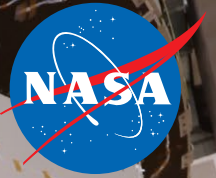


National Aeronautics and
Space Administration



ORION

STACKING UP FOR 2018

DECEMBER 2017

NASA DEEP SPACE EXPLORATION SYSTEMS LOOK AHEAD TO ACTION-PACKED 2018

Engineers preparing NASA's deep space exploration systems to support missions to the Moon, Mars, and beyond are gearing up for a busy 2018. The agency aims to complete the manufacturing of all the major hardware by the end of the year for Exploration Mission-1 (EM-1), which will pave the road for future missions with astronauts. Planes, trains, trucks and ships will move across America and over oceans to deliver hardware for assembly and testing of components for the Orion spacecraft and the Space Launch System (SLS) rocket while teams at NASA's Kennedy Space Center in Florida prepare the Ground Systems infrastructure. Testing will take place from the high seas to the high skies and in between throughout the year and across the country, not only in support of EM-1, but also for all subsequent exploration missions.



Early in the year, engineers at Kennedy will bolt Orion's heat shield to the crew module. The heat shield will endure temperatures as high as 5,000 degrees Fahrenheit, half as hot as the surface of the Sun, when Orion returns from its missions near the Moon. Mating the heat shield is a crucial step before the service module arrives from Europe in the middle of the year. Once the powerhouse for the spacecraft arrives, technicians will outfit it for mating with the crew module and stack the elements together, joining propulsion lines, avionics and other connections. After the major elements are stacked together, technicians will verify that the integrated crew and service module work as expected and hardware is responding as intended before shipping the stack to NASA's Plum Brook Station in Sandusky, Ohio for testing in 2019.

NASA engineers and the U.S. Navy will head out to sea off the coast of California in January to evaluate how they plan to recover Orion after the EM-1 test flight. In Yuma, Arizona, engineers will perform three remaining tests to qualify Orion's parachutes for missions with crew, and at White Sands Test Facility in New Mexico, workers will continue tests to verify the propulsion system for Orion's European Service Module works as planned. At the Denver facility of Orion prime contractor Lockheed Martin, a structural test article will undergo pressure, acoustic, pyrotechnic and other testing to help ensure Orion can stand up to vibrations, loads, sounds and blasts associated with separation events in flight.

Work is already well underway and will continue for the Orion spacecraft that will carry astronauts on Exploration Mission-2 (EM-2). Workers are welding the primary elements of Orion's structure at Michoud Assembly Facility in New Orleans and will ship the completed vessel to Kennedy by the end of 2018. At NASA's Johnson Space Center in Houston, engineers will review the life support and crew survival systems, and astronauts and test subjects will continue evaluations of the crew interface. NASA engineers are preparing a test version of the spacecraft and separation ring for a mid-air test of Orion's launch abort system. A precursor to the EM-2 crewed flight of Orion, the test, called Ascent Abort 2, will validate the operations of the launch abort system in a dynamic flight environment.

Read more about upcoming EM-1 milestones:
go.nasa.gov/2mTiLHC



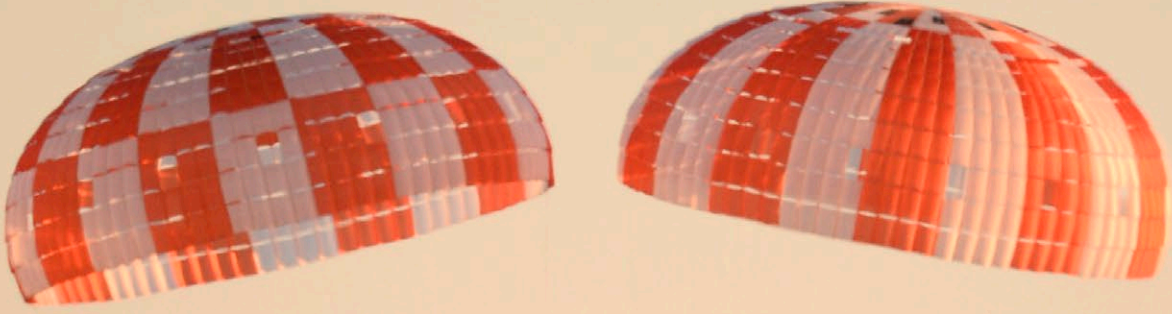
Orion's Exploration Mission-1 heat shield.



