

National Aeronautics and
Space Administration



ORION

JANUARY 2016

WE SHIP SPACE SHIPS



ORION'S PRESSURE VESSEL NOW IN FINAL ASSEMBLY AND TESTING FOR EXPLORATION MISSION-1

NASA's Orion spacecraft is another step closer to launching on its first mission to deep space atop the agency's Space Launch System rocket. On Jan. 13, Lockheed Martin engineers at NASA's Michoud Assembly Facility in New Orleans finished welding together the primary structure of the Orion spacecraft destined for deep space, marking another important step on the journey to Mars.

Welding Orion's seven large aluminum pieces, which began in Sept. 2015, involved a meticulous process. Engineers prepared and outfitted each element with strain gauges and wiring to monitor the metal during the process. The pieces were joined using a state-of-the-art process called friction-stir welding, which produces incredibly strong bonds by transforming metals from a solid into a plastic-like state, and then using a rotating pin tool to soften, stir and forge a bond between two metal components to form a uniform welded joint, a vital requirement of next-generation space hardware.

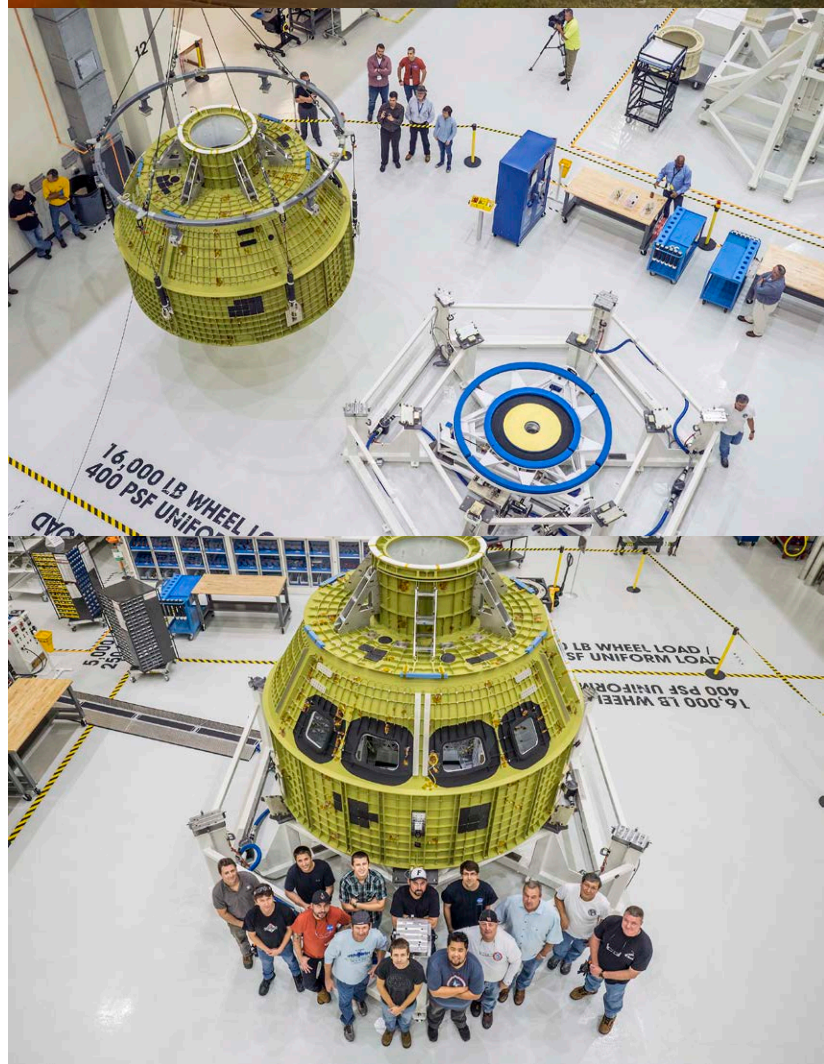
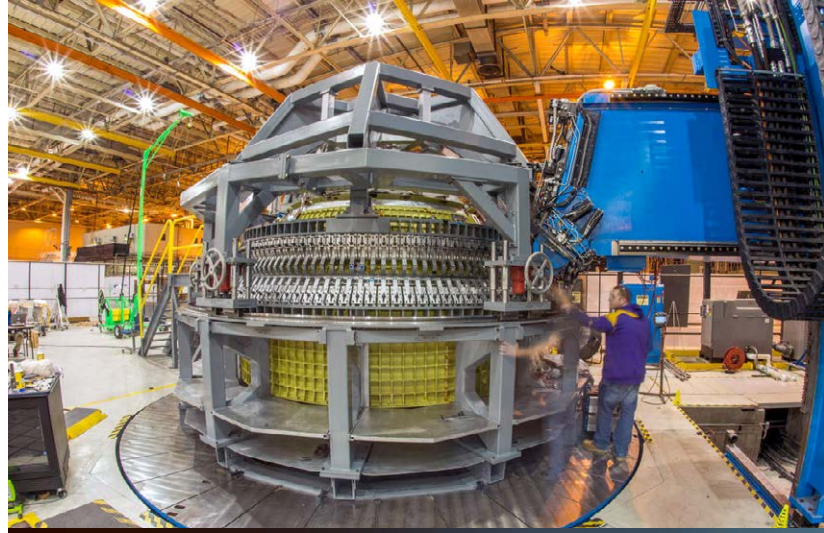
1: *The Orion pressure vessel is encased in a structural tool that secures the spacecraft in place during welding operations at Michoud Assembly Facility.*

