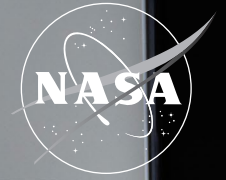


National Aeronautics and  
Space Administration



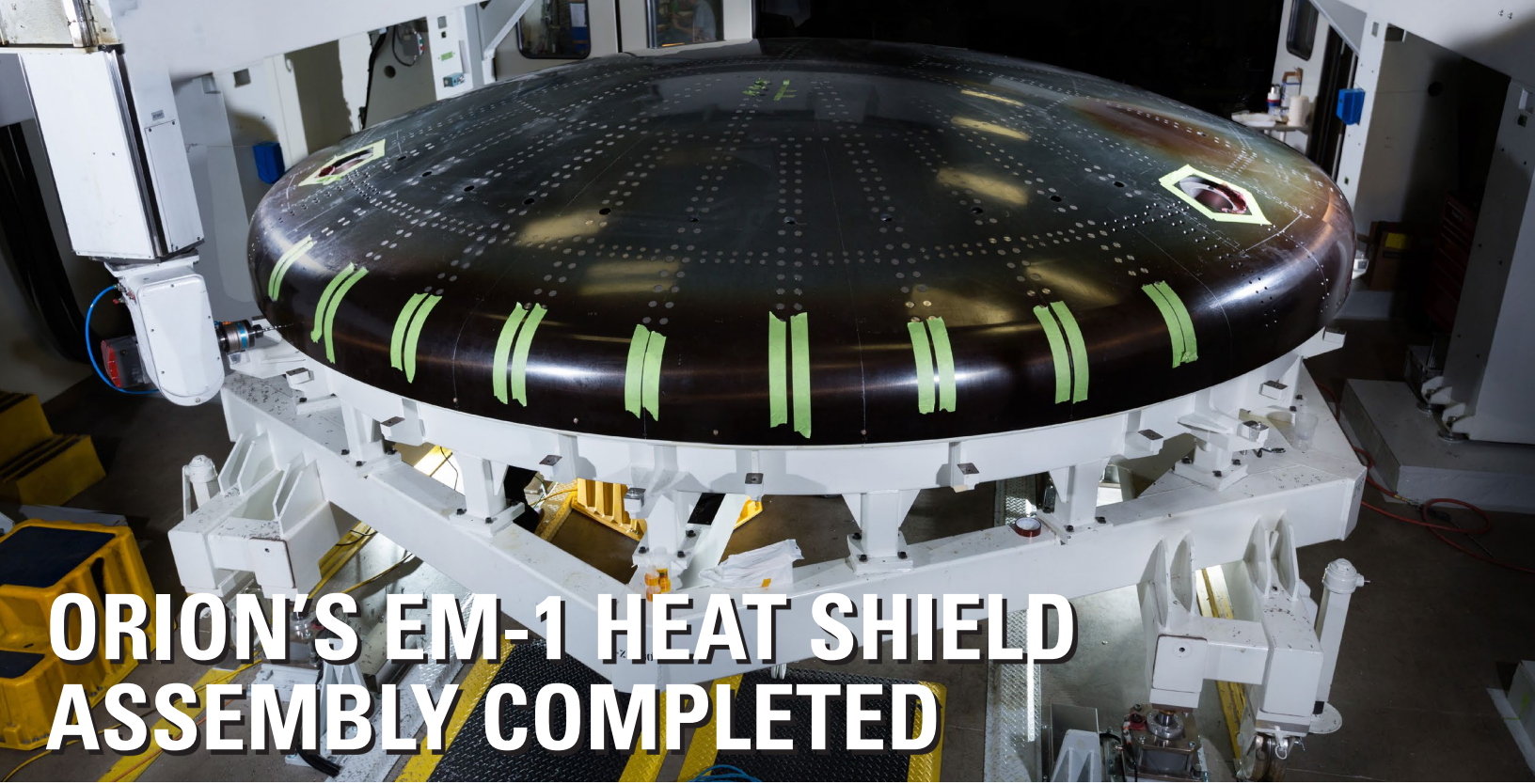
# ORION

JULY 2016

# NOW THIS IS COOL!







# ORION'S EM-1 HEAT SHIELD ASSEMBLY COMPLETED

In mid-July, the Orion team completed the heat shield structure for NASA's Exploration Mission-1 (EM-1) at Lockheed Martin's Space Systems Company Waterton facility near Denver. The completed structure then underwent static loads testing, proving it can endure the 350,000-pound load the spacecraft will experience during its next flight beyond the moon and back.

