NASAfacts

Pad Abort 1

Ensuring Astronaut Safety

NASA is continuing its mission to develop and demonstrate technologies that will allow the U.S. to pursue new approaches to human space exploration. Flight tests are where technological concepts meet reality when designing a new spacecraft. All of the math, engineering and computer-aided design and development work is put through real-world challenges that encourages correction of the design and ensures the vehicles are safe for human use.

Pathfinder mockups are used to practice various procedures before handling the actual PA-1 flight hardware.

Pad Abort 1, a flight test being conducted to validate the Orion crew exploration vehicle's launch abort system, will be conducted at the Orion Abort Flight Test launch complex 32E at the U.S. Army's White Sands Missile Range near Las Cruces, N.M. Although Orion is a component of the agency's Constellation program, the future of which is currently under Congressional review, the test will be conducted as part of NASA's ongoing mission to develop safer space vehicles for all human spaceflight applications. Information gathered through PA-1 testing will be valuable in design and development of future systems built for use in providing a safe escape for the crew in the event of an emergency. The launch abort system, or LAS, could be used on the launch pad or during the first stage of ascent to orbit.

Launch Abort System Configuration

The LAS, positioned on a tower atop a crew module boilerplate, will activate within milliseconds to pull the vehicle to safety and position the module for a safe landing. Boilerplates are the same size, shape and weight as the potential vehicles, but not exact replicas. The LAS and crew module boilerplate together are called the launch abort vehicle.

The LAS comprises three solid propellant rocket motors: an abort motor, an attitude control motor, and a jettison motor. The primary motor is the abort motor which will fire nearly 500,000 pounds of thrust to propel the crew module away from the pad. The attitude control motor exerts up to 7,000 pounds of steering force to maintain stability and reorient the vehicle as needed. The jettison motor will pull the whole launch abort system away from the crew module and make way for parachute deployment and landing.

The launch abort system also includes an adapter cone which attaches to the crew vehicle, a motor stack and a nose cone.

PA-1 Flight Test Sequence

During the test, an abort command will be sent from the mobile operations facility that ignites the LAS abort motor. The motor will burn for approximately six seconds, with the highest impulse in the first 2.5 seconds. The crew module will reach approximately 445 miles per hour in the first three seconds in its upward trajectory away from the pad, to about one mile high.

The launch abort vehicle lifts off the pad for the PA-1 flight test.

The attitude control motor fires simultaneously with the abort motor and provides adjustable thrust vectoring to keep the crew module on a controlled flight path. As the launch abort vehicle completes the burnout of the abort motor, it is reoriented in preparation for a programmed sequence of events. First, explosive bolts fire and the jettison motor separates the spent abort system from the boilerplate crew module to allow the recovery parachute system to be deployed. Drogue parachutes deploy first to 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. After about 100 seconds aloft, the crew module will land approximately one mile downrange from the launch pad.

The PA-1 launch abort system is assembled in NASA's final integration and test facility at the U.S. Army's White Sands Missile Range.

Flight Test Objectives

Testing the LAS performance and LAS to crew module interface are the principal objectives of PA-1. This data will have wide applicability to future launch vehicles and will also demonstrate the performance of three new types of motors and innovations in their design. Some of the primary objectives are to:

- Demonstrate ground-initiated abort;
- Demonstrate the capability of the LAS to propel the module to a safe distance from a launch vehicle during a pad abort;
- Demonstrate stability and control characteristics of a crew module in regards to the LAS;
- Obtain LAS/crew module interface structural loads and external acoustics data;
- Determine the performance of the abort, jettison and attitude control motors;
- Demonstrate abort event sequencing from abort initiation through LAS jettison.

Secondary objectives of the test are to:

- Demonstrate parachute assembly system event sequencing;
- Demonstrate the performance of the main parachute system.

Testing Team

The Orion project office at NASA's Johnson Space Center is leading the team to test the LAS. The development of the LAS is led by NASA's Langley Research Center in partnership with NASA's Marshall Space Flight Center. Langley also designed and produced the crew module simulator that will be used for the flight test. Marshall is responsible for propulsion, safety and mission assurance, and oversight of assembly integration and production.

NASA's Dryden Flight Research Center prepared the crew module for integration after it was transported from Langley and leads the flight test vehicle integration at WSMR

Lockheed Martin is the prime contractor to NASA for the Orion crew exploration vehicle. The nationwide industry team includes major subcontractors Aerojet, Alliant Techsystems (ATK), Hamilton Sundstrand, Honeywell, Orbital Sciences Corporation and United Space Alliance.

Orbital is responsible for the design, development, test and integration of the LAS for Lockheed Martin. ATK is responsible for the launch abort and attitude control motors and Aerojet is responsible for the jettison motor. All three motors were integrated into the LAS assembly by a Lockheed Martin-lead team at WSMR.

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