2: *Packaged for travel, Orion's pressure vessel is moved by truck to the airfield in New Orleans where it was loaded onto NASA's Super Guppy airplane for transfer to Kennedy Space Center.*

3: *Engineers load the Orion pressure vessel onto a work stand in the Neil Armstrong Operations & Checkout Building at Kennedy on Feb. 2.*

4: *The Orion team surrounds the pressure vessel on the floor of the Operations and Checkout Building high bay.*

On the cover: *The Orion crew module pressure vessel, or underlying structure, was shipped from NASA's Michoud Assembly Facility in New Orleans to NASA's Kennedy Space Center in Florida on board the Super Guppy cargo aircraft on Feb. 1.*



A large, green and white Orion spacecraft is shown in a factory setting. The spacecraft is mounted on a wooden platform. A blue sign with a yellow diamond in the center and the text "Foreign Object Debris FOD AWARENESS AREA" is attached to the side of the spacecraft. In the background, several people are visible, and the factory floor is made of wood. The lighting is bright, and the overall atmosphere is industrial.

Orion's Ground Test Article and Exploration Flight Test-1 Heat Shield ready for water drop tests at NASA Langley Research Center in Virginia.

ORION MILESTONES TO TRACK IN 2016

Throughout 2016, engineers and technicians will continue refining, assembling and testing the Orion spacecraft that will send astronauts to deep-space destinations on NASA's journey to Mars.

In Colorado, Lockheed Martin engineers will evaluate a new acoustic technology called Direct Field Acoustic Testing. The test will use customized, high-energy speakers configured in a circle around the crew module flown in space in 2014 to control how much energy reaches the vehicle. The evaluation of the acoustic testing will determine if the method can produce enough energy to simulate the acoustic loads Orion will experience during launch and ascent on the SLS rocket. In 2016, Engineers at NASA Glenn Research Center's Plum Brook Station will put a structural representation of the Orion service module provided by ESA (European Space Agency) and built by Airbus through a series of crucial tests to verify the structural integrity and ability to withstand the dynamic launch environment atop the SLS rocket.

In the spring, tests at NASA Langley Research Center's Hydro Impact Basin, will mimic some of the most stressful water landing conditions Orion could experience with it returns from deep space and splashes down in the Pacific Ocean. Engineers outfitted a test version of the crew module with Orion's heat shield that flew in space and two test dummies strapped inside to evaluate loads the crew may experience during real missions.

The tests highlighted in 2016 are only part of the overall test plan for Orion and SLS in preparation for their first exploration mission. With the progress made so far, and tests planned at Kennedy in 2017 and 2018 when the rocket and ground systems are ready, NASA is on a path to be ready to launch Exploration Mission-1 in 2018.

► [Read the full story](#)

FASTER, LIGHTER, BETTER

NASA engineers recently tested new parachute designs for the Orion spacecraft with lighter materials that can safely deploy at faster descent velocities.

A dart-shaped test vehicle descended from the skies above the Arizona desert under Orion's parachutes Wednesday, Jan. 13, successfully completing the final development test of the parachute system. NASA engineers evaluated modifications to the system for the last time before the start of qualification testing for Orion missions with astronauts.

