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VISION, MISSION & CORE COMPETENCIES

KSC Vision

KSC is the world's preeminent launch complex for government and commercial space access, enabling the world to explore and work in space.

KSC Mission

KSC safely manages, develops, integrates and sustains space systems through partnerships that enable innovative, diverse access to space and inspires the nation's future explorers.

KSC Core Competencies

- Acquisition and management of launch services and commercial crew development
- Launch vehicle and spacecraft processing, launching, landing and recovery, operations and sustaining
- Payload and flight science experiment processing, integration and testing
- Designing, developing, operating, and sustaining flight and ground systems, and supporting infrastructure
- Development, test and demonstration of advanced flight systems and transformational technologies to advance exploration and space systems

CENTER DIRECTOR'S MESSAGE

The past fiscal year has been one of continued change at NASA's Kennedy Space Center that brought our vision of transforming the center into a multi-user spaceport to reality. From the Shuttle Landing Facility to Launch Complex 39 and out to Exploration Park, the transformation is visible as our commercial partners and NASA contractors work side-by-side with us to advance the United States' position in space.

In the history of space exploration, only three countries have launched humans to space: the U.S., Russia and China. Today at Kennedy we have four U.S. companies working to send humans to space: Blue Origin's New Glenn rocket, Boeing's CST-100 Starliner, Lockheed Martin with its Orion spacecraft and SpaceX's Crew Dragon spacecraft. Kennedy Space Center paved the way for an amazing future of human spaceflight, and fiscal year (FY) 2016 was a key stepping stone to these exciting times.

During FY 2016, the Launch Services Program (LSP) launched the Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer (OSIRIS-REx) and Joint Altimetry Satellite Oceanography Network-3 (Jason-3). OSIRIS-REx will bring back a sample of an asteroid in 2023. Jason-3 launched atop a SpaceX Falcon 9 rocket. LSP also awarded the contract for our next Mars 2020 rover mission to United Launch Alliance.

In FY 2016, the shell of NASA's Orion crew module arrived at the center for Exploration Mission 1 (EM-1), slated for 2018. EM-1 will lift off from Kennedy atop the Space Launch System rocket, the most powerful rocket ever built. The outstanding work the Ground Systems Development and Operations Program conducted during FY 2016 will make that flight possible—from installing all 10 levels of platforms in High Bay 3 in the Vehicle Assembly Building to completing the modernization at Launch Pad 39B.



ROBERT D. CABANA
Center Director

NASA's Commercial Crew Program is continuing to work with our commercial partners, Boeing and SpaceX, to restore our capability to launch astronauts to the International Space Station from American soil. In FY 2016, United Launch Alliance completed the installation of the crew access tower at Space Launch Complex 41. NASA also ordered the second of four flights using Boeing's CST-100 Starliner and SpaceX's Crew Dragon spacecraft, solidifying NASA's commercial partners' contributions to NASA's mission.

Finally, our Exploration Research and Technology Programs continued to support the International Space Station through resupply missions and our Veggie plant growth system that was operated during NASA astronaut Scott Kelly's year in space.

All of these accomplishments could not have been achieved without the dedication and amazing teamwork of the workforce at the center. I invite you to read more about all of the amazing work going on here at Kennedy Space Center in the following pages.

SIGNIFICANT EVENTS

1 **Oct. 6, 2015: NASA's Ground Systems Program Began Critical Design Review**

The Ground Systems Development and Operations Program kicked off its critical design review at Kennedy Space Center, an important milestone to demonstrate that upgrades to necessary facilities and ground support equipment are on track for the launch of Orion on the first uncrewed flight test atop NASA's Space Launch System rocket.

2 **Oct. 6-8, 2015: Team Practiced Orion Egress Training**

Team members with NASA's Ground Systems Development and Operations Program and Orion Program practiced egress training using a mock-up of the Orion crew module in the Neutral Buoyancy Laboratory at Johnson Space Center in Houston.



3 **Oct. 9, 2015: Orion Spacecraft Recovery Training**

Astronauts and ground support teams trained in the Neutral Buoyancy Laboratory's massive pool in Houston to find out the best way to exit a spacecraft after coming back to Earth and landing in the water. The rehearsals will provide valuable insight into recovery planning for companies developing spacecraft for NASA's Commercial Crew Program.

4 **Oct. 14, 2015: NASA Awarded Venture Class Launch Services Contract**

NASA's Launch Services Program, managed at Kennedy Space Center, awarded multiple Venture Class Launch Services contracts to provide access to low-Earth orbit to small satellites, also called CubeSats, microsats or nanosatellites.



5 **Oct. 16, 2015: NASA Innovation Expo Highlighted Kennedy's Technology Advances**

Kennedy Space Center and the Kennedy Space Center Visitor Complex hosted the fourth annual Innovation Expo with the theme "From Earth to Mars." The event included technology and aeronautics exhibits, along with presentations by astronaut Nicole Stott and NASA scientists.

6 **Oct. 28, 2015: Spacewalkers Prepped Station for Future Commercial Spacecraft Arrival**

Astronauts Scott Kelly and Kjell Lindgren completed a number of tasks on the International Space Station during a seven-hour, 16-minute spacewalk. They carried out several tasks, including rigging power and data system cables for the future installation to the station of a docking port that will be used for the arrival of the Boeing CST-100 Starliner and SpaceX Crew Dragon spacecraft.



7 **Oct. 30, 2015: NASA Awarded Launch Services Contract for TDRS Satellite**

NASA selected United Launch Services LLC of Centennial, Colorado, to provide launch services for the agency's Tracking and Data Relay Satellite-M (TDRS-M) mission. The satellite will launch aboard an Atlas V rocket in August 2017 from Space Launch Complex 41 at Cape Canaveral Air Force Station in Florida.

8

Nov. 6, 2015: Smart Coating Developed at Kennedy Space Center Wins Award

Dr. Luz M. Calle, the technical lead for Kennedy Space Center's Corrosion Technology Laboratory, accepted NASA Tech Briefs magazine's "Create the Future Design" award in the automotive and transportation category for the "Smart Coating for Corrosion Detection and Protection." Calle and a team of scientists at Kennedy developed the environmentally friendly smart coating that could be used to detect and stop corrosion on metal.



9

Nov. 10, 2015: Crew Dragon Propulsion System Completed Development Testing

The propulsion system SpaceX will use to power its Crew Dragon out of danger in the event of an emergency – called SuperDracos – was test-fired 27 times on a test stand at the company's McGregor, Texas, rocket development facility.

10

Nov. 11, 2015: Orion Crew Module Adapter Lifted at Kennedy Space Center

The Orion crew module adapter for Exploration Mission 1 was lifted for the first and only time during its processing flow inside the Neil Armstrong Operations and Checkout Building high bay. The adapter was prepared for secondary structure outfitting.



11

Nov. 20, 2015: NASA Ordered SpaceX Crew Mission to International Space Station

NASA placed its first commercial crew mission order from SpaceX – the second in a series of four guaranteed orders from NASA under the Commercial Crew Transportation Capability contracts.