At 16.5 feet in diameter, the heat shield for Orion Exploration Flight Test-1 (EFT-1) was the largest composite heat shield ever built. And now, the team has completed the second. The structure is comprised of a titanium sub-structure joined with an advanced high-temperature resin and graphite fiber laminate coated with an ablative thermal protection system required to survive re-entry thermal conditions and water landing impacts.

The EFT-1 heat shield exceeded performance expectations, withstanding temperatures well in excess of 4,000 degrees Fahrenheit as Orion blasted through Earth's atmosphere at 20,000 mph and enduring the strains of a dynamic water impact landing. After a picture perfect landing in the Pacific Ocean, the Orion recovery team held the spacecraft at sea for a "heat soak" test to ensure the heat shield would remain water tight long after splashdown.

Since EFT-1, the Orion team has improved production and performance of the heat shield based on data collected from the first space flight. The EM-1 heat shield has been optimized to shed more than 1,250 pounds

from the EFT-1 structural design. In addition, the team has been able to reduce the EM-1 heat shield fabrication cost and schedule by as much as 30 percent, with an additional 15 percent cost and schedule reduction anticipated for the Exploration Mission-2 (EM-2) heat shield due to streamlined tooling and lean manufacturing processes. The team is already coordinating the logistics for a static test article build, which will be the model for the EM-2 heat shield.

The heat shield skeleton assembly process involves match drilling 205 individual parts and inserting fasteners in more than 1,200 holes. This is followed by skin-to-skeleton mating operations requiring 3,000 additional holes and fasteners across the entire structure. A dedicated team of manufacturing engineers stayed the course, working around-the-clock over several months to deliver the EM-1 heat shield assembly on time and under cost. The completed structure will be shipped to NASA's Kennedy Space Center in late August for final assembly and integration onto the Orion spacecraft.

## **Related Videos:**

**Meet Orion heat shield engineer Molly White:**  
[bit.ly/2b003UW](http://bit.ly/2b003UW)

**See and hear the Orion launch and entry experience:**  
[bit.ly/2aPZccs](http://bit.ly/2aPZccs)





# ROCKY EXERCISE DEVICE IS A REAL KNOCKOUT!

While engineers across NASA and industry are working to build the Orion spacecraft and Space Launch System rocket that will venture to deep space, NASA's Human Research Program team is building a compact, action-packed exercise device to maintain crew strength during multiyear missions in microgravity.

As astronauts travel beyond the Earth and moon on the journey to Mars, keeping them healthy in space will be critically important. They will need to be in top physical form when they arrive at their destination so they can effectively pioneer new frontiers and must also be able to quickly readjust to Earth's gravity upon their return home.

The design team took the necessary elements of exercise equipment needed to keep astronauts healthy and fit in space and made them exponentially smaller, lighter and more robust, while still providing a healthy dose of benefits for the crew. The result was ROCKY, the Resistive Overload Combined with Kinetic Yo-Yo Device developed by Zin Technologies of Middleburg Heights, Ohio.