During the test, engineers demonstrated that when the spacecraft is traveling faster during descent than in previous tests, Orion's parachutes can properly deploy and withstand high-inflation loads. The dart-shaped vehicle allows engineers to simulate faster descent conditions than the capsule-shaped test article that has been used in many previous evaluations. The test also evaluated new, lighter-weight suspension line material for the parachutes saving a significant amount of mass.

The test was the seventeenth in the developmental series. In July, engineers will begin qualifying Orion's parachute system for flights with astronauts. The series will encompass eight drop tests over a three year-period.

► [Read the full story](#)



ORION'S CREW & SERVICE MODULES GET HITCHED



The Orion team at NASA Glenn Research Center's Plum Brook station in Sandusky, Ohio, successfully tested mating operations that will connect the spacecraft's service module to the crew module adapter.

The European service module structural test article (E-STA) is used for testing purposes before installing the real thing. It is as close to the flight version as possible while keeping costs and development time manageable. The structure and weight are the same, while mass equivalents stand in for electronics boxes not needed for the series of tests.

The test article was installed under a test version of the crew module adapter, and sits on the spacecraft adapter that

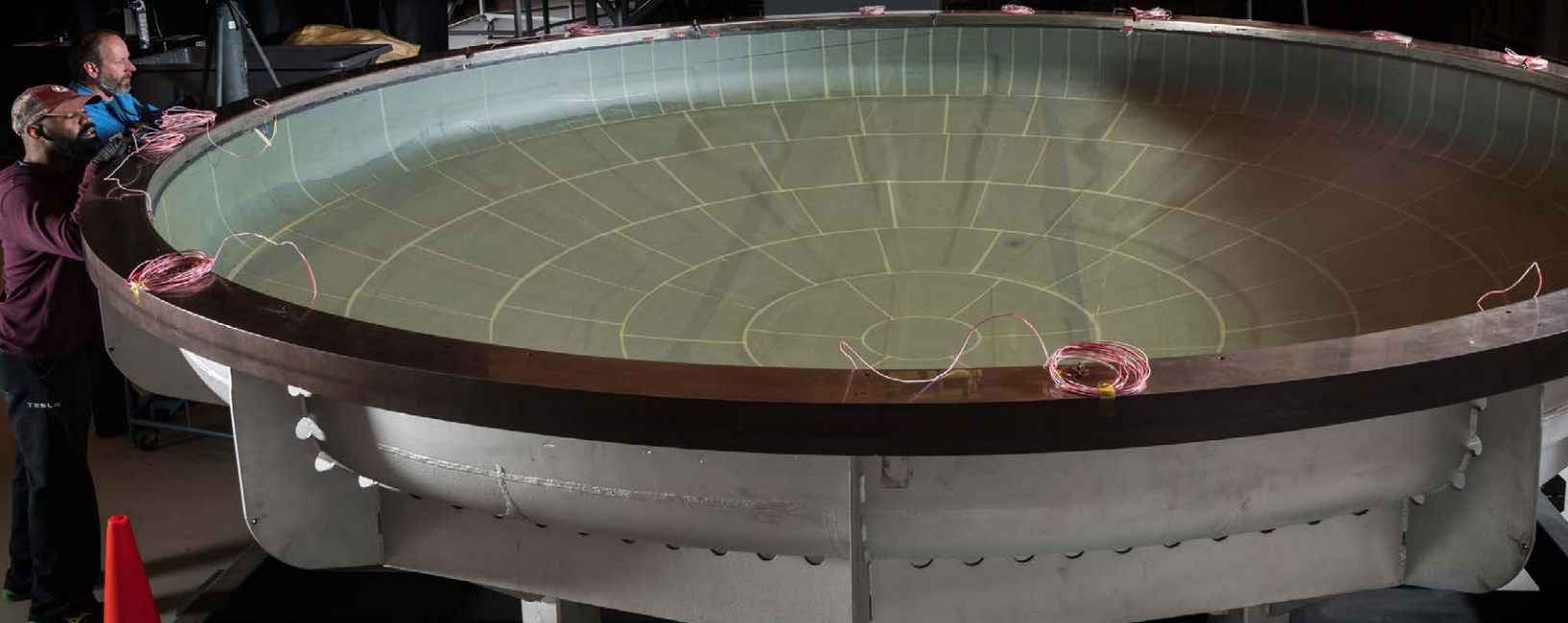
will attach Orion to its launch vehicle. This test marked the first time the European-built hardware has been physically connected to NASA's elements.

