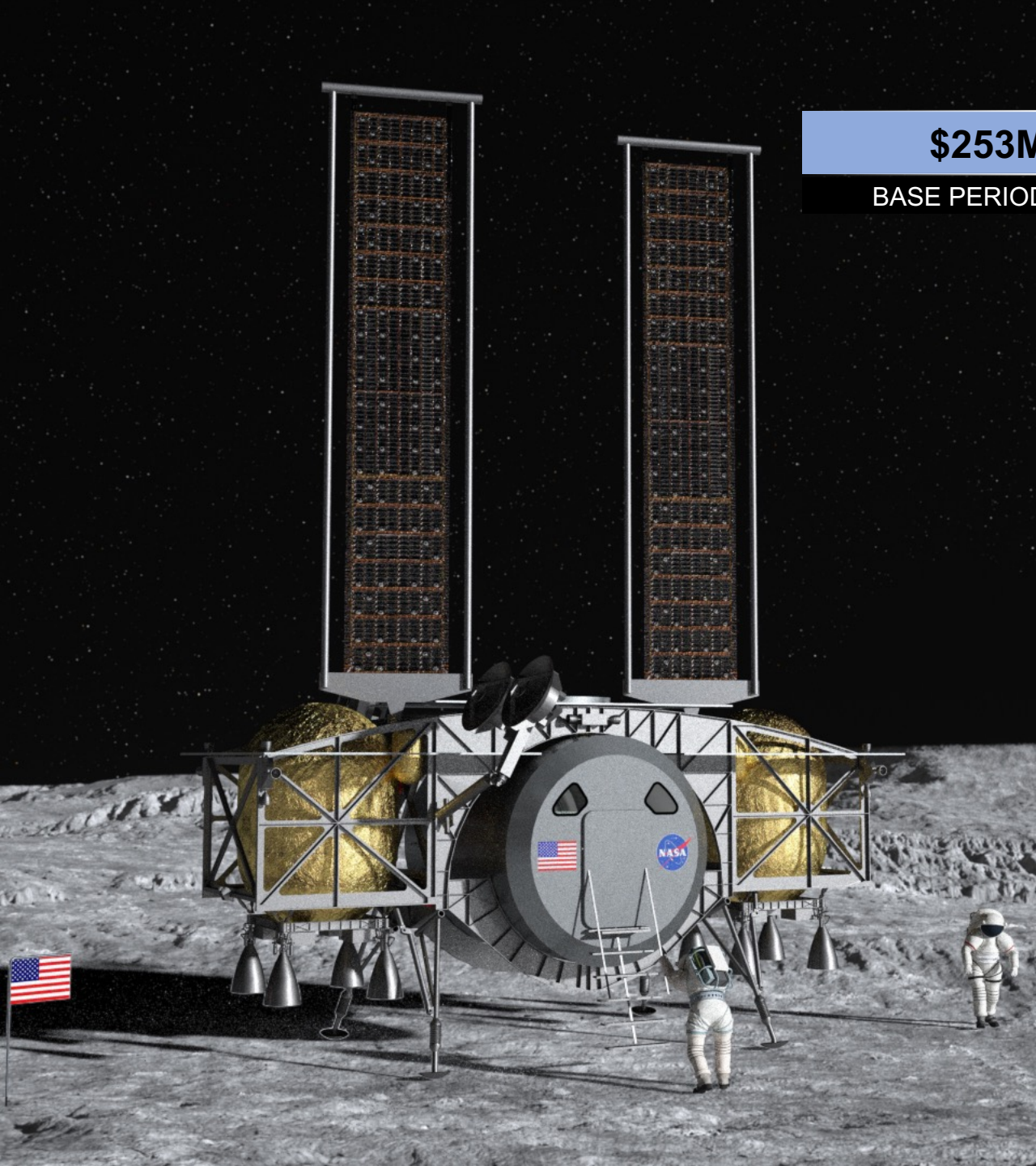
- Three-stage landing system
 - Ascent – Lockheed Martin
 - Descent – Blue Origin
 - Transfer – Northrop Grumman (future refueler)
 - GN&C, Avionics, Software – Draper
- Rockets: New Glenn & ULA Vulcan

KEY ATTRIBUTES

- Significant proven spaceflight heritage
- Orion and Gateway compatible

AWARD

- Represents mutually agreed to negotiated funding to meet company’s specific request



\$253M

BASE PERIOD

Dynetics

A Leidos Company

“DYNETICS HUMAN LANDING SYSTEM”

- Single element providing the ascent and descent capabilities
- Multiple modular propellant vehicles (MPVs) prepositioned to fuel the engines
- Large subcontractor team
- Rockets: ULA Vulcan