12

Dec. 6, 2015: NASA Cargo Launched to Space Station on Resupply Mission

Orbital ATK's Cygnus spacecraft launched on its fourth commercial resupply services mission, CRS-4, aboard a United Launch Alliance Atlas V rocket at 4:44 p.m. EST. Cygnus delivered 7,000 pounds of cargo to the International Space Station, including new hardware that will support dozens of NASA investigations and other science experiments from around the world.



13

Dec. 9, 2015: Kennedy Hosted Integrated Display Technology Demonstration

A technology demonstration of Kennedy Space Center's Integrated Display and Environmental Awareness System, or IDEAS, was presented to members of the media in Orlando, Florida. IDEAS is a unique technology that has the potential to improve mission safety and efficiency.

14

Dec. 10, 2015: Astronauts Celebrated with Builders to Top Crew Access Tower

NASA's four Commercial Crew Program astronauts gathered at Space Launch Complex 41 to witness the placement of one of the highest steel beams on the Crew Access Tower during a "topping off" ceremony with United Launch Alliance, Boeing and Hensel Phelps at the Cape Canaveral Air Force Station launch site in Florida.



15

Dec. 10, 2015: NASA's Ground Systems Program Completed Critical Design Review

The critical design review board for NASA's Ground Systems Development and Operations Program completed an in-depth assessment of the plans for Kennedy Space Center's facilities and ground support system required for processing and launch of the agency's Space Launch System and Orion spacecraft.



16

Dec. 16, 2015: Orion Service Module Umbilical Tested at Launch Equipment Test Facility

A simulated launch test of the Orion Service Module Umbilical was completed on a vehicle motion simulator at the Launch Equipment Test Facility.



17

Dec. 16, 2015: First Half of J Work Platforms Moved into the Vehicle Assembly Building

The first half of the J-level work platforms was moved into the Vehicle Assembly Building transfer aisle and placed on support stands to be prepared for installation in High Bay 3. The platforms will provide access for Space Launch System booster segment mate operations.

18

Dec. 18, 2015: NASA Ordered Second Operational Mission for Boeing's Starliner

NASA's Commercial Crew Program placed an order for the second operational mission to carry astronauts to the International Space Station aboard Boeing's CST-100 Starliner spacecraft.

19

January 2016: Work Continued to Upgrade Launch Pad 39B Flame Trench

Construction workers with J.P. Donovan of Rockledge, Florida, cut new heat-resistant bricks to size for the concrete walls of the flame trench. Pad B is being refurbished to support the launch of NASA's Space Launch System rocket and Orion spacecraft.



20

Jan. 7, 2016: Astronauts Took First Look at Starliner Trainers

Commercial Crew astronauts Bob Behken and Eric Boe sat at the simulated controls of Boeing's CST-100 Starliner as they evaluated sophisticated systems designed to train astronauts and mission controllers prior to missions to the International Space Station.

21

Jan. 17, 2016: Jason-3 Launched to Monitor Global Sea-Level Rise

Jason-3, a U.S.-European oceanography satellite mission with NASA participation that will continue a nearly quarter-century record of tracking global sea-level rise, lifted off from Vandenberg Air Force Base in California at 1:42 p.m. EST aboard a SpaceX Falcon 9 rocket.

22

Jan. 21, 2016: SpaceX Tested SuperDraco Descent Landing Capability

SpaceX tested its ability to fire engines that will be used to land a human-rated spacecraft safely on the ground at the company's test facility in McGregor, Texas.



23

Jan. 27, 2016: SpaceX Tested Crew Dragon Parachutes

Four red-and-white parachutes unfurled high above the desert near Coolidge, Arizona, during a test of the system that initially will be used to safely land SpaceX's Crew Dragon spacecraft carrying astronauts back from the International Space Station.

24

Jan. 28, 2016: Fallen Astronauts Honored on Day of Remembrance

Kennedy Space Center's employees and guests joined others throughout NASA to honor and celebrate the contributions of astronauts who have perished in the exploration of space during the Day of Remembrance at the Kennedy Space Center Visitor Complex.



25

Feb. 1, 2016 : Orion Crew Module Arrived for Exploration Mission-1

The pressure vessel portion of the Orion crew module arrived at Kennedy Space Center and was secured on a test stand in the Neil Armstrong Operations and Checkout Building high bay. Technicians and engineers with Orion manufacturer Lockheed Martin began preliminary checkout of the crew module.

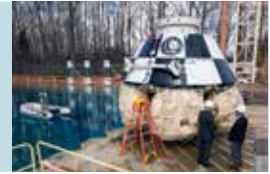


26 Feb. 5, 2016: SpaceX Tested Transporter Erector

A critical piece of large equipment was tested at Launch Complex 39A as SpaceX raised and lowered the transporter erector that will be used to move the Crew Dragon spacecraft atop a Falcon 9 rocket to the launch pad for missions.

27 Feb. 9, 2016: Starliner Performed Airbag Testing

The Boeing CST-100 Starliner airbag system was tested in the 20-foot-deep Hydro Impact Basin at NASA's Langley Research Center in Hampton, Virginia.



28 Feb. 11, 2016: Harvest of Zinnias at Kennedy Space Center Mimicked Harvest on Space Station

Zinnias from the Veggie ground control experiment were harvested in the same way that crew member Scott Kelly harvested zinnias growing in the Veggie system aboard the International Space Station on Feb. 14.



29 Feb. 16, 2016: Astronaut Practiced Crew Dragon Egress

Astronaut Anne McClain participated in egress training for the Crew Dragon at SpaceX's Hawthorne, California, headquarters.

30 Feb. 23, 2016: Test Version of Solid Rocket Booster Segments Arrived at Kennedy Space Center

Test versions of solid rocket booster segments for NASA's Space Launch System rocket arrived at the center's Rotation, Processing and Surge Facility for a series of lifts, moves and stacking operations to prepare for Exploration Mission-1.



31 Feb. 24, 2016: Advisory Councils Toured the Launch Equipment Test Facility

Members of the Aerospace Safety and Advisory Council, the NASA Advisory Council and the ISS Advisory Committee toured the control center at the Launch Equipment Test Facility. GSDO, Kennedy Engineering and support contractors are using the facility and test structures to check out the umbilical lines that will connect to the agency's Space Launch System rocket and Orion spacecraft on the mobile launcher tower.



32 March 1, 2016: Media Viewed Solid Rocket Booster Processing Facilities for Space Launch System

The Booster Fabrication Facility and the Rotation, Processing and Surge Facility were open for viewing by members of the media. The two facilities will be used to receive and process solid rocket booster segments for NASA's Space Launch System.

33 March 2, 2016: First Half of Platform K Installed in Vehicle Assembly Building

The first of 10 levels of new work platforms was installed in the Vehicle Assembly Building. The first half of the K-level work platforms, K south, was lowered into place in High Bay 3. The K platforms will provide access to the Space Launch System core stage and solid rocket boosters during processing.



34 March 7, 2016: Second Half of K Platforms Installed in Vehicle Assembly Building

A 250-ton crane lifted the second half of the K-level work platforms, K north, up from High Bay 4 in the Vehicle Assembly Building and lowered it into High Bay 3 for installation.