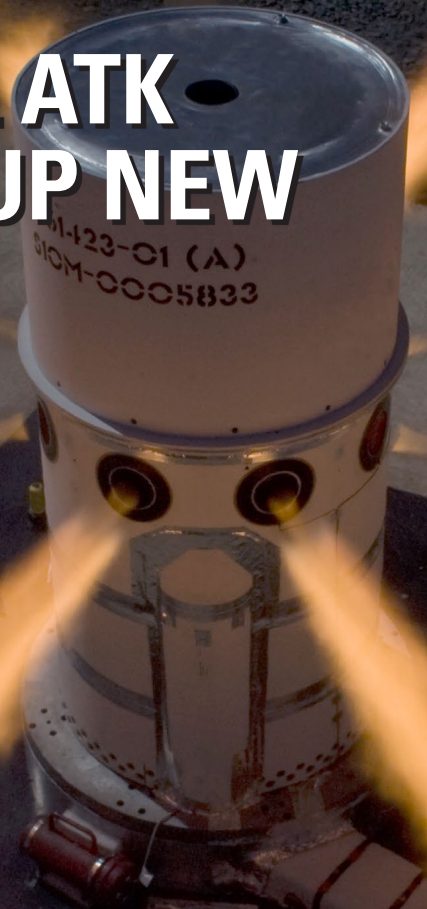
Astronauts will be able to use the device like a rowing machine for aerobic activity and for strength training with loads of up to 400 pounds to perform exercises such as squats, deadlifts and heel raises, as well as upper body exercises like bicep curls and upright rows. The device can be customized with specific workouts for individual astronauts. It will also incorporate the best features from a second device evaluated during the selection process called the Device for Aerobic and Resistive Training, or DART, developed by TDA Research in Denver, under NASA's Small Business Innovation Research Program.

ROCKY will get its first in-space warm up on Exploration Mission-2, the first crewed mission with Orion and SLS. Once Orion is in orbit, the crew seats will be stowed away to provide more interior space for the astronauts inside.

**Read the full story at:**  
[bit.ly/ROCKY\\_Orion](http://bit.ly/ROCKY_Orion)



# ORBITAL ATK LIGHTS UP NEW IGNITOR



At an historic solid rocket manufacturing and test facility in Elkton, Maryland, Orbital ATK's Upper Stages and Controls team completed a key milestone in the development of the Attitude Control Motor (ACM) for NASA's Orion spacecraft Launch Abort System (LAS).

On June 22 and 23, with Lockheed Martin and NASA on hand, the team successfully completed a series of four static tests on an improved igniter. The test met the required temperature ranges and performed as expected, despite a deliberately inserted error input from the ignition train.

Watch Attitude Control Motor Test Video: [bit.ly/2aSoBSX](http://bit.ly/2aSoBSX)

Using data from the successful Orion Pad Abort (PA-1) flight test in 2010, the Orbital ATK team has made the system's unique igniter even more robust by enlarging its throat and increasing its mass flow rate and total energy content. In order for any of that advanced technology to function, a simple but robust ignition train must get the ball rolling, and the ACM's igniter has to light at any time and altitude.

NASA's Langley Research Center manages the launch abort system program with partners and team members including NASA's Marshall Space Flight Center, Lockheed Martin and Orbital ATK. In the event of an emergency during launch or ascent, a powerful launch abort motor -- made by Orbital ATK in Utah -- pulls the Orion spacecraft off the Space Launch System (SLS) to propel it out of harm's way. To keep the crew module on the right path, a fast reacting control system is needed to provide variable thrust in any direction. Enter the Attitude Control Motor, or ACM.

Orbital ATK worked with Lockheed Martin to develop the ACM, which has two critical functions. In a mission abort scenario, it must first steer the Launch Abort System and crew module away from the launch vehicle. Then, once cleared from hazards, the ACM orients the crew module for safe parachute deployment.

Watch Pad Abort-1 Flight Test: [bit.ly/2bmAocQ](http://bit.ly/2bmAocQ)

The ACM consists of a solid-propellant gas generator, with eight proportional valves equally spaced around the circumference of the three-foot-diameter motor. In combination, the valves can exert up to 7,000 pounds of steering force to the vehicle in any direction upon command from the crew module. The valves are controlled by a redundant power and control system.

Working under the direction of prime contractor Lockheed Martin, Orbital ATK has continued to develop and test the ACM to meet the most demanding operating parameters. In addition to the 2010 pad abort test, Orbital ATK has performed several successful sub-scale and full-scale ground tests on the ACM, supplied the inert unit which flew as part of Orion's first test flight, Exploration Flight Test-1 (EFT-1) in 2014, and last year concluded a series of high-thrust valve tests, including a successful over-pressure test, HT-10.

