

National Aeronautics and Space Administration



# Human Landing System Program

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[www.nasa.gov](http://www.nasa.gov)

# The NASA Charge to the Moon

In keeping with SPD-1, NASA is charged with **landing the first American woman and next American man at the South Pole of the Moon by 2024**, followed by a sustained presence on and around the Moon by 2028.

NASA will **“use all means necessary”** to ensure mission success in moving us forward to the Moon.



Vice President Mike Pence speaks about NASA's mandate to return American astronauts to the Moon and on to Mars at the U.S. Space & Rocket Center in Huntsville, Alabama.



# The Artemis Program

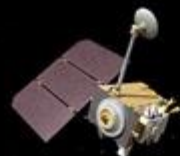
Artemis is the twin sister of Apollo and goddess of the Moon in Greek mythology. Now, she personifies our path to the Moon as the name of NASA's program to return astronauts to the lunar surface by 2024.

When they land, Artemis astronauts will step foot where no human has ever been before: the Moon's South Pole.

With the horizon goal of sending humans to Mars, Artemis begins the next era of exploration.



# ARTEMIS : Landing Humans On the Moon in 2024



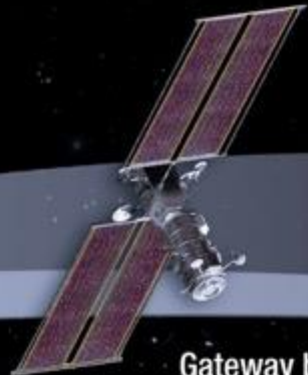
LRO: Continued surface and landing site investigation



Artemis I: First human spacecraft to the Moon in the 21st century



Artemis II: First humans to orbit the Moon and rendezvous in deep space in the 21st Century



Gateway begins science operations in lunar orbit with launch of PPE and HALO



Initial human landing system delivered to lunar orbit



Artemis III: Orion and crew dock to human landing system for crew expedition to the surface



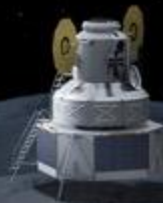
## Early South Pole Robotic Landings

Science and technology payloads delivered by Commercial Lunar Payload Services providers



## Volatiles Investigating Polar Exploration Rover

First mobility-enhanced lunar volatiles survey



## Humans on the Moon - 21st Century

First crew leverages infrastructure left behind by previous missions



**LUNAR SOUTH POLE TARGET SITE**



# Human Landing System

- Firm Fixed Price Broad Agency Announcement for rapid development and crewed demonstration to return humans to the lunar surface by 2024
- Leveraging commercial capabilities to the maximum extent possible; may tailor the traditional NASA program management and systems engineering processes to expedite the schedule
- NASA will not take ownership of the HLS hardware/software
- HLS will launch as commercial cargo; checkout and testing will occur on orbit prior to any crew launch and egress
- NASA provides certification and technical expertise

