

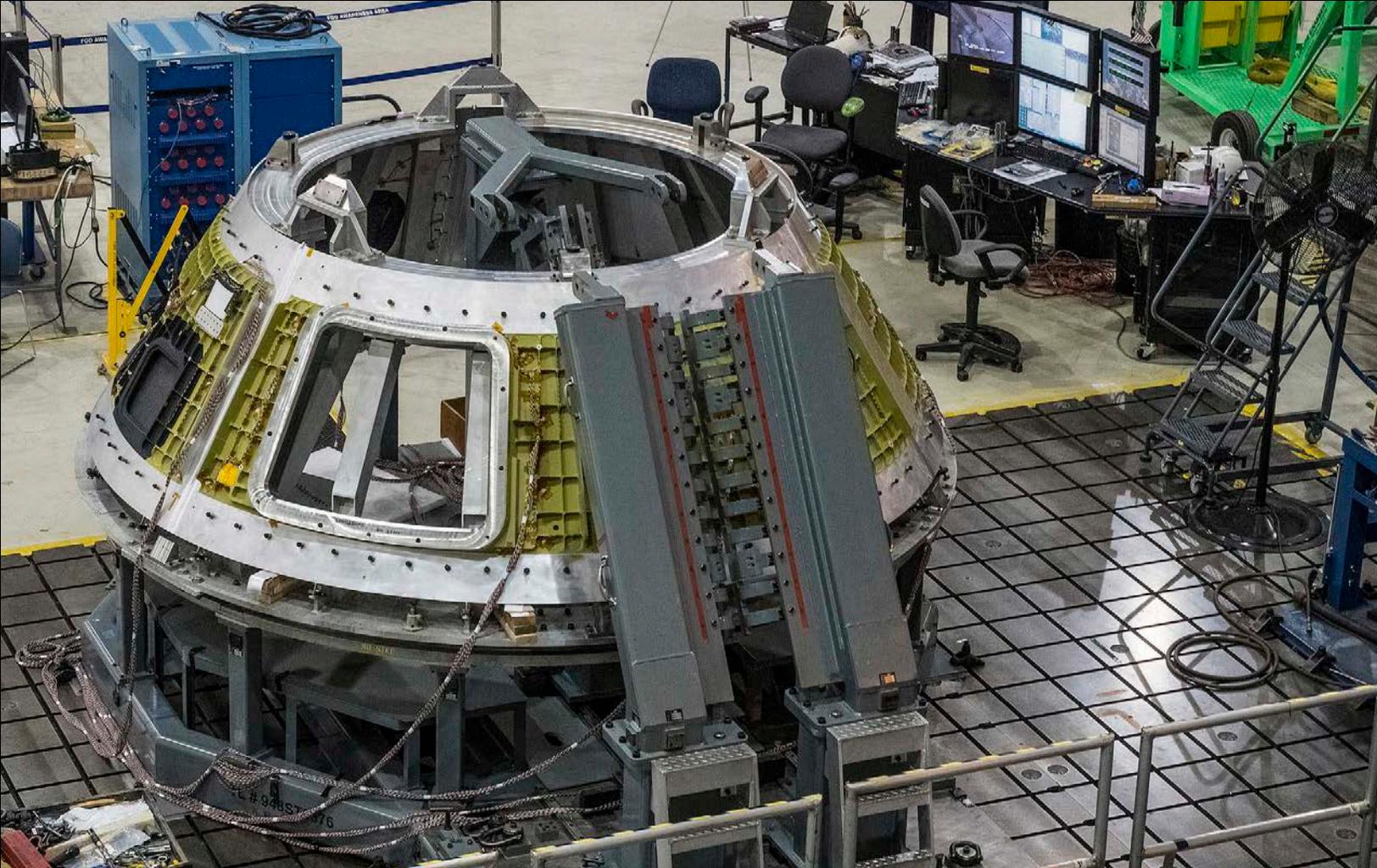
National Aeronautics and  
Space Administration



# ORION

DECEMBER 2015

**ONE YEAR AFTER MAIDEN VOYAGE,  
ORION CONTINUES ITS JOURNEY**



Welding continues on Exploration Mission-1 pressure vessel at Michoud Assembly Facility in New Orleans.

# LAUNCHING INTO EM-1

December 5 marked the one-year anniversary of the successful inaugural space flight of NASA's Orion spacecraft. Exploration Flight Test-1 launched the uncrewed spacecraft 3,600 miles into space and safely returned it to Earth. In the year since the flight, teams around the country have taken apart the spacecraft to learn everything possible from having flown the first human rated vehicle in deep space in over 40 years. Meanwhile, teams across the nation and in Europe have continued to make substantial progress toward the next flight of Orion and the first flight of the Space Launch System rocket into deep space — Exploration Mission-1 (EM-1).

