

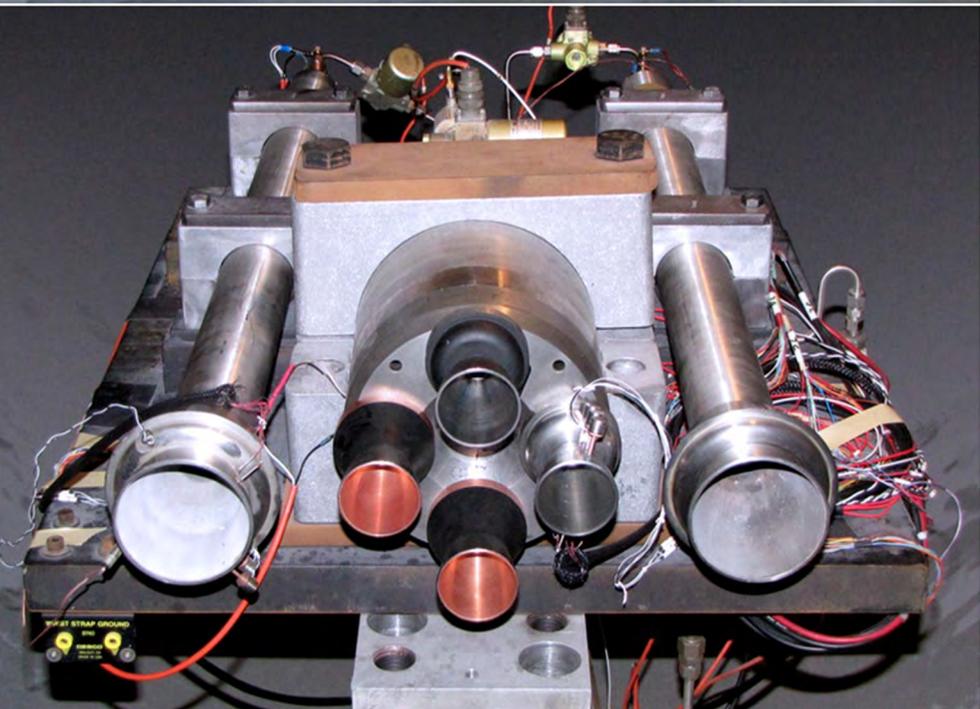


ESD

EXPLORATION SYSTEMS DEVELOPMENT

COMBINED MONTHLY HIGHLIGHTS

FEBRUARY 2014



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ORION SPACE LAUNCH SYSTEM GROUND SYSTEMS DEVELOPMENT & OPERATIONS

**MONTHLY
ACCOMPLISHMENTS**
February 2014

Orion



Exploration Flight Test-1 Launch Prep Gets Boost as Rocket Arrives in Florida



The Orion spacecraft has moved another step closer toward its first test flight, as the core and starboard boosters for the United Launch Alliance (ULA) Delta IV Heavy rocket contracted by Lockheed Martin for that flight have arrived at Cape Canaveral Air Force Station. The rocket will undergo testing and processing at ULA's Horizontal Integration Facility to prepare for Orion's Exploration Flight Test-1 later this year.

Technicians offloaded the boosters from a specially designed ship called the Delta Mariner, which departed from the ULA facility in Decatur, Ala., on Feb. 21 and arrived in Florida

on March 3. Once in the Horizontal Integration Facility, processing and testing will be completed in preparation for rolling the Delta IV Heavy out to Space Launch Complex 37 for launch.

Prior to its departure from Decatur, NASA, Lockheed Martin and ULA senior leadership participated in a media event on Feb. 21. They conducted interviews with Alabama television, print and radio reporters. Media coverage included WAFF-TV, WAAY-TV, WHNT-TV, Space Coast Daily, Huntsville Times and The Decatur Daily.



Photo: Ball Aerospace

Orion Communication Antennas Delivered for EFT-1 Mission

Ball Aerospace & Technologies Corp. delivered four phased array antennas to Lockheed Martin and NASA's Kennedy Space Center for the inaugural test flight of the Orion spacecraft. The antennas, which will be installed on the exterior of Orion, are the primary means of voice, data and video communications for the future astronaut crews that will pilot the nation's next generation spacecraft beyond low-Earth orbit on long-duration, deep-space missions.