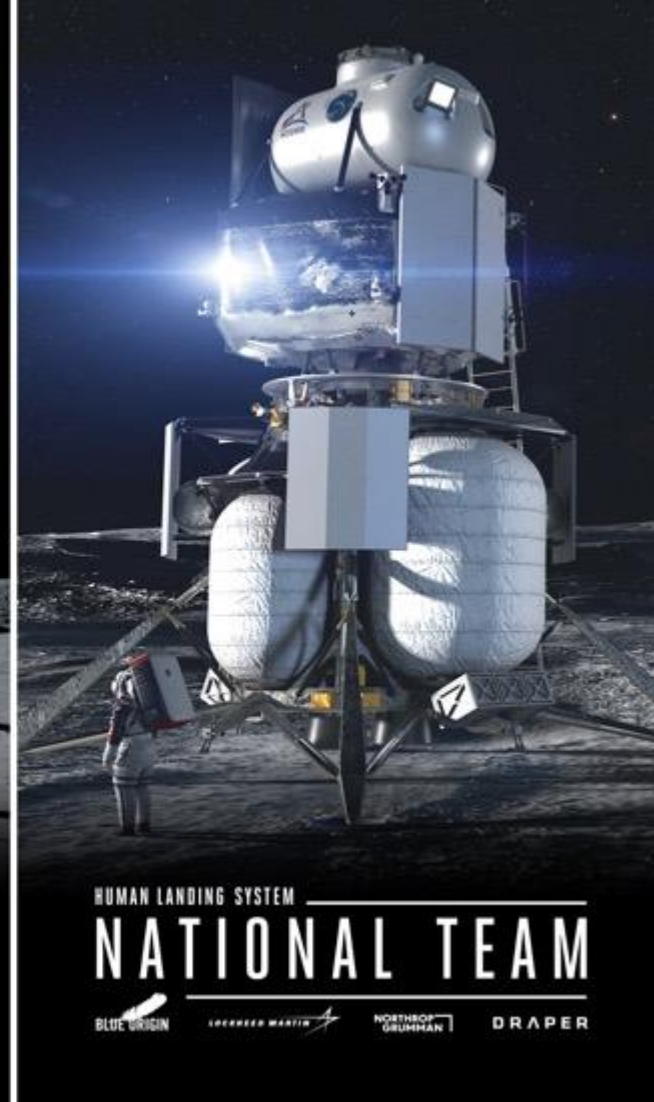
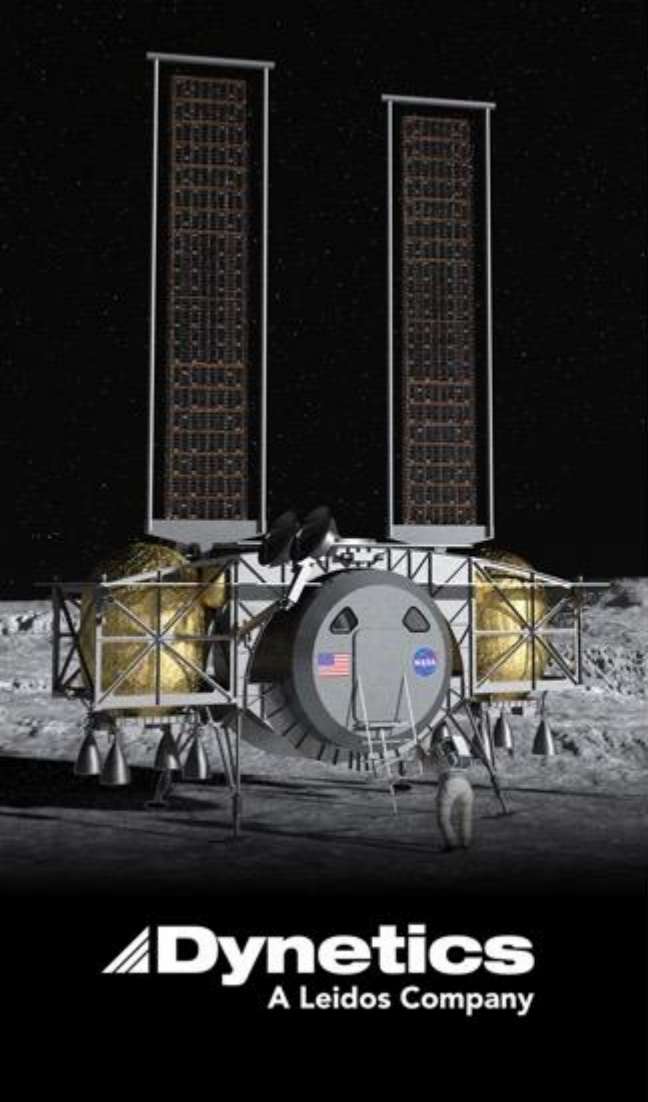
*The HLS plan is to leverage the speed and operating models of the commercial space industry while applying NASA expertise to ensure safety and mission success*

