

National Aeronautics and
Space Administration




ORION

MAY 2016

PERFORMANCE UNDER PRESSURE



A large, green, conical Orion crew module is suspended by a crane in a vast, white industrial facility. Several technicians in blue and white uniforms are working around the module. The room is filled with various pieces of equipment, including ladders, carts, and structural beams. The lighting is bright and even.

Lockheed Martin engineers and technicians prepare the Orion crew module for a series of tests inside the proof pressure cell in the Neil Armstrong Operations and Checkout Building at NASA's Kennedy Space Center in Florida.

ORION SPACECRAFT PASSES PRESSURE TEST SERIES

Engineers at NASA's Kennedy Space Center in Florida recently completed a series of pressure tests on the Orion crew module. The tests confirmed that the weld points of the underlying structure, called the pressure vessel, will protect astronauts during the launch, in-space, re-entry and landing phases of spaceflight.

Orion's pressurized crew module contains the atmosphere that a crew would breathe during a mission. It is also the living and working space for the crew and must withstand the loads and forces experienced during launch and landing.

Orion was tested inside the proof pressure cell in the high bay of the Neil Armstrong Operations and Checkout Building. Lockheed Martin, the manufacturer of the Orion crew module, ran the test at incremental steps over two days to reach the maximum pressure. During each step, the team pressurized the chamber and then evaluated the data

to identify changes for the next test parameter. The results revealed the workmanship of the crew module pressure vessel welds and how the welds reacted to the stresses from the pressurization.

Future tests at Kennedy will include a launch simulation and power-on procedure. Orion and its service module also will be sent to NASA Glenn Research Center's Plum Brook Station facility in Sandusky, Ohio, for acoustics and vibration tests.

NASA's Space Launch System will launch Orion on its next flight, Exploration Mission 1 (EM-1), when the spacecraft will travel beyond the moon and back on an uncrewed flight test.

[Read the full story about the pressure test series.](#)

A press conference in Germany marks the arrival of the EM-1 flight structure to Bremen and the start of the assembly by Airbus.



ORION SERVICE MODULE ASSEMBLY UNDERWAY AT AIRBUS

Airbus Defence and Space, the world's second largest space company, began assembling the European-built service module for Exploration Mission-1. The service module sits below the crew module and is known as the powerhouse of NASA's next-generation Orion spacecraft.

After the arrival of the flight model structure from Thales Alenia Space Italy, final assembly will be carried out at Airbus Defence and Space's site at Bremen, Germany, where officials from ESA (European Space Agency), NASA, Airbus Defence and Space and partners gave an update on the Orion program's progress on May 19.



Shown in photo from left to right: Jim Free (NASA), Jan Wörner (ESA), Carsten Sieling (Lord Mayor Bremen), Bart Reijnen (Airbus) and Michael Hawes (Lockheed Martin).

Integrating more than 20,000 parts and components in the flight model ranging from electrical equipment to rocket engines, solar arrays, tanks for propellant and life support consumables as well as hundreds of meters of cables and tubes marks a major milestone for the Orion program.