KEY ATTRIBUTES

- “Mass produced” MPVs
- Crew cabin sits low to the surface
- Double-androgynous docking system
- Orion and Gateway compatible

AWARD

- Represents mutually agreed to negotiated funding to meet company’s specific request⁴



\$135M

BASE PERIOD

SPACEX

“STARSHIP”

- Integrated lander
- Fully reusable launch and landing system
- Fueling in low-Earth orbit with Starship storage and Starship Tanker variants
- Rocket: SpaceX Super Heavy

KEY ATTRIBUTES

- Spacious cabin
- Two airlocks
- Orion and Gateway compatible; Orion for first demo

AWARD

- Represents mutually agreed to negotiated funding to meet company’s specific request⁵



Base Period Activities

During the 10-month base period, NASA teams will be embedded with the companies to help streamline the review of required deliverables to NASA and to impart expertise that the agency has acquired over the last 60 years of human spaceflight systems development.

- The Base Period CLINs (contract line item numbers) include:
 - **CLIN 001 – Base: 2024 HLS Design and Development.** 2024 Design and Development, excepting long lead items.
 - **CLIN 002 – Base: 2026 HLS Design.** Risk-reduction design work in direct support of a potential 2026 HLS performed during the Base period will be permitted. Note that long lead items necessary to support the 2026 mission are not within the scope of this CLIN. *(Intended for sustaining)*
 - **CLIN 003 – Base: Indefinite Delivery/Indefinite Quantity (IDIQ) for 2024 Long Lead Items.** For this CLIN, long lead items are defined as flight hardware with a value of over \$100,000 required to be procured during the Base period to enable a 2024 flight demonstration. Proposed long lead purchases are only allowed beginning one month after Authority to Proceed (ATP). Each long lead item shall be proposed as a separate sub-CLIN.
 - **CLIN 004 – Base: IDIQ - Special Studies.** Special studies, analysis, and/or support tasks as initiated by written direction from the Contracting Officer.



Challenges & Risks

BLUE ORIGIN

- Proposed launch vehicle maturity
- Complex integrated power and propulsion systems development
- Propulsion system development complexities
- Integrated system checkout after crew arrival

DYNETICS

- Proposed launch vehicle maturity
- Complex integrated propulsion systems development
- Propulsion system development complexities
- Damage to common descent-ascent vehicle from engine induced surface debris during landing

SPACEX

- Numerous, highly complex launch, rendezvous, and refueling operations in quick succession
- Proposed launch vehicle maturity
- Complex integrated propulsion systems development
- Crew egress-ingress height above the surface

Government collaboration team, including JPL providing additional expertise
Cross-Agency NASA subject matter experts providing insight for certification
Effectuate changes through quick turnaround trade studies with the contractor via IDIQs
Pursuant to reduced risk, IDIQ to the contractor to use only higher TRL technologies for 2024



Potential Trades to Enable 2024



- NASA Trade Studies to enable 2024
 - Assessing TRL of systems
 - Inter-element mechanisms for mating / in-space aggregation of the HLS
 - Extravehicular mobility suit mass reduction effort
 - Orbit best suited for fast abort and optimal stay capability
- Purpose of Government trades are to improve overall mission success and decrease mission risk



Types of Work – Insight

- **Insight**: Traditional government review of contractor products leading to certification of flight readiness
 - Review and approval of required contract deliverables (e.g. Type 1 & 2 Data Requirements Description (DRDs))
 - The primary goal of insight is linked to the certification of flight readiness of the integrated system (including launch vehicle)
 - HLS Program directed tasks intended to understand the contractors' designs, processes and products and to ensure the contractor is following purported processes
 - Insight supports verification, certification, compliance to design/construction standards, cybersecurity requirements, safety and health & medical requirements/standards
- **Joint Flight Operations including mission planning (Blended Team)**
 - Jointly responsible activities with contractor led by Lander Flight Operations Office within JSC's Flight Operations Directorate (FOD) to assure design meets operational scenarios
 - Flight Operations/Contractor joint activities developing operational products, training and flight control, to include the mission architecting across the Agency
 - Lander Flight Operations NASA team is leading all aspects of the mission when crew dons the integrated HLS, through landing on the moon and safe return to the Orion



