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National Aeronautics and Space Administration

KENNEDY SPACE CENTER'S

SPACEPORT magazine

FIRED UP! SLS booster passes major milestone

Aeronautics Research | Mars | Technology | Earth Right Now | ISS | Solar System & Beyond

KENNEDY SPACE CENTER'S

SPACEPORT MAGAZINE

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Back Cover: Astronomers are using NASA's Hubble Space Telescope to study auroras — stunning light shows in a planet's atmosphere — on the poles of the largest planet in the solar system, Jupiter. For the complete story, go to http://go.nasa.gov/298tVTU. Photo credit: NASA, ESA, and J. Nichols (University of Leicester)

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KSC BLOG

THE SPACEPORT MAGAZINE TEAM

Editorial

Editor.....Frank Ochoa-Gonzales

Assistant Editor.....Linda Herridge

Copy Editor.....Kay Grinter

Writers Group

Anna Heiney, Bob Granath, Kay Grinter, Linda Herridge, Steven Siceloff

Creative Group

Richard Beard, Amy Lombardo, Lynda Brammer, Matthew Young, Greg Lee

NASA'S LAUNCH SCHEDULE

Date: July 6, 9:36 p.m. EDT
Mission: Launch of Expedition 48 Crew
Description: Launch of the Expedition 48 crew on the Soyuz MS-01 spacecraft from the Baikonur Cosmodrome in Kazakhstan to the International Space Station.
http://go.nasa.gov/1VHuSAv

Date: July 18. 12:45 a.m. EDT
Mission: SpaceX CRS-9 Launch
Description: An uncrewed SpaceX Dragon spacecraft, carrying crew supplies and station hardware, will lift off on a Falcon 9 rocket from Space Launch Complex 40 at Cape Canaveral Air Force Station.
http://go.nasa.gov/293FmfN

Targeted Date: August
Mission: Orbital ATK CRS-5
Description: Orbital ATK's fifth Cygnus cargo delivery to the International Space Station is targeted for no earlier than an August launch on the Antares rocket from the Mid-Atlantic Regional Spaceport's Pad 0A at NASA Wallops Flight Facility.
http://go.nasa.gov/293FCLC

Date: Sept. 8, 7:05 p.m. EDT
Mission: OSIRIS-REx
Description: The mission will study Bennu, a near-Earth asteroid that is about one-third of a mile across. OSIRIS-REx will bring a small sample back to Earth for study. As planned, the spacecraft will reach its asteroid target in 2018 and return a sample to Earth in 2023.
http://go.nasa.gov/1ItsRkl

Date: Oct. 14
Mission: Geostationary Operational Environmental Satellite-R Series (GOES-R)
Description: The advanced spacecraft and instrument technology used on the GOES-R series will result in more timely and accurate forecasts and warnings.
http://go.nasa.gov/1YubP2g

I am KENNEDY SPACE CENTER

GLENN CHIN

I am the deputy manager for the Orion Production Operations Office within the Orion Program. Orion Production Operations is responsible for overseeing the production of the Orion spacecraft for the Exploration Mission 1 launching in 2018. My Kennedy career started in 1989 with the historical Spacelab Program as a "hands-on" fluid systems engineer. Spacelab was where I received my dose of engineering touch labor on flight hardware as a young engineer fresh out of college.From June 1996, I worked with the International Space Station Program, and in 2000, I became an ISS mission manager where I managed a Mission Processing Team that processed the ISS flight hardware from Kennedy delivery to launch and post-mission processing. I will always treasure the intensity and teamwork within the Launch Control Center firing room during launch countdown and the post-launch beans and cornbread.I transferred to the Orion Program in 2007. My current position is truly inspiring and challenging as I live my dream building America's next generation deep-space crew exploration vehicle.Looking back at my unique "payloads" career at Kennedy, I realize how fortunate I've been to be a member and contributor to the U.S. Space Program from Spacelab, International Space Station and now Orion. Kennedy is one of the best kept secrets where you do live your dreams.

The second and final qualification motor (QM-2) test for the Space Launch System's booster is seen June 28 at Orbital ATK Propulsion Systems test facilities in Promontory, Utah. During the Space Launch System flight, the boosters will provide more than 75 percent of the thrust needed to escape the gravitational pull of the Earth, the first step on NASA's Journey to Mars.

The booster was tested at a cold motor conditioning target of 40 degrees Fahrenheit — the colder end of its accepted propellant temperature range. When ignited, temperatures inside the booster reached nearly 6,000 degrees. The two-minute, full-duration ground qualification test provided NASA with critical data on 82 qualification objectives that will support certification of the booster for flight. Engineers now will evaluate these data, captured by more than 530 instrumentation channels on the booster. Photo credit: NASA/Bill Ingalls

WHAT IS QM-2?

THE CHILL BEFORE THE THRILL

QM-2 (QUALIFICATION MOTOR-2) is the last full-scale ground test of the solid rocket booster motor before the first uncrewed flight of NASA's Space Launch System with Orion in 2018. The propellant has been chilled to about **40 degrees Fahrenheit** (**4** degrees Celsius) so engineers can understand the effects of temperature on how the propellant burns.

WHAT'S THE OBJECTIVE? TO TEST...

COOL PROPELLANT: Engineers need to make sure the chilled propellant burns as expected on launch day.

NEW NOZZLE: Steering will be tested as part of a redesigned nozzle, which controls the ejecting gases.

IMPROVED INSULATION: Engineers need to understand how the new and improved insulation protects parts of the motor.

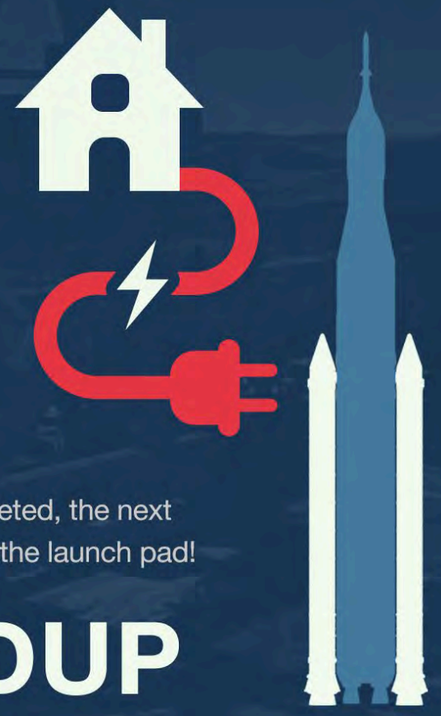
BIGGER BOOSTER. BOLDER MISSIONS.

Designed by Orbital ATK, the **5-SEGMENT** SLS solid rocket boosters are the largest, most powerful ever made for flight.

During their **2 MINUTE** flight, the SLS boosters together generate **7.2 MILLION** pounds of thrust — more than **75%** of total thrust generated at liftoff.

INCREDIBLE POWER

If the energy produced by the boosters firing for two minutes were converted to electric power, it would equal **2.3 MILLION KILOWATTS** — enough juice to power more than **92,000** homes for a full day!



THE PATH TO THE PAD

After the QM-2 test is successfully completed, the next time you see a booster ignite it will be on the launch pad!

#SLSFIREDUP

I Will **LAUNCH AMERICA**

Restoring America's Human Launch Capability

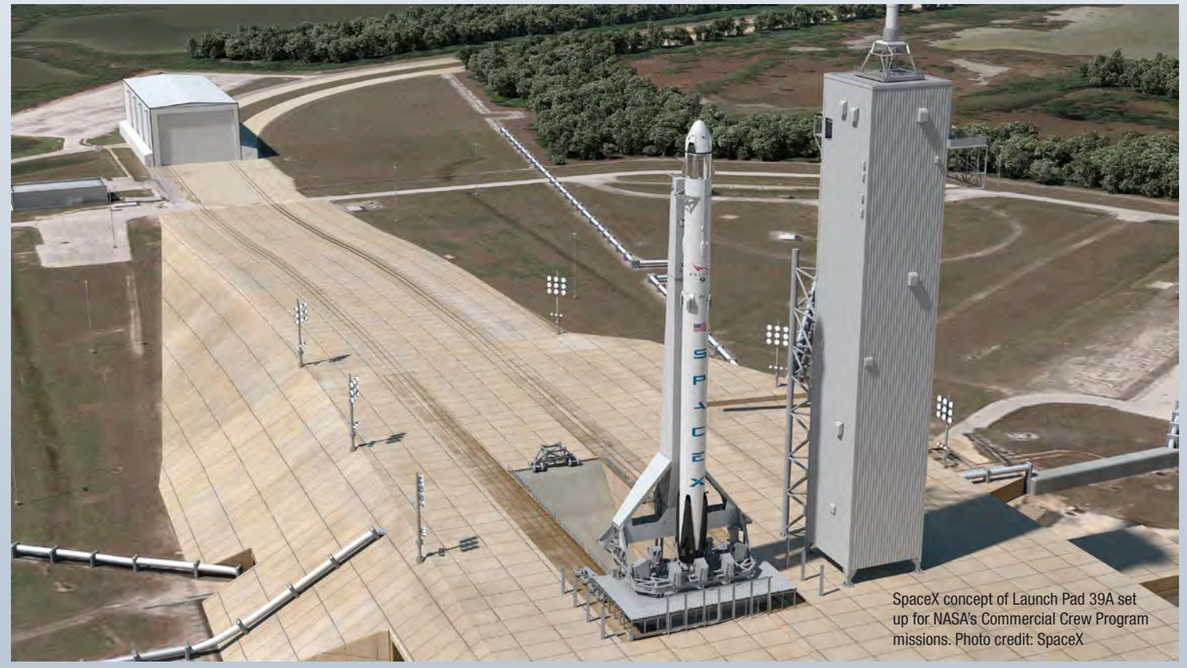
Misty Snopkowski
NASA Launch Site Integrator
NASA's Commercial Crew Program

I Will Launch America: Launch Site Integrator Misty Snopkowski

BY STEVEN SICELOFF

Misty Snopkowski has worked on human spaceflight initiatives since 2003, building up expertise with the Space Shuttle and International Space Station Programs and now standing on the precipice of the new era in human spaceflight with NASA's Commercial Crew Program.

"I got to work up until the very last shuttle launch in 2011, which was a pretty amazing period in time," Snopkowski said. "Then I joined Commercial Crew. You flip the script and go into a brand new program. I was this young person who got to start at the very beginning of a new program and most people don't ever get that opportunity."



SpaceX concept of Launch Pad 39A set up for NASA's Commercial Crew Program missions. Photo credit: SpaceX

A graduate of Embry-Riddle Aeronautical University and the University of Florida, Snopkowski's work for NASA now revolves around teaming with the SpaceX engineers modifying Launch Pad 39A at NASA's Kennedy Space Center in Florida for missions flying astronauts to the space station aboard the SpaceX Crew Dragon spacecraft on Falcon 9 rockets. As the launch site integrator, Snopkowski is part of the team certifying when SpaceX will be ready to launch commercial crew missions. The company, which has launched a series of cargo resupply missions to the station from a launch pad a couple miles south, also intends to use 39A for its Falcon Heavy rockets.

Snopkowski hoped her career would lead to space work, but she did not expect to be part of a team helping bring the worlds of her favorite movies into the reality of 21st century spaceflight.

"When I was a younger kid, I was always into math and science and, it's going to sound nerdy, but I was into Star Wars and Star Trek and was fascinated by it at a young age," Snopkowski said. "I found out what an engineer was and I just went down that road. The things I've been able to do are bigger than I've ever dreamed. Way cooler than I could've ever thought."

Right now, the focus is on the crew access arm, a movable bridge that astronauts will use to cross from the launch tower to the spacecraft on launch day. Access arms are vital to safety plans for everything from simple spacecraft loading to emergency evacuations in the final minutes of a countdown. That's why designs for them are so closely scrutinized and their installation watched so closely.

But the crew access arm is just one small component of the launch complex that made its iconic reputation launching Apollo-Saturn V missions to the moon and then served as one of two shuttle launch pads for 30 years. In the time SpaceX has spent modifying the pad, the company also added a 300-foot-long rocket processing hangar at the base of the pad, built a rail system to roll the rocket out of the hangar up to the top of the launch mount and constructed a large transporter-erector able to stand up the rocket to its vertical launch position.

Unlike previous programs that called for NASA to design a structure and system while the company built it, the commercial crew effort is centered on industry designing, building, operating and maintaining the systems themselves. NASA provided a list of requirements the systems must meet in order to launch astronauts to the station, and the companies were encouraged to bring forward their unique approaches.

"I'm out at Pad A at least once a week," Snopkowski said. "We do a walkdown and look at the modifications they are making for crew launches. We're one of many customers that are going to be using that launch pad."

The teams at NASA and SpaceX know the decisions they make could have ultimate consequences much later down the road, but that doesn't deter them from getting the work done, Snopkowski said.

"One of the things that we have learned in working with all the partners is that you don't need 200 people to come to a meeting to get something done," Snopkowski said. "There is something to having a small group of focused folks to come together and come to a solution.

"We've been in this development and design phase, and now we're turning a corner where we're starting to get into fabrication and manufacturing and operations, and we're seeing real hardware."

–Misty Snopkowski
NASA Launch Site Integrator for NASA's Commercial Crew Program

We've learned a lot about that, being lean and to pick up the pace to keep up with our energetic partners."

For NASA, the benefit of this effort is regular U.S. astronaut transportation services to the station from two independent providers — SpaceX with the Crew Dragon atop its Falcon 9 and Boeing with its CST-100 Starliner atop a United Launch Alliance Atlas V rocket. The new systems will allow the station to add another resident crew member and double the amount of time dedicated to scientific research in orbit.