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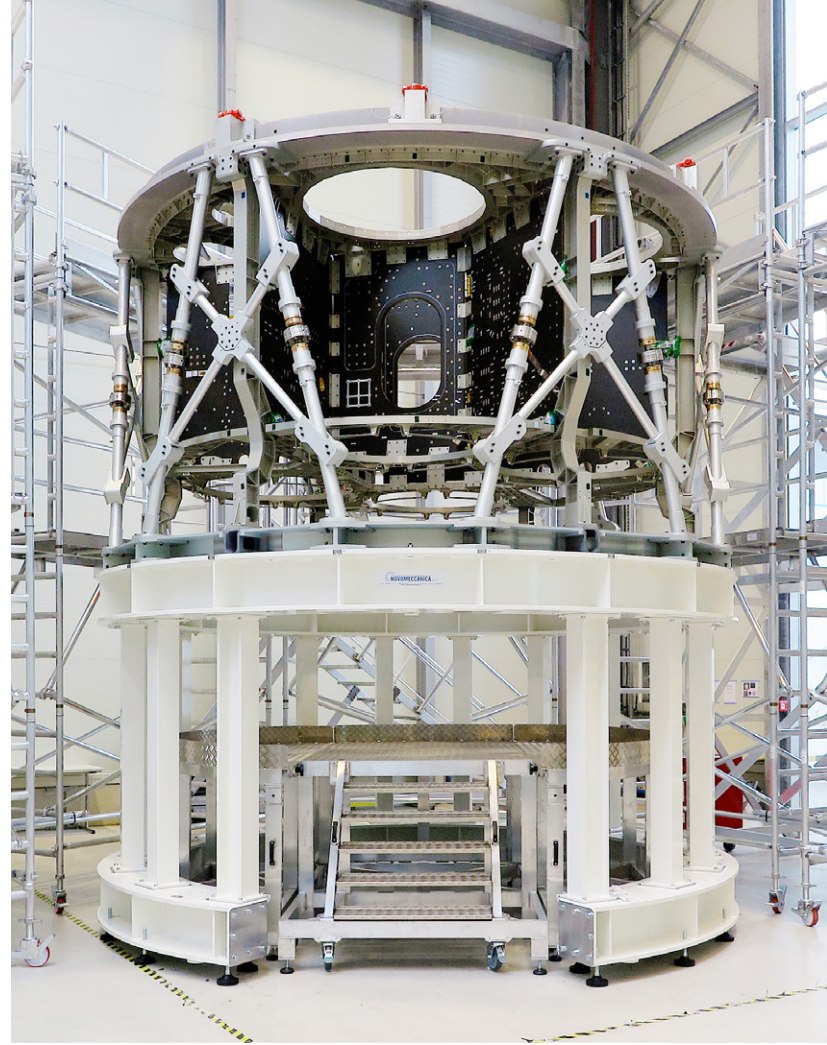
Airbus Defence and Space was chosen by ESA as the prime contractor to develop and build the service module, which will supply propulsion, power, thermal control, air and water for astronauts on missions beyond the moon and to Mars.

In managing the development and construction of the module, Airbus Defence and Space is drawing on its extensive experience as prime contractor of ESA's Automated Transfer Vehicle, which made regular deliveries of experiment equipment, spare parts, food, air and water for the crews on board the International Space Station.

[Read the full story about the Orion assembly.](#)

On the right, the primary structure for the Exploration Mission-1 service module is prepared for final assembly at the Airbus Defence and Space facility in Bremen, Germany.

Picture below, Oliver Juckenhöfel, head of the Orion European service module for Airbus Defence and Space hosted 170 team members across the program to exchange information, provide a status of the program, and work on quality and team building. Team members are from Les Mureaux, France; Lampoldshausen & Bremen, Germany; and the United States.





Orion and SLS industry representatives discuss the technologies in place today that are capable of safely transporting humans to Mars and back to Earth.

D.C. SUMMIT SETS SITES ON MARS

NASA, industry, policy figures, entertainment industry representatives and STEM education professionals presented perspectives on the future of human space exploration beyond the Earth and moon at the Humans to Mars Summit held May 17-19 at George Washington University in Washington.

Over the course of three days, the summit featured discussions about the technical, scientific, policy and public outreach challenges associated with the goal of sending humans to Mars. Speakers included Ellen Stofan, NASA chief scientist; Wanda Sigur, Lockheed Martin vice president of the civil space line of business; Tony Antonelli, Lockheed Martin exploration chief technologist; Andy Weir, author of *The Martian*; Buzz Aldrin, former Apollo astronaut; Abigail Harrison (Astronaut Abby) of *The Mars Generation*; and many others.