35

March 23, 2016 : Upgraded Crawler-Transporter 2 Completed Test Drive

NASA's upgraded crawler-transporter 2 took a trek along the crawlerway to Launch Pad 39B to test recently completed upgrades and modifications. CT-2 will carry the Space Launch System rocket and Orion spacecraft atop the mobile launcher to the pad.



36

March 28, 2016: Water System Tested on Crew Access Arm

Engineers and technicians gathered at Kennedy Space Center in Florida and tested systems that will support Boeing's CST-100 Starliner spacecraft. The Crew Access Arm and White Room were tested when hundreds of gallons of water were sprayed along the arm and beneath it for an evaluation of its water deluge system.

37

April 5, 2016: Seeds from Veg-03 Experiment Planted in White House Kitchen Garden

Seeds from the same lot as those from the Veggie plant growth system's Veg-03 experiment on the International Space Station were planted in the White House Kitchen Garden. The Tokyo Bekana Chinese cabbage, along with some red romaine lettuce seeds, were prepared inside a laboratory at Kennedy Space Center and shipped to the White House.



38

April 5, 2016: First Half of J Platforms Installed in Vehicle Assembly Building

The first half of the J-level work platforms, J south, was lifted by crane for installation in High Bay 3 of the Vehicle Assembly Building. Access for booster segment mate operations will be located on the J level.



39

April 15, 2016: Second half of J Platforms Installed in Vehicle Assembly Building

The second half of the J-level work platforms, J north, was lowered into place for installation about 112 feet above the floor in High Bay 3 of the Vehicle Assembly Building. The J platforms are the second of 10 levels of new platforms.

40

April 21, 2016: Orion Pressure Vessel Prepared for Pressure Test

The Orion pressure vessel for the Exploration Mission-1 uncrewed flight was moved into the proof pressure cell in the Neil Armstrong Operations and Checkout Building high bay for a series of pressure tests in May. The tests over several days confirmed that the weld points of the underlying structure would contain and protect astronauts during launch, in-space, re-entry and landing phases.



41

April 26, 2016: Astronauts Evaluated Starliner Trainers

Commercial Crew astronauts Suni Williams and Eric Boe evaluated the systems they and other astronauts will use to train for every detail and situation that could arise during a CST-100 Starliner mission to the International Space Station.

42

April 28, 2016: New Liquid Hydrogen Transfer Hose at Launch Pad 39B Prepared for Fit Check

Engineers and technicians reviewed procedures with liquid hydrogen provider PRAXAIR to prepare for a fit and function check of the new LH2 transfer flex hose from the truck to the tank.



43

April 28, 2016: New Work Platforms Successfully Powered On and Tested

For the first time, two work platforms, the J-level platforms, were powered on and extended on their rail beams to test their motors, tracks and roller systems for functionality. The J platforms are located about 112 feet above the floor, or nearly 11 stories high, and will support the processing of the Space Launch System rocket.

44

May 2, 2016: Starliner Test Article Joined to Complete First Hull

The first CST-100 Starliner hull was joined after engineers bolted together the upper and lower domes. It is the first spacecraft to come together inside the former shuttle hangar since shuttle Discovery was moved out of the facility following its retirement and move to the Smithsonian's Udvar-Hazy Center near Washington, D.C., in 2012.



45

May 14, 2016: U.S. Astronaut Hall of Fame Inducted Two New Members

During a ceremony at the Kennedy Space Center Visitor Complex, space shuttle astronauts Brian Duffy and Scott Parazynski joined an elite group of American space heroes as they were inducted into the U.S. Astronaut Hall of Fame.



46

May 16-20, 2016: NASA Hosted 7th Annual Robotic Mining Competition

Teams of students from colleges and universities around the U.S. brought their unique robotic excavators to the Kennedy Space Center Visitor Complex for the annual Robotic Mining Competition. The goal was to dig in simulated Martian regolith, or Mars dirt, and deposit as much of it as possible into a bin within 10 minutes.

47

May 20, 2016: Spacecraft 1 Major Components Arrived for Assembly

The upper dome of a test version of Boeing's CST-100 Starliner arrived at the company's spacecraft factory at Kennedy Space Center to begin assembly to the docking hatch and lower dome elements.



48

May 24, 2016: First Half of H Platforms Installed in Vehicle Assembly Building

The first half of the H-level work platforms, H north, was lifted up from the transfer aisle of the Vehicle Assembly Building and lowered into place for installation in High Bay 3. The H platforms will provide access for booster segment stacking operations.

49

May 26, 2016: Second Half of H Platforms Installed in Vehicle Assembly Building

The second half of the H-level work platforms, H south, is lifted by crane from the transfer aisle of the Vehicle Assembly Building and lowered for installation in High Bay 3. The H platforms are the third of 10 levels of new platforms.



50

June 2, 2016: NASA Issued Notice of Availability for Kennedy Space Center Land Use

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.

51

June 20, 2016: First Half of G Platforms Installed in Vehicle Assembly Building

The first half of the G-level work platforms, G south, was lifted up from the transfer aisle of the Vehicle Assembly Building and lowered into position for installation at about the 14th-floor level in High Bay 3. The G platforms will provide access for booster segment stacking operations.



52

June 21, 2016: Boeing Opened Training Facility for Commercial Crew Missions

Astronauts, engineers and trainers will learn how to fly and operate Boeing's Starliner spacecraft inside the Space Training, Analysis and Review, or STAR, training facility dedicated to the spacecraft being developed in partnership with NASA's Commercial Crew Program.

53

June 23, 2016: Second Half of G Platforms Installed in Vehicle Assembly Building

The second half of the G-level work platforms, G north, was installed in High Bay 3 in the Vehicle Assembly Building. The G platforms are the fourth of 10 levels of new platforms.

54

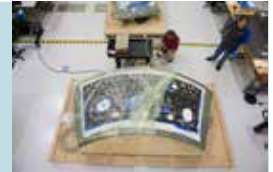
June 24, 2016: Crew Dragon Pressure Vessel Put to the Test

Pressure vessels built by SpaceX to test its Crew Dragon designs completed structural testing to analyze the spacecraft's ability to withstand the harsh conditions of launch and spaceflight. A pressure vessel is the area of the spacecraft where astronauts will sit during their ride into orbit.

55

July 8, 2016: Tiles Bonded to Orion Crew Module

Inside the Neil Armstrong Operations and Checkout Building high bay, technicians began bonding thermal protection system tiles on the nine panels that will cover NASA's Orion crew module. The tiles will help protect Orion from the 5,000 degree Fahrenheit heat of re-entry from space.



56

July 15, 2016: First Half of F Platforms Installed in Vehicle Assembly Building

The first half of the F-level work platforms, F south, was lifted up by crane and moved into High Bay 3 for installation about 192 feet above the floor. The F platforms will provide access to the core stage intertank umbilical for mate operations.

57

July 18, 2016: SpaceX Launched on Ninth Cargo Resupply Mission to International Space Station

The SpaceX Dragon cargo craft launched at 12:45 a.m. EDT on a Falcon 9 rocket from Space Launch Complex 40 at Cape Canaveral Air Force Station in Florida. The Dragon delivered nearly 5,000 pounds of cargo to the International Space Station on its ninth cargo resupply mission for NASA.