"Misty is the kind of person you really want on your team," said Don Pearson, manager of Ground and Mission Operations for the Commercial Crew Program. "She has the technical expertise, the ability to coordinate and collaborate among multiple disciplines, and the passion and energy to make it successful in our rapid-paced world".

Although flight tests and the operational missions will be the most visual progress, Snopkowski said the team is keeping a close eye on all of the work ahead of them.

"We've been in this development and design phase, and now we're turning a corner where we're starting to get into fabrication and manufacturing and operations, and we're seeing real hardware," Snopkowski said. "That's kind of challenging, because it's been five years since we've done operations for human spaceflight. We've got to learn everything we can about these systems, what they are doing and how to apply that to crew."

SpaceX concept of Launch Pad 39A set up for NASA's Commercial Crew Program missions. Photo credit: SpaceX

STARLINER

READY TO BUILD

Final Spacecraft 1 major component arrives for assembly

STEVEN SICELOFF

Technicians move the upper dome of a Boeing Starliner spacecraft inside the company's Commercial Crew and Cargo Processing Facility at Kennedy Space Center on May 20. Photo credit: Dimitri Gerondidakis

The last major element of a test version of Boeing's CST-100 Starliner arrived at the company's spacecraft factory at Kennedy Space Center to begin assembly. The upper dome of the craft the company is calling Spacecraft 1 rolled through the doors of the Commercial Crew and Cargo Processing Facility at Kennedy on May 20 so engineers and technicians could begin outfitting it with systems before joining the upper dome to the docking hatch and lower dome elements that arrived earlier in May. The spacecraft's arrival points toward a time when the company routinely produces and launches Starliners on operational missions taking astronauts to the International Space Station for NASA's Commercial Crew Program.

Machined into a honeycomb pattern to reduce weight while maintaining strength, the upper and lower domes will form the crew compartment of the Starliner once assembled together. Thermal shielding will encase the domes on the outside and a base heat shield will be connected to the bottom to complete the spacecraft ahead of its pad abort flight test. That flight test will not carry people, but will include an attached service module holding propellant and supply tanks along with four powerful launch abort engines. The test will be an automated demonstration of the launch escape system's ability to lift the Starliner out of danger in the unlikely event of an emergency on the launch pad or during the climb into orbit.

The work is taking place as the Starliner's structural test article — a complete Starliner spacecraft designed only for tests on Earth — finishes its assembly and is readied for shipping to California for analysis in conditions similar to those found in space

For more about the arrival of Boeing's CST-100 Starliner and its importance to NASA's goals for the Commercial Crew Program and enhanced research on the space station, go to http://go.nasa.gov/1UtFLU4.

Journey to Jupiter

Juno spacecraft sets sights on orbit

BY FRANK OCHOA-GONZALES

NASA's Juno spacecraft is arriving to its destination with fanfare and fireworks. At about 9 p.m. Eastern Daylight Time on the Fourth of July, NASA's Juno spacecraft will fly within 2,900 miles of the cloud tops of Jupiter. It will conduct a 35-minute burn of its main engine, slowing by about 1,200 mph so it can enter the polar orbit of our solar system's largest planet.

"I'm sure it will be a tense 35 minutes on July Fourth during the main engine firing necessary to slow Juno down enough to achieve orbit around Jupiter," said John Calvert, Juno's mission manager for the Launch Services Program (LSP) at Kennedy Space Center. "We are all excited to finally start revealing the mysteries of the origins and evolution of Jupiter."

On Aug. 5, 2011, the solar-powered, 4-ton probe the size of a basketball court was launched from Cape Canaveral Air Force Station in Florida.

But it was seven years before the launch of NASA's Juno spacecraft when LSP's Eric Haddox first began helping with the spacecraft's trajectory design. LSP developed simulations for each of the launch vehicles capable of launching

An Atlas V rocket with NASA's Juno spacecraft lifts off from Space Launch Complex 41 at Cape Canaveral Air Force Station in Florida, on Aug. 11, 2001. Photo credit: NASA

Juno and performed trade studies to help the project determine the best path from Florida to Jupiter, how long their launch windows could be, what times of the day they would be launching, the solar conditions throughout the trajectory and what tracking locations around the Earth would be able to provide data for various launch vehicle events.

In August 2007, an LSP-led team selected an Atlas V 551 launch service for the task of launching Juno during a narrow 20 day period opening in the summer of 2011. Following four more years of intense spacecraft to launch vehicle mission integration and analysis, the LSP launch team verified all was nearly perfect with the launch ascent and the intended injection target was hit precisely. The Juno team at the Jet Propulsion Laboratory (JPL) then took over control of the mission, deployed Juno's huge solar arrays, and began checking out all the spacecraft systems and instruments to make sure all was well at the start of the long journey.

Now five years later and some 1.75 billion miles traveled, Juno will enter into an orbit around Jupiter that will gradually get closer and closer to the planet during its mission lifetime.

During the 37 planned flybys over a 20-month span, Juno will probe beneath the obscuring cloud cover of Jupiter and study its auroras to learn more about the planet's origins, structure, atmosphere and magnetosphere. Once the mission is complete, Juno will descend into the planet, which is made up mostly of hydrogen and helium.

"I'm expecting to see some of the most fascinating imagery we've ever seen of the planet," said LSP's Eric Haddox, "as well as learning more about the planet itself and its origins.

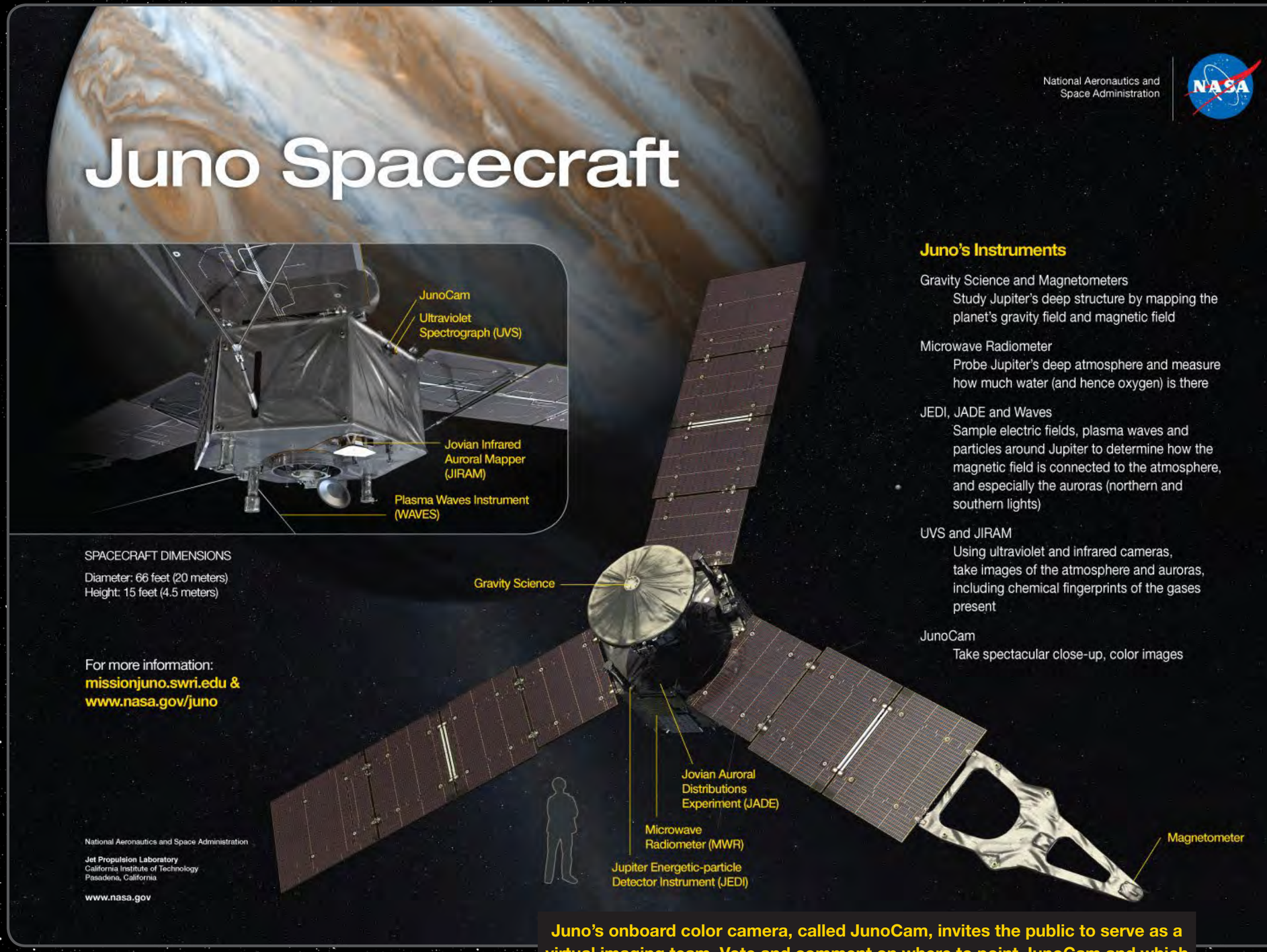
Juno's goal is to understand origin and evolution of Jupiter, look for solid planetary core, map magnetic field , measure water and ammonia in deep atmosphere, observe auroras.

Juno is the second orbiter ever sent to the largest planet in the solar system and it has traveled farther than any solar-powered spacecraft ever launched. Juno has three 30-foot-long solar arrays, along with 18,696 individual solar cells, to utilize the most of the solar power it receives on its trip.

On June 11, Juno began transmitting to and receiving data from Earth around the clock. This constant contact will keep the mission team informed on any developments with their spacecraft within tens of minutes of it occurring. On June 20, the protective cover that shields Juno's main engine from micrometeorites and interstellar dust was opened, and the software program that will command the spacecraft through the all-important rocket burn was uplinked.

One of the important near-term events that occurred on Juno's pre-burn itinerary was the pressurization of its propulsion system on June 28. The following day, all instrumentation not geared toward the successful insertion of Juno into orbit around Jupiter on July 4 was turned off.

Haddox added: "I'm excited to see Juno arrive at Jupiter and begin to provide us more knowledge about our neighbors in the solar system."



Juno's onboard color camera, called JunoCam, invites the public to serve as a virtual imaging team. Vote and comment on where to point JunoCam and which features to image on Jupiter using the new JunoCam web platform on this site.

https://www.missionjuno.swri.edu/junocam/

CRS-9 Carrying Crucial Port to Station

BY STEVEN SICELOFF

A metallic ring big enough for one or two people to fit through at a time will fly to the International Space Station in July as part of the cargo aboard an unpiloted SpaceX Dragon spacecraft loaded with materials for the orbiting laboratory and its crew. The ring is known as an International Docking Adapter, or IDA, and its main purpose is to provide a port for spacecraft bringing astronauts to the station in the future as part of NASA's Commercial Crew Program

Outfitted with a host of sensors and systems, the adapter is built so spacecraft systems can automatically perform all the steps of rendezvous and dock with the station without input from the astronauts. Manual backup systems will be in place on the spacecraft to allow the crew to take over steering duties, if needed.

With the IDA loaded in the rear trunk of the Dragon, the spacecraft will hold nearly 4,900 pounds of materi al including experiment supplies for dozens of the 250 research projects taking place on the station during Expeditions 48 and 49. The Dragon and its cargo will fly into orbit aboard a SpaceX Falcon 9 rocket that will take about 10 minutes to lift the spacecraft from its launch pad at Cape Canaveral Air Force Station in Florida to an orbit to catch up with the station. It will take about two days for the Dragon to reach the station. Once within reach of the station's robotic arm, the Dragon will be berthed to the orbital complex by the astronauts already on the station.

While the crew will be able to move the supplies out of the interior, pressurized compartment of the Dragon without leaving the station, the robotic arm will be called on to pull the IDA from the trunk and maneuver it near the port where it will be connected. Astronauts aboard the station will perform a spacewalk later this summer to make the final connection of the IDA to the Harmony module.