The antennas are currently being tested at Kennedy to verify that the beam-pointing algorithm works accurately in the fully integrated vehicle configuration. During Exploration Flight Test-1, the antennas will be tested for their ability to maintain telemetry and command links to/from the ground under the extreme conditions encountered during ascent and re-entry, and to support high-data-rate video on orbit.



The Orion team at Kennedy Space Center successfully completed the structural loads testing of the Exploration Flight Test service module this month. The service module is now complete and ready for mating to the crew module in May.



Read about Cindy Nafus, senior production leader at United Launch Alliance in Decatur, Ala. on.fb.me/OhK22g

Orion Testing Provides Lessons and Data for Splashdown Recovery Operations

The first full joint testing between NASA and the U.S. Navy for Orion recovery procedures off the coast of California was suspended after the team experienced issues with handling lines securing a test version of Orion inside the well deck of the USS San Diego.

NASA and the Navy were conducting tests to prepare for recovery of the Orion crew module after it splashes down in the Pacific Ocean at the end of its first space-flight later this year. The testing was planned to allow teams to demonstrate and evaluate the processes, procedures, hardware and personnel that will be needed for recovery operations.

The lines were unable to support the tension caused by crew module motion that was driven by wave turbulence in the well deck of the ship. The team called off the week's remaining testing to allow engineers to evaluate next steps.

The challenges that arose demonstrate why it is important to subject Orion to tests in the actual environments that the spacecraft will encounter during a mission.

The testing has provided important data that is being used to improve recovery procedures and hardware ahead of Orion's first flight test. Several of the test objectives were accomplished before the remaining tests were called off, including successful recoveries of the forward bay cover, parachute and demonstrations of the coordination required between the team onboard the ship and mission control in Houston.



Spacewalk and Suit Testing in the NBL

An upgraded version of the Advanced Crew Escape Suit that astronauts wore for shuttle launches and landings is being developed for that role in future Orion spacecraft flights, as well as for use during contingency spacewalks. Two of those suits were tested simultaneously in the Neutral Buoyancy Laboratory (NBL), by astronauts Dan Burbank, and Rex Walheim, who is chief of the Exploration Branch in NASA's Astronaut Office and representative to the Orion program.

Watch a recent interview with Rex Walheim on Space Station Live: bit.ly/1cNHj7A



Engineers Continue Pushing Orion Parachute System to its Limits

The parachute system designed for NASA's Orion spacecraft passed another hurdle on Feb. 26, in a test that put extra stress on its drogue parachutes and simulated a failure of one of its three main parachutes.

Engineers dropped a dart-shaped test vehicle that simulates Orion's parachute compartment from a C-17 flying 35,000 feet above the U.S. Army's Yuma Proving Ground in Arizona. Although one test has been conducted from that height before, this was the first using the dart-shaped vehicle at that altitude.

This test verified that the drogue parachutes will perform successfully during the most extreme speed, altitude and pressure loads they would see in a mission, providing invaluable information to add to the computer models used to design the system that will allow crews in Orion to splashdown safely in the Pacific Ocean.

During this test, engineers repeated the failure of one of the three main parachutes from a previous test to provide more data and opened the two main parachutes at different rates from previous tests to assess a design improvement. They also were able to use three forward bay cover parachutes as programmers to set the test up, which allowed them to obtain more data on those parachutes, even though no cover was used during the test.

Testing Orion's parachutes will ensure that the system is dependable when the spacecraft reenters Earth's atmosphere.

The next parachute test, set for April 23, will skip the drogue parachutes altogether, demonstrating a launch abort scenario that relies only on the three main parachutes to slow the spacecraft safely.



Orion subcontractor Alliant Techsystems, Inc. (ATK) and NASA hosted media preview and grand opening events Feb. 26-27 for the new exploration exhibit at the Clark Planetarium in Salt Lake City, Utah. Orion and Space Launch System content is included in the exhibit, where students participated in Exploration Design Challenge activities, met astronauts, and received a photo of themselves launching on a rocket.