The success of the ACM igniter tests confirms that this key subsystem will move onto critical design review in August. The new igniter design will be used on the next ACM development motor test, HT-11, later this calendar year, and will support the ACM qualification tests and EM-2 flight delivery scheduled for 2017.

Watch HT-10 Test Video: [bit.ly/2b0TRha](http://bit.ly/2b0TRha)



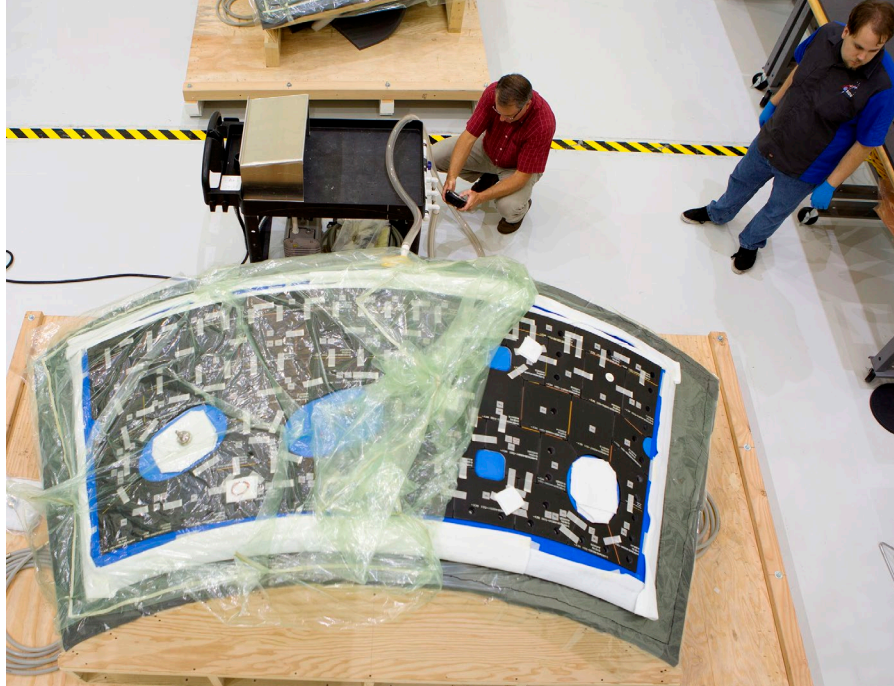
# ORION TEAM FORMS PROTECTIVE BOND

A crucial part of preparing NASA's next Orion spacecraft for flight has begun as technicians bond thermal protection system (TPS) tiles to panels that will be installed on the spacecraft's back shell and forward bay cover. The silica tiles are an advanced version of those used on the space shuttle and will protect Orion's crew from the searing heat of re-entry that can reach 5,000 degrees Fahrenheit during return from deep-space missions.

The first integrated mission of NASA's Space Launch System (SLS) rocket with Orion, Exploration Mission-1, or EM-1, will lift off from Launch Complex 39B at NASA's Kennedy Space Center in Florida. On the mission, the spacecraft will venture 40,000 miles beyond the orbit of the moon, farther than any spacecraft built for humans has ever traveled, testing the systems needed for the agency's journey to Mars. The mission will conclude with Orion re-entering the Earth's atmosphere at 25,000 mph and then slowing down to a gentle splashdown in the Pacific Ocean.

The bonding process began in July and will continue over several months. The work is taking place in the high bay of the Neil Armstrong Operations and Checkout Building where assembly of the Orion crew module's pressure vessel, or underlying structure, has been taking place since it arrived at the Florida spaceport in February. The newly designed tiles incorporate a stronger coating called "toughened uni-piece fibrous insulation," or TUF1 coating, and will also be covered with an aluminized coating that improves on-orbit thermal control of the vehicle and gives Orion its shiny new look.