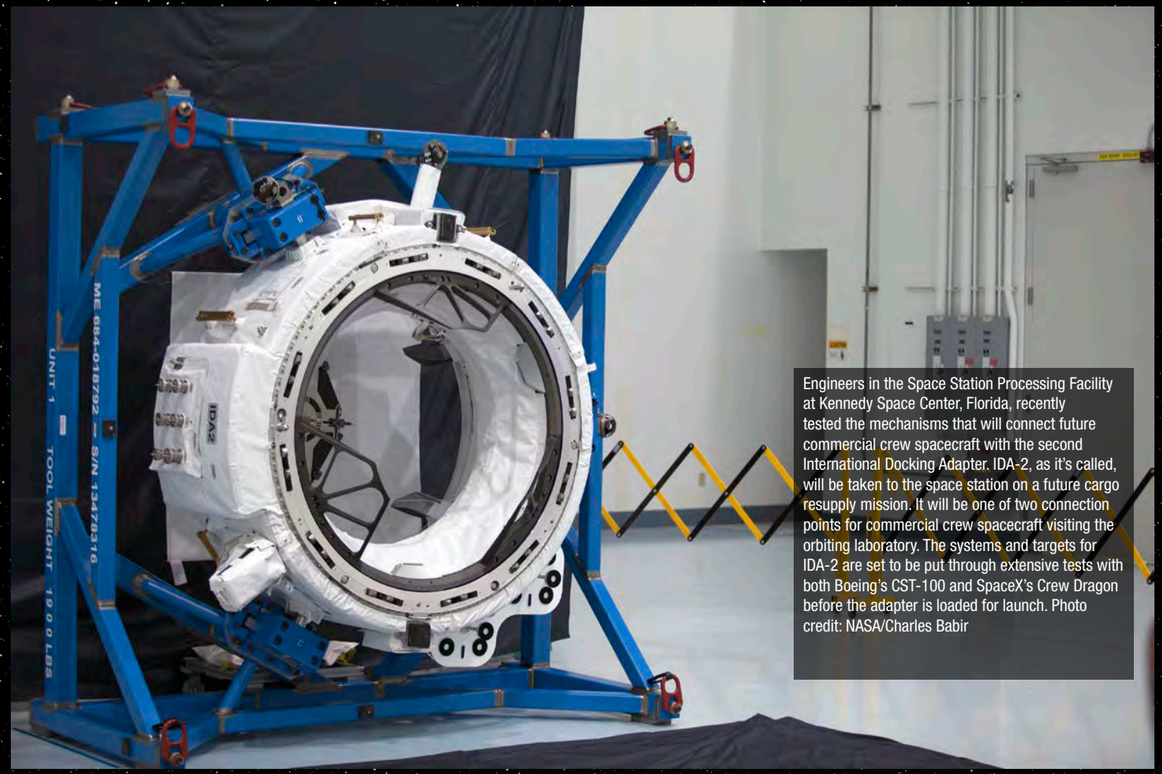
The IDA stands about 42 inches tall and is 63 inches in diameter on the inside. Sensors and other fittings ring the perimeter of the adapter and give it an overall diameter of about 94 inches.

This adapter will be one of two at the station. Another already being assembled at Kennedy will be carried into orbit during a future SpaceX cargo resupply mission and attached to another open port on the station, giving the station two docking areas for the new generation of human-rated spacecraft. Both of the IDAs are identical.

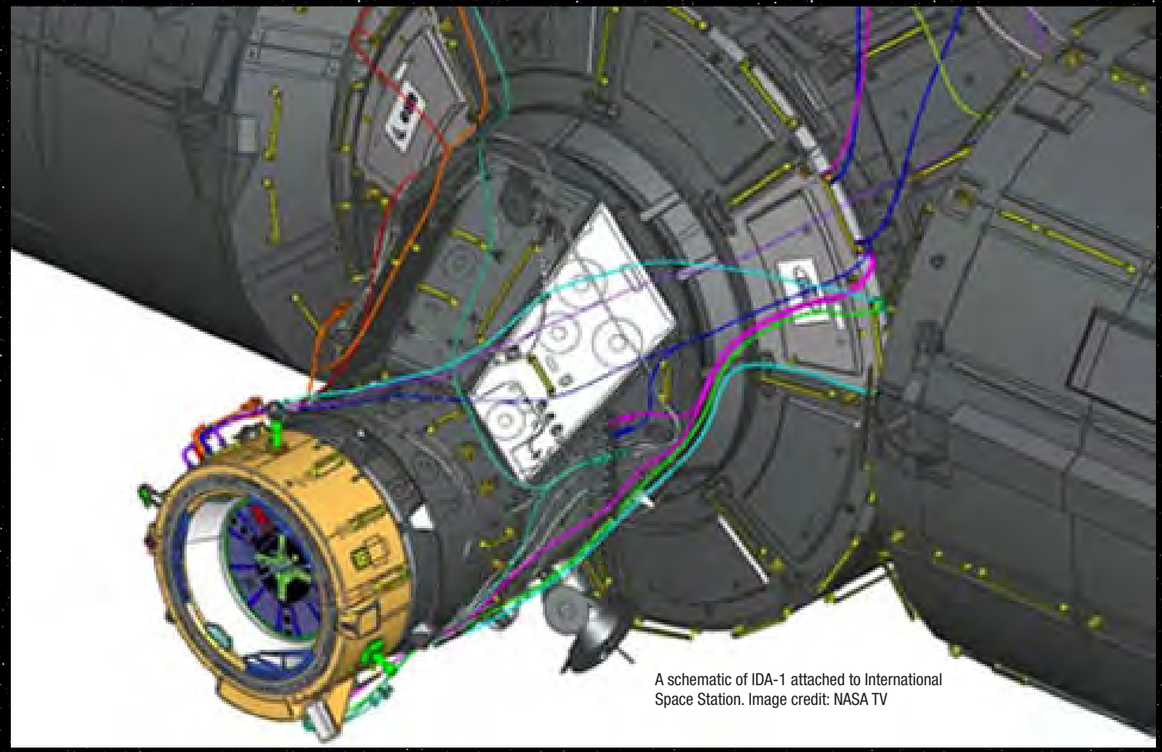
The IDA's first users are expected to be the Boeing Starliner and SpaceX Crew Dragon spacecraft now in development in partnership with NASA, which will return crewed launches to and from low-Earth orbit and the space station from the United States on American-led systems. The two new spacecraft will be the primary means of transportation for NASA astronauts to the space station. Because the adapter is designed to an international standard, future spacecraft will be able to dock there, too.

The companies are competitors in delivering astronauts to the station, but they both play a large role in the IDA project, with Boeing having built the docking port and SpaceX ferrying it into orbit.

Built by Boeing, the IDA is comprised of parts from 25 states in the United States. The primary structure of the adapter was built by Russian company RSC-Energia.



Engineers in the Space Station Processing Facility at Kennedy Space Center, Florida, recently tested the mechanisms that will connect future commercial crew spacecraft with the second International Docking Adapter. IDA-2, as it's called, will be taken to the space station on a future cargo resupply mission. It will be one of two connection points for commercial crew spacecraft visiting the orbiting laboratory. The systems and targets for IDA-2 are set to be put through extensive tests with both Boeing's CST-100 and SpaceX's Crew Dragon before the adapter is loaded for launch. Photo credit: NASA/Charles Babir



A schematic of IDA-1 attached to International Space Station. Image credit: NASA TV

2016 COMMERCIAL CREW ADVANCES

A mockup of Boeing's CST-100 Starliner splashes into a water tank at NASA's Langley Research Center in Virginia during landing system testing. Photo credit: NASA Langley

2016 advances mark Commercial Crew's path to flight

BY STEVEN SICELOFF

Hundreds of engineers and technicians with NASA, Boeing, and SpaceX have ramped up to complete the final designs, manufacturing, and testing as they continue the vital, but meticulous work to prepare to launch astronauts to the International Space Station.

Halfway through the pivotal 2016 year, the companies building the next generation of human-rated spacecraft and launch vehicles are testing systems in more demanding, flight-like environments. Boeing and SpaceX are manufacturing the systems that will return America's human launch capability, while they simultaneously build and modify launch facilities, and complete mission simulators. All while continuing to test and refine their designs, and analyze the results to ensure they are meeting NASA's requirements.

"We knew 2016 would be a critical year as Boeing and SpaceX build qualification and flight hardware, and test the integrated systems to ensure the rockets and spacecraft function as designed," said Kathy Lueders, manager of NASA's Commercial Crew Program. "Their careful design, analysis and early prototype testing during the last several years has put us on the right course, and now we are excited to see flight hardware coming together. The companies are excited, too, but we know there are many steps ahead to successfully and safely complete these flight tests and begin operational missions to the International Space Station."

Boeing is building the CST-100 Starliner spacecraft, which will launch from Space Launch Complex 41 at Cape Canaveral Air Force Station in Florida on United Launch Alliance's Atlas V rockets.

"Our spacecraft design is in firm configuration, teams are conducting about one component qualification test per week and Starliner crew and service modules are coming together in Florida," said John Mulholland, vice president and program manager of Boeing's Commercial Programs. "It's an exciting time to be a part of American human spaceflight and we're looking forward to our first flight in 2017."

SpaceX is independently building its Crew Dragon to launch on the company's Falcon 9 rockets from Launch Pad 39A at Kennedy Space Center.

"There's a lot of work to do, and we're making great progress," said Benjamin Reed, director of Commercial Crew Mission Management at SpaceX. "We're excited to return America's crew carrying capability and are on track to complete a number of important milestones on the path to flying astronauts next year."

The systems that will go into each spacecraft – such as avionics, flight computers, life support, communications and numerous others – are being tested individually and in complex networks to make sure they don't interfere with each other.

A pool at NASA's Langley Research Center in Virginia was the site for simulated contingency water landings for Boeing's Starliner. The testing enabled Boeing and NASA engineers to evaluate the capsule's six perimeter airbags and uprighting capabilities. Starliner missions will normally land on land, so the same Starliner mock up will be dropped at another Langley facility to qualify the vehicle for land landings.

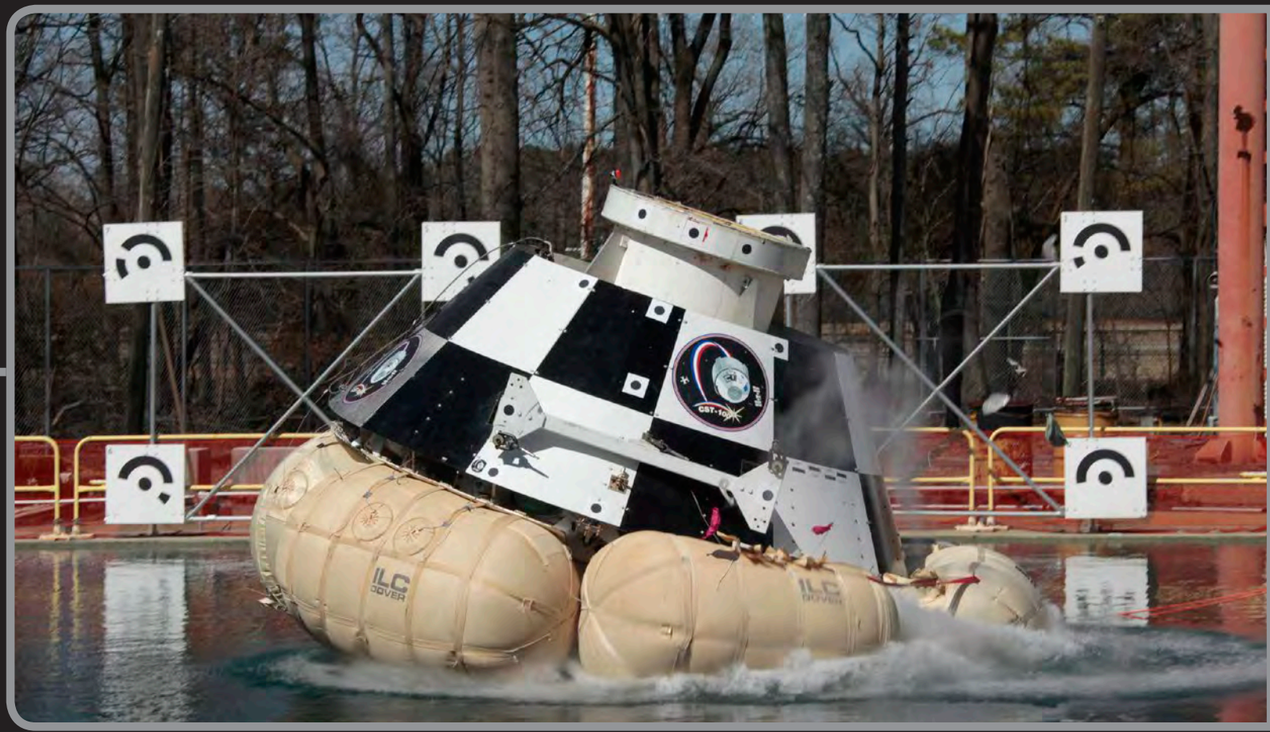
Later this year, Boeing will test parachute components to be used on Starliner flights, in a series of progressively more flight-like drop tests, including high-altitude boilerplate releases from balloons.

SpaceX has begun a campaign of parachute tests in which weight simulators with Crew Dragon parachutes and connectors are dropped from airplanes to determine their deployment behavior. Engineers use the results to feed computer models that can evaluate different deployment conditions and indicate whether the hardware will work as designed in a host of flight conditions, including aborts. The tests will continue throughout this year and next, growing more complex and verifying the safety and reliability of the system.

Boeing's reaction control system thrusters – the small jets that maneuver the spacecraft in orbit – and the launch abort engines that would push a Starliner and its crew out of danger in an emergency also are being prepped for qualification tests before the systems are installed for flights. Simultaneously, a 12-foot-long, 600-plus-pound Starliner/Atlas V wind tunnel model equipped with hundreds of sensors is providing engineers with high-fidelity dynamic and static pressure data the vehicle will experience during ascent.

Once the 2016 work has been completed, NASA and its partners will stand on the verge of conducting the first human-rated spaceflights to launch from American soil in six years. The teams at NASA, Boeing and SpaceX understand that the finish line for development is near, but they are keeping a close eye on every detailed step along the way.

