Launching to the Moon and Beyond
Agenda

♦ What is NASA’s mission?
♦ Why do we explore?
♦ What is our time line?
♦ Why the Moon first?
♦ What will the vehicles look like?
♦ What progress have we made?
♦ Who is on our team?
♦ What are the benefits of space exploration?
What is NASA’s Mission?

♦ Safely fly the Space Shuttle until 2010
♦ Complete the International Space Station (ISS)
♦ Develop a balanced program of science, exploration, and aeronautics
♦ Develop and fly the Orion Crew Exploration Vehicle (CEV)
  • Designed for exploration but will initially service ISS
♦ Land on the Moon no later than 2020
♦ Promote international and commercial participation in exploration
Why Do We Explore?

♦ Inspiration
  • Inspire students to explore, learn, contribute to our nation’s economic competitiveness, and build a better future

♦ Innovation
  • Provide opportunities to develop new technologies, new jobs, and new markets

♦ Discovery
  • Discover new information about ourselves, our world, and how to manage and protect it
NASA’s Exploration Roadmap

05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25…

- Exploration and Science Lunar Robotics Missions
- Research and Technology Development on ISS
- Commercial Orbital Transportation Services for ISS
- Space Shuttle Operations
- SSP Transition
- Ares I and Orion Development
- Orion and Ares I Production and Operation
- Ares I-X Test Flight October 2009
- Altair Development
- Ares V & Earth Departure Stage
- Surface Systems Development

Lunar Outpost Buildup

Research and Technology Development on ISS
Commercial Orbital Transportation Services for ISS
Space Shuttle Operations
SSP Transition
Ares I and Orion Development
Operations Capability Development (EVA Systems, Ground Operations, Mission Operations)
Orion and Ares I Production and Operation
Ares I-X Test Flight October 2009
Altair Development
Ares V & Earth Departure Stage
Surface Systems Development

National Aeronautics and Space Administration
Lunar missions allow us to:

- Gain exploration experience
  - Space no longer a short-term destination
  - Will test human support systems
  - Use Moon to prove ability to build and repair long-duration space assets
- Develop exploration technologies
  - Launch and exploration vehicles
  - In-situ resource utilization
  - Power and robotic systems
- Conduct fundamental science
  - Astronomy, physics, astrobiology, geology, exobiology

The Next Step in Fulfilling Our Destiny as Explorers
There Are Many Places To Explore

We Can Land Anywhere on the Moon!
Our Exploration Fleet
What Will the Vehicles Look Like?

- Earth Departure Stage
- Orion Crew Exploration Vehicle
- Altair Lunar Lander
- Ares V Cargo Launch Vehicle
- Ares I Crew Launch Vehicle
# Building on a Foundation of Proven Technologies
## Launch Vehicle Comparisons

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Height</th>
<th>Gross Liftoff Mass (GLOM)</th>
<th>Payload Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saturn V: 1967–1972</td>
<td>360 ft</td>
<td>2,948.4 mT (6,500K lbm)</td>
<td>99.0K lbm to TLI</td>
</tr>
<tr>
<td>Space Shuttle: 1981–Present</td>
<td>184.2 ft</td>
<td>2,041.1 mT (4,500.0K lbm)</td>
<td>262.0K lbm to LEO</td>
</tr>
<tr>
<td>Ares I: First Flight 2015</td>
<td>325.0 ft</td>
<td>933.2 mT (2,057.3K lbm)</td>
<td>55.1K lbm to LEO</td>
</tr>
<tr>
<td>Ares V: First Flight 2018</td>
<td>381.1 ft</td>
<td>3,704.5 mT (8,167.1K lbm)</td>
<td>156.7K lbm to TLI with Ares I</td>
</tr>
</tbody>
</table>

**Saturn V**
- Height: 360 ft
- Crew: 3
- Lunar Lander: 1
- S-IVB (One J-2 engine) LOX/LH2
- S-II (Five J-2 engines) LOX/LH2
- S-IC (Five F-1) LOX/RP-1
- Altair
- Earth Departure Stage (1 J-2X) LOX/LH2
- Two 4-Segment Reusable Solid Rocket Boosters (RSRBs)