58

July 19, 2016: New Platform Installation Reached Halfway Point in Vehicle Assembly Building

Installation reached the halfway point as the fifth of ten levels of work platforms were installed in High Bay 3 of the Vehicle Assembly Building. The F north platform was installed on the north side of the high bay, joining its other half, F south, which was just installed four days prior.



59

July 25, 2016: Aerojet Rocketdyne Tested Starliner Service Module Engines

The small jets designed to steer Boeing's CST-100 Starliner spacecraft in orbit were fired in a vacuum chamber at NASA's White Sands Test Facility in New Mexico. Aerojet Rocketdyne built the reaction control engines and used a chamber to pulse fire three engines up to 4,000 times for a total of 1,600 seconds each. Both are record times for lightweight thrusters with composite chambers.



60

July 26, 2016: NASA, Industry Boosted Opportunities for Small Businesses

NASA and Boeing announced a Small Business Mentor-Protégé Program agreement at Boeing's Commercial Crew and Cargo Processing Facility at Kennedy Space Center. The program will provide a platform for large companies to assist eligible small business with strengthening business and technical capabilities.

61

July 28, 2016: NASA Awarded Protective Services Contract

NASA selected Chenega Infinity LLC of Chantilly, Virginia, to provide protective services at the agency's Kennedy Space Center in Florida.

62

July 29, 2016: NASA Ordered Second Operational Mission for SpaceX's Crew Dragon

NASA's Commercial Crew Program placed an order for the second operational mission to carry astronauts to the International Space Station aboard SpaceX's Crew Dragon spacecraft.

63

August 2016: Orion Crew Module for Exploration Mission-1 Reached Processing Milestone

The first propellant system tube welds on the exterior of the Orion pressure vessel were completed in the Neil Armstrong Operations and Checkout Building high bay. With the first tubes in place, X-ray specialists performed inspections of the welds for any imperfections.

64

Aug. 2, 2016: First Tail Service Mast Umbilical Delivered for Testing

The first of two Tail Service Mast Umbilicals (TSMUs) arrived at Kennedy Space Center and was transported to the Launch Equipment Test Facility where it was tested and validated to verify it is functioning properly. The TSMUs will provide liquid propellants and power to the Space Launch System rocket's core stage engine.



65

Aug. 15, 2016: Crew Access Arm Installed at Space Launch Complex 41

The 50-foot-long, 90,000-pound Crew Access Arm was installed at Space Launch Complex 41 at Cape Canaveral Air Force Station. Workers modified the launch pad so astronauts can climb aboard Boeing's CST-100 Starliner spacecraft ahead of NASA Commercial Crew Program missions to the International Space Station.



66

Aug. 18, 2016: Engine Test Showed Design Ready for New Era

Three NASA astronauts, including two training for flight tests aboard Commercial Crew Program spacecraft, toured the Aerojet Rocketdyne facility in West Palm Beach, Florida, and watched as an RL10 engine successfully was test-fired.

67

Aug. 19, 2016: SpaceX Conducted Successful Crew Dragon Parachute System Test

A Crew Dragon test article successfully deployed its four main parachutes as planned during a test that saw the SpaceX-made test article dropped from a C-130 aircraft 26,000 feet above Delamar Dry Lake, Nevada.



68

Aug. 24, 2016: Starliner Tested for Ground-Landing Conditions

Boeing engineers evaluated the CST-100 Starliner spacecraft's ability to withstand the shocks and other challenges of landing on the ground with a series of drop tests at NASA's Langley Research Center in Virginia.

69

Aug. 25, 2016: Launch Services Contract for Mars 2020 Rover Mission Awarded

NASA selected United Launch Services LLC of Centennial, Colorado, to provide launch services for a mission that will address high-priority science goals for the agency's Journey to Mars.

70

Aug. 26, 2016 : Orion Heat Shield Arrived for Exploration Mission-1

The Orion heat shield for Exploration Mission-1 arrived at the Shuttle Landing Facility at Kennedy Space Center aboard NASA's Super Guppy aircraft and was transported to the Neil Armstrong Operations and Checkout Building high bay. It was unpacked and secured onto a test stand the next day to begin processing.



71

Aug. 26, 2016: First Half of E Platforms Installed in Vehicle Assembly Building

The first half of the E-level work platforms, E south, was installed in High Bay 3 of the Vehicle Assembly Building. The E platforms will provide access to the core stage forward skirt umbilical for mating operations.

72

Aug. 29, 2016: First Half of D Platforms Installed in the Vehicle Assembly Building

A heavy-lift crane lowered the first half of the D-level work platforms, D south, for installation in High Bay 3 of the Vehicle Assembly Building. Access to the launch vehicle stage adapter lower access doors is at this level.



73

Sept. 6, 2016: Safety and Mission Assurance Support Services Contract Awarded

NASA awarded a contract to Alphaport Inc. of Cleveland for safety and mission assurance support services at Kennedy Space Center, NASA Headquarters in Washington, D.C., and other sites supported by Kennedy programs and projects.

74

Sept. 8, 2016: NASA's OSIRIS-REx Speeds Toward Asteroid Rendezvous

NASA's first asteroid sampling mission, the Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer (OSIRIS-REx) launched into space at 7:05 p.m. EDT from Cape Canaveral Air Force Station. The spacecraft began a journey that could revolutionize our understanding of the early solar system.



75

Sept. 8, 2016: Left-Hand Aft Skirt for Space Launch System Moved to Booster Fabrication Facility

The left-hand aft skirt was moved to the Booster Fabrication Facility at Kennedy from Hangar AF at Cape Canaveral Air Force Station. The aft skirt was inspected, resurfaced, primed and painted for use on the booster of NASA's Space Launch System rocket.



76

Sept. 8, 2016: Second Half of E Platforms Installed in Vehicle Assembly Building

The second half of the E-level work platforms, E north, was installed in High Bay 3 of the Vehicle Assembly Building. E platforms will provide access to the core stage forward skirt umbilical for mating operations. The E platforms are the sixth of 10 levels of new platforms.

77

Sept. 9, 2016: Second Half of D Platforms Installed in Vehicle Assembly Building

The second half of the D-level work platforms, D north, was lowered into position and installed in High Bay 3 of the Vehicle Assembly Building. The D platforms are the seventh of ten levels of work platforms that will surround NASA's Space Launch System and Orion spacecraft during processing. The D platforms are the seventh of 10 levels of new platforms.

78

Sept. 20-21, 2016: NASA and U.S. Navy Divers Practiced Orion Recovery Techniques

A group of Navy divers, Air Force pararescuemen and Coast Guard rescue swimmers practiced Orion underway recovery techniques in the Neutral Buoyancy Laboratory at NASA's Johnson Space Center in Houston. Kennedy Space Center's Ground Systems Development and Operations Program leads Orion recovery operations.



79

Sept. 28, 2016: Boeing Unveiled New Home for Starliner Trainers

Boeing installed its Crew Part-Task Trainers that simulate aspects of missions aboard the company's CST-100 Starliner spacecraft at NASA's Johnson Space Center in Houston.