A full-size test article of a SpaceX Crew Dragon fires its eight SuperDraco engines in a development test of its ability to land with the accuracy of a helicopter using only the thrusters. Photo credit: SpaceX



A mockup of Boeing's CST-100 Starliner splashes into a water tank at NASA's Langley Research Center in Virginia during landing system testing. Photo credit: NASA Langley

Commercial Crew manufacturing gains momentum coast to coast

BY STEVEN SICELOFF

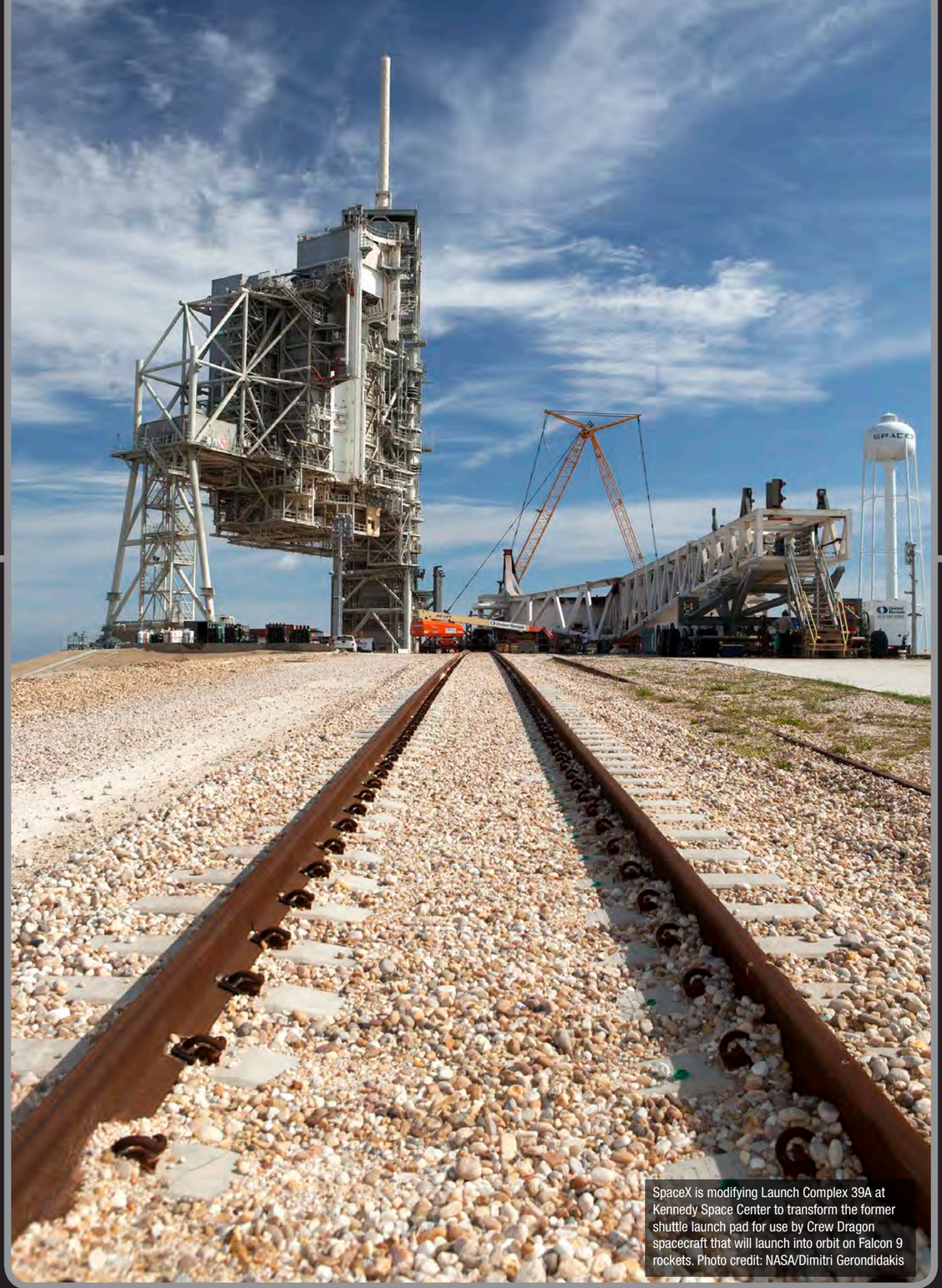
Manufacturing facilities are in operation on the east and west coasts to build the next generation of spacecraft to return human launch capability to American soil. During the past six months, Boeing and SpaceX — the companies partnered with NASA to transport astronauts to and from the International Space Station — each have begun producing the first in a series of spacecraft.

Rather than building one Boeing CST-100 Starliner or SpaceX Crew Dragon at a time, each company set out to produce several spacecraft in an assembly-line fashion while maintaining the careful attention to detail and inspections required of any spacecraft, particularly those that will carry astronauts into orbit.

NASA's Commercial Crew Program partners are building and testing components across the United States as prototype spacecraft and flight test vehicles are carefully assembled. Subsystems for the operational missions are coming together, as spacecraft and rocket assembly lines gear up for production.

In Florida, where Boeing is constructing Starliners, engineers have assembled the crew module of the Structural Test Article that will be shipped to Huntington Beach, California, where it will join the previously delivered service module for extensive testing under a host of exhaustive conditions. The two main elements of the first flight-like Starliner — the upper and lower pressure domes — inside the Commercial Crew and Cargo Processing Facility at Kennedy Space Center are undergoing early check outs and assembly before they are joined together for environmental qualification tests and the pad abort test.

Boeing and United Launch Alliance constructed a Crew Access Tower at Space Launch Complex 41 to give astronauts access to the Starliner spacecraft as it stands atop an Atlas V rocket for liftoff. Photo credit: NASA/Charles Baker



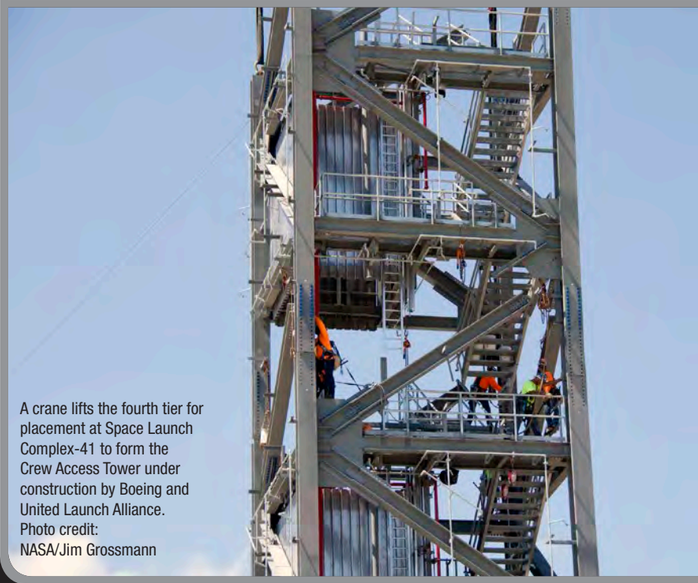
SpaceX is modifying Launch Complex 39A at Kennedy Space Center to transform the former shuttle launch pad for use by Crew Dragon spacecraft that will launch into orbit on Falcon 9 rockets. Photo credit: NASA/Dimitri Gerondidakis

SpaceX is welding the pressure vessels for four Crew Dragons, two test articles and two flight vehicles in the company's Hawthorne, California, factory. The next six months are expected to see each of the pressure vessels built up to different stages for structural and subsystem testing followed by uncrewed and crew flight tests known as Demo 1 and Demo 2 for "Demonstration Mission."

The launch facilities for both companies are deep into their modifications and construction. The Crew Access Tower on Space Launch Complex 41, at Cape Canaveral Air Force Station in Florida, is in place and the Crew Access Arm astronauts will use to cross from the tower to the Starliner hatch will be transported to the pad for placement on the tower this summer. Additionally, about 25,000 lines of software code have been written for the rocket and launch site to communicate with all the new crew-specific hardware. All the work has been completed while still allowing launches of the United Launch Alliance Atlas V from the launch pad.

At historic Launch Pad 39A at Kennedy, where Apollo and space shuttle missions began, SpaceX is taking down the rotating service structure designed to handle shuttle payloads. They've also removed more than 500,000 pounds of steel from the fixed service structure and are building shielding around the tower to protect from the blast of the Falcon 9 and Falcon Heavy rockets. Its Crew Access Arm also is under construction and is slated to be installed on the tower later this year.

Numerous readiness reviews, which assemble engineers from NASA and the respective company, will be held throughout development before the launch sites are used for the first time to launch astronauts.



A crane lifts the fourth tier for placement at Space Launch Complex-41 to form the Crew Access Tower under construction by Boeing and United Launch Alliance. Photo credit: NASA/Jim Grossmann

Commercial Crew astronauts, left to right, Bob Behnken, Suni Williams, Eric Boe, and Doug Hurley stand on the Crew Access Arm leading to the White Room at a construction yard near NASA's Kennedy Space Center in Florida. Photo credit: NASA/Kim Shiflett

Astronauts provide vital feedback for new commercial spacecraft

BY STEVEN SICELOFF

NASA astronauts are working closely with commercial partners Boeing and SpaceX to analyze designs, try out spacecraft simulators and prepare for missions to the International Space Station. Bob Behnken, Eric Boe, Doug Hurley and Suni Williams, the four astronauts selected to train for Commercial Crew Program flight tests, routinely visit both companies' facilities across the country to examine progress up-close and practice all aspects of a mission to the station.

The commercial crew astronauts work side-by-side with Boeing and SpaceX engineers to evaluate their systems and trainers as they each prepare to return launches to the International Space Station from American soil. They have performed fit checks in mock up spacecraft and assessed the spacecraft's display panel and controls among numerous other systems.

Behnken and Boe joined flight director Richard Jones and his NASA/Boeing flight control team June 7 in the first Mission Control Center on-console simulation of a Starliner launch, climb to orbit and post-orbital insertion timeline. The ascent simulation included a training team inserting problems remotely from a nearby building, which allowed the control team to follow checklists and procedures to solve issues that could arise during a dynamic, real-flight situation.

Other astronauts not assigned to train for Commercial Crew flight tests also work with the teams of engineers on everything from simulators and spacesuits to component designs. With two new spacecraft in development, there are plenty of evaluations served by astronauts' expertise. Anne McClain, for example, joined a team of astronauts and engineers to practice exiting the SpaceX Crew Dragon mock up through the top hatch as well as using the side hatch. The work is common in assessing spacecraft design.

Boeing completed a set of trainers in late April that will be a cornerstone of astronaut and crew training throughout the CST-100 Starliner's life. Paired with instructor stations, the trainers are complex simulators outfitted with controls like those on real Starliners and designed to perform for the astronauts just as the spacecraft will in flight. The trainers will be housed in Building 5 at NASA's Johnson Space Center in Houston. The company also is constructing a full-size mission simulator identical to a Starliner flight deck. It also will be fully integrated with NASA's Mission Control Center simulators at Johnson, Boeing's Space Training, Analysis, and Review Facility in Houston, also known as STAR, and International Space Station simulator to allow full mission practices for the astronauts, as well as launch and mission instructors and flight controllers.

SpaceX expects its spacesuit design to go through

qualification testing this year and be ready for use in 2017. Just as with the spacecraft, the numerous components for the suits will be tested separately and then as a complete unit to make sure they will work as needed during a mission, potentially saving an astronaut in an unlikely emergency scenario.

Although launch systems and orbital operations get a substantial amount of review and oversight, the landing phases of the missions and abort scenarios also undergo intense scrutiny.

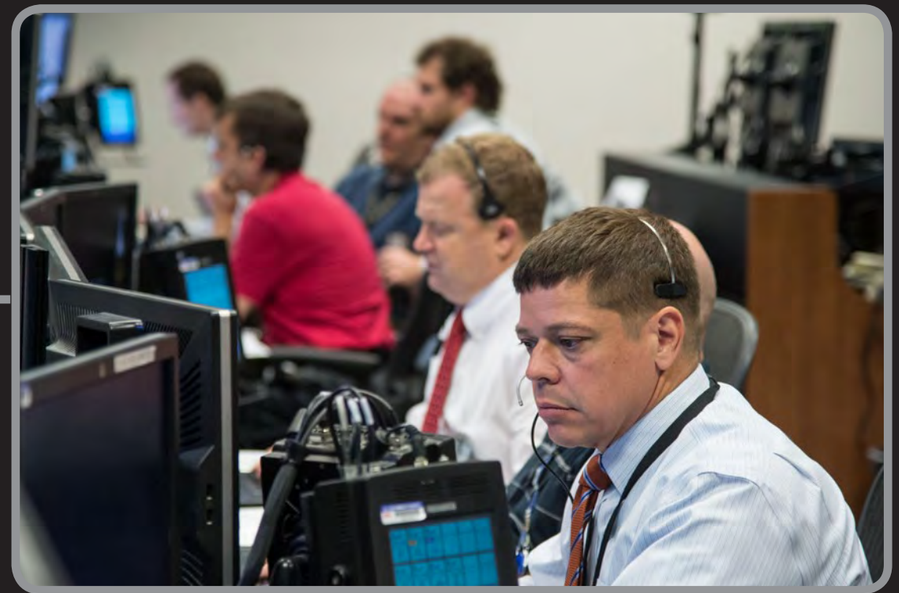
While the development work focuses on the spacecraft, rockets, and ground systems, there also are important steps being taken in space where astronauts continue to live and work daily on the space station. The space station advances scientific knowledge in Earth, space, physical and biological sciences for the benefits of people living on our home planet. These new spacecraft will be able to carry up to four astronauts to the station, bringing the crew size to seven. This will allow the crew to double the amount of time they have to conduct microgravity research.