Read the full story at: [bit.ly/OrionTileBonding](http://bit.ly/OrionTileBonding)



In the Neil Armstrong Operations and Checkout Building at NASA's Kennedy Space Center, technicians have begun bonding thermal protection system tiles to the nine panels that will cover the Orion crew module for the agency's first unpiloted flight test with the Space Launch System (SLS) on the agency's Journey to Mars.



Technicians prepare to bond thermal protection system tiles on the Orion crew module for the agency's Exploration Mission-1 flight with the Space Launch System (SLS) rocket. Orion requires about 1,300 tiles. Many of the Orion tiles are standard, except for those which fit around windows, thrusters or antennae. Along with the spacecraft's heatshield, the tiles will protect Orion from the 5,000 degree Fahrenheit heat of re-entry.





# TO DREME, TO FLY



Learn more about them at:  
**DREME Foundation:** [bit.ly/2aPjJIG](http://bit.ly/2aPjJIG)  
**Bronze Eagles:** [bronzeeagles.com](http://bronzeeagles.com)

Orion engineers Kat Coderre (left) and Darrel Gaines helped to inspire future generations of aviators and space explorers through several STEM engagement events in July. The Community Science Fair of the Dr. Ronald E. McNair Educational (DREME) Science Literacy Foundation was held at Houston Community College and presented science, technology, engineering, and math (STEM) information as well as career awareness and preparation in an exciting hands-on learning atmosphere for the public. More than 200 middle and high school students participated in this year's fair.

The annual Bronze Eagles Fly-In gave more than 100 kids the opportunity to learn about flight, space exploration and the thrill of being airborne. The Bronze Eagles of Texas Flying Club promotes aviation to inner-city and disadvantaged youth. Through fly-ins and educational outreach, the club fosters an awareness of careers in aviation and contributions made by black aviators, and encourages students to stay in school and pursue positive avenues. The club has chapters in several cities in Texas and is an affiliate of the Black Pilots of America.

These events expose students from all across Houston to the excitement of engineering and exploration.





# IT'S OSHKOSH BY GOSH!

NASA's Orion and Space Launch System (SLS) team members supported space-themed exhibits and panel presentations at EAA Airventure Oshkosh 2016 in Wisconsin July 25-31. The Oshkosh event is one of the world's largest air shows and attracts more than 500,000 visitors annually. More than 7,300 participants attended the seven presentations hosted by the Orion and SLS industry team and more than 25,000 people visited the exhibits.

The team extended their reach well beyond Wisconsin through social media chats and posts, featuring hashtags and handles such as #GeeksAtMars and #OSH16.

NASA's deep space team members from NASA's Glenn Research Center and Marshall Space Flight Center joined the four prime SLS and Orion contractors to support Journey to Mars displays and host forums with special guests including current astronaut Mike Hopkins, as well as former space flight veterans Charlie Precourt, Brian Duffy and Kent Rominger. Forums included former astronauts sharing their insights alongside astronaut hopefuls about working in space, how to become an astronaut and careers in space exploration. Special panel presentations included Women in Space – Redefining Glamour, Star Trek – Fact vs. Fiction, and The Journey to Mars Has Begun.

Supporting the four prime contractors Aerojet Rocketdyne, Boeing, Lockheed Martin and Orbital ATK, are numerous suppliers from all across the United States. Current suppliers in Wisconsin include ATI Metals (Ladish Company) in Cudahy; Marine Travelift in Sturgeon Bay; Amorim Cork Composites in Trevor; and Hentzen Coatings in Milwaukee.

To explore the network of companies in 49 states supporting deep space missions, visit the SLS and Orion supplier map at:

[www.nasa.gov/externalflash/ESDSuppliersMap](http://www.nasa.gov/externalflash/ESDSuppliersMap)

Read more at: [bit.ly/NASA\\_OshKosh](http://bit.ly/NASA_OshKosh)

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# AUGUST

- Clean room operations begin at KSC
- Docking hatch crew testing at JSC
- Water impact testing at LaRC
- OMS-E arrives at White Sands for testing