NASA selected Orbital ATK to begin negotiations on an agreement to use High Bay 2, in the iconic Vehicle Assembly Building (VAB) at Kennedy Space Center in Florida. The prospective property use agreement reflects the center's transformation to a multi-user spaceport supporting both government and commercial organizations.



CENTER PLANNING & DEVELOPMENT

Through purposeful planning, strategic partnerships and focused outreach and communication, Kennedy Space Center's Center Planning and Development (CPD) Directorate was able to achieve a significant milestone during Fiscal Year 2016 by helping the center become a multi-user spaceport. The multi-user vision proposed in 2010 and described in the KSC Master Plan has become a reality!

In March, CPD, in conjunction with the Spaceport Integration and Services Directorate, hosted two public meetings to present the Programmatic Environmental Impact Statement (PEIS) that would enable the multi-user vision. The intent of the PEIS was to evaluate the potential environmental impacts from centerwide operations and activities from 2013 to 2032, and to ensure that NASA is in compliance with applicable environmental statutes as it sets priorities for future operations and activities at the center. At the conclusion of the PEIS, after receiving a number of very positive public

comments, the center's Partnership Board approved the final Master Plan Land Use map changes.

CPD also released its second Notice of Availability in June, targeting users interested in developing commercial capabilities on vacant Kennedy property in accordance with Kennedy's Master Plan. CPD continues to receive interest from commercial companies for utilization of the multi-user spaceport.

In early 2016, Blue Origin began clearing land at Exploration Park, Phase 2, to build a 750,000-square-foot manufacturing facility in which to assemble its reusable fleet of orbital launchers. These vehicles will lift off from Space Launch Complex 36 on Cape Canaveral Air Force Station in Florida. The manufacturing facility is expected to be operational by the beginning of 2018, and launches from Complex 36 are expected as early as 2020.

After a competitive Announcement for Proposals in June



The Center Planning and Development Directorate held a roundtable discussion with government and industry representatives, led by Scott Colloredo, CPD director, standing. The group toured facilities at the multi-user spaceport and then participated in a discussion about Kennedy's partnership efforts and future plans.



2015, NASA selected Orbital ATK in April 2016 to begin negotiations to utilize Vehicle Assembly Building (VAB) High Bay 2 for its commercial operations. This prospective property-use agreement, which also includes use of a mobile launcher platform, demonstrates Kennedy's true multi-use strategy, expanding the capabilities of its historic assets to allow for both government and commercial users. NASA will continue to be the primary user of the VAB for the Space Launch System and Orion programs.

CPD held a Partnership Landscape Forum in April, focused on the emerging small launch provider market. More than 20 prospective partners attended the workshop, which discussed how Kennedy is preparing to enable small launch capabilities from its property. During the forum, representatives from various Kennedy organizations shared information on

the requirements needed to do business with the center, including agreement approach and framework, safety and mission assurance requirements, how FAA licensing will apply, Kennedy's payload services capabilities, the Universal Propellant Servicing System, the Autonomous Flight Termination System that is available to customers through the center's Technology Transfer Office, and potential launch locations on the center that could accommodate this new class of launch vehicle.

CPD hosted its sixth semiannual roundtable discussion in August, as NASA and local and state officials focused on the center's horizontal infrastructure and discussed near- and long-term solutions to ensure continued access to space processing capabilities.

Kennedy's hard-working CPD team, which includes representatives from almost every directorate at the center, took on the challenge of changing the way that business was done at the center during FY 2016. Making the best use of taxpayer-funded resources has been a key objective, from reorganization of the space center's management structure, to providing optimum utilization of available assets. As America's multi-user spaceport, Kennedy Space Center continues to make history as it evolves, launching to low-Earth orbit and beyond. ✨

Construction is progressing on Blue Origin's 750,000-square-foot facility being built at Exploration Park on Kennedy Space Center property in Florida. Blue Origin will use the factory to manufacture its two-stage super-heavy-lift New Glenn launch vehicle and launch the vehicles from Space Launch Complex 36 at Cape Canaveral Air Force Station. Photo credit: Blue Origin



COMMERCIAL CREW PROGRAM

NASA's Commercial Crew Program worked throughout 2016 to move the agency closer to launching its astronauts from American shores aboard American vehicles. Diligent engineering and close involvement with industry partners have kept the Commercial Crew Program on the path to certify two new spacecraft and associated launch systems for flight tests and future operational missions to the International Space Station.

The program's efforts spanned NASA's spaceflight community from the manufacturing sites in Florida and California to launch sites at the Kennedy Space Center multi-user spaceport to training at the Johnson Space Center in Texas. In addition, the program draws from a broad base of engineering expertise at the Kennedy Space Center, Johnson Space Center, and the Marshall Space Flight Center in Alabama along with support from numerous other centers and NASA facilities. Above Earth, astronauts aboard the space station contributed their expertise to the program as

they retrofitted the station's docking ports to host the new generation of crewed spacecraft.

The unique nature of the Commercial Crew Program allowed for a rich record of successes in 2016. Boeing and SpaceX applied their industrial know-how to manufacture multiple spacecraft and perform increasingly complex and realistic testing in order for NASA's engineers and spaceflight specialists to evaluate individual systems that will ultimately build up into a complete spacecraft for evaluation.

Boeing is developing the CST-100 Starliner to launch to the station atop a United Launch Alliance Atlas V rocket. Boeing built a structural test article for the Starliner in 2016 so it could begin strenuous testing of the overall spacecraft design. All the Starliners will be built in Boeing's factory at Kennedy before processing and launching from Space Launch Complex 41. The first actual Starliner spacecraft, called Spacecraft 1, arrived at the Florida facility for assembly. In Houston, Boeing unveiled Starliner trainers that astronauts and crew are using

to learn the systems and techniques necessary to fly the spacecraft to the space station and back to Earth.

SpaceX is developing the Crew Dragon spacecraft, which will launch aboard the company's Falcon 9 rocket. Assembling the spacecraft at the company's headquarters and factory in Hawthorne,

Commercial Crew astronauts Doug Hurley, center, and Sunita "Suni" Williams sit inside a Crew Dragon mock-up during an evaluation visit for the Crew Dragon spacecraft at SpaceX's Hawthorne, California, headquarters on Oct. 28, 2015. Photo credit: SpaceX





A building-sized mural adorns the Commercial Crew and Cargo Processing Facility (C3PF) in Launch Complex 39 on Jan. 26, 2016, at NASA's Kennedy Space Center in Florida. The mural features an image of Boeing's CST-100 Starliner orbiting above Florida. The Starliner will be assembled and processed in the C3PF in partnership with NASA's Commercial Crew Program.



Commercial Crew astronaut Suni Williams practices docking operations for Boeing's CST-100 Starliner on April 26, 2016, using a simulator designed to mimic the controls and behavior of the spacecraft. Working at Boeing's St. Louis facility, Williams and astronaut Eric Boe ran through numerous mission phases to assess the machines – called part-task trainers.

California, SpaceX built test pressure vessels to demonstrate key aspects of the craft's overall design. In 2016, SpaceX also evaluated its landing system for the Crew Dragon spacecraft and performed a series of engine tests at the company's test site in MacGregor, Texas. In Florida, SpaceX built the transporter-erector at Launch Complex 39A that will move Falcon 9 rockets, with Crew Dragon spacecraft, into position for liftoff.