The 2014 flight was a big step on NASA's journey to Mars, providing insights engineers have used to inform how they design, develop and build Orion that will help astronauts pioneer deep space destinations. Teams learned as much about what it takes to build and process Orion as they did about successfully flying it in space, and the flight test yielded more than 500

gigabytes of data to prove that the spacecraft's many systems and subsystems performed as expected.

After NASA returned the spacecraft back to NASA's Kennedy Space Center in Florida, Orion's flown heat shield was shipped to NASA's Marshall Space Flight Center in Huntsville, Alabama, where its outer layer was removed for analysis before then being sent to the agency's Langley Research Center in Hampton, Virginia. The heat shield protected the Orion spacecraft during its 4,000 degree reentry. At Langley, teams have fitted it to a test article and are preparing for a slate of tests in Langley's Hydro Impact Basin that will evaluate how it fares in different potential splashdown scenarios. Overall, engineers developing Orion's thermal protection system have been refining the spacecraft's heat shield design and manufacturing process.

In September, the flown crew module was shipped to Lockheed Martin's Littleton, Colorado, facility to evaluate a new acoustic technology to determine if

the method can produce enough energy to simulate the acoustic loads Orion will experience during launch and ascent atop SLS. Meanwhile technicians at NASA's Michoud Assembly Facility in New Orleans began welding together Orion's pressure vessel, the underlying structure of the crew module for EM-1. The majority of the welds were completed by December and the crew module is set to be shipped to NASA's Kennedy Space Center in Florida in February for outfitting and processing.

In November, NASA welcomed the arrival of a structural test article of the ESA (European Space Agency)-provided service module for testing at Glenn Research Center's Plum Brook Station in Sandusky, Ohio. NASA's work with ESA on this element expands an already strong partnership and ensures continued international collaboration on the journey to Mars. Next year, engineers will test the hardware to make sure the service module, which provides Orion's in-space propulsion, power, air and water, can withstand the powerful launch into space.

Engineers also made strides to refine the spacecraft's design in other areas. Orion's heat shield will be built in blocks for the next mission, rather than as a monolithic structure, as a result of the insights gained testing the design in space. On the next flight, Orion will

experience colder temperatures in space and hotter temperatures upon reentry than during EFT-1, and data from last year's test flight is helping NASA improve the design of the heat shield to meet this challenge. Engineers also reduced the Orion crew module's mass, evaluated design changes to its protective fairings that encase the service module and continue to evaluate its parachute system through testing.

The Orion team also completed two important programmatic milestones leading up to the spacecraft's next flight. The Critical Design Review was carried out over a 10-week period and included a review of common aspects of the spacecraft for EM-1 and the spacecraft for EM-2, the first Orion mission with astronauts, such as the spacecraft's structures, pyrotechnics, launch abort system, guidance, navigation and control and software, among other elements. With the design confirmed, work is now underway to manufacture the parts and assemble the spacecraft. Agency officials also completed a separate, rigorous technical and programmatic review, confirming continued support of the program and establishing NASA's commitment to the program's technical, costs and schedule baseline.

In 2016, NASA will make more critical progress building Orion for its next mission, continuing to build on the foundation of the spacecraft's successful first trip to space.



## ORION'S POWER SYSTEM TO BE PUT TO THE TEST

NASA is about to begin testing the heart of Orion's power systems at the world's largest, most powerful space environment simulation facility early next year. Test engineers at NASA Glenn Research Center's Plum Brook Station in Sandusky, Ohio, are preparing to put a full-size test version of the European Service Module (ESM) for the spacecraft through a series of crucial tests to verify the structural integrity of the hardware to withstand the dynamic environment of launch into space atop the agency's Space Launch System (SLS) rocket.

► [Read the full story](#)



## NASA LANGLEY PREPARES TO MAKE THE DROP

Engineers at NASA's Langley Research Center in Hampton, Virginia, coupled a NASA Orion crew module mockup with the heat shield from the spacecraft's first flight test, Exploration Flight Test 1. The integrated Orion mockup and EFT-1 heat shield will be tested next year to simulate water landings during actual missions.

# NASA NAMES CHARLIE LUNDQUIST AS DEPUTY PROGRAM MANAGER FOR ORION



On Dec. 9, NASA named Charlie Lundquist as deputy manager of the agency's Orion Program. Along with Program Manager Mark Kirasich, Lundquist will be responsible for oversight of design, development and testing of the Orion spacecraft, as well as spacecraft manufacturing already underway at locations across the country and in Europe. Lundquist has served as manager of the Orion crew and service module office since 2008.

"Charlie has outstanding program management skills and has played pivotal roles in many of Orion's accomplishments, including Orion's successful flight test last year," said Kirasich. "As we manufacture and deliver hardware and software for Orion's next mission during the coming months and years, his leadership will be essential."