Working outside the station during spacewalks, astronauts have routed more than 800 feet of cable along the station complex to provide power and data to the commercial crew spacecraft when they are docked at the orbiting laboratory. Next month, a cargo resupply mission is scheduled to deliver an International Docking Adapter, built by Boeing and launched by SpaceX, to the space station where it will be connected to a port so both Starliners or Crew Dragons can dock with the orbiting laboratory. The connection of the docking adapter will require at least one more spacewalk this summer. A second adapter will be delivered and connected to the station on a future SpaceX cargo resupply mission.

The station crew also activated one of the two radios they will use to talk to the astronauts inside the Commercial Crew spacecraft as they near the orbiting laboratory. The communications will be vital to tracking the progress of rendezvous and docking operations along with the flight of the two spacecraft when they are near each other.

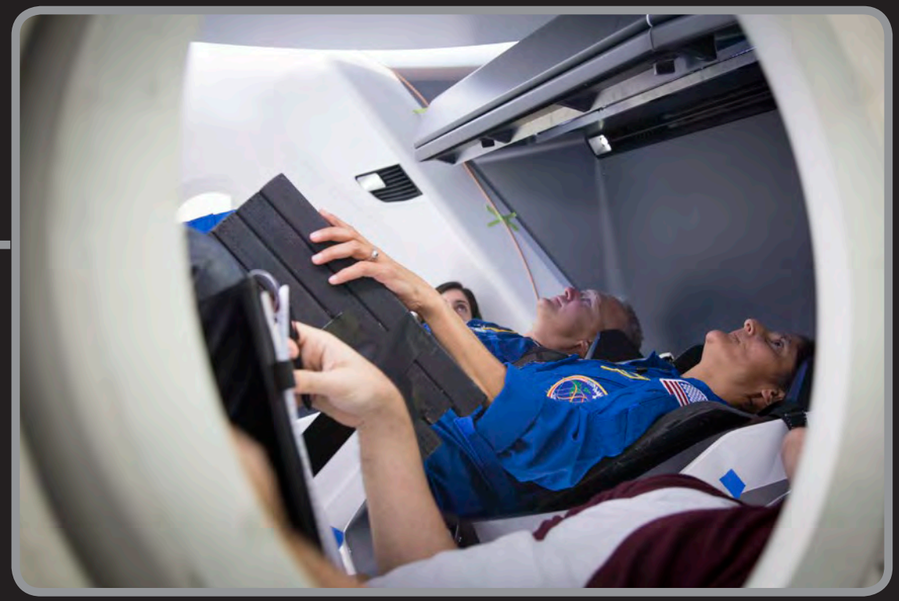
The astronauts who fly into orbit aboard commercial crew spacecraft will do so in the seats of the most automated ships built for crew thus far. But even with those expectations, the teams of engineers and potential crew members are working hard to operate the systems efficiently and be able to take over effectively if manual control is needed.

Astronaut Suni Williams evaluates Starliner control systems using a part-task trainer that simulates aspects of flight for the Boeing-made spacecraft. Photo credit: NASA/Dimitri Gerondidakis



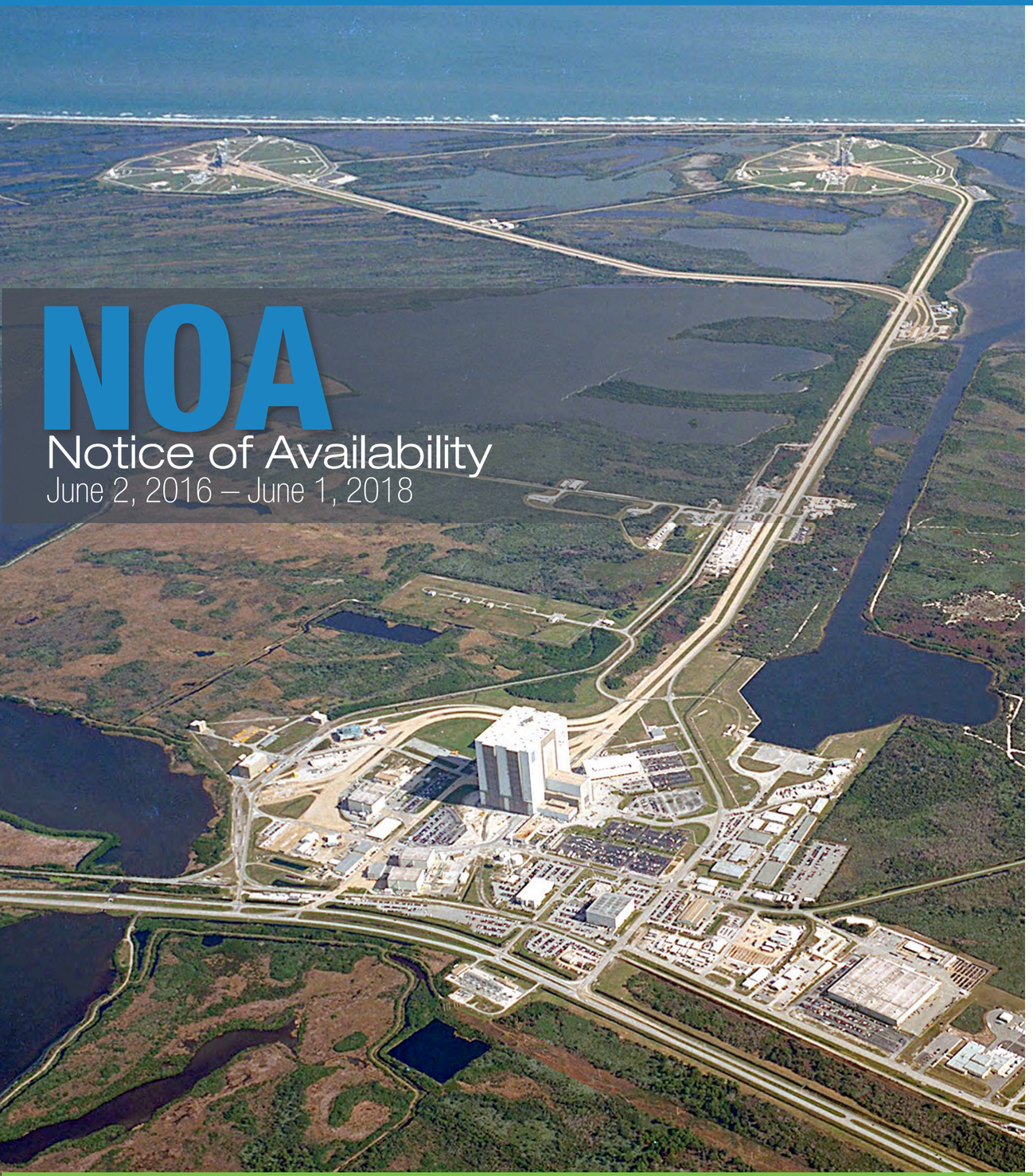
Astronauts Bob Behnken and Eric Boe work with Mission Control teams in a simulation of mission operations for a Starliner flight. Photo credit: NASA

Astronauts Anne McClain practices egress procedures for the SpaceX Crew Dragon in a mockup of the spacecraft at the company's Hawthorne, California, headquarters. Photo credit: SpaceX



Astronauts Suni Williams and Doug Hurley evaluate the flight deck of a SpaceX Crew Dragon in a spacecraft mockup at the company's Hawthorne, California, headquarters. Photo credit: SpaceX

To watch a short video on Commercial Crew's progress in 2016, go to http://go.nasa.gov/268czKM



Kennedy Space Center makes land available for potential commercial partnerships

Kennedy Space Center released a notice of availability for undeveloped land to potentially support activities in launch operations and support, assembly, testing and processing of space systems, renewable energy, research and development, and vertical launch and landing. The announcement is part of Kennedy's transformation to a multi-user spaceport based on effectively utilizing land assets identified in the center's 20-year Master Plan.

"We look forward to new commercial partnerships as KSC supports emerging space markets. Making this land available is yet another step in our evolution as a diverse spaceport that supports NASA and the commercial space industry," said Scott Colloredo, director of Kennedy's Center Planning and Development.

The center has transformed from a government-focused launch base to a multi-user spaceport that can accommodate different vehicles, systems and commercial launch providers. Kennedy features a host of launch and processing facilities, a one-of-a-kind runway and laboratories suited to multiple requirements. The center is well-equipped to support the full spectrum of needs for space launch service companies.

Kennedy Space Center
Center Planning and Development

Visit us on the web or contact us via email:

Kennedy's Master Plan is available at:
http://masterplan.ksc.nasa.gov

To view the official announcement and additional details, go to:
http://go.nasa.gov/1XuxYLw

Contact us at:
http://kscpartnerships.ksc.nasa.gov

National Aeronautics and Space Administration

Ed Stanton
Systems Engineer for Orion Production Operations
Ground Systems Development & Operations Program

www.nasa.gov
SP-2016-05-147-KSC

KENNEDY SPACE CENTER
Exploration Begins Here

Ed Stanton

Systems Engineer, Orion Production Operations Group
Supporting the Ground Systems Development and Operations Program

My name is Ed Stanton, and I am a systems engineer in the Orion Production Operations group at Kennedy Space Center.

The Orion Production Operations group is within the Ground Systems Development and Operations Program and also is part of the Orion Program. We are responsible for helping Lockheed Martin build the spacecraft.

I've worked at Kennedy for almost 11 years, since July 2005. I started working in the ISS Payload Processing Directorate, focusing on Node 2, and then moved over to the Orion Production Operations group, and I've been there since 2007.

The coolest part of this job is being able to walk out into the Operations and Checkout Building high bay and watch the Orion spacecraft come together. Basically, it arrived as an empty shell, and then all the wires, cables and tubes, all the structures and thermal panels are added. It's an amazing feat. It's like a puzzle. All the pieces have to go on in a specific order. I was able to see that, with the Orion capsule for Exploration Flight Test-1 (EFT-1), and now I'm working on Exploration Mission 1.

My proudest achievement, to date, is seeing the launch of EFT-1 happen and watching the successful mission unfold. It was a great feeling to have been a part of the team that helped make that mission happen.

I always wanted to work at Kennedy. Even though I worked at other NASA locations, including Johnson Space Center in Houston, Ames Research Center in Moffett Field, California, and NASA Headquarters in Washington, D.C., I always wanted to work at Kennedy because this is the place where everything gets launched from. All the action happens here. I really wanted more of a hands-on role that Kennedy had to offer. So, going into the space station payloads office was a great opportunity. And then, obviously working on Orion, actually building a spacecraft that will go around the moon, to an asteroid and eventually Mars, has been a fantastic opportunity. This is what I've always wanted to do.

I first became interested in space when I was about 5 or 6 years old. A couple of things happened around that time. The Apollo program had just ended, but I was just old enough to understand that. Then Star Trek was on television all the time. That got me keyed into space. And then a trip to Florida and a visit to the space center also sparked my interest during the 1970s and 1980s.

My hometown is Madison, Connecticut. I moved to Florida in July 2005. I've been here ever since.

I graduated from the University of Southern California in 1990 with a Bachelor of Science in aerospace. I graduated from the University of Houston in 1994 with a master's in mechanical engineering. I also earned a second master's degree, in aerospace engineering, from the University of Southern California in 2002.

The advice I would give to students who are interested in becoming an engineer is to study math and science. That's critical. Once they get to college, graduate with an engineering degree and then they can do anything with that degree. Study hard on math and sciences and continue that all the way through.

My big hope for NASA's exploration missions is to get a mission to Mars and have humans on the surface of the Red Planet, then ultimately, a colony on Mars would be an absolutely amazing feat.

NEW HEIGHTS

Platforms will provide access to world's most powerful rocket

NASA's Space Launch System (SLS) rocket will be the most powerful rocket in the world. The rocket will launch an uncrewed Orion spacecraft on Exploration Mission 1 (EM-1) from Launch Pad 39B at Kennedy Space Center. SLS will be capable of launching crewed missions to deep-space destinations, including the journey to Mars.

The massive SLS rocket and its twin solid rocket boosters will require a large high bay from which to process and prepare them for launch. The Ground Systems Development and Operations Program is upgrading and modifying the iconic Vehicle Assembly Building (VAB) High Bay 3 at Kennedy to stack, process and test the rocket and Orion spacecraft atop the new mobile launcher.

New work platforms are currently being installed in High Bay 3, Towers E and F, to accommodate the rocket. A total of 10 levels of work platforms, 20 platform halves altogether, will surround the SLS and Orion spacecraft and provide access for testing and processing before they are transported to the launch pad.

Each of the giant steel platforms measures about 38 feet long and close to 62 feet wide. Each weighs between 300,000 and 325,000 pounds. The platforms are attached to rail beams which provide structural support and contain the drive mechanisms to retract and extend them. Each platform will ride on four Hillman roller systems on each side — much like how a kitchen drawer glides in and out. A mechanical articulated tray also moves in and out with each platform.

Platform A will provide access to the Orion spacecraft's Launch Abort System (LAS) for Orion Lifting Sling removal and installation of the closeout panels. LAS Antenna Testing (Antenna Hat installation for testing) is also performed on this level.

Platform B will provide access to the Orion Service Module Umbilical for mate. Platform B also has emergency egress stairs from the Crew Access Arm White Room

Platform C will provide access to the Multi-Purpose Crew Vehicle Stage Adapter and the Interim Cryogenic Propulsion Stage (ICPS) for mate activities. ICPS mate to the Launch Vehicle Stage Adapter (LVSA) operations occur on Platform C. ICPS Umbilical (ICPSU) mate operations also are performed on this level. LVSA upper access doors are located on Platform C for entry to the top of ICPS.

Platform D will provide access to the LVSA lower access doors for entry to the ICPS to perform flight battery and computer installation on the ICPS equipment shelf.