For NASA missions, both the Starliner and Crew Dragon will carry up to four astronauts and 220 pounds of cargo, including experiment hardware and supplies. The spacecraft are designed to remain docked at the station for several months at a time before returning astronauts safely to Earth.

NASA's Commercial Crew Program also worked throughout 2016 with Blue Origin and Sierra Nevada Corp. to develop and refine their respective crew spacecraft and launch systems. Sierra Nevada Corp.'s Dream Chaser spacecraft was selected to fly without crew to deliver supplies and equipment to the space station under NASA's Commercial Resupply Services-2 contract. ✨



Launch Pad 39A at NASA's Kennedy Space Center in Florida undergoes modifications by SpaceX in November 2015 to adapt it to the needs of the company's Falcon 9 and Falcon Heavy rockets, which are slated to lift off from the historic pad. A horizontal integration facility has been constructed near the perimeter of the pad where rockets will be processed for launch prior of rolling out to the top of the pad structure for liftoff. Photo credit: SpaceX



A full-scale engineering test article of Sierra Nevada Corp.'s Dream Chaser spacecraft is nearing completion Oct. 2, 2015, leading to a second round of atmospheric evaluations at NASA's Armstrong Flight Research Center in Edwards, California. The flight testing, which calls for the Dream Chaser to be released high over California's Rogers Dry Lakebed and glide to a safe landing, will build upon an earlier free-flight test milestone that returned valuable data for the design team. Photo courtesy: Sierra Nevada Corp.

Blue Origin's New Shepard space vehicle successfully flew to space before executing a historic landing back at the launch site in West Texas. Image courtesy: Blue Origin



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 Kennedy Space Center in Florida.

LAUNCH SERVICES PROGRAM

During Fiscal Year 2016, NASA's Launch Services Program (LSP) at the Kennedy Space Center supported two mission campaigns and continued efforts to improve agency infrastructure. As the Earth's bridge to space, LSP provides safe, reliable, cost-effective and on-schedule access to space for the agency and NASA-sponsored payloads.

A skilled NASA/contractor team provides leadership, expertise and cost-effective services in the commercial arena to satisfy agencywide space transportation requirements and maximize the opportunity for mission success.

LSP Launches

On Jan. 17, 2016, a SpaceX Falcon 9 rocket lifted off from Vandenberg Air Force Base in California with NASA's Jason-3 satellite. The spacecraft now is helping scientists continue studies of the seas from a vantage point 830 miles above the Earth.

Built by Thales Alenia of France, Jason-3 is measuring the topography of the ocean surface for a four-agency international partnership consisting of NASA, the National Oceanographic and Atmospheric Administration (NOAA), France's space agency – the Centre National d'Etudes Spatiales – and the European Organization for the Exploitation of Meteorological Satellites.

A United Launch Alliance (ULA) Atlas V rocket lifted off from Space Launch

Complex 41 at Cape Canaveral Air Force Station on Sept. 8, 2016, with NASA's Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer, or OSIRIS-REx spacecraft.

In preparing OSIRIS-REx for launch, LSP collaborated with NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California. While processing was taking place in Kennedy's Payload Hazardous Servicing Facility (PHSF), the adjacent MIL-71 data and telemetry facility was used to electronically simulate millions of miles in space to test and confirm the communication signals through JPL's Deep Space Network. The facility also was used to confirm the success of communication signals to and from the spacecraft after it was launched.

OSIRIS-REx will be the first U.S. mission to sample

an asteroid, retrieve at least two ounces of surface material and return it to Earth for study. The destination Bennu asteroid may hold clues to the origin of the solar system and the source of water and organic molecules found on Earth.

A crane lifted a United Launch Alliance Atlas V rocket first stage booster in position Aug. 8, 2016, at the Space Launch Complex 41 Vertical Integration Facility at Cape Canaveral Air Force Station in Florida. The booster was mated to the Centaur upper stage in preparation for launch of the OSIRIS-REx spacecraft.





The SpaceX Falcon 9 rocket rolled from a hangar at Vandenberg Air Force Base in California to Space Launch Complex 4 on Jan. 15, 2016. The launch vehicle boosted the Jason-3 satellite to orbit Jan. 17, 2016. Jason-3 is the fourth in a series of spacecraft providing scientists with essential information about global and regional changes in the seas.

Cygnus Prepped

Inside Kennedy's PHSF, Orbital ATK and ULA engineers and technicians encapsulated a Cygnus cargo spacecraft in its payload fairing Feb. 27, 2016. LSP operates the PHSF, the only hazardous payload processing clean-room at Kennedy with the capability of encapsulating the Atlas V-size payload fairings. LSP also has a long history serving as effective advisors with ULA on Atlas V missions.

The Cygnus launched to the space station on March 22, 2016, on the Orbital ATK Commercial Resupply Services-6 mission. The spacecraft delivered experiments, hardware and supplies to the orbiting outpost.

CubeSats

NASA assisted with deployment of three small research satellites selected through the CubeSat Launch Initiative (CSLI) for two universities and one primary school as part of the ninth

installment of the Educational Launch of Nanosatellite (ELaNa) missions. CubeSats are small, cube-shaped satellites that are relatively simple to build, but provide opportunities for high school and university students to learn more in the fields of science, technology, engineering and math, or STEM.

The ELaNa launch was part of the Orbital ATK CRS-4 Commercial Resupply Services mission to the International Space Station. Launched from Cape Canaveral on Dec. 6, 2015, atop an Atlas V rocket, the Cygnus resupply spacecraft delivered more than 7,700 pounds of essential crew supplies, equipment and scientific experiments to the station.

CubeSats are playing an increasingly important role in exploration, technology demonstrations, scientific research and educational investigations. More than 400 students have been involved in the design, development and

construction of the CubeSats that will be deployed from the space station via the commercially operated NanoRacks CubeSat Deployer (NRCSD) system.

CubeSat deployments from the ISS via the CubeSat deployer are made possible through a Space Act Agreement between NASA and NanoRacks of Houston, Texas, a company focusing on space operating systems.

NASA launched four more CubeSats, selected through the CubeSat Launch Initiative as part of the 12th installment of the ELaNa missions. Over 50 students have been involved in the design, development and construction of the CubeSats flown on the National Reconnaissance Office's (NRO) Government Rideshare Advanced Concepts Experiment (GRACE), which was an auxiliary payload to the NRO's L-55 mission launched on Oct. 8, 2015, from Vandenberg. GRACE carried a total of 13 CubeSats, four of which are sponsored by NASA's CubeSat Launch Initiative.

Facility Upgrades

Inside Hangar AE at Cape Canaveral



Insulation and Finish System, provides an insulated, water-resistant, finished surface in an integrated composite material. Work also included new blast-proof windows and upgrades in the main conference room, restrooms and lobby entrance.

LSP Capabilities

LSP is developing testing capabilities to better understand the acoustic material properties of payload fairing blankets.