Orion Teams Received The Prestigious Orion Program Manager's Commendation Award



Members of the United Launch Alliance Common Booster Core and Integration, Assembly and Check Out team received the Orion Program Manager's Commendation for their dedication to perfect product delivery, continuous hard-work and focus on mission success for the Exploration Flight Test vehicle.



The Orion Program Manager's Commendation was presented to the Orion Spacecraft Adapter Cone Acceptance Test team for their outstanding efforts in successful testing of the Orion spacecraft adapter cone in support of Exploration Flight Test-1.



The Orion Service Module Composite Fairing Acceptance Test team received the Orion Program Manager's Commendation for their outstanding efforts in successful testing of the Orion service module composite fairings in support of Exploration Flight Test-1.



Brent Gaddes and Patrick Hull, engineers at NASA's Marshall Space Flight Center in Huntsville, Ala., recently were honored for their work on Orion's spacecraft adapter hardware. The awards were presented by John Casper, Orion special assistant for program integration and former astronaut.



Get On Board!

The NASA Orion Program kicked off I'm on Board, a public engagement campaign to generate awareness and excitement about Orion's first space flight – Exploration Flight Test-1. Banners for the campaign were featured at several outreach and supplier events held in February, including on board the USS San Diego, the Reuben H. Fleet Science Center and San Diego Air & Space Museum Feb. 21 – Feb. 23, the Clark Planetarium in Salt Lake City, Utah, on Feb. 26-27 and United Launch Alliance in Decatur, Ala., on Feb 19.

The “I'm on Board” outreach gives people of all ages a chance to learn about Orion, sign the I'm on Board banner and post their “selfies” to the #ImOnBoard Twitter, Facebook and Instagram conversations. Social media postings from these events can be seen on:

Facebook	facebook.com/NASAO Orion
Twitter	twitter.com/NASA_Orion
Instagram	instagram.com/explorenasa



◀ Julie Kramer White, Orion's chief engineer, discussed the future of human spaceflight at a Lunch and Learn event at the Johnson Space Center on Feb. 13.

View the latest Exploration Systems Development quarterly videos at:

bit.ly/1ITw2dC
bit.ly/1epD9me





Californians Contribute to Orion Progress

NASA and Lockheed Martin representatives met with California suppliers Feb. 22-25 in the San Diego and Los Angeles area in conjunction with the Underway Recovery Testing at Naval Base San Diego. Pentair Technical Solutions of San Diego, Meggitt Sensing Systems of Irvine, and Martinez & Turek Inc. of Rialto,

hosted employee all-hands Orion presentations and facility tours to provide a behind-the-scenes look at how they design and build their components for the Orion spacecraft. Photos of the visits can be found on the Orion Facebook page at: on.fb.me/1oJ895n



SEEC and Ye Shall Learn

Lockheed Martin and NASA Orion team members supported the 2014 Space Exploration Educators Conference held at Space Center Houston on Feb. 6 - 7.

Hundreds of teachers from around the world attended presentations by NASA program scientists, engineers and educators to learn new ideas to invigorate Science Technology, Education and Math (STEM) education in the classroom, including the Exploration Design Challenge, which will fly a student payload on Orion this fall.

In addition, Orion engineers provided briefings for the educator tours as they stopped by the full-scale Orion mockup in the Space Vehicle Mockup Facility at Johnson Space Center. More information and photos from the event can be found at: on.fb.me/1foXZ9o



Read about John Menoni, captain in the United States Navy, USS San Diego, San Diego, Calif. on.fb.me/PoG4pX

Coming up in March

- Crew module functional testing
- Forward bay cover ground jettison testing
- Launch abort system fillets on dock at KSC



