# Orion Multi-Purpose Crew Vehicle

***Orion Team,*** *Johnson Space Center*

Drawing from more than 50 years of space flight research and development, NASA has designed the Orion Multi-Purpose Crew Vehicle (MPCV) to meet the evolving needs of our nation's beyond low-Earth orbit space exploration program for decades to come (figure 1).

The Orion MPCV features dozens of technology advancements and innovations that have been incorporated into the spacecraft's subsystem and component design. The Orion MPCV spacecraft includes both crew and service modules, a spacecraft adaptor, and a revolutionary launch abort system that will significantly increase crew safety (figure 2).

The Orion MPCV's unique life support, propulsion, thermal protection, and avionics systems in combination with other deep space elements will enable extended-duration deep space missions. These systems were developed to facilitate integration of new technical innovations as they become available in the future.

The Orion MPCV is capable of transporting astronauts on a variety of expeditions beyond low-Earth orbit, ushering in a new era of space exploration.

The past 18 months of development yielded phenomenal accomplishments by the Orion NASA-industry team. The flawless flight test of the launch abort system—one of only four ever developed and flown—was a significant achievement. The advanced technologies developed for this system enable state-of-the-art crew survivability in the event an emergency occurs during launch or ascent to orbit. In addition, the team fabricated the world's largest heat shield structure, demonstrated an inventive new navigation and docking

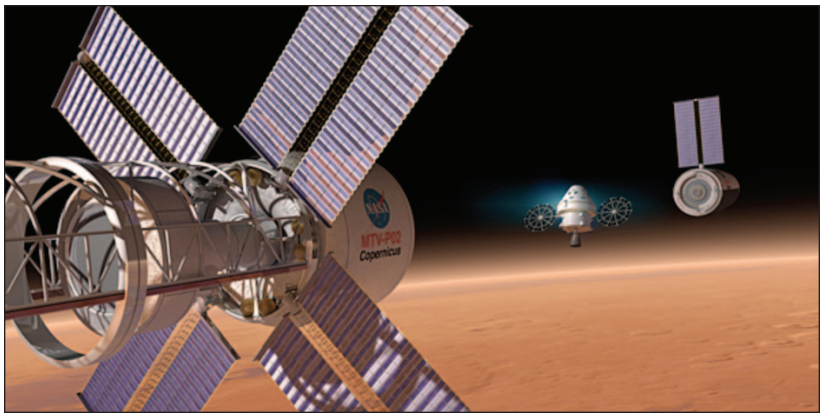

***Fig. 1.*** *Artist concept of the Orion Multi-Purpose Crew Vehicle on a beyond low-Earth orbit mission.*

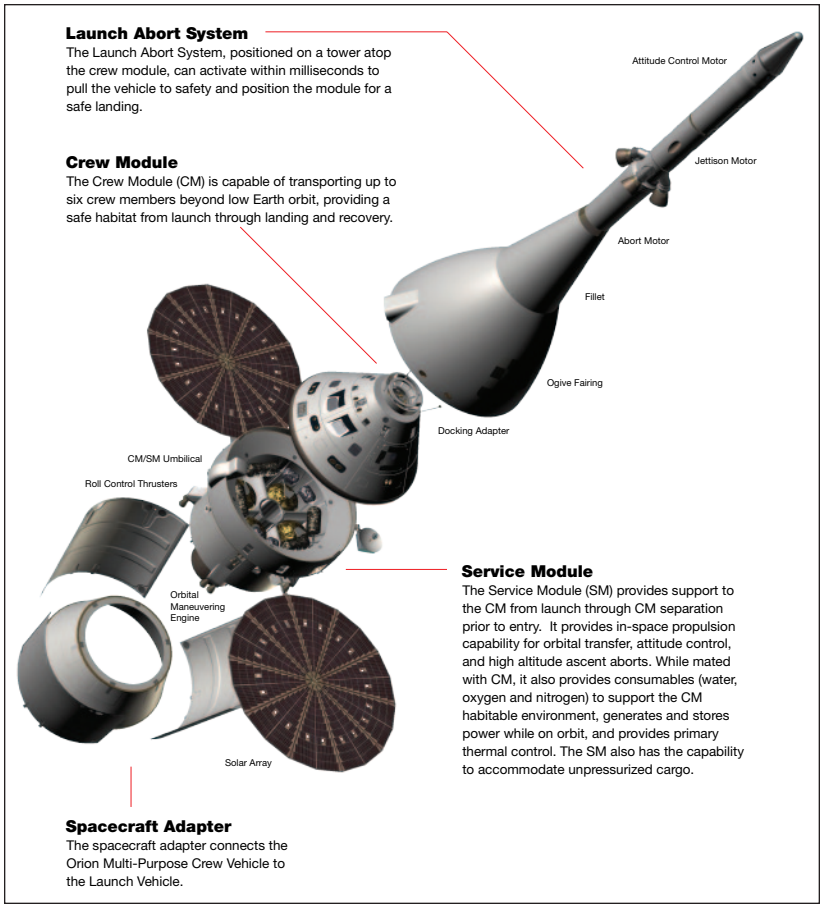


***Fig. 2.*** *Orion Multi-Purpose Crew Vehicle systems.*

## Orion Multi-Purpose Crew Vehicle

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system, validated Orion's assembly and production operations, completed the first space-flight-worthy Orion crew module, and made significant progress on Orion's thermal protection and software systems. All of this work will result in creating the only U.S. spacecraft for deep space exploration that meets NASA's stringent human rating requirement.