Platform E will provide access to the Core Stage Forward Skirt Umbilical for mating operations. LVSA to Core Stage (CS) mate is performed on an elevated access platform. Entry into the CS Forward Skirt for alignment measurements of critical navigation components is provided.

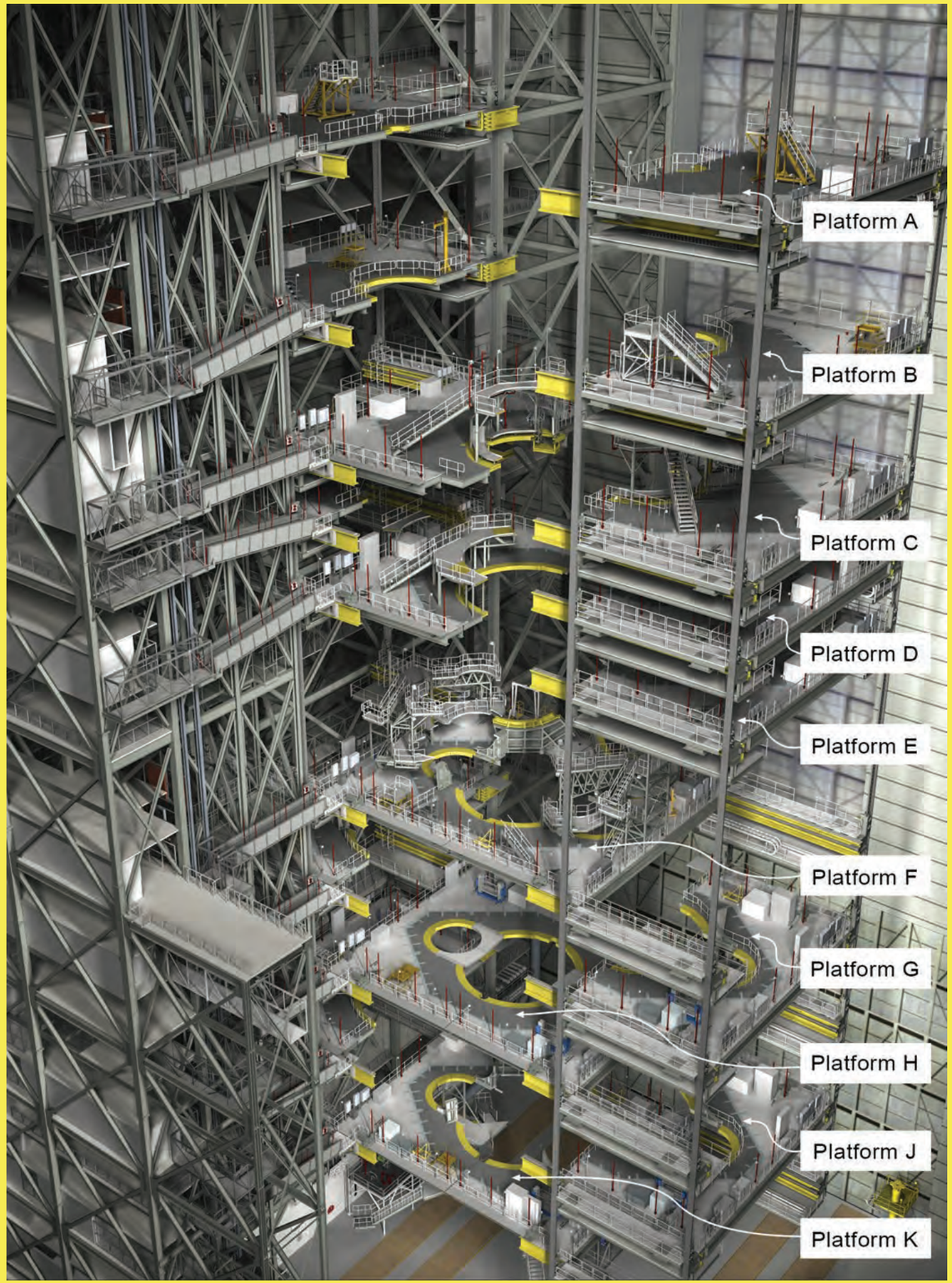
Platform F will provide access for Core Stage Intertank Umbilical (CSITU) for mate operations. Access into the CS Intertank is gained on this level. The "F-1" multi-level ground support equipment access platform is used for access to the booster forward assemblies and the CS to booster forward attach points. The upper level of F-1 is used for lifting sling removal during forward assembly mate for booster stacking.

Platform G will provide access for booster segment stacking operations of the forward segment to the forward/center segment and booster systems tunnel cable routing and closeouts.

Platform H will provide access to the booster segment for mate operations of the forward/center segment to the center/center segment and booster systems tunnel cable routing and closeouts.

Platform J will provide access for booster segment mate operations of the center segment to the aft/center segment and booster systems tunnel cable routing and closeouts.

Platform K will provide access for booster segment stacking operations of the aft center segment to the booster aft assembly and booster systems tunnel cable routing and closeouts. Level K-1 is installed under Platform K for access to the CS to booster aft attach points.



Team Manatee Law pauses for a group photo during the 2016 qualifying tournament. Image courtesy of Riviera Elementary/ Team Manatee Law

NASA's Ground Systems Team Puts Students 'FIRST'

BY ANNA HEINEY

NASA's Ground Systems Development and Operations (GSDO) Program focuses primarily on preparing Kennedy Space Center to support future launches on the journey to Mars. But investing in that future extends beyond facilities and hardware; it also means reaching out to help students gain hands-on experience in robotics.

Funding provided by the GSDO Robotics Grant Program supports teams across Florida's Space Coast. This financial assistance allows new teams to form and helps existing teams cover the costs of registration, equipment, competitions and travel costs when teams could not otherwise afford to move on in the competition season.

The program funds 29 FIRST Lego League teams (ages 9-14), 12 Florida Tech Challenge Teams (grades 7-12) and four FIRST Robotics Competition Teams. FIRST, meaning "For Inspiration and Recognition of Science and Technology," was founded in 1989 to encourage students' interest and participation in these fields.

The program's main objective in offering the grant is to motivate, educate, and inform students of the importance and application of science, technology, engineering, and mathematics. It is also GSDO's goal to inspire students, teachers, and the general public about NASA, the program itself, and how the world benefits from United States space exploration activities.

Team Manatee Law from Riviera Elementary School in Palm Bay, Florida, is exactly the sort of team GSDO sought to help when it created the grant program in 2014.

Manatee Law struggled to continue as their Title 1 school funding couldn't afford them a new robotics kit and ultimately the team robot died during a competition and was irreparable.

The next year, Coach Lynette Rivera was granted a GSDO Rookie Team Grant to fund purchase of a brand new EV3 Robotics kit, a field setup and a laptop to allow the team to program their robot.

Students on the Manatee Law team show off the 2015-2016 Central Florida Regional FIRST LEGO League Championship Tournament Judges Award. Image courtesy of Riviera Elementary/Team Manatee Law

"What they did with that funding was nothing short of phenomenal," said Jennifer Levitt, GSDO grant program coordinator.

A trio of Riviera Elementary students brought the FIRST Core Values to life, Levitt explained. The new team competed locally and made it to the central Florida Regional FIRST LEGO League Championship Tournament, where it received the Judge's Award.

Manatee Law didn't stop there. The team worked throughout the robotics season to reach out to the community, banding together to participate in the local Cancer Walk, maintained the LEGO/Earth Day Garden for their school, and collected more than 5,000 pop-can tabs to support a local family's stay at the Ronald McDonald House while their infant was in the hospital receiving treatment for a heart defect.

At the GSDO Robotics Grant Appreciation Banquet in March, Manatee Law team member Sebastian Macias presented Levitt with an appreciation plaque and team T-shirt.

"This team inspires me to ensure that we keep our GSDO Robotics Grant Program alive," Levitt said.

"Manatee Law embodies the core values of FIRST. They apply STEM and imagination to solve real-world problems, they conduct themselves as gracious competitors and they realize the impact they can have in helping their community.

"They represent why this program means so much to me."

Rivera shared similar sentiments. She cited the support of the team's school principal, assistant coach, sponsors, family members and mentors in helping Manatee Law succeed, adding, "Without GSDO's and Jennifer's gracious professionalism, support and grant, we wouldn't have been able to get our EV3 Robot and compete."

"When you have faith, good team work, fun, and GSDO as a sponsor, anything can happen," Rivera said.

KENNEDY SPACE CENTER VIGIL FOR ORLANDO

Vigil for Orlando offers solace, hope to Kennedy team

BY ANNA HEINEY

For a community accustomed to dealing with astronomical distances, the June 12 shooting at Pulse nightclub in Orlando struck terribly close to home.

Kennedy Space Center employees gathered for a vigil June 21 to remember the 49 victims who lost their lives in the Orlando tragedy. The spaceport is located less than an hour east of Orlando; many workers live in the area. Some lost friends in the tragedy, noted Kennedy's director, Bob Cabana.

"What happened in Orlando a week ago last Sunday was horrific and unimaginable to those who were there for an evening of fun with friends," Cabana said. "It has impacted our entire community."

Many had tears in their eyes as they listened to the songs of a 10-member ensemble from the Orlando Gay Chorus. They wore rainbow ribbons or bracelets bearing the message #OrlandoUnited.

Photos of the victims and of vigils held around the world flashed by on the screen overhead as the chorus performed a cappella covers of Cyndi Lauper's "True Colors" and "You'll Never Walk Alone" from the 1945 musical Carousel.

"You know, this tragedy hit very close to home," said Nancy Bray, who leads Kennedy's Spaceport Integration and Services Directorate and also serves as the executive champion of the LGBT Employees and Allies Network. "We do have employees who were touched very deeply by this."

Kennedy's Employee Resource Group Team and Employee Assistance Program organized the event in order to offer a safe space to share grief, but also hope and encouragement.

Rev. Kathy Schmitz, minister of First Unitarian Church of Orlando, praised the Central Florida community for pulling together in the spirit of love and support and demonstrating a compassionate response.

"[The shooting] was a recipe for division: a gay bar, a Latin-themed night, a shooter claiming ties to radical Islam," Schmitz said. "It could have torn us apart — but it did not. We have refused to be divided by sexual orientation, race or ethnicity. We have claimed our common humanity. This week, we are all Orlando, and we are united."

She cautioned against giving in to anger, instead inviting listeners to seek a deeper understanding of what led to such a tragic event.

"We yearn for justice, but we often settle for having someone to blame," Rev. Schmitz said. "But I am compelled to try to understand him as a broken and wounded part of who we are."

It's important to respect our own needs as we tend our own wounds and process information, she added.

"As time goes on, let us reach out for more and deeper understanding; let us find our common ground while at the same time celebrating the beauty and wonder of our diversity."

Maritza Sans of Orlando-based Latino Leadership Inc. echoed that sentiment, pointing out that by supporting one another through the tragedy, the community is creating an opportunity to safely talk about the differences between us and find more common ground.

"Sometimes sad moments bring out the best," Sans said. "I know the Central Florida community will make a difference. It's hard, but it's going to open the door for conversation."

"Goodness and love will always conquer over evil and hate," Cabana said. "That is truly evident in the outpouring of love and support for the victims, their families and their friends."

Members of the Orlando Gay Chorus perform a rendition of Cyndi Lauper's "True Colors" during a slideshow featuring vigils held around the world in the wake of the June 12 shooting at Orlando's Pulse nightclub. Photo credit: NASA/ Cory Huston

"It could have torn us apart — but it did not. We have refused to be divided by sexual orientation, race or ethnicity. We have claimed our common humanity. This week, we are all Orlando, and we are united."

Rev. Kathy Schmitz
Minister of First Unitarian Church of Orlando

“Goodness and love will always conquer over evil and hate. That is truly evident in the outpouring of love and support for the victims, their families and their friends.”

Bob Cabana
Kennedy Space Center Director

The 49 victims of the June 12 shooting in Orlando were remembered during the vigil at Kennedy Space Center. Photo credit: NASA/ Cory Huston

CIVIL RIGHT

NASA helped kick-start diversity in employment opportunities

BY BOB GRANATH

NASA mathematician Katherine Johnson, seen in a 1966 photo, was known for verifying the calculations made by electronic computers for John Glenn's 1962 orbital spaceflight and the Apollo 11 trajectory to the moon in 1969. Photo credits: NASA

Katherine Johnson was awarded the Presidential Medal of Freedom, the nation's highest civilian honor, by President Barack Obama on Nov. 24, 2015. Photo credits: NASA/Bill Ingalls

For many Americans, 1961 began with a sense of anticipation. John F. Kennedy was sworn in as the new president, promising to reach for a "New Frontier." Part of that growing excitement focused on the nation's space agency which was on the verge of launching the first astronauts into space.

As background to the era, attention abroad concentrated on the Cold War with the Soviet Union. But closer to home, there was increasing unrest among those who were being left behind simply because of their race.

NASA soon would be thrust into the forefront of both issues.

On May 4, 1961, the first group of Freedom Riders, left Washington, D.C., for New Orleans. These civil rights activists traveled on interstate buses into the segregated areas of the nation, following years of non-enforcement of Supreme Court decisions which ruled segregated public transportation was unconstitutional.

News of the Freedom Riders protest soon was eclipsed. The next day at Cape Canaveral Air Force Station, NASA astronaut Alan Shepard was strapped into a Mercury spacecraft atop a Redstone rocket and propelled 116 miles into space.

