National Aeronautics and Space Administration

NASA's Moon to Mars Architecture Workshop

What: Mars Forward Capabilities at the Moon

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WHEN WILL WE ACHIEVE LUNAR OBJECTIVES?

Multi-decadal campaign

Support annual cadence of crewed missions

Development of permanent infrastructure

Expansion of economic sphere to the Moon

WHO DOES THIS APPROACH INCLUDE?

NASA

U.S Government

Industry

International Partners

Academia

Public

WHAT FOUNDATIONAL CAPABILITIES ARE NEEDED

Long-duration microgravity systems

Partial gravity destination platforms

Low Earth Orbit assets and infrastructure

WHERE SHOULD SYSTEMS BE?

Ensure access to the Lunar South Pole

Capability for non-polar expeditions

HOW WILL WE GET THERE AND RETURN?

Lunar Microgravity staging in NRHO

Earth ⟷ NRHO ⟷ Lunar surface

Surface Mobility

WHY EXPLORE?

- SCIENCE -

Understand the universe
Direct observations

- INSPIRATION -

“Artemis Generation”
Overcome challenges
Succeed with hard work

- NATIONAL POSTURE -

Enrich lives on Earth
Technology development
International partnerships

WHAT: Mars Forward Capabilities at the Moon

Driving M2M Objectives:

OP-1: Conduct human research and technology demonstrations on the surface of Earth, low Earth orbit platforms, cislunar platforms, and on the surface of the moon, to evaluate the effects of extended mission durations on the performance of crew and systems, reduce risk, and shorten the timeframe for system testing and readiness prior to the initial human Mars exploration campaign.

OP-7: Validate readiness of systems and operations to support crew health and performance for the initial human Mars exploration campaign.

Key Mars Forward Capabilities that would Benefit from Risk Reduction Activities at the Moon

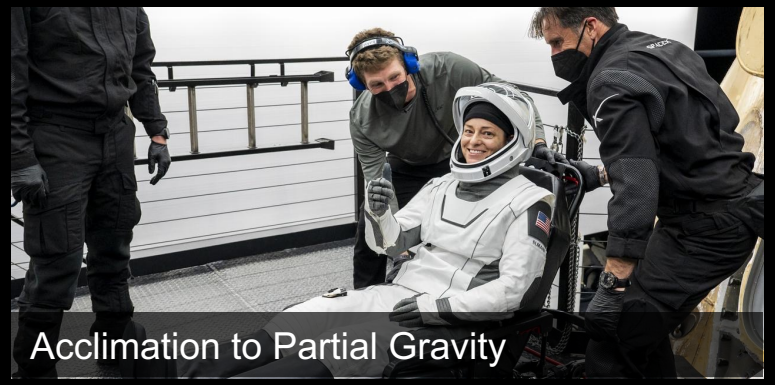

Human Adaptation and Accommodation in a Long-Duration Deep Space Environment


Deep Space Delivery and Aggregation

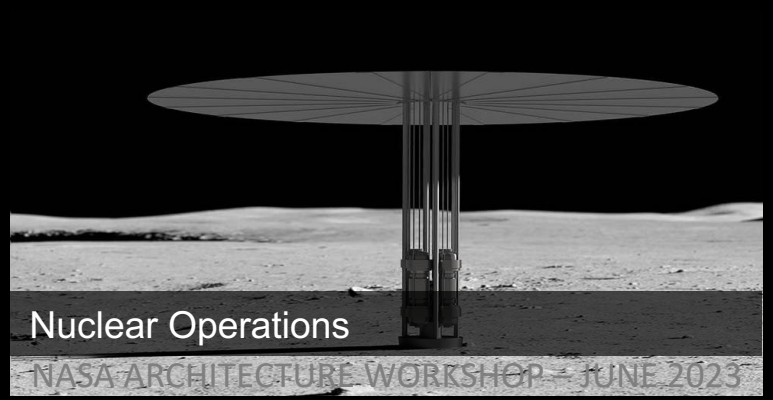

Long Duration & Dormancy


Autonomous Operations


Surface Landing & Ascent


Acclimation to Partial Gravity


Crewed Surface Operations and Surface Mobility


Nuclear Operations


Interoperability Standards & Capability Modularity

Lunar Missions as Preparation for Mars: Human Lunar Return (HLR)

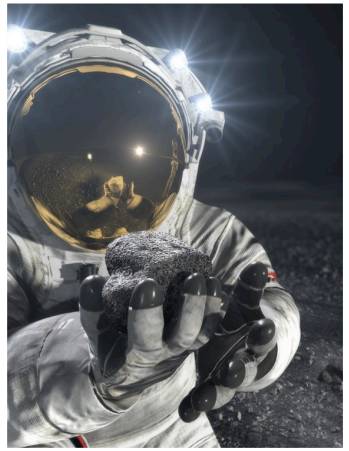
Mars Forward Elements:

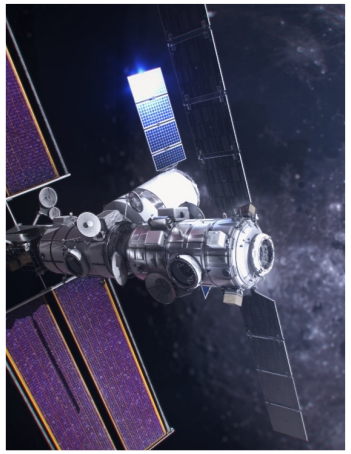
- SLS/Orion and other commercial launch systems to transport crew & cargo to deep space
- HLS ascent as a demonstration for Mars ascent
- HLS autonomous terminal descent and landing including plume ejecta dynamics
- xEVAS suit is feed forward to a partial gravity Mars EVA suit
- Gateway systems such as solar electric propulsion, autonomous systems, and habitation feed forward to Mars transit and habitation
- VIPER is feed forward for Mars ice core drilling

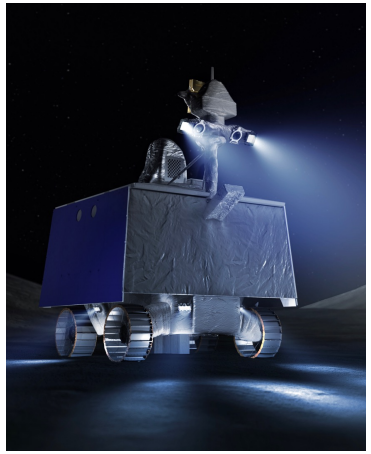

SPACE LAUNCH SYSTEM


ORION SPACECRAFT

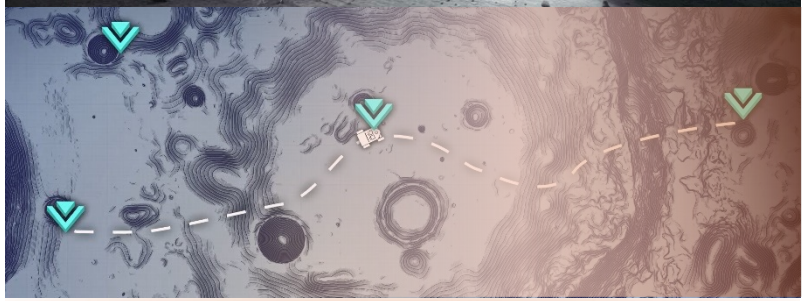

HUMAN LANDING SYSTEM


xEVA Systems


GATEWAY

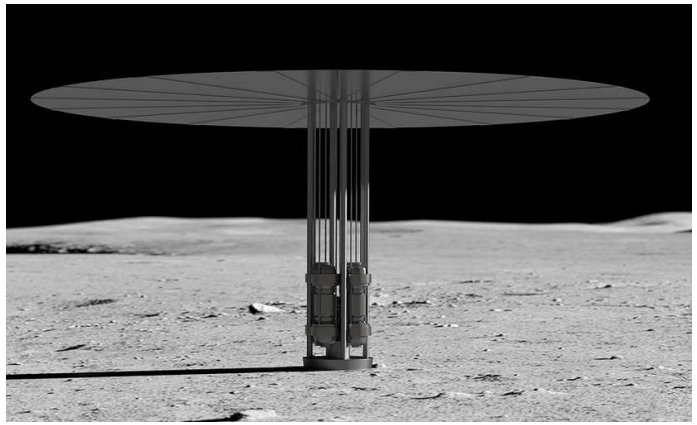

VIPER

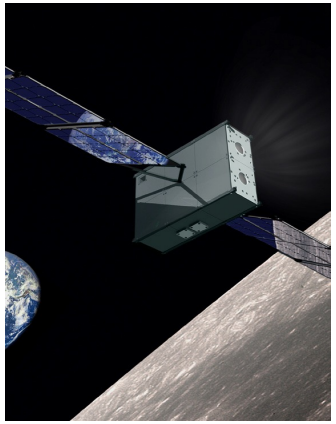
Lunar Missions as Preparation for Mars: Foundational Exploration



Notional Mars Forward Elements:

- Unpressurized mobility to transport cargo, elements, logistics and crew both prior to and during crew missions
- Pressurized mobility for crew exploration of the planetary surface
- Cargo transportation to deliver large elements and cargo to the surface
- Surface habitation (mobile or perhaps stationary) to support the crew while on the surface
- Power generation, storage, and distribution on the surface
- High bandwidth communication and position, navigation and timing systems





Summary

While the environmental and operational strategies will differ, every mission to the Moon can help inform design and operational strategies for future Mars missions by:

- **Providing key information and approaches necessary to support humans at greater duration and distance in deep space**
- **Demonstrating key operational capabilities and techniques**
- **Evaluating advanced exploration and surface exploration techniques**
- **Reducing the risk of advanced technologies and system concepts**

Access the white paper with this QR code or at www.nasa.gov/MoonToMarsArchitecture