**Space Shuttle**
- Height: 184.2 ft
- Crew: 7
- Crew: 4
- S-IVB (One J-2 engine) LOX/LH2
- S-II (Five J-2 engines) LOX/LH2
- S-IC (Five F-1) LOX/RP-1
- Upper Stage (One J-2X) LOX/LH2
- One 5-Segment RSRB
- Two 4-Segment Reusable Solid Rocket Boosters (RSRBs)

**Ares I**
- Height: 325.0 ft
- Crew: 7
- Lunar Lander: 1
- Crew: 3
- S-IVB (One J-2 engine) LOX/LH2
- S-II (Five J-2 engines) LOX/LH2
- S-IC (Five F-1) LOX/RP-1
- Upper Stage (One J-2X) LOX/LH2
- One 5-Segment RSRB
- Two 4-Segment Reusable Solid Rocket Boosters (RSRBs)

**Ares V**
- Height: 381.1 ft
- Crew: 7
- Crew: 4
- S-IVB (One J-2 engine) LOX/LH2
- S-II (Five J-2 engines) LOX/LH2
- S-IC (Five F-1) LOX/RP-1
- Upper Stage (One J-2X) LOX/LH2
- One 5-Segment RSRB
- Two 5.5-Segment Reusable Solid Rocket Boosters (RSRBs)
Ares I Elements

Upper Stage
- 137.7 mT (303.5K lbm) LOX/LH₂ prop
- 5.5-m (18-ft) diameter
- Aluminum-Lithium (Al-Li) structures
- Instrument unit and interstage
- Reaction Control System (RCS) / roll control for first stage flight
- Primary Ares I control avionics system
- NASA Design / Boeing Production

Instrument Unit
- Primary Ares I control avionics system
- NASA Design / Boeing Production

Upper Stage Engine
- Saturn J-2 derived engine (J-2X)
- Expendable
- Pratt and Whitney Rocketdyne

Stack Integration
- 933.2 mT (2,057.3K lbm) gross liftoff mass (GLOM)
- 99.1 m (325.0 ft) in length
- NASA-led

First Stage
- Derived from current Shuttle RSRM/B
- Five segments/Polybutadiene Acrylonitrile (PBAN) propellant
- Recoverable
- New forward adapter
- Avionics upgrades
- ATK Launch Systems

Encapsulated Service Module (ESM) Panels
Orion CEV

Interstage

DAC 2 TR7
National Aeronautics and Space Administration
Orion Crew Exploration Vehicle

Launch Abort System

- Attitude Control Motor
  (Eight Nozzles)
- Canard Section
  (Stowed Configuration)
- Jettison Motor
  (Four Aft, Scarfed Nozzles)
- Abort Motor
  (Four Exposed, Reverse Flow Nozzles)

Crew Module

Service Module

Encapsulated Service Module (ESM) Panels

Spacecraft Adapter

Volume: 19.6 m³ (690.6 ft³)
- 80% larger than Apollo
Diameter: 5.0 m (16.4 ft)

Lockheed Martin Design/Production
**Earth Departure Stage (EDS)**
- One Saturn-derived J-2X LOX/LH$_2$ engine (expendable)
- 10-m (33-ft) diameter stage
- Aluminum-Lithium (Al-Li) tanks
- Composite structures, instrument unit and interstage
- Primary Ares V avionics system

**Stack Integration**
- 3,704.5 mT (8,167.1K lbm) gross liftoff mass
- 116.2 m (381.1 ft) in length

**Solid Rocket Boosters**
- Two recoverable 5.5-segment PBAN-fueled boosters (derived from current Ares I first stage)

**Core Stage**
- Six Delta IV-derived RS-68 LOX/LH$_2$ engines (expendable)
- 10-m (33-ft) diameter stage
- Composite structures
- Aluminum-Lithium (Al-Li) tanks
Journey to the Moon
What Progress Have We Made?