Thousands of individuals with NASA, the military and industry made the historic achievement possible. While most of those involved were white males, the hiring landscape was quickly changing at the nation's space agency.

Many of those following NASA knew the seven Mercury astronauts were based at the agency's Langley Research Center in Hampton, Virginia. Among the African-Americans working there was a mostly unseen group of black women putting their extraordinary mathematical skills to work.

The group included Dorothy Vaughan who worked in the Langley Analysis and Computation Division. Mary Jackson was a specialist in analyzing information from wind tunnel experiments and aircraft data on flight tests. In the Guidance and Navigation Department, Katherine Johnson calculated the trajectory for Shepard's spaceflight.

The story of the trio's work in a white, male-dominated program soon will be featured in the upcoming motion picture "Hidden Figures," based on a book of the same name by Margot Lee Shetterly. The film is due in theaters in January 2017.

Now 97, Johnson explains that at the time women mathematicians at Langley were called "computers."

"The early (Project Mercury) trajectory was a parabola, and it was easy to predict where it would be at any point," Johnson said. "When they said they wanted (Shepard's) capsule to come down at a certain place, they were trying to compute when it should start. I said, 'Let me do it. You tell me when you want it and where you want it to land, and I'll do it backwards and tell you when to take off.'"

By the time NASA was preparing for the first Mercury orbital flight on Feb. 20, 1962, the agency was using electronic computers. However, astronaut John Glenn had so much faith in Johnson's calculations, he insisted that she confirm the math produced by the new systems.

Vaughan, Jackson and Johnson were not the first African-Americans in America's missile development and space exploration efforts.

When Julius Montgomery began work at Cape Canaveral as an electronics technician in 1956, he was the first black to serve there in a role other than janitor.

After earning a bachelor's degree at Tuskegee Institute in Alabama, Montgomery served in the U.S. Air Force. During his time in the military, he earned a first class radio-telescope operator's license. Looking for an opportunity to use his technical background, he applied for and was hired to work in the Cape's RCA Development Lab.

During Montgomery's first day on the job, most of his all-white co-workers refused to shake his hand or even speak to him.

He persevered, working primarily among those known as "range rats." Their efforts involved radar, telemetry, tracking and repairs for classified military missiles.

Montgomery later made history when he decided to add to his educational background. He was the first African-American to desegregate and graduate from Brevard Engineering College, now the Florida Institute of Technology in Melbourne, Florida.

While blacks were beginning to find jobs in the space business, advancement was another hurdle.

Frank Crossley was the first African-American to earn a doctorate in metallurgical engineering. When he approached his superiors at Lockheed Missiles and Space Company seeking equal status with his peers, he was told, "You are qualified to be a senior member, but because you are so advanced for a Negro, we thought you were content."

Crossley too persisted becoming a pioneer in the field of titanium metallurgy receiving seven patents, including five in titanium base alloys used in the aerospace industry.

Three weeks after Shepard's successful Mercury flight, Kennedy asked Congress to approve a massive effort to land a man on the moon by the end of the 1960s. While the nation rallied around the space program, racial unrest spread throughout the country as many

were not content and the civil rights movement intensified.

During a June 11, 1963, speech to the nation, Kennedy called for Congress to enact legislation "giving all Americans the right to be served in facilities which are open to the public," as well as "greater protection for the right to vote."

Speaking at the 15th annual African-American History Month celebration on Feb. 21, 2014, the Florida spaceport's deputy director, Janet Petro, noted that President Kennedy and Vice President Lyndon B. Johnson took steps to create more inclusive job opportunities as part of the buildup for the Apollo lunar landing program.

"In an unprecedented move, knowing that NASA was planning to hire approximately 200,000 people in Southern states," she said, "recruiters were asked to travel around the country trying to persuade African-American scientists and engineers to work in the space program."

NASA was encouraging African-Americans to come to work at facilities such as the Launch Operations Center (now Kennedy Space Center) in Florida, Marshall Space Flight Center in Alabama, Mississippi Test Facility (now Stennis Space Center) in Mississippi, the Michoud Assembly Facility in Louisiana and Manned Spacecraft Center (now Johnson Space Center) in Texas.

In 1964, Marshall began a Cooperative Education Program, recruiting at historically black colleges. NASA hired Charlie Smoot, who was one of those black engineers seeking to come south. As "co-ops," students alternate semesters at school with semesters at agency centers. Students worked in paid positions directly related to their fields of study.

Smoot was successful in finding seven students to become the first African-American co-op engineers working for NASA.

But the challenge was locating a place for them to live. Segregated apartments and hotels were not available to blacks. Smoot found families in Huntsville's African-American community to provide homes for the young engineers.

In a 1964 address on civil rights to contractors who were members of the Association of Huntsville Area Companies, Dr. Wernher von Braun, director of NASA's Marshall Space Flight Center, spoke out against discrimination. He was particularly critical of laws such as poll taxes, which discouraged or prevented many African-Americans from voting. He compared these restrictions to the barrier that divided West Berlin from Communist East Berlin from 1961 to 1989.

"All these regulatory barriers form a 'Berlin Wall' around the ballot box," he said. "I am not going to sit quietly on a major issue like segregation."

According to Fred Schultz of General Electric's Space Division, von Braun's remarks gave association members "the backing they needed to launch further successful drives for equal employment opportunities."

President Johnson also continued to press for landmark legislation that outlawed discrimination. He signed the Civil Rights Act on July 2, 1964, the same day it was passed by Congress.

"It's really important that we take time to commemorate the 50th anniversary of the Civil Rights Act," said Kennedy's director, Bob Cabana, in July 2014. "It all started with President Kennedy in 1963, and after his assassination, it was President Johnson that actually brought it into law."

While efforts in the mid-1960s was a start, Cabana noted that, initially, progress was slow.

"I look back at the Apollo Program and there were something like seven black employees working at the Kennedy Space Center," he said. "It was an unbelievably small number. While we're doing a lot better, we can always provide improved opportunities for minority employment."

U.S. Air Force Lt. Col. Robert Lawrence was America's first African-American astronaut. Selected in 1967 for the Manned Orbiting Laboratory, he was killed later that year in an F-104 crash during a training exercise at Edwards Air Force Base, California. Photo credit: U.S. Air Force

One of the steps to include minorities in the most visible area of space exploration was selection of those who would travel there.

America's first black astronaut was U.S. Air Force pilot Robert Lawrence, who was selected in 1967 to fly aboard the Manned Orbiting Laboratory. The military program, which was cancelled in 1969, involved a small, single-use space station in which crews would launch and land in an advanced Gemini spacecraft. Unfortunately, six months after his selection, Lawrence was killed in a training accident.

Following Apollo, Skylab and the Apollo-Soyuz Test Project, NASA began gearing up for the Space Shuttle Program and, in 1978, announced the selection of 35 of the most diverse group of astronauts to date. In addition to a mix of pilots and mission specialists, the

NASA astronaut Guy Bluford, the first African-American in space, uses a treadmill exercising device for a medical test during the STS-8 space shuttle mission in 1983. Photo credit: NASA

group included the first women and minorities.

From this group, Guy Bluford would go on to become the first African-American to fly in space in 1983 as a member of the STS-8 crew. When STS-33 launched in 1989, Fred Gregory became the first African-American to command a spaceflight. Ellison Onizuka was the first Asian-American astronaut. Sally Ride became the first American woman in space and Kathy Sullivan the first American woman to walk in space.

Two years later, the next class of astronauts included Charlie Bolden who would not only command two shuttle missions, but also go on to hold the agency's top position as NASA administrator.

While astronauts may be the most visible part of NASA, by the 1980s, one in ten of the Kennedy Space Center's civil service workforce was made up of minorities, increasing to 17 percent in the mid-1990s.

This progress was aided by NASA Administrator Dan Goldin and other agency leaders who, in 1993, developed initiatives such as the Science, Engineering, Mathematics and Aerospace Academy. The program was designed for pre-collegiate minority and female students. NASA also established university research center relationships with historically black colleges and universities in 1995.

NASA now offers extensive educational efforts including resources for educators and students at all grade levels, encouraging young people to pursue careers in science, technology, engineering and math, or STEM.

By 2007, minority hiring at Kennedy increased to 23 percent. Today, minorities make up 27.2 percent of slightly more than 2,000 NASA civil service employees at the Florida spaceport.

While the Apollo Program was, in part, a response to competition in space with the Soviet Union, Kennedy and Johnson saw NASA as an additional opening for progress on Earth. It was a chance to kick-start equal employment opportunities for deserving, yet underrepresented, groups, allowing them to contribute to a government program receiving global attention.

"Everybody deserves to be treated equally and with respect," Cabana said. "No one should ever be discriminated against for any reason."

SAGE III instrument to aid in studies of atmospheric ozone

Operations are underway to close out processing of the agency's Stratospheric Aerosol and Gas Experiment III, or SAGE III, instrument in the Space Station Processing Facility at Kennedy Space Center. Since December of 2015, engineers and technicians have prepared the device for its launch to the International Space Station later this year aboard a SpaceX Dragon spacecraft launched atop the company's Falcon 9 rocket. Once at the station, SAGE III will take long-term measurements of ozone, aerosols and other trace gasses to help scientists better understand how to monitor and protect the Earth's atmosphere. This is important because ozone in the atmosphere helps filter out sunlight wavelengths, including those in the ultraviolet, or UV, spectrum. Ozone UV absorption is crucial to life, since it extends the absorption of UV by ordinary oxygen and nitrogen in air. The small unabsorbed part that remains of UV light after it passes through ozone causes sunburns in humans and direct DNA damage in living tissues in both plants and animals. Photo credit: NASA/Charles Babir

PROJECT GEMINI

PART 7

Gemini X command pilot John Young, left, and pilot, Mikel Collins, pause on July 16, 1966, during training at Cape Kennedy (now Cape Canaveral) Air Force Station in Florida. Photo credit: NASA

Gemini X sets records for rendezvous, altitude above Earth

BY BOB GRANATH

In mid-1966, Gemini X continued advancing NASA's capabilities for operating in space with a record-setting, three-day flight. Two astronauts completed rendezvous with two separate targets, retrieved an experiment package from another orbiting object and set a new altitude record for human flight. All were designed as stepping stones in preparation for the Apollo moon landings to follow.

But the spaceflight technology developed at that time continues to play a crucial role today in missions to the International Space Station and planning for the agency's journey to Mars.

Like the two previous Gemini flights, the Gemini X plan included rendezvous and docking with a separately launched Agena spacecraft. Additionally, this mission would be the first to include two spacewalks.

The command pilot for Gemini X was John Young, a veteran of the first mission in America's two-man spacecraft. A naval aviator, he would go on to fly to the moon twice, aboard Apollo 10 in 1969 and Young commanded the Apollo 16 lunar landing in 1972. He later was selected to command the first space shuttle mission in 1981 and the STS-9 flight in 1983.

Pilot for Gemini X was Mike Collins, a U.S. Air Force test pilot. He went on to serve as command module pilot on Apollo 11 in 1969, remaining in lunar orbit as Neil Armstrong and Buzz Aldrin landed on the moon.

The Agena launched atop an Atlas rocket on the afternoon of July 18, 1966. Gemini X followed 101 minutes later, climbing into the blue sky on its Titan II launch vehicle.

George Mueller, Ph.D., NASA's associate administrator for Manned Space Flight, had high praise for the launch teams at Cape Kennedy (now Cape Canaveral) Air Force Station, noting the dual launches were near perfect.

"This is a most auspicious beginning," he said. "It is an excellent demonstration of on-time launch capability. We're pleased with all the ground support crews."

Once in orbit, Young and Collins were 1,116 miles behind the Agena target spacecraft. Rendezvous was achieved a little over five hours after liftoff on the fourth orbit.

"Gemini X, what is your status?" asked fellow astronaut Gordon Cooper, the spacecraft communicator at Mission Control in Houston. "Are you there yet?"

"We're there," Young said as Gemini X passed over Madagascar off the east coast of Africa. "Our range is about 40 feet."

Minutes later, they were given a "go to dock" with the Agena from controllers aboard the tracking ship Coastal Sentry Quebec as they passed between the Philippines and Japan — 5 hours, 59 minutes into the mission.

All was well, except the rendezvous required more of Gemini X's propellant than planned.

"We're reading 36 percent," Young reported just prior to docking.

With fuel needed for other portions of the mission, flight director Glynn Lunney directed the crew to skip a planned practice of undocking and re-docking. The fuel aboard the Agena now would not only aid in maneuvering, it would boost Young and Collins to new heights.

The Agena target docking spacecraft lifts off atop its Atlas rocket from Cape Kennedy's Launch Complex 14 at 3:39 p.m. EST on July 18, 1966. The Agena served as a rendezvous and docking vehicle for the Gemini X spacecraft. Photo credit: NASA

The Gemini Titan X vehicle launches from Cape Kennedy's Launch Complex 19 at 5:20 p.m. EST, July 18, 1966, carrying astronauts John Young and Mike Collins. Liftoff occurred 101 minutes after its Agena target spacecraft. Photo credit: NASA

The Agena primary propulsion system engine roared to life with 15,960 pounds of thrust. For 80 seconds, the target vehicle pushed itself and Gemini upward to a record 475 mile altitude. At the time, it was the highest any humans had traveled.

"When that baby lights, there's no doubt about it," Collins said.

Young later described the Agena engine firing in detail.

"We were thrown forward (against their harnesses) in the seats," he said. "Fire and sparks started coming out of the back end of that rascal. The light was something fierce, and the acceleration was pretty good."

