NASA’s Plans for going Forward to the Moon

Timothy Tawney
NASA Europe Representative
U.S. Embassy Paris/
Office of International and
Interagency Relations (OIIR)
NASA Headquarters
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http://oiir.hq.nasa.gov/europe/
NASA 60th Anniversary
Since 1976, *Spinoff* has highlighted NASA technologies that benefit life on Earth in the form of commercial products – nearly 2,000 in total.
“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.”
## FY 2020 Budget Request ($M)

<table>
<thead>
<tr>
<th>Budget Authority ($ in Millions)</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
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<td>Deep Space Exploration Systems</td>
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<tr>
<td>Construction &amp; Envrlml Compl Restoration</td>
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<tr>
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<tr>
<td><strong>NASA Total</strong></td>
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<td><strong>$21,441.5</strong></td>
<td><strong>$21,655.9</strong></td>
<td><strong>$21,872.5</strong></td>
</tr>
</tbody>
</table>

*FY 2018 reflects funding amounts specified in Public Law 115-41, Consolidated Appropriations Act, 2018, as adjusted by NASA's FY 2018 Operating Plan.*

*Table does not reflect emergency supplemental funds also appropriated in FY 2018, totaling $81.3 million.*

*FY 2019 reflects funding as enacted under Public Law 116-96.*
A Budget Increase Towards 2024

This FY 2020 budget amendment provides an increase of $1.6 billion above the President’s initial $21 billion budget request to accelerate our return to the lunar surface. This additional investment is a down payment on NASA’s efforts to land humans on the Moon by 2024, and is required to achieve that bold objective. It’s the boost NASA needs to move forward with design, development and exploration.

- **Human Lunar Landing System**: This budget includes $1 billion to enable NASA to begin supporting the development of commercial human lunar landing systems three years earlier than previously envisioned to bring humans to the Moon’s surface by 2024.
  - This acquisition strategy will allow NASA to purchase an integrated commercial lunar lander that will transport astronauts from lunar orbit to the lunar surface and back.
  - Focusing Gateway development on capabilities needed to support a lunar landing of 2024 allowed a scope reduction of $321 million. This budget amendment shifts potential development of additional Gateway capabilities into the future.

- **Space Launch System Rocket and Orion Spacecraft**: With an additional $651 million for SLS and Orion, this budget supports the most powerful rocket in the world and our new spacecraft to ultimately take the astronauts to the staging point for reaching the lunar surface, the Gateway in lunar orbit.

- **Exploration Technology**: An additional $132 million for technologies that will support NASA to advance key precursor capabilities on the lunar surface. This includes various exploration technologies like solar electric propulsion and a demonstration converting polar ice to water.

- **Science**: An augmentation of $90 million to enable increased robotic exploration of the Moon’s polar regions in advance of a human mission.
Space Technology for 2024 and Beyond

- Cryofluid Management
- High Performance Spaceflight Computing
- Precision Landing
- Solar Electric Propulsion
- Surface Excavation/Construction
- Extreme Environments
- In Situ Resource Utilization
- Extreme Access
- Lunar Dust Mitigation
- Lunar Surface Power

Lunar Surface Innovation Initiative
Transportation to the Moon

DEEP SPACE EXPLORATION SYSTEM

Recent Accomplishments
To the Lunar Surface by 2024

Artemis Phase 1: To the Lunar Surface by 2024

ARTEMIS 1: FIRST HUMAN SPACECRAFT TO THE MOON IN THE 21ST CENTURY

ARTEMIS 2: FIRST HUMANS TO THE MOON IN THE 21ST CENTURY

FIRST HIGH POWER SOLAR ELECTRIC PROPULSION (SEP) SYSTEM

FIRST PRESSURIZED CREW MODULE DELIVERED TO GATEWAY

ARTEMIS 3: CREWED MISSION TO GATEWAY AND LUNAR SURFACE

Commercial Lunar Payload Services
- CLPS delivered science and technology payloads

Early South Pole Crater Rim Mission(s)
- First robotic landing on eventual human lunar return and ISRU site
- First ground truth of polar crater volatiles

Large-Scale Cargo Lander
- Increased capabilities for science and technology payloads

Humans on the Moon - 21st Century
First crew leverages infrastructure left behind by previous missions

LUNAR SOUTH POLE CRATER TARGET SITE

2019

2024
Gateway Role for 2024 Landing

Gateway is Essential for 2024 Landing

- Initial Gateway focuses on the minimum systems required to support a 2024 human lunar landing while also supporting Phase 2
- Provides command center and aggregation point for 2024 human landing
- Establishes strategic presence around the Moon – US in the leadership role
- Creates resilience and robustness in the lunar architecture
- Provides building block for the future, expanded capabilities on and around the Moon
Transformative Lunar Science

- Based on the decadal survey, a SSERVI white paper identified top areas of lunar science, including:
  - Establish the period of giant planet migration
  - Provide absolute chronology for Solar System events
  - Use the vantage from lunar far side to view universe at key wavelengths
  - Understand sources of water and the water cycle on the Moon
  - Characterize the lunar interior (core, mantle, crust)
  - Evaluate solar wind interactions with the lunar surface and extend the record of extreme space weather events of the past
Commercial Lunar Payload Services (CLPS)

- US commercial providers of space transportation services,
- 10-year multi-vendor catalog for payload missions
CubeSats
InSight Results

First vortices sensed by Lander

InSight

MARS WIND  LIKELY MARSQUAKE  ROBOTIC ARM

Horizontal Amplitude SEIS-SP

Accel m/s²

Horizontal Amplitude SEIS-VBB

Accel m/s²

Apr 07, 2019

MARS WIND  LIKELY MARSQUAKE  ROBOTIC ARM

Apr 07, 2019
Seeking Signs of Life: Mars 2020 Rover

Mars 2020

Critical ISRU and technology demonstration required for future Mars exploration.
Mars
Vistas of opportunity and discovery