One of the goals of the test is to build a database of porous foam acoustic properties that are not typically available through material specification sheets. The test included three different commercially available porous foam material types in varying grades: melamine, polyimide and urethane. A total of 11 different baseline samples were tested and data collected.

LSP also hosted its first Customer Forum, May 3-5, 2016. The goal of the forum was to provide LSP's spacecraft customers with the latest update on the program, its processes and the fleet of contracted vehicles. Updates on SmallSats and developing access

Technicians monitored the progress as the Geostationary Operational Environmental Satellite (GOES-R) was lifted to the vertical position on an "up-ender" Sept. 15, 2016, inside the Astrotech payload processing facility in Titusville, Florida, near Kennedy Space Center. GOES-R is the first satellite in a series of next-generation NOAA GOES satellites. The spacecraft launched aboard a United Launch Alliance Atlas V rocket Nov. 19, 2016, at 6:42 p.m. EST.

and Building 836 at Vandenberg, a project is nearing completion to replace the consoles in all five of LSP's Launch Vehicle Data Centers (LVDC).

Cabling and installation of the new computers and monitors also was completed. The new consoles feature a continuous flat work surface area with more than double the surface area of the old consoles. This allows room for customer laptops, tables and other accessories.

The new consoles also provide support for multiple 34-inch curved-screen monitors with ultra-wide quad high-definition resolution. The new system features rail-mount tracks for monitor installation, articulating monitor arms, sliding computer mounts and easy-access wire trays.

An overhead crane moves NASA's OSIRIS-REx spacecraft toward a work stand May 26, 2016, inside the Payload Hazardous Servicing Facility at Kennedy Space Center. The spacecraft was being prepared for its upcoming launch Sept. 8 aboard a United Launch Alliance Atlas V rocket.

At Vandenberg, Building 840 is another crucial facility that serves as the primary office for LSP at the west coast launch site. The NASA resident office houses the NASA LSP support and contractor team as well as the launch team during the final phases of a launch campaign.

Renovations to the exterior recently were completed.

The most significant effort was the removal of windows and installation of additional structural steel columns and beams. Additionally, a new wall cladding system, called the Exterior





A United Launch Alliance Atlas V rocket lifted off Sept. 8, 2016, from Space Launch Complex 41 at Cape Canaveral Air Force Station in Florida, carrying NASA's Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer (OSIRIS-REx) on the first U.S. mission to sample an asteroid, retrieve at least two ounces of surface material and return it to Earth for study. Liftoff was at 7:05 p.m. EDT.

to space for those missions also were discussed during the three-day meeting.

Launch vehicle providers, including ULA, Orbital ATK and SpaceX, all made presentations for their respective launch vehicle fleets. The LSP team provided feedback to the customers following each of the provider presentations.

Spacecraft 3-D App

During an all-hands meeting Oct. 22, 2015, LSP team members participated in a presentation on real-time, interactive 3-D visualization applications. Kevin Hussey, manager

of the Visualization Technology Applications and Development Group in the Office of Communications and Education at JPL, showed how planets and spacecraft can become 3-D virtual experiences as images that can move in the NASA application.

LSP is teaming up with JPL to develop a “rockets module” to the spinoff application, Spacecraft 3-D. Work now is underway to create applications for a 3-D Delta II Heavy, Atlas V, Pegasus, CubeSats, and other rockets.

As the fiscal year was drawing to a close, NASA's LSP team was

preparing to launch an Atlas V rocket with NOAA's Geostationary Operational Environmental Satellite, or GOES-R, spacecraft. The first satellite in a series of next-generation weather satellites, GOES-R will orbit in a geostationary position over the U.S. to provide images of storms and help meteorologists develop more accurate weather forecasts. Ultimately, more timely warnings will save lives in advance of approaching lightning and severe storms.

Looking Ahead

Planning for future programs, NASA awarded a launch services contract for the Mars 2020 Rover Mission. During the past year, NASA selected United Launch Services of Centennial, Colorado, to provide support for a mission that will address high-priority science goals for the agency's Journey to Mars.

Targeted for launch in July 2020 aboard an Atlas V at Cape Canaveral, the Mars 2020 rover will build on the achievements of Curiosity and other Mars Exploration Program missions by conducting geological assessments of its landing site on the Red Planet, determining the habitability of the environment, searching for signs of ancient Martian life, and assessing natural resources and hazards for future human explorers.

NASA's Launch Services Program ensures the nation has dependable access to space for sending probes to low-Earth orbit and beyond. LSP also is part of the agency's exceptional team of experts with decades of experience in innovative technology and compelling scientific research. ✨

GROUND SYSTEMS DEVELOPMENT AND OPERATIONS

The Ground Systems Development and Operations Program completed significant upgrades and modifications to facilities and ground support equipment at Kennedy Space Center during Fiscal Year 2016. All of the work contributed to the transition of the center to a multi-user spaceport and preparations for NASA's Exploration Mission-1.

GSDO successfully completed its critical design review on the path to preparing for the agency's Journey to Mars. Members of the review board completed an in-depth assessment of the plans for the facilities and ground support systems at the center.

Veteran spaceflight engineer Charlie Blackwell-Thompson was named launch director for the first flight of NASA's Space Launch System (SLS) rocket with an uncrewed Orion spacecraft atop. Her selection as launch director means that she will be the first woman to oversee a NASA launch team and liftoff.

One of the most notable facility modifications is visible in High Bay 3 inside the massive Vehicle Assembly Building. Seven levels of new work platforms were installed on the north and south walls of the high bay by the end of the fiscal year, with the final three sets of topmost platforms added shortly after.

In April 2016, two work platforms, the J-level platforms, were powered on and extended on their rail beams for the first time to test their motors, tracks and roller systems for functionality.

Ten levels of platforms, 20 platform halves altogether, will surround NASA's Space Launch System rocket and Orion spacecraft atop the mobile launcher during stacking and processing operations in the high bay before rollout to Launch Pad 39B.

A metamorphosis has taken place at Launch Pad 39B. All of the Apollo-era bricks were removed from the flame trench



NASA's upgraded crawler-transporter 2 traveled along the crawlerway from the Vehicle Assembly Building at Kennedy Space Center on its trek to Launch Pad 39B on March 23, 2016, to test recently completed upgrades and modifications. The crawler will carry the mobile launcher with Orion atop the Space Launch System rocket to the launch pad for Exploration Mission-1.



◀ *Modifications continued on the mobile launcher, or ML, at the Mobile Launcher Park Site at Kennedy Space Center. Scaffolding was installed around the base of the tower to continue upgrades and modifications to the structure.*

beneath the pad. Nearly 100,000 new heat-resistant bricks, in three different sizes, were secured to the walls of the north side of the flame trench using bonding mortar in combination with adhesive anchors. The flame trench will withstand temperatures of up to 2,000 degrees Fahrenheit during launch of the SLS rocket's engines and solid rocket boosters.

Upgrades to pad B also included a new communication system; a new heating, ventilation and cooling system; replacement of water system piping in the pad perimeter; and installation of new ignition overpressure/sound suppression bypass valves at the valve complex.