***Fig. 3.*** *The Orion Multi-Purpose Crew Vehicle at the Lockheed Martin Vertical Test Facility in Colorado.*

### A National Undertaking

Supported by a network of major and minor subcontractors and small businesses working at 88 facilities across the country, Lockheed Martin Space Systems Company serves as NASA's prime contractor for the Orion MPCV (figure 3).

In addition, the program contracts with more than 500 small businesses across the United States through an expansive supply chain network.

Lockheed Martin facilities in California, Colorado, Florida, Louisiana, and Texas help support the Orion MPCV's design and development work. Additionally, the company has independently invested in a network of Exploration Development and System Integration Labs that conduct early risk mitigation and system-level analyses to help reduce project costs, schedule, and risk.

Subcontractor facilities have been instrumental in the design, fabrication, and testing of myriad components and subsystems for the Orion MPCV.

ATK's facilities in Utah and Maryland tested the abort and attitude control motors for the Orion MPCV launch abort system. Aerojet's propulsion center in California has provided ongoing testing and verification for the Orion MPCV's powerful motors and engines, and United Space Alliance's Thermal Protection Facility in Florida has painstakingly handcrafted all of the Orion MPCV's thermal tiles. Hamilton Sundstrand's engineers in Connecticut, Illinois, and Texas have developed the Orion MPCV's intricate life-support and power systems, while Arizona-based Honeywell has developed intelligent avionics and software that support data, communications, and navigation.

In addition to large aerospace contractors, small businesses from all socioeconomic interests have provided specialized skills and engineering services critical to the Orion MPCV's development. Risk management, life-cycle cost, systems analysis, and propulsion trade studies are just a few examples of their expertise. Additionally, small businesses support all of the spacecraft's systems with design, development, and manufacturing of advanced space flight hardware.

### Ready to Explore

NASA's Orion MPCV will be capable of sustaining a crew of up to six astronauts on deep space missions that could last anywhere from 6 days for a lunar flyby mission (figure 4) to as many as 900 days for a Mars exploration mission when paired with additional propulsion and habitation systems. These long-duration missions will require sophisticated life support and power systems that can endure the harsh environments of deep space

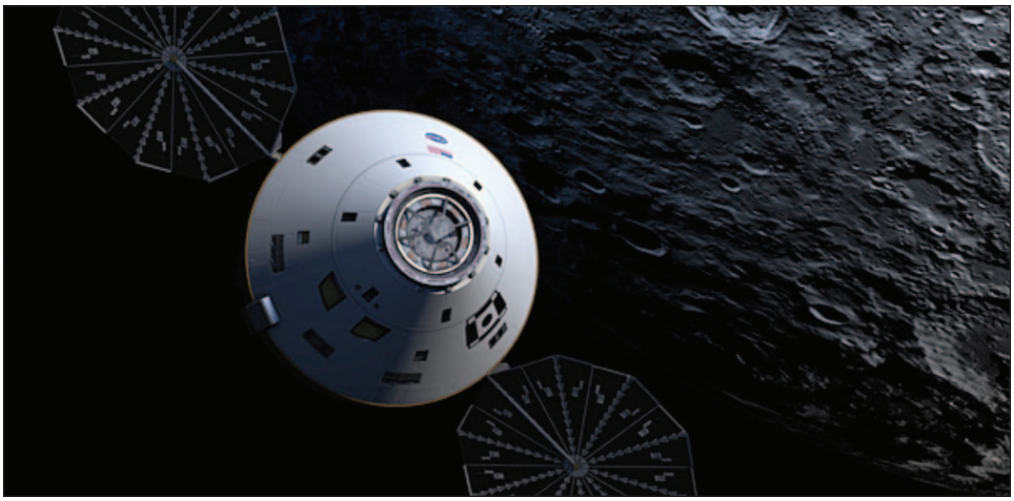

***Fig. 4.*** *Artist rendering of Orion Multi-Purpose Crew Vehicle in lunar orbit.*

and return the crew safely to Earth. New and innovative technologies have been designed and integrated into the spacecraft to achieve such a daunting task, making the Orion MPCV the most advanced human space exploration vehicle ever built.

The advanced technologies developed for the Orion MPCV launch abort system will enable state-of-the-art crew survivability in the event of an emergency on the launch pad or during ascent to orbit. Orion MPCV's increased thrust is necessary to meet the abort needs at launch and provide the required separation distance.

The Orion MPCV's advanced communications and tracking system must ensure optimal communications for the crew. Global Positioning Systems and other tracking systems used in low-Earth orbit are not available for space-to-ground communications from deep space because of the extreme distances traveled.

The Orion MPCV long-duration deep space exploration missions require 40% more habitable space than short-duration low-Earth orbit missions, such as crew and cargo ferry flights to the International Space Station. This additional living space is needed to accommodate suit entry/egress, and exercise. These mission requirements also call for extended life support and multi-day contingency survival ability in spacesuits.

The Orion MPCV will have stringent human rating requirements to ensure optimal crew health and safety throughout the entire mission, regardless of its duration.

The Orion MPCV's deep mission trajectory will require the spacecraft to reenter the Earth's atmosphere at a velocity about 50% higher than a low-Earth orbit return. This high-speed trajectory combined with the capsule diameter determines the heating rate. The Orion MPCV advanced heat shield material, Avcoat, is designed to withstand the extreme heating rate associated with this type of reentry.

For deep space exploration missions, the change in direction/speed or delta-v is driven by the spacecraft's return from deep space. For missions in low-Earth orbit, the delta-v requirements are driven by the need to break the Earth's orbit, rendezvous, and deorbit. A typical Orion MPCV deep space mission requires three to five times more delta-v than a typical ferry mission to the International Space Station. The change in delta-v is the most important measure of "distance" in space flight. The requirements for delta-v determine the need for additional propellant tanks, structure design, and launch abort system design.