Following a busy day, Young and Collins were ready for the upcoming eight-hour sleep period.

The first task for the second flight day was another firing of their Agena's engine to lower their spacecraft to the 235-mile orbit of the Agena used on Gemini VIII four months earlier.

After undocking from the Gemini X Agena, fellow astronaut Clifton Williams, the spacecraft communicator in Mission Control Houston, gave the crew an update on the distance to their second rendezvous target.

"At the time you separated from the Agena, your VIII Agena was 138 miles away from you," he said.

The crewmen then began preparing for Collins' first spacewalk. His task was to open the hatch and stand on his seat using a 70-mm camera to photograph stars in ultraviolet light. This was important because imaging the stars in the ultraviolet spectrum is only possible outside the Earth's atmosphere. For 49 minutes, he took 22 images of the southern Milky Way.

The first activity of the next day would bring an unprecedented second rendezvous and another spacewalk. As Gemini X closed in on their second target, Young reported to Mission Control.

"I see it dead ahead," he said. "We have the Gemini VIII Agena in sight. We've been watching it for about 5 minutes."

Following a few additional firings of their spacecraft maneuvering thrusters, the Gemini X crew were 10 feet from the Gemini VIII Agena. The rendezvous was completed just 90 minutes prior to the start of the second spacewalk. The fact that the Agena was stable and in good condition was good news. Plans called for Collins to retrieve an experiment package from the side of the now dormant spacecraft.

"The flight contributed significantly to the knowledge of manned spaceflight, especially in the areas of rendezvous, docked maneuvering with large propulsion systems, extravehicular activity (spacewalking), and controlled re-entry."

–NASA's official post-mission report

The Gemini X Agena target docking vehicle is photographed from the spacecraft during rendezvous in space. The two spacecraft are about 38 feet apart. Photo credit: NASA/Mike Collins

He also planned to use a nitrogen-propelled hand-held maneuvering unit (HHMU) to move himself between the Gemini and Agena. It was similar to the "zip gun" used by Ed White on Gemini IV a year earlier. This one was designed to be plugged into the adapter section behind the spacecraft hatch, thus providing more fuel for the HHMU.

As Collins floated free from his Gemini hatch, he reported some of the same frustrations as Gene Cernan on Gemini IX.

"Everything is going well," he said, "but, it's taking a lot more time to do each item than I had anticipated."

Collins plugged in the nitrogen fuel line for the HHMU and prepared to move to Agena VIII. He then moved to the Agena and attempted to grasp the docking cone, however he discovered it was impossible since it was smooth and had nothing to grasp.

"When I translated over to the Agena, I found that the lack of hand holds is a big impediment," Collins said. Young reported to controllers at the Hawaii tracking station that Collins was able to hold some wire bundles on the Agena and was successful in retrieving a micrometeorite collector experiment.

As Collins began a planned activity to further test the HHMU, he noted that while retrieving the micrometeorite experiment and moving to and from the Agena, he inadvertently lost his Hasselblad camera. To date, this is the only spacewalk not captured with photographs.

Young's challenge during the spacewalk was "station keeping" the spacecraft, that is, ensuring Gemini remained properly positioned in close proximity to both the Agena and his spacewalking pilot while not bumping either. All this maneuvering was using propellant. Mission Control noticed that the already low fuel supplies were quickly diminishing.

"We don't want you to use any more fuel (for station keeping)," the Hawaii spacecraft communicator told Young.

"Then, we'd better get Mike back in," Young said.

The 90-minute spacewalk was terminated after only 39 minutes.

About an hour later, Collins' hatch was opened again for about 3 minutes to toss out the 50-foot umbilical and other no longer needed equipment, freeing up space in the already cramped cockpit. The umbilical provided oxygen and communications while keeping Collins connected to the Gemini spacecraft.

On the last day of the mission, retrofire brought Young and Collins down 2 days, 22 minutes after liftoff, splashing down only 3.5 miles away from the targeted landing point. Once again, the Gemini spacecraft was seen descending under its parachute on live television using a satellite antenna on the deck of the recovery ship, the USS Guadalcanal.

"John, you're on television," Mission Control radioed up to the crew.

Guadalcanal control personnel soon reported the same, except they were watching the nearby skies.

"Gemini X, Guadalcanal Control. We have you in sight," onboard controllers said.

Young and Collins were picked up by a recovery helicopter and delivered to the deck of the ship to the cheers from the U.S. Navy crew on the carrier.

The overall performance of the astronauts, mission support teams, the two launch vehicles, Gemini spacecraft and Agena target vehicle all earned high praise following the flight.

Gemini X astronauts John Young, left, and Mike Collins stand on the deck of USS Guadalcanal following splashdown and recovery on July 21, 1966. Shortly thereafter, they would begin post-flight medical and technical debriefings. Photo credit: NASA

"Gemini has fully matured," said Chuck Matthews, NASA's Gemini Program manager, summing up his appraisal of the flight.

"The flight contributed significantly to the knowledge of manned spaceflight," NASA's official post-mission report stated, "especially in the areas of rendezvous, docked maneuvering with large propulsion systems, extravehicular activity (spacewalking), and controlled re-entry."

EDITOR'S NOTE: This is the seventh in a series of feature articles marking the 50th anniversary of Project Gemini. The program was designed as a steppingstone toward landing on the moon. The investment also provided technology now used in NASA's work aboard the International Space Station and planning for the journey to Mars. In September, read about a first orbit rendezvous. For more, see "On the Shoulders of Titans: A History of Project Gemini."

In Memoriam

Gene Thomas
1934 -2016

NASA mourns loss of former Kennedy Deputy Director Gene Thomas

BY BOB GRANATH

James A. (Gene) Thomas, former deputy director at Kennedy Space Center, died June 7. He was 82. Thomas worked in increasingly responsible roles for the space agency from 1962 until his retirement in 1997.

"Gene was a tremendous asset to NASA and Kennedy Space Center," said Kennedy's director, Bob Cabana. "Although I never had the privilege of personally knowing him, he left behind an outstanding legacy of integrity, values, and work ethic. I'm grateful for his service to NASA and our space program."

Born in 1934 in Meridian, Mississippi, Thomas received his bachelor's degree in electrical engineering from Mississippi State University in 1962. He later earned a master's degree in technical management from Florida State University in 1973.

After graduating from Mississippi State, Thomas began his employment with NASA in 1962, and served as lead engineer for prelaunch testing and checkout of communications systems on the Apollo spacecraft.

Following the Apollo lunar landing program, Thomas became the Kennedy engineering team's lead flight project engineer in the Space Shuttle Program, participating in the Approach and Landing Tests, or ALT, in 1977. The ALT program was a series of taxi and flight trials of the prototype shuttle Enterprise conducted at Edwards Air Force Base, California. The tests verified the shuttle's flight characteristics both on its own and when mated to the Boeing 747 shuttle carrier aircraft, or SCA.

Thomas' team was also responsible for the site activation of the orbiter hangar and mate-demate device, or MDD, at NASA's Dryden Flight Research Facility in preparation for preflight servicing and checkout of Enterprise. The MDD was a specialized gantry-like structure and crane used throughout the Space Shuttle Program to lift an orbiter onto and off the back of an SCA.

In November 1977, Thomas was selected as the lead orbiter flight project engineer for the space shuttle Columbia during preparations for the first launch, STS-1, which took place on April 12, 1981.

In June 1983, Thomas became the chief shuttle flight project engineer in NASA's Shuttle Engineering Directorate, with overall responsibility for integration of all testing and checkout of shuttle orbiters, external fuel tanks and solid rocket boosters.

Shortly after becoming director of Kennedy Space Center, U.S. Air Force Lt. Gen. Forrest McCartney, far right, stands in front of the space shuttle Atlantis during a briefing the morning of Oct 9, 1986. Also participating, from the left, are Gene Thomas, director of Launch and Landing Operations, Bill Warren, pad site manager and Bob Sieck, director of Shuttle Management and Operations. Atlantis was moved to Launch Pad 39B for a variety of launch team proficiency exercising and emergency egress simulations. Photo credit NASA

Thomas served as acting director of Shuttle Launch and Landing Operations in September 1985 and was subsequently named director, holding the position of launch director for shuttle missions STS-51J in October 1985 through STS-51L in January 1986.

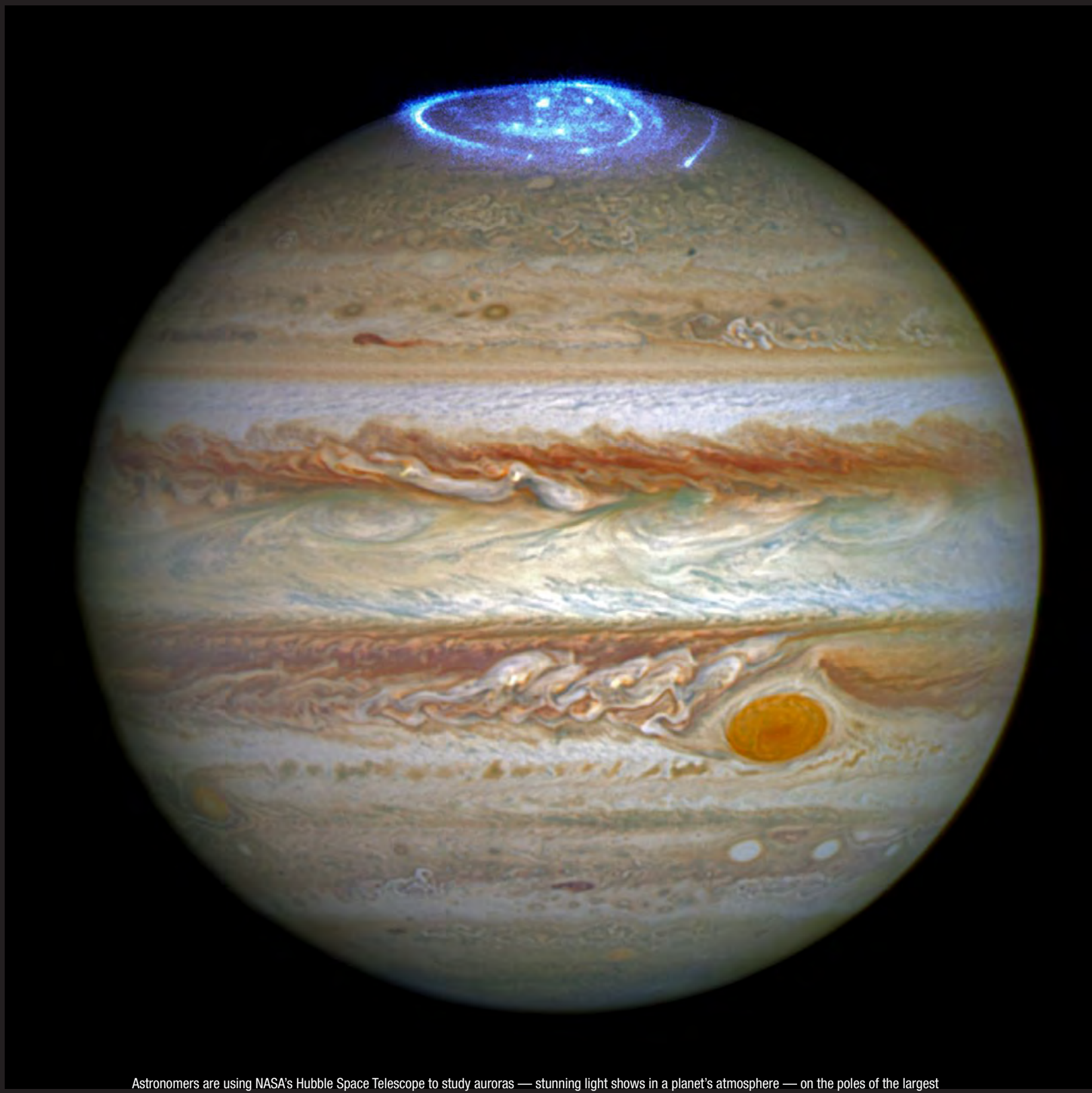
Following the loss of the shuttle Challenger and its crew on the STS-51L mission, Thomas was selected as the director of Safety, Reliability and Quality Assurance at Kennedy in February 1987. He was responsible for developing and implementing overall safety policy and procedures at Kennedy and related activities at Cape Canaveral Air Force Station, Florida, and Vandenberg Air Force Base, California.

Thomas was appointed deputy director at Kennedy on Jan. 5, 1990. He served in this role until his retirement in early 1997.

Significant awards presented to Thomas included the NASA Exceptional Service Medal in 1981, the Outstanding Leadership Medal in 1988, the NASA Meritorious Service Award in 1992 and the NASA Equal Employment Opportunity Medal in 1994.

In 2006, Thomas authored the book, "Some Trust in Chariots." In it he details his Christian faith, experiences in the Space Shuttle Program and his personal perspective on the loss of Challenger.

Thomas and his wife, the former Juanita Purvis, lived on Merritt Island, Florida, before moving to the Memphis suburb of Collierville, Tennessee. They had two daughters, Karen and Wendy; a son, Chuck; and numerous grandchildren.



Astronomers are using NASA's Hubble Space Telescope to study auroras — stunning light shows in a planet's atmosphere — on the poles of the largest planet in the solar system, Jupiter. For the complete story, go to http://go.nasa.gov/298tVTU. Photo credit: NASA, ESA, and J. Nichols (University of Leicester)

National Aeronautics and Space Administration

John F. Kennedy Space Center
Kennedy Space Center, FL 32899

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