



# Orion Recovery Operations

The Orion spacecraft is NASA's newest exploration vehicle. It is a capsule designed to carry astronauts to destinations never before explored by humans, including an asteroid and eventually Mars. Orion will have emergency abort capability, sustain the crew during space travel and provide safe re-entry from deep space.

Orion will launch on its first mission, Exploration Flight Test-1, this fall. The uncrewed spacecraft will launch aboard a United Launch Alliance Delta IV Heavy rocket from Cape Canaveral Air Force Station in Florida. It will travel 3,600 miles into Earth's orbit and then return to Earth at a speed of approximately 20,000 mph. Orion will splashdown in the Pacific Ocean, about 600 miles south of San Diego, Calif. The mission will provide engineers with information that will help improve the design of Orion to carry astronauts to deep space and return them home.

## Recovery Operations

After Orion's splashdown, an integrated team of U.S. Navy amphibious specialists, engineers and technicians from NASA's Ground Systems Development and Operations (GSDO) program at the agency's Kennedy Space Center in Florida, Johnson Space Center in Houston, and Lockheed Martin Space Operations, will recover the Orion crew module and attempt to recover the jettisoned hardware, including the forward bay cover and parachutes.

Two rigid-hull inflatable boats and two smaller Zodiac boats will be used to tow the crew module into the flooded well deck of a Navy ship and secure it in a

specially designed cradle. Water will be drained from the well deck, leaving Orion secure and dry.

Two more rigid-hull inflatable boats will be used to secure and reposition Orion's recovered forward bay cover and parachutes to the port side of the Navy ship where a crane will lift them onto the ship's main deck. The crew module and jettisoned hardware will then be transported from the landing site to a pier at the U.S. Naval Base San Diego. After they are secured in the Recovery Transportation Fixture, a platform nicknamed the Armadillo, the Orion crew module and hardware will be transported by truck to Kennedy, where they will be prepared for the next mission.

During future crewed exploration missions in Orion propelled by NASA's Space Launch System rocket currently in development, the recovery procedures will be adjusted to allow for extraction of the crew members. NASA astronauts will remain inside Orion after splashdown and be removed after the craft is secured inside the well deck of the Navy ship. There, a platform will be moved into place after the water has drained from the deck, allowing the astronauts to climb out. They will undergo a thorough medical evaluation on the ship.

Several of the unique pieces of Orion recovery hardware were designed and developed by NASA and Lockheed Martin engineers and technicians at Kennedy. For example, Lockheed Martin designed the cradle Orion will sit in inside the well deck. It will be used to secure Orion in the recovery ship and move it out of the ship after returning to port. NASA, meanwhile, designed the fixture that Orion will be stored in aboard the ship.



A stationary recovery test using the Orion boilerplate test article was conducted at the Naval Station Norfolk near NASA's Langley Research Center in Virginia on Aug. 15, 2013. A second test will be conducted this year in the open waters of the Pacific Ocean.

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It uses a bolt-on bumper assembly with cushions, or bumpers, that float up and down on guiderails to guide the vehicle into the proper orientation on the fixture.

During a stationary recovery test in August 2013 at the Naval Station Norfolk in Virginia, divers in small boats approached a test version of the Orion crew module. They attached tow lines and led the test article to a flooded well deck. With the test article in position over the recovery cradle, the water was drained to facilitate access by handling personnel.

The hardware used in the stationary test was sent to the West Coast in advance of February 2014 testing in open water off the coast of San Diego.

Building on 50 years of experience in spacecraft recovery operations, NASA's GSDO Program at Kennedy Space Center is helping the agency prepare for future human deep space exploration, and will play a key role in Orion recovery operations.

During NASA's Apollo Program, Launch Services Program rocket launches and all 135 historic space shuttle launches, Kennedy's expertise included deploying and leading complex integrated teams at off-site locations throughout the world, working hand in hand with military personnel (both foreign and domestic), developing and coordinating search and rescue efforts with the Department of Defense, and creating and implementing a recovery operations concept that is compatible with the unique spacecraft, payload hazards and requirements.

### More online

For more information about the Orion Program, visit:

<http://www.nasa.gov/orion>.

For more information about the GSDO Program, visit:

<http://go.nasa.gov/groundsystems>.



**ABOVE:** A test version of Orion, secured in a cradle, is reflected in water on a U.S. Navy ship at the Naval Station Norfolk near NASA's Langley Research Center in Virginia on Aug. 12, 2013, during a test of recovery operations. **BELOW:** A test version of Orion is returned to a U.S. Navy ship following a stationary recovery test in the water Aug. 13, 2013. NASA and the U.S. Navy conducted tests to prepare to recover the Orion crew module and forward bay cover on its return from a Deep Space mission. Orion is the exploration spacecraft designed to carry astronauts to destinations not yet explored by humans, including asteroids and Mars. Orion's first mission is scheduled to launch in 2014 atop a Delta IV rocket and in 2017 on NASA's Space Launch System rocket. For more information, visit <http://www.nasa.gov/orion>.



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