Several mission concepts for interplanetary transportation and Mars surface systems were presented during the conference. During the Vision to Reality: Human Exploration of Mars panel, Tony Antonelli unveiled the Lockheed Martin Mars Base Camp mission concept for sending humans to Mars by 2028. The Mars Base Camp

concept is built on a strong foundation utilizing today's technologies – making it safe, affordable and achievable:

- > **Orion:** The world's only deep-space crew capsule, built with long-duration life support, deep-space communications and navigation, and safe Earth reentry capability.
- > **Space Launch System:** The rocket with super heavy lift capability to send critical labs, habitats and supplies to Mars.
- > **Habitats:** Building on NextSTEP research, deep space habitats will give astronauts room to live and work on the way to, from and at Mars.
- > **Solar Electric Propulsion:** Based on technology already in place on satellites, this advanced propulsion can pre-position key supplies in Mars orbit.

Read the Popular Science article about Mars Base Camp.

Watch a replay of Humans to Mars presentations.

Close-up view of the structural representation of Orion's service module which was recently tested in the Reverberant Acoustic Test Facility at NASA Glenn's Plum Brook Station.

ORION SERVICE MODULE TESTING SOUNDS OFF

Replicating the thunderous noise of a rocket launch is no easy task, but engineers at NASA Glenn Research Center's Plum Brook Station in Sandusky, Ohio, are mimicking the launch environment the Orion spacecraft will experience on a 2018 mission beyond the moon. They recently concluded a series of tests on a structural representation of the Orion service module to help

ensure it can withstand the force and pressure of the acoustics environment it will experience as it makes its way from the launch pad to space atop NASA's Space Launch System rocket.

[Read the full story about the service module testing.](#)



Engineers at NASA's Langley Research Center in Hampton, Virginia, dress a 105-pound representative female crash-test dummy into a modified Advanced Crew Escape Suit to prepare for water-impact testing at Langley's 20-foot-deep Hydro Impact Basin.

NASA CRASH-TEST DUMMIES SUIT UP FOR ACTION

Engineers at NASA's Langley Research Center in Hampton, Virginia, are working to ensure astronauts are safe during splashdown by performing water-impact tests of an Orion test capsule with suited crash test dummies inside.

- > **[Read about the crash-test dummies through NASA's website.](#)**
- > **[Read about the crash-test dummies through Lockheed Martin.](#)**



NASA representatives pose in front of the Ikhana aircraft at NASA's Armstrong Flight Research Center. The Ikhana remotely-piloted aircraft, which is based at Armstrong, was used to capture live video during the Orion re-entry and landing during Exploration Flight Test-1.

ARMSTRONG TEAM HONORED FOR EXCEPTIONAL ORION WORK

NASA's Orion program representatives visited NASA Armstrong Flight Research Center in California to honor employees' contributions and talk about the space program.

Charlie Lundquist, NASA Orion deputy program manager; C.J. Johnson, Orion project manager for the Capsule Parachute Assembly System (CPAS); Ann Bufkin, Orion CPAS test engineer; and Barbara Zelon, Orion program communications manager, were briefed about the center's support of the Orion program during their visit.

During the award ceremony, Lundquist presented Armstrong Deputy Director Patrick Stoliker with an American flag that was flown aboard the Orion spacecraft during the Exploration Flight Test-1 mission.

To support CPAS, Armstrong provides air-to-air aircraft imagery and chase plane support for the C-17 air launch of the system tested at the U.S. Army's Yuma Proving Ground. Photography and videography is used for test reconstruction and parachute performance photogrammetric analysis.

NASA Armstrong is supporting Orion launch abort system flight test development, including preparations for the AA-2 flight test in 2019. Armstrong will provide development flight instrumentation for AA-2 and manages the NASA contract for the Abort Test Booster for the AA-2 launch.