Space Launch System

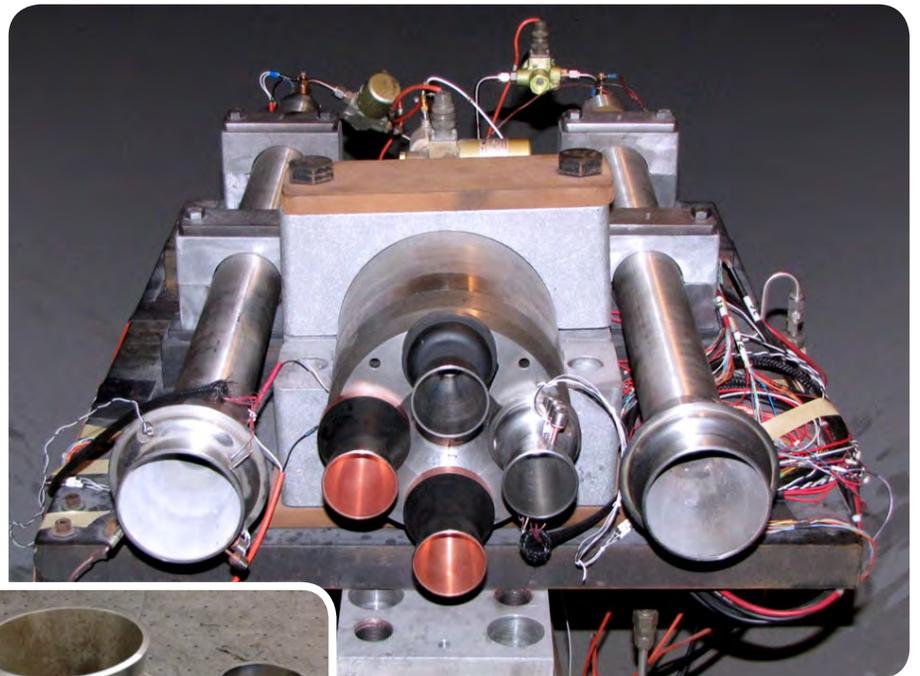
Highlights

February 2014



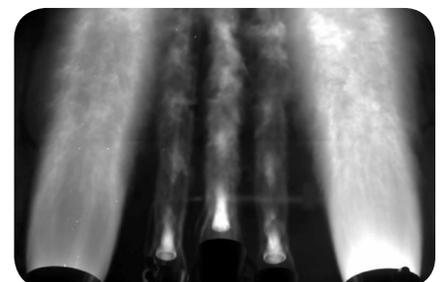
Mini Rocket Models to be Used in a Big Way for SLS Base Heating Test

As part of the Pathfinder Test Program, 2-percent scale models of the SLS solid rocket boosters and core stage RS-25 engines have been designed and built ahead of base heating testing scheduled this summer. Engineers will use the models of the SLS propulsion system to understand heating environments that the base of the vehicle will experience upon ascent. Data from tests on those models will be used for the design of the rocket's base thermal protection system, which keeps major hardware, wiring and—later—the crew safe from the extreme heat the boosters and engines create when ignited. The current model RS-25 engine clocking configuration, different from the SLS configuration, is used to adequately visualize plumes during testing. The work was a collaborative effort between Marshall Space Flight Center engineers and Calspan-University of Buffalo Research Center Inc., in Buffalo, N.Y.



◀ A size comparison of the model booster and engine nozzles to a quarter. (NASA/MSFC)

The 2-percent scale models of the SLS boosters and core stage engines are ignited for a 100-millisecond, hot-fire test. The test was used to validate the design of the models. (NASA/MSFC) ▶



Spaceflight Partners: Beranek Inc. Precision Machining

EDITOR'S NOTE: Every month, SLS Highlights turns the spotlight on one of the industry partners helping to create the largest rocket ever built for human space exploration. In this issue, we profile Beranek Inc. Precision Machining in Los Angeles.

The Aerojet Rocketdyne RS-25 engines that will power the first stage of the SLS have a storied history in support of the Space Shuttle Program. Beranek Inc. Precision Machining, a family-owned and operated business in the South Bay of Los Angeles, plays a key role in that story as the manufacturer of detailed components for the workhorse engines.

Established in 1978 by Hector Beranek and his sons Daniel, George, Doug and Eric Beranek, the company is predominantly a machine shop with CNC Milling & Turning capabilities for high-precision machining and assembly of complex components for the aerospace and communications industry.

“If you look at an automobile engine—that is a big part of a car. If you break down that engine, it has several parts, and each part is a detailed component,” said Efrain Montemayor, purchasing manager at Beranek. “There are pistons, rings, rods, fans, valves and springs that are critical to operations. If you translate the car engine to an RS-25 engine, you’ll better understand that there are hundreds to thousands of detailed components, including engine



Team members from Beranek Inc. Precision Machining in Los Angeles. (Beranek)

turbine fans, blades, injectors, plates and bells.”