# Human Landing System – NextSTEP-2 Appendix H



- Final solicitation issued September 30
  - Drafts issued July 19 and August 30; +1,150 comments from industry
- Proposals submitted November 5, 2019
- Selections announcement April 30, 2020
- Base Period ends February 2021





3 HLS contracts  
awarded April 30,  
2020

Complete lander  
systems were  
proposed  
including launch  
vehicles for an  
end to end  
solution for 2024  
and sustaining

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

Base Period:  
May 2020 –  
February 2021



HUMAN LANDING SYSTEM

# NATIONAL TEAM

BLUE ORIGIN

LOCKHEED MARTIN

NORTHROP  
GRUMMAN

DRAPER

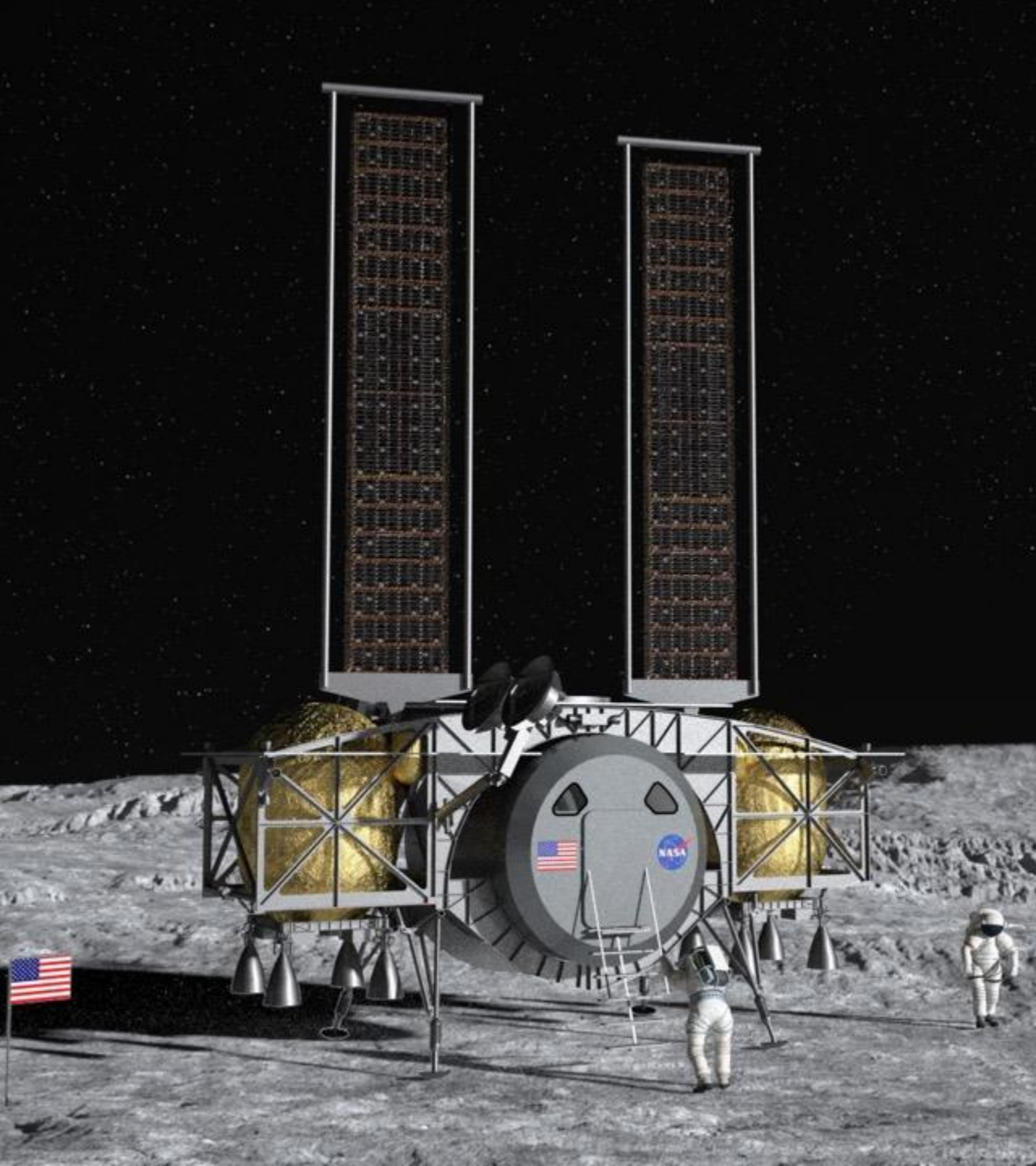
## “INTEGRATED LANDER VEHICLE” (ILV)