♦ Programmatic Milestones
  • Completed Ares I System Requirements Reviews, System Definition Review and Preliminary Definition Review
  • All Ares I Prime contractors on board
  • Ares I-X test flight scheduled for October 2009

♦ Technical Accomplishments
  • Testing first stage parachutes and DM-1
  • Constructing new J-2X test stand at Stennis Space Center
  • Performing J-2X injector tests and power pack tests
  • Extensive testing on upper stage fuel tank panels
  • Full-scale upper stage demonstration hardware under construction
  • Testing in wind tunnels
  • Ares I-X stacked at Kennedy Space Center

For more information go to www.nasa.gov/ares
Ares I-X Test Flight

♦ Demonstrate and collect key data to inform the Ares I design:
  • Vehicle integration, assembly, and KSC launch operations
  • Staging/separation
  • Roll and overall vehicle control
  • Aerodynamics and vehicle loads
  • First stage entry dynamics for recovery

♦ Performance Data:

<table>
<thead>
<tr>
<th></th>
<th>Ares I-X</th>
<th>Ares I</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Stage Max. Thrust (vacuum):</td>
<td>14.1 MN</td>
<td>15.8 MN</td>
</tr>
<tr>
<td>Max. Speed:</td>
<td>Mach 4.7</td>
<td>Mach 5.84</td>
</tr>
<tr>
<td>Staging Altitude:</td>
<td>39,600 m (130K ft)</td>
<td>57,700 m (188K ft)</td>
</tr>
<tr>
<td>Liftoff Weight:</td>
<td>816 mT (1,799K lbm)</td>
<td>927 mT (2,044K lbm)</td>
</tr>
<tr>
<td>Length:</td>
<td>99.7 m (327 ft)</td>
<td>99.1 m (325 ft)</td>
</tr>
<tr>
<td>Max. Acceleration:</td>
<td>2.46 g</td>
<td>3.79 g</td>
</tr>
</tbody>
</table>
Ares Nationwide Team

ATK Launch Systems

Ames

Pratt & Whitney Rocketdyne

Boeing

ATK Launch Systems

Marshall

Glenn

Langley

Johnson

Kennedy

Michoud Assembly Facility

Stennis

National Aeronautics and Space Administration
Down-to-Earth Benefits from the Space Economy

NASA powers innovation that creates new jobs, new markets, and new technologies.

♦ Personal Health
  • Eye tracker for LASIK surgery
  • Breast biopsy system

♦ Consumer Products
  • Wireless light switch
  • Remote appliance programmer
  • Global Positioning Systems (GPSs)

♦ Environmental
  • Water Filtration system
  • Environmentally friendly chemical cleanup

♦ Security
  • Stair-climbing tactical robot
  • Crime scene video enhancement

For more information see http://technology.jsc.nasa.gov

Every Dollar Invested in Space is Spent on Earth.
NASA Explores for Answers that Power Our Future

NASA powers inspiration that encourages future generations to explore, learn, and build a better future

♦ NASA relies on a well-educated U.S. workforce to carry out missions of scientific discovery that improve life on Earth

♦ America’s technological edge is diminishing
  • Fewer engineering graduates from U.S. colleges and universities
  • More engineering and science graduates in other countries

♦ The global marketplace is increasingly competitive and technology-driven

♦ Students need motivating goals and teachers with information to share

♦ NASA continues to develop educational tools and experiences that inspire, educate, and motivate

♦ Space exploration offers new economic opportunities through technology and resource development
Summary

♦ The Ares family will provide the U.S. with unprecedented exploration capabilities
  • Can inject almost 60% more mass to the Moon than Apollo/Saturn

♦ The Ares team has made significant progress since its inception in October 2005
  • Full team is onboard
  • All major milestones met to-date, with CDR scheduled for 2011
  • Ares I-X test flight scheduled for October 2009

♦ We are making extensive use of lessons learned to minimize cost, technical, and schedule risks

♦ The NASA-led/Contractor partnership is very effective in developing the Ares I
www.nasa.gov/ares