The company prides itself on the detail-oriented work it does on complex hardware that serves a bigger purpose for human spaceflight and exploration.

“I’m very patriotic,” said Montemayor. “To be able to see something go from a basic piece of metal to its finite end of launching people into space is very emotional. There is no better feeling than seeing something from beginning to end.”

Tools Building Space Launch System Progress at Michoud



The second SLS core stage forward liquid oxygen (LO2) tank dome recently was completed on the **Circumferential Dome Weld Tool** at NASA’s Michoud Assembly Facility. The dome was welded as a “confidence” article to ensure that the weld tool can produce the qualification and flight domes. The SLS **core stage** liquid hydrogen and liquid oxygen tanks will each have two domes similar to the confidence article. The dome will be used to develop inspection techniques for the flight articles. It also will be used for future confidence welding on the Vertical Assembly Center—one of the world’s largest welding tools scheduled to be completed in 2014. (NASA/Michoud)

(continued on page 3)

Tools

(continued from page 2)



Above left, the foundation has been completed, and tooling structure built, on the Vertical Assembly Center. The tool will be used to join domes, rings and barrels together to complete the tanks or dry structure assemblies for the SLS. The tool also will perform nondestructive evaluation on the completed welds. When finished, as depicted in the artist concept, above right, the Vertical Assembly Center will measure 170 feet tall and 78 feet wide. (NASA/Michoud)

I am
building
SLS

Manish Mehta
Aerospace Engineer



To find out more about the people who are building SLS, [click here](#).

SLS On the Road...

SLS Boosters Office Manager Alex Priskos, left, talks about SLS at the ATK rocketry display ribbon cutting at Clark Planetarium. Seated, from left, are ATK space launch executive and former astronaut Charlie Precourt, NASA astronaut Tony Antonelli and Seth Jarvis, executive director of the Clark Planetarium. Priskos, a native of Salt Lake City, also took part in a panel discussion on deep space exploration with Precourt and Antonelli. Team members from the SLS Program attended the ATK display unveiling and led SLS events and activities—including interactive displays—at the planetarium. During his visit, Priskos returned to his alma mater, the University of Utah, to meet with students and discuss the positive impact his education has had on his NASA career and building America's next great rocket. *(NASA/MSFC)*



The SLS model makes an appearance at the Association of the United States Army (AUSA) Winter Symposium and Exposition, held this year for the first time in Huntsville, Ala. This year's event managed to quadruple previous years' attendance numbers and provided attendees with an opportunity to learn about SLS. *(NASA/MSFC)*



David Hitt, at chalkboard, talks about SLS on Feb. 20 with students at Sacred Heart Elementary School in Cullman, Ala. Hitt is an ASRC Federal/Analytical Services employee on the SLS Strategic Communications Team at NASA's Marshall Space Flight Center. *(NASA/MSFC)*



For more SLS news, updates and resources, visit www.nasa.gov/sls

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SLS on Deck:

- South by Southwest
- Bolden visit to Marshall Center
- NASA Day in Montgomery



PROGRAM HIGHLIGHTS • FEBRUARY 2014

At NASA's Kennedy Space Center in Florida, the Ground Systems Development and Operations (GSDO) Program Office is leading the center's transformation from a historically government-only launch complex to a spaceport bustling with activity involving government and commercial vehicles alike. GSDO is tasked with developing and using the complex equipment required to safely handle a variety of rockets and spacecraft during assembly, transport and launch. For more information about GSDO accomplishments happening around the center, visit <http://go.nasa.gov/groundsystems>.