First weld of the Exploration Mission-2 crew module.



Ascent Abort-2 flight test.



ORION PARACHUTE TESTS PROVE OUT COMPLEX SYSTEM FOR HUMAN DEEP SPACE MISSIONS

When NASA's Orion spacecraft hurtles toward Earth's surface during its return from deep-space missions, the capsule's system of 11 parachutes will assemble itself in the air and slow the spacecraft from 300 mph to a relatively gentle 20 mph for splashdown in the

Pacific Ocean in the span of about 10 minutes. As the astronauts inside descend toward the water on future missions, their lives will be hanging by a series of threads, tested and validated to ensure the parachute-assisted end of Orion missions are a success.



Through a series of tests in the Arizona desert, the engineers refining Orion's parachutes have made the road to certifying them for flights with astronauts look easy, including a successful qualification test Dec. 13 that evaluated a failure case in which only two of the system's three orange and white main parachutes deploy after several other parachutes in the system used to slow and stabilize Orion endure high aerodynamic stresses. But behind the scenes, engineers are working hard to understand and perfect the system that must be able to work across a broad range of potential environmental conditions and bring the crew home.

While Orion's parachutes may look similar to those used during the Apollo-era to the untrained eye, engineers can't simply take that parachute system and scale it up to accommodate Orion's much larger size. Through testing and analysis, technicians have developed Orion's parachutes to be lighter, better understood and more capable than Apollo's. NASA has also been able to adjust the system as elements of the spacecraft, such as attachment points, have matured.

Orion's parachute system is also incredibly complex. About 10 miles of Kevlar lines attach the spacecraft to the outer rim of nearly 12,000 square feet of parachute canopy material – over four times the average square footage of a house – and must not get tangled during deployment. In addition to the fabric parachutes themselves, there are cannon-like mortars that fire to release different parachutes. Embedded in several

parachutes are fuses set to burn at specific times that ignite charges to push blades through bullet proof materials at precise moments, slowly unfurling the parachutes to continue the sequential phases of the deployment sequence. All of these elements must be developed to be reliable for the various angles, wind conditions and speeds in which Orion could land.

With the analysis capabilities that exist today and the historical data available, engineers have determined that approximately 20-25 tests, rather than the more than 100 performed during the Apollo era, will give them enough opportunities to find areas of weakness in Orion's parachute system and fix them. After the three remaining final tests this year, the system will be qualified for missions with astronauts.

Orion parachute engineers have also provided data and insight from the tests to NASA's Commercial Crew Program partners. NASA has matured computer modeling of how the system works in various scenarios and helped partner companies understand certain elements of parachute systems, such as seams and joints, for example. In some cases, NASA's work has provided enough information for the partners to reduce the need for some developmental parachute tests.

Parachute testing is just one part of the vast expanse of work being performed across the country that enable humans to venture farther into space than ever before.



AA-2 MOTOR TAKES SHAPE IN UTAH



In December, the Launch Abort System team completed a number of significant accomplishments on the Ascent Abort-2 (AA-2) abort motor, which will be used to test the system responsible for carrying astronauts to safety during ascent. The loaded motor was successfully cast and completed non-destructive inspection at Orbital ATK's facility

in Utah. The igniter was successfully cast with propellant as well. The reverse flow manifold completed insulation and instrumentation operations and is now ready for shipment to the Rocket Motor Assembly Operations Facility. Additional qualification motor testing was also completed, and results showed successful testing as expected.