- 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





# **Dynetics**

**A Leidos Company**

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## **“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



# SPACEX

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## **“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

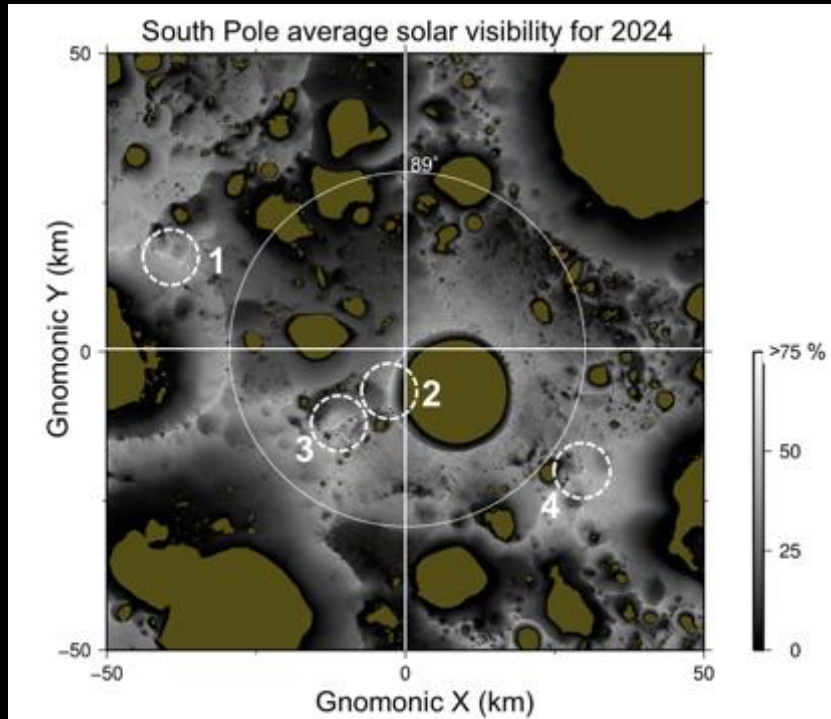
## **KEY ATTRIBUTES**

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



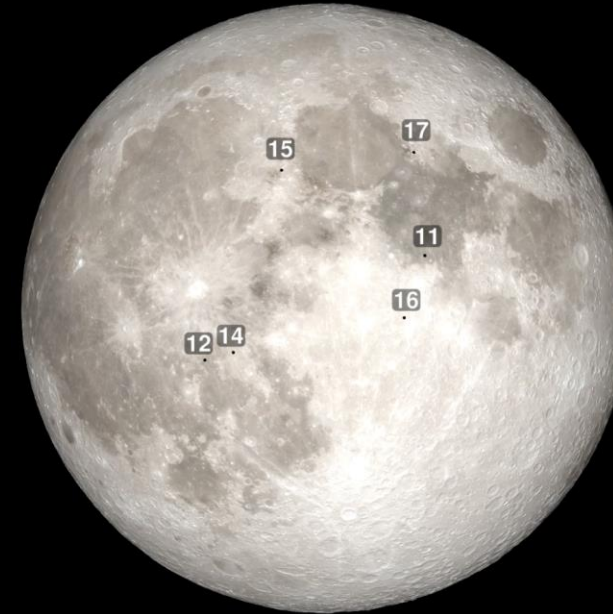
# American Strategic Presence on the Moon –

High solar illumination areas within 2 degrees (<50 km) of the lunar south pole.