► [Read the full story](#)

## BACK STORY ON THE BACK SHELL PANEL



Orion's EFT-1 back shell panel continued its world tour with a stopover at Space Center Houston during the holiday season. The historic artifact complemented the full-scale Orion crew module mockup that is on permanent loan to the visitors center. In addition, NASA and Lockheed Martin leadership presented Space Center Houston with a U.S. flag flown on Orion's first spaceflight in 2014. The back shell panel has been displayed at events around the world including the Paris Air Show in France, Space Symposium in Colorado and SpaceCom in Houston. The panel was recently shipped back to Lockheed Martin's Littleton, Colorado, facility where it is now undergoing additional testing and analysis on the EFT-1 crew module.

**Pictured above:** Fred Haise Jr., Apollo 13 astronaut with NASA Orion Program Manager Mark Kirasich in front of the Orion back shell panel display at Space Center Houston.

## ACTION! NEW NASA VIDEO HIGHLIGHTS PROGRESS ON EXPLORATION MISSION-1

The latest quarterly video produced by NASA's Exploration Systems Development division features many of the manufacturing, testing and facility upgrade milestones completed in 2015 to send NASA's Orion spacecraft to deep space atop the Space Launch System on Exploration Mission-1.

► [Watch the video](#)



# MORE SNOOPYS FOR ORION TEAM!

Image: Charles Shulz

NASA and Lockheed Martin Orion team members were recognized this fall with Silver Snoopy awards presented at various recognition events across the country.

The top awards presented by NASA's Space Flight Awareness program, Silver Snoopys are given to NASA employees and contractors across the agency for outstanding achievements related to human flight safety and mission success. The small silver lapel pins were flown in space and are traditionally presented by an astronaut.

Silver Snoopy events were held across Lockheed Martin Orion program sites in Houston, Denver, NASA's Michoud Assembly Facility and Kennedy Space Center. Astronauts Ricky Arnold, Stan Love, Christina Hammock Koch and Eric Boe presented the Silver Snoopys at these events.

Lockheed Martin honorees included: Lisa Akers, Matt Allen, Tim Cichan, John Creasey, Jonathan DeLaRosa, Thomas Haregot, Michael Heckwolf, Gary Keyser, Aaron Larson, Lance Lininger, John McCulley, Sandy Mossman, Jim Olson, Carolyn Overmyer, Chad Purser, Jules Schneider, Jim Skaggs, Johnny Spriggs and Todd Surla.

**Pictured below:** Astronaut Lee Morin presented NASA's Elizabeth Fountain with a Silver Snoopy on Sept. 16 at Johnson Space Center in recognition of her exemplary sustained performance in contract management supporting NASA's next human-rated exploration spacecraft.



# 2015 YEAR IN REVIEW

Take a look back at our accomplishments from 2015. We analyzed the first Orion spacecraft which flew in 2014 and started construction and testing of the next spacecraft which will fly on the Space Launch System in 2018.



► Read

Heat shield evaluation at NASA's Marshall Space Flight Center in Huntsville, Alabama



► Read

Crew module structural test article adapter arrives at the Space Power Facility at NASA Glenn Research Center's Plum Brook Station



► Read

Orion avionics mockup at Lockheed Martin Integrated Test Lab in Littleton, Colorado



► Read

Machining the aft bulkhead for EM-1 crew module at Ingersoll Machine Tools in Rockford, Illinois



► Read

Parachute tests at the U.S. Army Yuma Proving Ground in Arizona



► Read

Lockheed Martin engineers perform the first weld of Orion's Exploration Mission-1 crew module at the Michoud Assembly Facility in New Orleans



► Read

Astronaut egress training at NASA Johnson Space Center's Neutral Buoyancy Lab in Houston, Texas



► Read

Lockheed Martin engineers complete 5 of 7 welds at the Michoud Assembly Facility in New Orleans, Louisiana



► Read

Airbus Defence and Space delivers the ESA - European Space Agency service module structural test article to NASA Glenn Research Center's Plum Brook Station in Sandusky, Ohio



► Read

ESA - European Space Agency service module structural test article is ready for testing at the Space Power Facility at NASA Glenn Research Center's Plum Brook Station

## ORION BACKSTAGE PASS

Meet the people building the spacecraft that will take humans on the journey to Mars. In this episode, Tobias Fricke, a quality engineer from Airbus Defence and Space, discusses testing a structural representation of Orion's service module at NASA Glenn Research Center's Plum Brook Station in Sandusky, Ohio.

► Watch the video



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## JANUARY:

- Six Orion Milestones to Track in 2016
- Final Engineering Design Unit Air Drop Test
- Crew Module Completion Event at Michoud
- Deep Space Exploration Panel at Space Center Houston