New Roller Bearings Tested on Crawler-Transporter 2

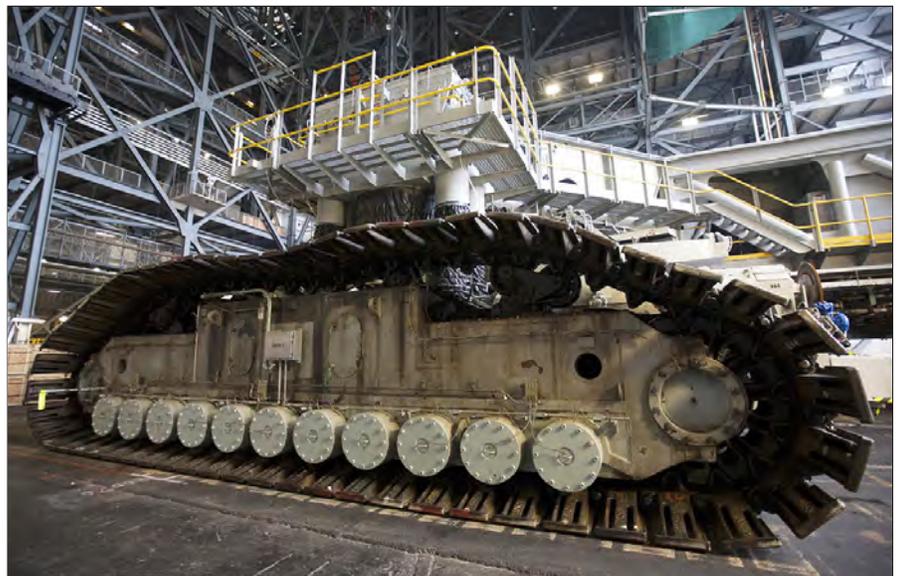
The crawler-transporter that will carry NASA's Space Launch System (SLS) and Orion spacecraft to Launch Pad 39B for liftoff on Exploration Mission-1 in 2017 recently passed the first phase of an important milestone test at Kennedy Space Center in Florida.

The Ground Systems Development and Operations Program completed testing of the new traction roller bearings on crawler-transporter 2 (CT-2), on two of the massive vehicle's truck sections, A and C, in late January. During the test, CT-2 was driven unloaded on crawlerway C, between the Vehicle Assembly Building and Ordnance Road.

As the crawler moved along, the left- and right-hand steering was tested in both directions. Workers performed visual inspections of the roller bearing pumps, valves and lines to ensure that the grease injectors worked properly and provided the required flow of grease to the new roller assemblies.

"The temperatures of the roller assemblies were monitored and recorded using newly installed thermocouples," said Mike Forte, a senior project manager with QinetiQ on the Engineering Services Contract. "We were looking for any anomalies and establishing a baseline operating temperature for the new roller assemblies."

Forte said temperature data on the surface of the roller assemblies also was collected using hand-held infrared temperature monitoring devices. "We also closely



Crawler-transporter 2 enters the Vehicle Assembly Building at Kennedy Space Center on Jan. 31. Visible are the new roller bearing assemblies that were installed on the crawler. GSDO recently completed a roller bearing assembly test on truck sections A and C of the crawler.

monitored the system for any unanticipated vibrations or noise, which are indications of problems," Forte added.

Upgrades to CT-2 are necessary in order to increase the lifted-load capacity from 12 million to 18 million pounds to support the weight of the mobile launcher and future launch vehicles, including the SLS and Orion.

For the complete story, visit <http://go.nasa.gov/1qfWy1s>.

Mobile Launcher Upgrades Will Support Space Launch System

The mobile launcher that will support NASA's next heavy-lift launch vehicle, the powerful Space Launch System (SLS), is being bulked up in preparation for the forces of liftoff.

The steel mobile launcher towers 405 feet above its construction site in the heart of Launch Complex 39 at NASA's Kennedy Space Center in Florida. While the structure itself is undergoing significant modifications to fit the new vehicle, additional work is bringing new capabilities to the construction site.