ORION TEAM MEMBERS RECEIVE RECOGNITION

Orion team members went above and beyond their work duties to ensure that Orion moved forward on its way to Exploration Mission-1. This past fall, individuals and teams at NASA centers and subcontractor sites across the country were presented awards by NASA astronauts and program managers who personally thanked them for their contribution to Orion's progress and impact on future mission success. All of the Orion team members who received recognition throughout 2017 the dedication and perseverance that the Orion team counts on to ensure that the spacecraft will continue its pace towards NASA's Exploration Missions.

Fall 2017 Recipients Include:

NASA Exceptional Service Medal

Cynthia Cross Karen Potter

NASA Director's Commendation Award

Clinton Baggerman Quyen Jones
Shanna Deleon John McCullough
David Dannemiller Christine Worstell

NASA Group Achievement Award

Orion Exploration Mission-2 Developmental Flight Instrumentation
Government Furnished Equipment Proposal Team

NASA Director's Team Innovation Award

Orion Software Verification Streamlining Team

Space Flight Awareness Trailblazer Award

Eric Hinkson John Marcantonio
John Neuman Vincent Nichols

Space Flight Awareness Silver Snoopy Award

Mark Ashley Doug Gruba
Jen Brown Larry Lovett
Kim Fleming Matt Thompson
Bill Green

Space Flight Awareness Team Award

European Service Module Solar Array Wing Conops Team
Orion Ground Test Article Water Impact Test Team

ORION SHOWCASED AT SPACECOM 2017

At SpaceCom2017, Orion team members participated in panel and exhibit presentations to share innovations and learn more about how smaller companies and other industries can positively impact deep space exploration.

During exposition, Space Florida Senior Vice President, Chief Operating Office and Director of Cape Canaveral Spaceport Jim Kuzma announced an agreement between Space Florida and NASA's Johnson Space Center for use of Space Launch Complex 46 for the Orion spacecraft's Ascent Abort-2 test. This gives Johnson Space Center and Orion priority use of the launch complex to ensure testing timelines are met.

Highlights from SpaceCom 2017: bit.ly/2DgcLPf

Launched in 2015, the Space Commerce Conference and Exposition, known as SpaceCom, is a three-day event located in Houston, Texas, which is engineered to fuel business innovation across the aerospace, medical, energy, maritime, agribusiness, and advanced manufacturing industries. During SpaceCom, public and private stakeholders involved in domestic and international space commerce are united with groups of global business executives looking for competitive advantage through the application of space technologies to their industries.

Orion's agreement with Space Florida: bit.ly/2BbBqCP



Lockheed Martin's Josh Erlich, astronaut (ret.) Scott Altman with ASRC, Orion's Paul Marshall, and MEI's Rich Larson.



Johnson Space Center Director Dr. Ellen Ochoa and Space Florida Senior Vice President Jim Kuzma.