Four highly illuminated areas shown above:

1. De Gerlache Rim,
2. Shackleton Rim
3. Shackleton – De Gerlache Ridge
4. Plateau near Shackleton

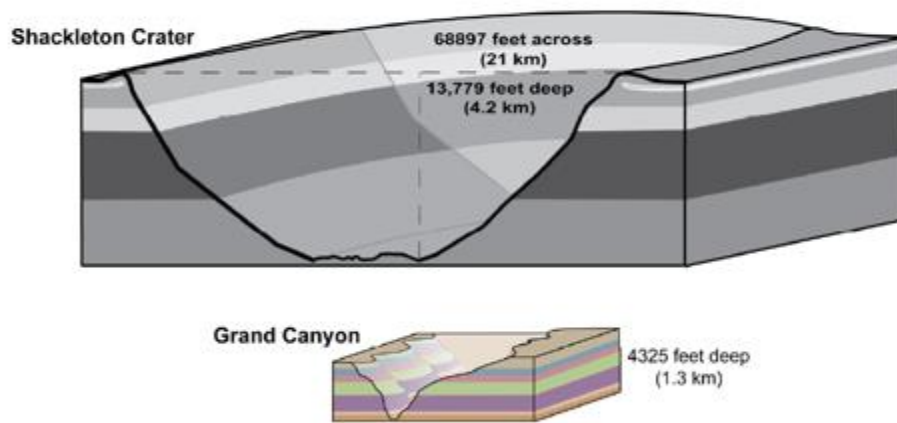


## High Priorities for Sustained Surface Activities

- **Long duration access to sunlight:** A confirmed resource providing power and minimal temperature variations
- **Surface roughness and slope:** Finding the safest locations for multiple landing systems, robotic and astronaut mobility
- **Direct to Earth communication:** Repeatable Earth line-of-sight communication for mission support
- **Permanently Shadowed Regions and Volatiles:** Learning to find and access water ice and other resources for sustainability

# The Lunar South Pole

SHACKLETON CRATER vs. GRAND CANYON



29,500 feet across  
(8.96 km)

Shackleton Crater: ~20 km in diameter, ~4 km deep and ~3x deeper and wider than the Grand Canyon



# Lunar Science by 2024



## Polar Landers & Rovers

- First direct measurement of polar volatiles, improving understanding of lateral and vertical distribution, physical state
- First surface exploration of permanently shadowed regions

## Non-Polar Landers & Rovers

- Explore scientifically valuable terrains not investigated by Apollo. Examples could include young volcanic areas, magnetic anomalies, pyroclastic deposits, farside
- Move to a PI-led CLPS delivered instrument model conducting focused science for a selected location
- Provide opportunities for international cooperation

## Orbital data

- High-resolution mapping of permanently shadowed regions
- CubeSats delivered by Artemis I
- High priority new data sets acquired by CubeSats or SmallSats delivered by CLPS

## In-Situ Resource Initial Research

- Answering questions on composition and ability to use lunar ice for sustainment and fuel



# Moon Before Mars

On the Moon, we can take reasonable risks while astronauts are just three days away from home.

There we will prove technologies and mature systems necessary to live and work on another world before embarking on what could be a 2-3 year mission to Mars.





ARTEMIS

**Let's go.**  
***The time is now.***

**We have the capability**

**We have the purpose**

**We have the charge**

**We have the responsibility**