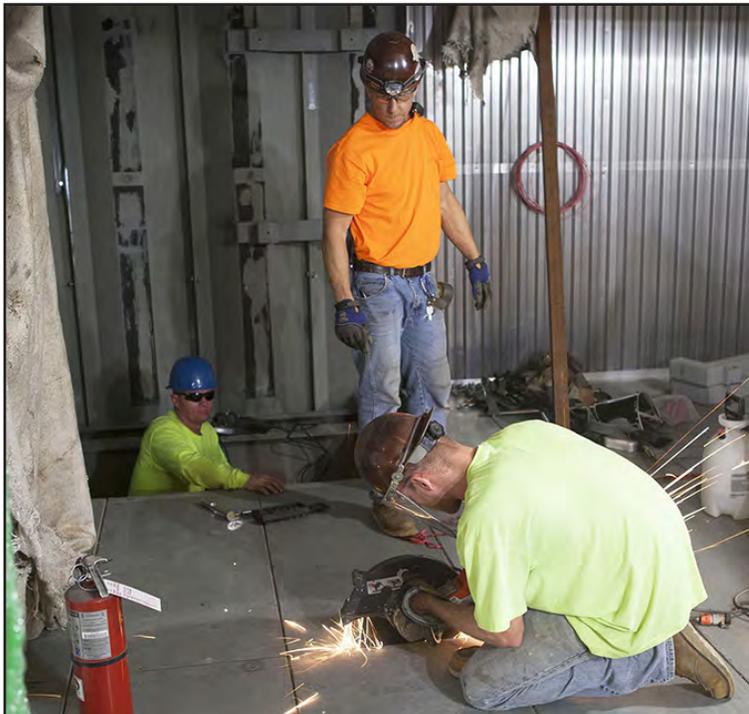
The SLS rocket will be capable of sending humans to an asteroid, Mars or other destinations. Its first flight test is slated for 2017, and efforts to prepare launch facilities and support equipment are in full swing at Kennedy. The Ground Systems Development and Operations (GSDO) Program, based at Kennedy, manages the project.

Although the SLS vehicle still is in development, there is enough information already available that the team could begin the time-consuming work of updating the launcher's structure. The primary goal is to reconfigure and strengthen it to accommodate the weight, size and thrust of the new rocket.

"Ultimately, we're modifying the mobile launcher to expand the exhaust opening from about 22 by 22 feet to approximately 64 by 32 feet," said Mike Canicatti, mobile launcher construction manager. That means re-



Fog envelops the top of the 405-foot-tall Mobile Launcher at Kennedy Space Center on Feb. 7.



Modifications continue Feb. 12 on the Mobile Launcher at the Mobile Launcher Park Site at Kennedy Space Center. A construction worker uses a saw to cut through a portion of the flooring beneath the surface of the ML.

arranging one of the massive steel support beams within the launcher's platform, installing five newly fabricated pieces, and relocating and modifying another piece.

Prime contractor J.P. Donovan of Rockledge, Fla., is handling the work for this part of the project with support from Midwest Steel of Detroit. Work under the current contract began in June 2013 with completion scheduled for December 2014. Nearly all of the necessary demolition work around the original exhaust opening already is complete, clearing the way for structural changes.

"We have to make sure everything fits perfectly," Canicatti said. "There are a lot of tight tolerances on this particular project, so if things shift just half an inch or a quarter of an inch, we'll say, 'OK, what do we need to do?'"

For the complete story, visit <http://go.nasa.gov/1qg13Jf>.

Orion Underway Recovery Test Begins off Coast of California

About a hundred miles off the coast of San Diego, in the Pacific Ocean, a U.S. Navy ship's well deck filled with water as underway recovery operations began Feb. 18 on a test version of NASA's Orion crew module, tethered inside, to prepare for its first mission, Exploration Flight Test-1, in September.

Building on the knowledge gained from previous Orion recovery tests performed in calm waters near NASA's Langley Research Center in Virginia, the agency's Ground Systems Development and Operations (GSDO) Program began the next phase, seeking turbulent water off the west coast in which to practice recovering the Orion crew module, one parachute and a forward bay cover, which keeps Orion's parachutes safe until being jettisoned, just before the parachutes are needed.

During the testing, the tether lines were unable to support the tension caused by crew module motion that was driven by wave turbulence in the well deck of the ship. NASA and the U.S. Navy called off the week's remaining testing to allow engineers to evaluate the next steps.

"Even though the testing didn't go as we had planned, we're learning lessons that will help us be better prepared to retrieve Orion after it travels more than 3,600 miles into space and comes home," said Bill Hill, assistant deputy associate administrator for exploration



During an Orion Underway Recovery Test about 100 miles off the coast of San Diego, Calif., NASA and the U.S. Navy successfully retrieved the forward bay cover and a parachute from the Pacific Ocean on Feb. 18.