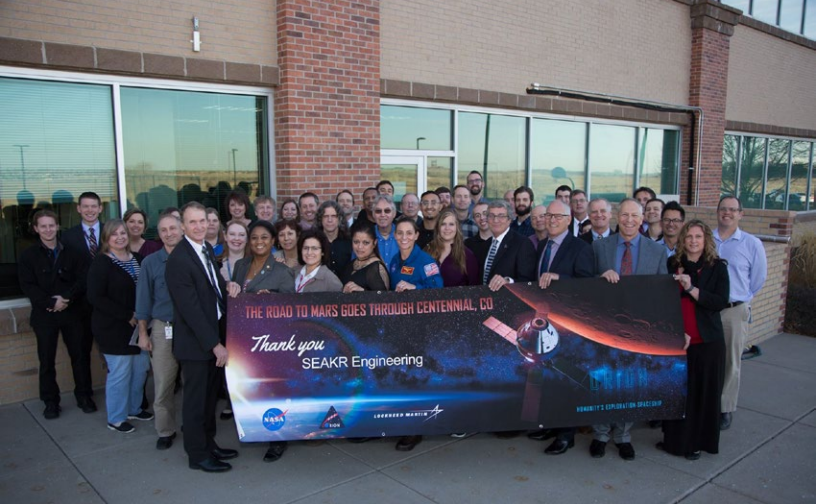
COLORADO COMPANIES HELP PAVE THE ROAD TO MARS

Space got a little closer to home on Dec. 11 and 12, as NASA astronaut Nicole Mann, NASA Orion Deputy Program Manager Charlie Lundquist, Lockheed Martin Orion Deputy Manager Larry Price and other Orion management got a behind-the-scenes look inside several Orion supplier facilities in Colorado. The group first toured Orion battery supplier EnerSys in Longmont to see how the batteries that will power the launch abort system on Orion are constructed, tested, and verified. The group continued its tour in Centennial at SEAKR Engineering, which has been an avionics hardware supplier since Orion's inception and recently delivered video processing unit parts for EM-1 and EM-2. The trip culminated with the group touring the Electronics Manufacturing facility at Lockheed Martin's Waterton Canyon facility to see work in progress on Orion's electronic systems and components.

At each location, Orion managers and astronaut Nicole Mann took time to speak with the employees and recognize them for their accomplishments, share Orion's overall progress and note how the company's specific contributions were making a difference for NASA's future space exploration missions. At every stop they made sure it was clear that the road to Mars runs through Colorado.

Denver Post: [dpo.st/2DrNDzi](https://www.denverpost.com/2017/12/11/colorado-companies-help-pave-the-road-to-mars/)

9News: [on9news.tv/2mR3A1M](https://www.9news.com/story/news/2017/12/11/colorado-companies-help-pave-the-road-to-mars/1000000000/)



SUPPLIER SPOTLIGHT

ARCTIC SLOPE REGIONAL CORP.



Arctic Slope Regional Corporation (ASRC) Federal Space & Defense works on various aspects involved in manufacturing and testing the Orion spacecraft. Headquartered in Beltsville, Maryland, with offices in 40 states, ASRC Federal is integrated in supporting Orion's development in locations spanning across the United States from NASA Kennedy Space Center in Florida to Lockheed Martin's offices in California, all the way to providing support at the Airbus facility in Bremen, Germany. ASRC Federal has a longstanding history of working on NASA programs including the International Space Station and Space Shuttle programs. On Orion

they provide a wide variety of services including avionics lab design and development, assembly and integration, fabrication and installation of the vehicle's thermal protection systems, and mission operations support. In 2016 ASRC Federal was honored with Lockheed Martin's prestigious Rigel Award which recognizes an Orion small business subcontractor who performs above and beyond its contractual commitments. ASRC Federal also recently entered into a strategic teaming agreement that will ensure a long-term partnership with Orion. Apart from work on Orion and other space programs, ASRC has a significant impact on the oil and gas industry of Alaska.

CANADIAN BRASS SERENADES JSC



The world-renowned Canadian Brass quintet performed holiday music for employees of NASA's Johnson Space Center before embarking on a tour of the site. Formed in 1970, the quintet performs around the world and often puts on masterclasses for students and young audiences to learn. During their tour at Johnson, they were able to learn more about Orion from Matt Lemke, NASA Orion deputy manager of Avionics, Power and Software.

FOLLOW THE PROGRESS OF NASA'S NEW SPACECRAFT FOR HUMAN EXPLORATION:

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Episode 4

How to Build a
Spaceship

SPOTLIGHT SPACE: HOW TO BUILD A SPACESHIP

Go behind the scenes with @TheSpaceGal Emily Calandrelli to see how Orion is being assembled at NASA's Kennedy Space Center in Florida by employees from NASA, Lockheed Martin, and other contractors leading the way to deep space.

Watch the video:
bit.ly/2DqLxZB



JAN 2018

Underway Recovery Test-6 off coast of San Diego
STA stacking operations in Denver
EM-2 crew module welding at Michoud