The service module will soon be vigorously shaken on the vibration table at Plum Brook's Space Power Facility to recreate the vibrations of launch. The spacecraft test structure will also be subjected to acoustic and shock environments. Built by European Space Agency and Airbus, the European service module will provide electricity, water, oxygen and nitrogen, and thermal control as well as propulsion for the spacecraft.

► [Read about the Service Module on ESA blog](#)

THE HEAT IS ON

NASA's Super Guppy aircraft arrived at Moffett Field in California on Jan. 7, carrying the Orion Exploration Mission-1 heat shield skin. The heat shield is primarily being built at Lockheed Martin's Littleton, Colorado, facility, and was temporarily sent to Lockheed Martin's Sunnyvale, California, facility for an autoclave cure (shown here). The heat shield has a stiffened skin design, and this cure process is the last step prior to attaching titanium stiffeners to the interior surface. Once the skin and stiffeners are attached, it will be sent to Kennedy where ablative material will be applied to the exterior.



STENNIS PROPULSION TEAM FIRES UP ORION TESTING

It is widely known that rocket engines tested at NASA's Stennis Space Center near Bay St. Louis, Mississippi, will launch NASA's new Space Launch System on its missions. What is not so widely known is that the south Mississippi center also contributes to the propulsion system that will power the Orion crew vehicle once it leaves Earth's atmosphere and separates from the SLS.



In late 2015, Stennis engineers completed a series of tests on a subscale diffuser system, providing valuable data for the final development testing of the engines that will provide the power Orion needs for deep-space missions.

Stennis engineers also concluded a subscale diffuser test series that recorded 38 hot fires for a total of 172.46 seconds. Data gathered from the testing of the subscale configurations now will be used to build a full-scale diffuser chamber at NASA's White Sands Test Facility near Las Cruces, New Mexico, which will be used to provide a simulated space environment during an actual hot fire test series of the Orion service module propulsion system.

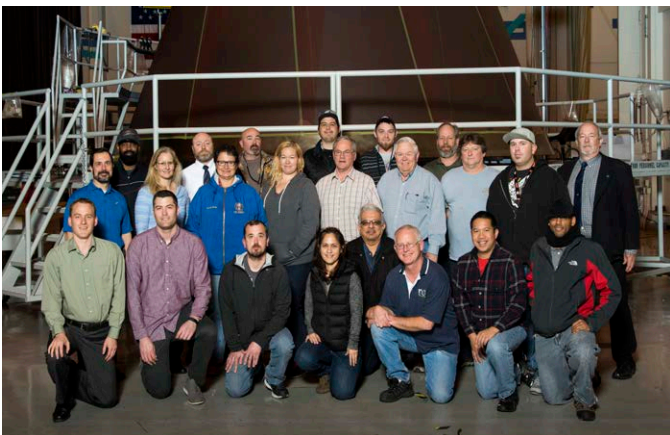
► [Read the full story](#)

QUALIFYING FOR QUALITY

Orbital ATK team members stand proud in front of an Orion launch abort motor.

Orbital ATK conducted a successful structural qualification test Jan. 26 on its abort motor case that is being manufactured for use on NASA's Orion crew module. Orbital ATK's launch abort motor is integral to Orion's Launch Abort System, which is designed to ensure the safety of the astronauts inside the spacecraft that fly atop NASA's Space Launch System.

The successful test of the Motor Structural Test case represents a significant milestone on the path to qualifying the abort motor production design. Motor qualification tests demonstrate the abort motor design is capable of performing under the extreme temperatures, G-forces and speed of a crew rescue.



LOCKHEED MARTIN'S SUNNYVALE ORION TEAM RECOGNIZED FOR SUCCESS

The Orion management team hosted a recognition event at Lockheed Martin's facility in Sunnyvale, California, for the build teams' completion and delivery of the Exploration Mission-1 spacecraft adaptor cone and the successful test for Orion's first two jettisonable panels. Pictured left is the Service Module Spacecraft Adaptor Cone & Fairing Panel Build Team in front of the structural test article cone.