On the USS San Diego, a crane is used to lower a rigid hull inflatable boat into the Pacific Ocean as part of the Orion underway recovery test Feb. 18. The Orion boilerplate test vehicle and other hardware were secured in the well deck of the ship in preparation for the test about 100 miles off the coast of San Diego, California. NASA and the U.S. Navy practiced recovery of the Orion forward bay cover and a parachute.

systems development at NASA Headquarters in Washington. "The Orion testing work we do is helping us work toward sending humans to deep space."

Several of the objectives were accomplished before the remaining tests were called off. NASA and the U.S. Navy were able to successfully recover the forward bay cover and parachute, and demonstrations of the coordination required between the team aboard the ship and mission control in Houston were accomplished.

To read more about the recovery test, visit <http://go.nasa.gov/1qfXdQe>.

For more information about Orion, visit <http://www.nasa.gov/orion>.

Employee Spotlight – Yves Lamothe

Yves Lamothe is a system engineer in the Ground Systems Development and Operations (GSDO) Program at Kennedy Space Center. His main responsibilities include providing technical leadership, management and integration of development activities for the program.

Prior to working in GSDO, Lamothe worked in the Engineering & Technology Directorate as a systems engineer supporting the Constellation Program. He has worked at Kennedy since 2005.

“Working in the GSDO Program, I get to be part of the team that will transform Kennedy’s infrastructure to process and launch the Space Launch System rocket and the Orion capsule,” Lamothe said. “Part of that also will be helping to posture the center to support commercial entities.”

One of Lamothe’s recent accomplishments was successfully leading, coordinating and executing the kickoff of the Preliminary Design Review for GSDO.

When he’s not working, Lamothe is a DJ, a personal trainer and a life coach.

“I enjoy working with and helping people as much as I can,” Lamothe said.

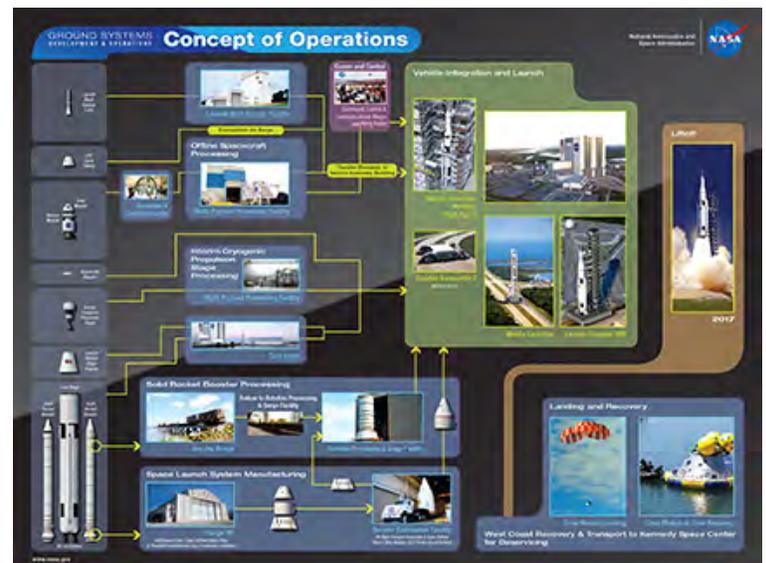
His first car was a 1986 Chevy Cavalier Hatchback that he purchased from a neighbor for \$50.



Lamothe lives in Rockledge with his wife, Jael, who also works at Kennedy, and their three children, Alena, Christian and Brielle.



From left, NASA astronauts Tyler “Nick” Hague, Andrew Morgan, Jessica Meir, Christina Hammock, crawler-transporter integration manager Mary Hanna, and astronauts Nicole Mann, Anne McClain, Josh Cassada and Victor Glover pose in front of crawler-transporter 2 inside the Vehicle Assembly Building during a daylong set of briefings and tours of different facilities March 3 at NASA’s primary launch center.



GSDO developed a Concept of Operations chart that illustrates the processing flow and facilities that will be used to prepare the Orion spacecraft, launch abort system and Space Launch System for launch, splashdown and recovery. To view a full page version of the chart, click on the photo.

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EXPLORATION SYSTEMS DEVELOPMENT



The United Launch Alliance (ULA) Delta IV Heavy rocket contracted by Lockheed Martin has arrived at Cape Canaveral Air Force Station in preparation for Exploration Flight Test -1 later this year.