National Aeronautics and
Space Administration

Langley's Contributions to Orion

NASA embarks on a new era of human space exploration as it prepares Orion for journeys to an asteroid and onward to Mars. Orion will serve as the spacecraft that will carry astronauts to deep space, provide emergency abort capability, sustain the crew during space travel, and provide safe re-entry from deep space return velocities. The Space Launch System (SLS), NASA's new heavy-lift rocket, will allow Orion to venture beyond low-Earth orbit. SLS will be the world's most powerful rocket, offering the highest-ever payload mass and volume capability and energy, while meeting a variety of crew and cargo mission needs. NASA centers and industry partners are critical to its success. NASA's Langley Research Center in Hampton, Virginia, contributes to Orion through Launch Abort System development, structural impact testing, wind tunnel testing, recovery testing and heat shield validation.

Launch Abort System

Langley is the lead for Orion's launch abort system, or LAS, which is positioned atop the Orion crew module, and is designed to protect astronauts if a problem arises during launch by pulling the spacecraft away from a failing rocket. The LAS can activate within milliseconds to pull the vehicle to safety and position the crew module for a safe landing. Langley engineers have provided a better understanding of how the vehicle performs in flight through wind tunnel test data, computational aerodynamics, flight simulation modeling and control law development. Langley has also contributed to design development of the vehicle by designing mechanisms and performing structural tests and analyses. Langley played a major role in the first flight test of the LAS, which successfully launched May 6, 2010, at the U.S Army's White Sands Missile Range near Las Cruces, New Mexico. That was the first fully integrated test of the launch abort system's three solid rocket motors and Orion's parachute landing system. In the future, Langley will lead another LAS flight test, which will assess components of Orion, including avionics, communications, the reaction control system and parachutes. This test will prove the LAS's readiness for human flight.

Structural Impact Testing

Langley engineers design, test and certify Orion structures and landing concepts by providing simulation capabilities on a variety of terrains. Structural landing testing helps to validate the computer models used to design Orion. In the early stages of Orion development, the Langley team evaluated the performance of an Orion mockup by investigating landing technologies, including air bags, retro rockets, shock absorbing struts and crushable structures. Later, an 18,000-pound Orion mockup, built and designed at Langley, was dropped dozens of times into Langley's 115-foot-long, 90-foot-wide and 20-foot-deep Hydro Impact Basin. The campaign of swing and vertical drops simulated water landing scenarios to account for different velocities, parachute deployments, entry angles, wave heights and wind conditions the spacecraft may encounter when landing in the Pacific Ocean. In the future, the team will test an even higher fidelity mockup of Orion, preparing the spacecraft for crewed missions.

Recovery Testing

NASA and the U.S. Navy used the same Orion mockup that was used for water impact testing to practice recovery operations of the spacecraft on its return from deep space missions. Langley, in collaboration with NASA's Kennedy Space Center in Florida, played a pivotal role during recovery testing in both calm and rough seas, further validating recovery processes for future missions. Recovery testing simulates what Orion will experience when it splashes down in the ocean after each mission. During recovery procedures, Navy divers will use small boats to recover the spacecraft and then reel it into the flooded well deck of a Navy ship. The spacecraft will then be secured in a specially designed cradle, and the water will be drained from the well deck, leaving the capsule dry and secure. During crewed missions, astronauts will climb out of the spacecraft once the well deck is drained.

Heat Shield Validation

Langley, in collaboration with Orion prime contractor Lockheed Martin, worked to validate the structural integrity and performance of Orion's heat shield. As the largest of its kind, the heat shield serves as the thermal protection system for when the spacecraft experi-

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ences temperatures of 4,000 degrees Fahrenheit of heat upon re-entry of the atmosphere. The heat shield is equipped with 200 sensors, which provide data about its ability to protect Orion during uncrewed and crewed missions. In order to ensure mission success, Langley validated the structural design, analysis, manufacturing process, material testing, proof testing and installation of the hardware. Langley also performed complex thermal-mechanical analyses and tests. Due to extreme and complex environments it must endure, the heat shield is one of the most difficult pieces of hardware to analyze and test.

A model of the Orion Launch Abort System experiences simulated flight conditions in Langley's National Transonic Facility.

Wind Tunnel Testing

Wind tunnels provide insights that help NASA understand how forces and heat affect vehicles as they move through the atmosphere. Langley wind tunnels have been used extensively to define the aerodynamic and heating environments the Orion LAS and crew module will experience during flight. Langley personnel conducted tests in many of Langley's major facilities, including the National Transonic Facility, 14-by 22-Foot Subsonic Tunnel, Transonic Dynamics Tunnel, 20-Inch Mach 6 wind tunnel, 31-Inch Mach 10 wind tunnel, and the Unitary Plan Wind Tunnel. Approximately 25 tests, reaching speeds greater than Mach 5, were conducted providing the Orion team with critical data necessary for engineers designing the spacecraft's flight control system, thermal protection system and structural integrity. Collecting such pertinent data ensures the Orion crew module can fly in a stable manner under abort and re-entry conditions and can survive the high temperatures encountered during re-entry.

Collaborative Effort

Orion, which is led out of NASA's Johnson Space Center in Houston, is a joint effort involving NASA centers and industry partners from across the nation. This collaborative effort in the development, design and testing of Orion has allowed NASA to build upon knowledge from research gained on the International Space Station and past human spaceflight experience, taking NASA another step closer to sending humans to deep space.

Journey to Mars

Orion will be the exploration spacecraft that will help astronauts leave Earth and return home on the journey to Mars. Advanced robotic missions have found evidence of water on Mars and characteristics similar to Earth. Sending astronauts to explore the Red Planet will enable further scientific discovery and boost knowledge of our solar system and of Earth. Traveling to Mars will further help us understand whether the Red Planet could be a destination capable of sustaining human presence.

An 18,000-pound test version of Orion, which was built and designed at Langley, was dropped into Langley's Hydro Impact Basin, simulating what the spacecraft may encounter when landing in the Pacific Ocean.

An Orion mockup, built and designed at Langley, floats in the Pacific Ocean during an Underway Recovery Test.

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Langley Research Center
100 NASA Road
Hampton, Virginia 23681-2199

www.nasa.gov

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