[Read the full story about the Armstrong Team.](#)



Orion employees at the Neutral Buoyancy Laboratory

JSC EMPLOYEES VIEW A PART OF EFT-1 HISTORY

NASA's Johnson Space Center employees had the opportunity to view a traveling Exploration Flight Test-1 exhibit that is traveling to each of the NASA center. On display were two items flown aboard Orion's historic first flight test on Dec. 5, 2014: a written piece by Dr. Maya Angelou, "A Brave and Startling Truth," and a U.S. flag presented to NASA on behalf of Lockheed Martin.



Orion team in front of building 17



In the image above, Orion team members in the Mission Control Center. In the image below, Orion team in the Space Vehicle Mockup Facility.



SO-CAL CELEBRATES SPACE

On May 14, San Diego Composites, Inc. represented the Orion team at San Diego Air & Space Museum's 13th Annual Space Day Celebration. The celebration featured displays from aerospace organizations all over Southern California. SDC Vice President Ken Mercer said the event was a fun way to connect the Orion program with the San Diego Community. Employees gave students a hands-on experience and a chance to learn how today's advanced materials will help Orion venture out on missions deeper into space than ever before. San Diego Composites is a supplier to Lockheed Martin that manufactures several components for Orion's launch abort system, which propels astronauts to safety in the event of an emergency on the launch pad or during ascent to orbit.



EM-2 WORK HATCHED AT JSC

The Orion team completed engineering development unit vibration testing on the Exploration Mission-2 docking hatch at NASA's Johnson Space Center in Houston. The team also performed docking hatch swing/securing engineering evaluations in the full-scale Orion mockup on May 16 and 17.

In the picture, the Orion medium fidelity mockup at NASA's Johnson Space Center is being prepped for fit checks of the Exploration Mission-2 docking hatch.





SENATOR RUBIO TALKS SPACE WITH FLORIDA EDC GROUP

U.S. Senator Rubio (center) meets with community leaders from Brevard County, Florida.

Senator Marco Rubio (R-FL) met with Economic Development Commission (EDC) of Florida's Space Coast's Community Leaders group on May 11 in Washington. Joe Mayer, Lockheed Martin Space Systems government relations director for Florida, led the aerospace delegation discussions on the importance of

U.S. leadership in space, deep-space exploration with Orion and the Space Launch System, and preserving America's assured access to space. The Brevard County EDC group also held meetings with Senator Bill Nelson (D-FL) and Rep. Bill Posey (R-FL-8), as well as senior Air Force and Navy officials.



A IS FOR ASCENT

The Orion Ascent Abort-2 (AA-2) Crew and Separation Ring (CSR) team viewed the Orion boilerplate crew module at NASA Langley Research Center's fabrication facility this month. The CSR team is modifying and completing the boilerplate with the necessary systems to support the flight test objectives. Once complete, the vehicle will be shipped to NASA's Kennedy Space Center in Florida to support the AA-2 flight scheduled for December 2019.



PREPARING AMERICA FOR DEEP SPACE EXPLORATION: SOME ASSEMBLY REQUIRED

[Watch the full video.](#)



A SPRING IN ORION'S STEP

Read about Orion in the Spring 2016 edition of the JSC Roundup.

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

- NASA's Orion BlogBlogs.NASA.gov/Orion
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UNIVERSITY STUDENTS TAKE ON THE NEXT MICRO-G CHALLENGE



Orion engineer Dustin Neill was one of several guest presenters for the "Journey to Mars" panel at a microgravity workshop held at NASA's Johnson Space Center. Called Micro-g Neutral Buoyancy Experiment Design Teams (Micro-g NEXT), the program challenges students to work in teams to design and build prototypes of tools to be used by astronauts during spacewalk training in the center's Neutral Buoyancy Laboratory. University students from across the nation participated in space exploration workshops, toured center facilities, and presented their concepts and prototypes for deep-space spacewalks.



JUNE

- Ohio Senator Applauds Orion/SLS Suppliers
- ESA/Airbus Team Complete ESM CDR
- SLS/Orion Team Visits Alabama Suppliers
- Space Exploration Summer School Highlights