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Constellation Program: Orion Project Flight Tests

A robust series of flight tests is planned for the rockets and spacecraft of NASA's Constellation Program, which will support International Space Station missions in the next decade, and will later enable human exploration of the moon.

Flight tests are where concept meets reality for America's newest spacecraft. All of the math, engineering and computer-aided design and development work is put through real-world challenges that allow early correction of the design and ensures the vehicles are safe for human use.

The Pad Abort 1 test is the first in a series of up to five launch abort system flight tests that include two pad abort tests and up to three ascent abort tests. The earliest tests will be conducted at the Orion Abort Flight Test Launch Complex at the U.S. Army's White Sands Missile Range near Las Cruces, N.M., which broke ground on Nov. 14, 2007. The desert tests are part of a broader flight test campaign that will also include launches from Kennedy Space Center in Florida. The final launch abort system test is targeted for a combined Ares-Orion flight test prior to sending up the first crewed Orion spacecraft.

Ensuring the Safety of the Crew

The flight tests at White Sands will focus on the ability of Orion's launch abort system to pull the crew safely away from the Ares launch vehicle in the event of a problem on the launch pad or anytime during the first stage of the Ares rocket ascent to Earth orbit. These critically important tests will assure that all components of the new safety feature work, and that Orion's parachute landing systems function as planned. These flight tests, along with other ground tests, will help managers certify Orion's new launch abort system for flight.

This project was reviewed for environmental compliance as required under the National Environmental Policy Act. NASA published an environmental assessment in August for public and regulatory agency review and received no adverse comments.

The Testing Process

For the two pad abort tests, the launch abort system abort motor will be fired for about two seconds, lifting the Orion Crew Module test article directly from the launch pad to an altitude of about one mile. The crew modules are actual size, shape and weight, but they do not contain seats, life support systems and other equipment.

For the White Sands ascent abort test flights, surplus Peacekeeper missile rocket motors, provided by close collaboration with the Air Force, will be used to boost the crew modules to high-stress flight conditions along planned launch trajectories at various altitudes to mimic realistic abort conditions.

During all White Sands test flights, the launch abort system's directional control rockets and steering systems will actively guide the crew module after an abort is initiated. As the launch abort vehicle completes the burnout of the abort motor, a programmed sequence of events will occur.

First, explosive bolts fire and the launch abort system is jettisoned from the boilerplate crew module, clearing the module's recovery parachute system to activate. Next, a cover that protects the parachutes is quickly jettisoned. Then, two mortars fire small drogue parachutes upward into the airstream. These drogues stabilize the crew module through its initial descent. After a few seconds, they are cut away and three additional mortars fire pilot parachutes outward into the air stream. These pilots pull out the three main parachutes, each 116 feet in diameter, which inflate for a safe landing.

Launch Abort System Configuration

The launch abort system, mounted on top of the Orion Crew Module test article, is primarily composed of three solid propellant rocket motors: an abort motor; an attitude control motor; and a jettison motor.

The abort motor is a half-million-pound-thrust primary motor designed to lift the crew module off the Ares I booster rocket and fly it away safely.

The attitude control motor, composed of several small nozzles ringing the tip of launch abort system, fires simultaneously with the abort motor and provides adjustable thrust vectoring to keep the crew module on a controlled flight path.

The jettison motor discards the spent abort system from the crew module to allow the recovery parachute system to be deployed.

The launch abort system must be ready to operate in a wide variety of different environmental conditions, and the test program is designed to test the worst of these conditions.

A Cross-Agency Collaboration

NASA's Orion project office at NASA Johnson Space Center is leading a government and contractor team to validate and verify the spacecraft's launch abort system.

The launch abort system flight test vehicle integration and operations effort is led by NASA's Dryden Flight Research Center (DFRC). Orion Crew Module test article integration will occur at DFRC for the first two flights. Integration of the crew modules for the remaining flights will occur in the Orion Assembly Integration and Test facility at NASA's Kennedy Space Center.

Lockheed Martin Space Systems Corporation of Denver, Colo., is NASA's prime contractor for the Orion crew exploration vehicle and its launch abort system. Orbital Sciences Corporation of Dulles, Va., is building the launch abort system under contract to Lockheed Martin. NASA has a cooperative agreement with the U.S. Air Force to procure the abort test boosters that will serve as the test booster for the Orion ascent abort flight tests. Orbital Sciences Corporation of Chandler, Ariz., is building the abort test boosters and providing launch support services under contract to the Air Force.

The NASA Langley Research Center leads integration of the test launch abort system and is fabricating the primary structure of crew modules used for the first two abort flight tests. NASA's Glenn Research Center near Cleveland, Ohio, is providing a test-unique cold gas reaction control system that will steer the vehicle while under parachutes. NASA's Marshall Space Flight Center in Huntsville, Ala., is providing solid rocket booster engineering and operations expertise.

Test	Objective
Pad Abort 1 (PA-1)	Tests the basic functionality of the launch abort concept from the pad in its preliminary Orion design configuration.
Ascent Abort 1 (AA-1)	Tests the ability of the launch abort system to function while the spacecraft is traveling through the period of maximum aerodynamic pressure.
Pad Abort 2 (PA-2)	Continues to refine the data collected on PA-1, with higher fidelity test articles, and refined trajectories.
Ascent Abort 2 (AA-2)	Tests the ability of the launch abort system to function as the spacecraft breaks through the speed of sound.
Ascent Abort 3 (AA-3)	If required, this flight will test the performance of the launch abort system in the event of a loss of control of the launch vehicle.

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