Types of Work – Collaboration & Risk Reduction



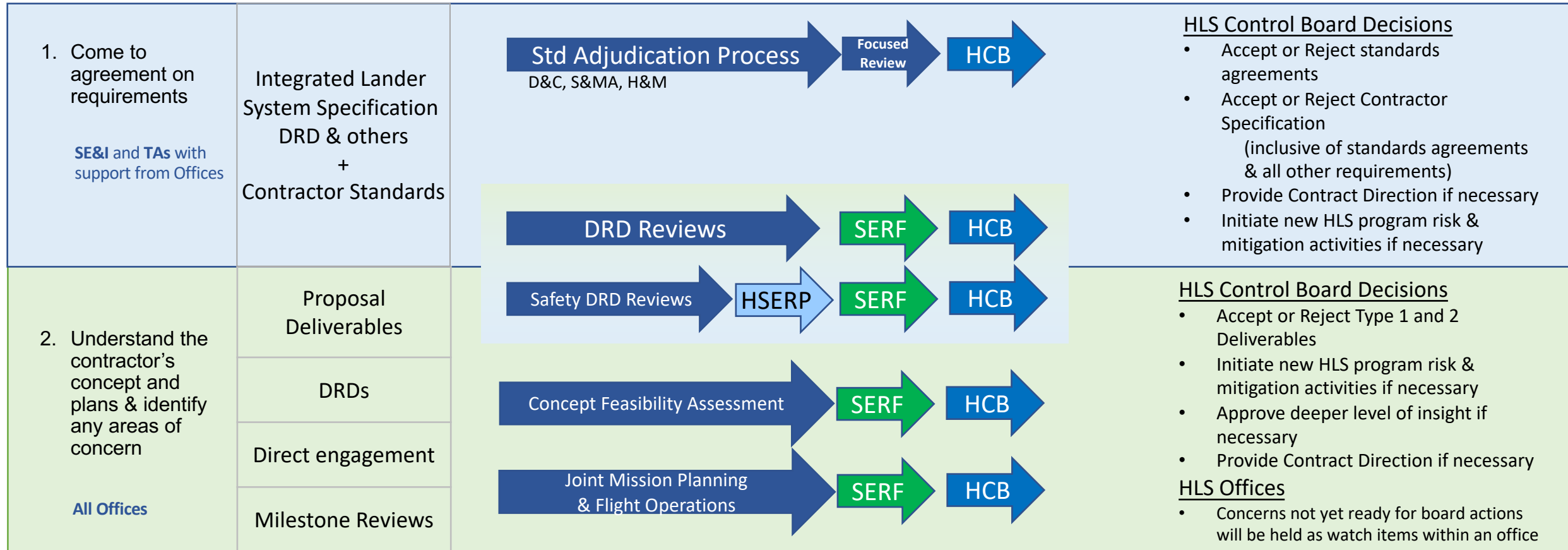
- **Collaboration**: Government experts working alongside the contractor developing products
 - Contractor requested Government support in the form of products, expertise or services
 - Collaboration workforce will execute specific tasks (e.g. design support, analysis, testing) or will provide subject matter expertise to the contractor as directed by the HLS Program Manager
 - Collaboration Workforce allows contractors to leverage NASA extensive expertise and experience to expedite their human landing systems and focus on crew safety
 - Government provided services and/or products to a contractor via Government Task Agreements (GTA)
 - Collaboration workforce provide the contractors extra labor to help expedite schedule (up to 50 EP)
- **Advanced Development & Risk Reduction**: Government team to work parallel activities to aid in quick turnaround risk mitigation informing the program and the contractor for decision-making
 - HLS Program directed tasks to reduce or mitigate risks for 2024
 - HLS Program directed and managed tasks to mature systems/subsystems necessary to support sustained architecture



BACKUP



Goals for First 3 Months



HC B HLS Control Board
 HSERP HLS Safety Engineering Review Panel
 DRD Data Review Documents
 TA Technical Authorities
 SERF Systems Engineering Review Forum
 HRAF HLS Risk Advisory Forum
 SE&I Systems Engineering and Integration





Government Furnished Equipment Mandatory List



System	Hardware
EVA	xEMU
EVA	xEMU Ancillary Equipment
EVA	Mounted Interfaces & Equipment
EVA	Umbilicals
Crew Systems	Clothing
Crew Systems	Hygiene Supplies
Crew Systems	Crew Personal Effects
Crew Systems	Operational Supplies
Utilization	Sample Return Equipment
Utilization	Science Equipment
EVA	xEMU Suits, Stowage Fitchek Hardware (not flight hardware)
EVA	xEVA Hardline Comm/Data functional checkout
EVA	xEVA SPCE Vehicle Interface V&V Unit
EVA	xEMU Simulator box ("Flat Suit" blackbox which simulates nominal suit telemetry data to facilitate end-to-end checkout)
EVA	EVA Handrails (Class III) for vehicle mockups
Crew Health & Performance	Food
Crew Health & Performance	Contingency Food
Crew Health & Performance	Radiation Detection
ECLSS	Waste Management System
Gateway/Orion	Gateway/Orion Simulator/Emulator (see SOW 6.4.2)

This represents the mandatory GFE that NASA will provide for HLS demonstration missions. Contractors have the option to request additional GFE such as access to testing facilities.