SPACE CAUCUS MEMBERS TOUR NASA

Texas Representative Dennis Paul, co-chairman of the Texas Legislative Space Caucus, invited Caucus members to the legislative district in which NASA's Johnson Space Center in Houston is located, to share information about commercial and government-led aerospace activities in the area, and to learn about their contributions to Texas. Members toured the Neutral Buoyancy Laboratory, the Boeing Company, Ellington Spaceport,

and Johnson. Lockheed Martin hosted a luncheon for the group during which Lockheed's Orion Deputy Program Manager Larry Price provided an Orion program update and Exploration Mission-1 mission overview. The representatives also toured the Orion mockup in the Space Vehicle Mockup Facility at Johnson with Orion engineer Stu McClung.

THANKS MICHLOUD TEAM FOR JOB WELL DONE



On Jan. 26, a VIP event, All Hands employee meeting and media event focusing on the Orion crew module pressure vessel took place at NASA's Michoud Assembly Facility in New Orleans. NASA participants included Bobby Watkins, Michoud Assembly Facility director; Ellen Ochoa, Johnson Space Center director; Bill Hill, deputy associate administrator for exploration systems development; Mark Kirasich, Orion program manager; Mike Bolger, Ground System Development and Operations manager; and Steve Doering, SLS core stage manager. Representing Lockheed Martin were Mike Hawes, Orion program manager and Jim Bray, Orion crew module manager. Attendees heard overviews on the Orion spacecraft production and Exploration Mission-1 progress.

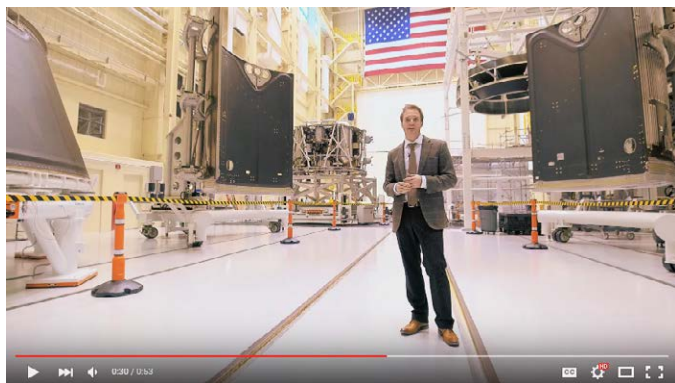
Read more about Michoud Assembly Facility in the news:

- ▶ Fox TV
- ▶ ABC TV
- ▶ The Times-Picayune
- ▶ Space News

The following employees at Michoud were recognized during the All Hands event with program manager commendations from NASA: Terri Ryan, Ryan Dardar, John Desforges, Jose Bueiz, Frank Middleton, Chris Bollinger, Rogan Bernard, Raymond Zibilich, Matthew Jackson, Linda Savage-Regan, Tom Kilroy, Gene Flores, James (JD) Dunn, Jason Amato and Steven Seipel.

Prior to the events at Michoud, NASA astronaut Rick Mastracchio also spoke with aspiring astronauts and engineers from Fannie C. Williams Charter School and Schaumburg Elementary School in New Orleans during the visit.





ORION BACKSTAGE

Even engineers like to shake things up now and then. Anthony Thirkettle is a Principal Mechanical Engineer working on the Orion spacecraft European service module and explains structural testing that is now underway at NASA Glenn Research Center's Plum Brook Station in Sandusky, Ohio. The service module elements are being built by ESA and Airbus Defence & Space for NASA's Orion spacecraft, which will launch in 2018.

► [View the video](#)



SPACE STATION LIVE: ORION

John McCullough, NASA's Orion vehicle integration manager, talks about the progress of preparing the Orion spacecraft in this edition of Space Station Live.

► [View the video](#)

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ORION TEAM MEMBERS INSPIRE FUTURE GENERATIONS



Raquel Redhouse in Orion's Vehicle and Integration Office recently gave a presentation to Fremont Junior High students in Mesa, Arizona, for the American Indian Science & Engineering Society's National Conference. ► [View the video](#)



Barry Bohnsack, Lockheed Martin Orion engineer, was involved in several FIRST Robotics Competition activities taking place in Florida. Jan. 8-11, Bohnsack participated in the "Robot in 3 Days" webcast, a rapid robot-build video, and presented an Orion overview to high school students in Ocala, Florida. He presented about Orion again on Jan. 16 and helped lead 300 students at the FIRST Tech Challenge Team Championship in Orlando. ► [View the video](#)

FEBRUARY:

Orion assembly and testing continues at Kennedy

NASA State of the Agency address

Orion/SLS Suppliers Conference in Washington, D.C.

Solar array deployment test at Plum Brook Station