Several modifications were completed on the mobile launcher that will carry the SLS rocket and Orion spacecraft to Launch Pad 39B. More than 800 mechanical, electrical and fluid panels, 300,000-plus feet of cabling, and miles of tubing and piping were installed on the 380-foot-tall structure. The flame bucket on the base of the ML was widened from approximately 22x22 feet to 34x64 feet to accommodate the increased size needed for the SLS core stage and solid rocket boosters.

The tower structure on the ML was readied for installation of a number of lines, called umbilicals, that will connect to the

▼ *A heavy-lift crane lifted the first half of the F-level work platforms, F south, into position for installation in High Bay 3 of the Vehicle Assembly Building at Kennedy Space Center on July 15, 2016. The F platforms are the fifth of 10 levels of work platforms that will surround and provide access to the SLS rocket and Orion spacecraft during processing for Exploration Mission-1.*





Team members from NASA's Orion and Ground Systems Development and Operations Programs practiced egress training Oct. 6-8, 2016, using a mock-up of the Orion crew module in the 6.2-million-gallon Neutral Buoyancy Laboratory at Johnson Space Center in Houston. The team evaluated the layout of equipment inside the spacecraft, the gear that will be used during the recovery process, and the most efficient way for astronauts to exit the spacecraft after weeks or months away from Earth.

SLS rocket and Orion spacecraft. At the Launch Equipment Test Facility, vehicle motion simulators were used to test several of these umbilicals, including the Orion Service Module Umbilical (OSMU), the Core Stage Inter-tank Umbilical (CSITU) and the Tail Service Mast Umbilicals (TSMUs) to validate they are functioning properly and ready for installation on the mobile launcher.

The OSMU will be located high on the tower and, prior to launch, will transfer liquid coolant for the electronics and air for the Environmental Control System to the Orion service module that houses these critical systems to support the spacecraft. The CSITU will be located at about the 140-foot level on the tower and provide conditioned air, pressurized gases, and power and data connection to the core stage. The umbilical will swing away before launch. The TSMUs will provide liquid propellants and power to the SLS rocket's core stage engine.

Upgraded crawler-transporter 2 took a trek along the crawlerway to Launch Pad 39B to test recently completed upgrades and modifications. Recent modifications to the crawler include redesigned and upgraded roller bearings, removal and replacement of the existing bearings with a new assembly that can carry a greater load, and an improved lubrication system. The crawler also received new 1,500-kilowatt generators, parking and service brakes, control



A tethered construction worker wearing safety gear works on one of the bolts during installation of the second half of the J-level work platforms April 15, 2016, for NASA's a Launch System rocket in High Bay 3 inside the Vehicle Assembly Building at Kennedy Space Center. The platform was installed about 112 feet above the floor, or nearly 11 stories high, inside the high bay.



A view from high above in the Vehicle Assembly Building at Kennedy Space Center on Dec. 22, 2015, shows a 325-ton crane lifting the first half of the K-level work platforms for installation in High Bay 3. The K work platforms will provide access to NASA's Space Launch System core stage and solid rocket boosters during processing and stacking operations on the mobile launcher.

Inside the RPSF, engineers and technicians practiced lifting and stacking techniques using pathfinders, or test versions, of an aft skirt and two inert segments of a solid rocket booster. The aft skirt and segments are similar to those that will be used on the SLS rocket. At launch, the twin boosters will provide more than 75 percent of the total SLS thrust and operate for about two minutes before separating from the core stage. The aft skirt is at the base of the booster and contains the system that will steer the booster nozzles.

GSDO made progress on a new Launch Control Center (LCC) Firing Room system-level platform of software called the Spaceport Command and Control System. The new software now hosts and enables the ground applications to run for nonhazardous testing at three facilities: Launch Pad 39B, the LETF and the MPPF. The master console software in LCC Firing Room 1 was verified and ready for use

system modifications, diesel engine refurbishments, vent hoods, and exhaust and other upgrades. These redesigns will give the crawler a longer operational life and enable the giant vehicle to carry the heavier loads anticipated with the Space Launch System (SLS) rocket.

The Multi-Payload Processing Facility (MPPF) and the Rotation, Processing and Surge Facility (RPSF) have been modernized and updated to support the Orion spacecraft and the SLS's modified boosters.

Orion will receive its flight load of propellant, high-pressure gases and coolant in the MPPF. The 19,647-square-foot facility was constructed in 1965. Extensive upgrades and modernizations to meet SLS design requirements and installation of state-of-the-art equipment began in 2013 and continued through 2016.

to monitor network command and polling data at all three facilities.

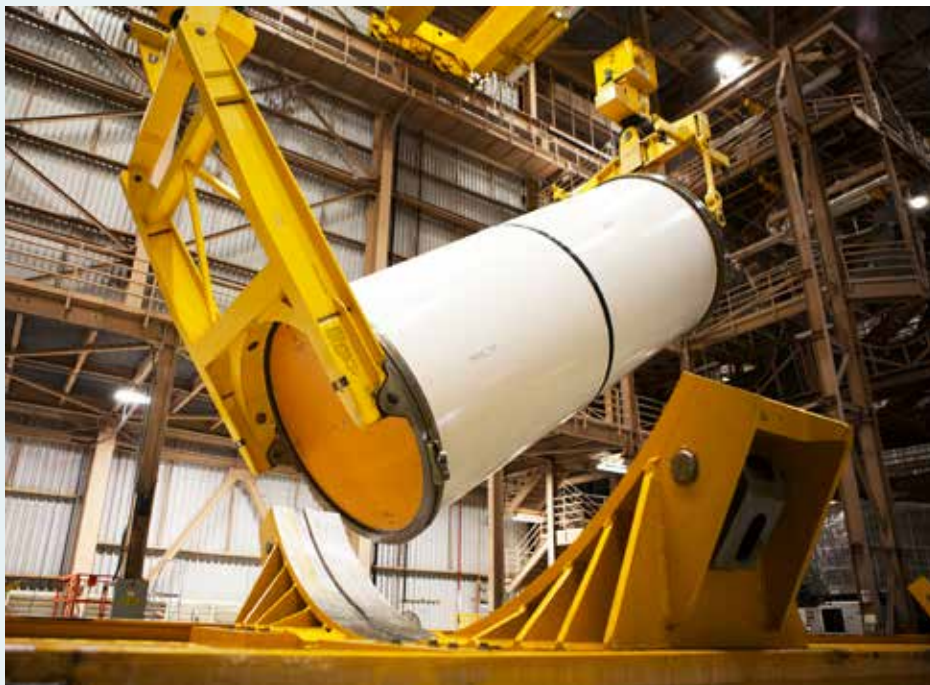
The first demonstration of the Ground Launch Sequencer (GLS) software for launch countdown also took place in LCC Firing Room 1. The software, developed by GSDO's Command, Control and Communications teams, was tested during a simulated countdown demonstration. A hold of the sequencer was initiated when fault detection occurred. After resolution of the anomaly, the software resumed successful countdown operations. The GLS will be used to sequence launch events for test flights of the SLS rocket and Orion spacecraft.

At the end of the fiscal year, GSDO's Orion Underway Recovery Team, U.S. Navy divers, Air Force pararescuemen and Coast Guard rescue swimmers practiced Orion underway

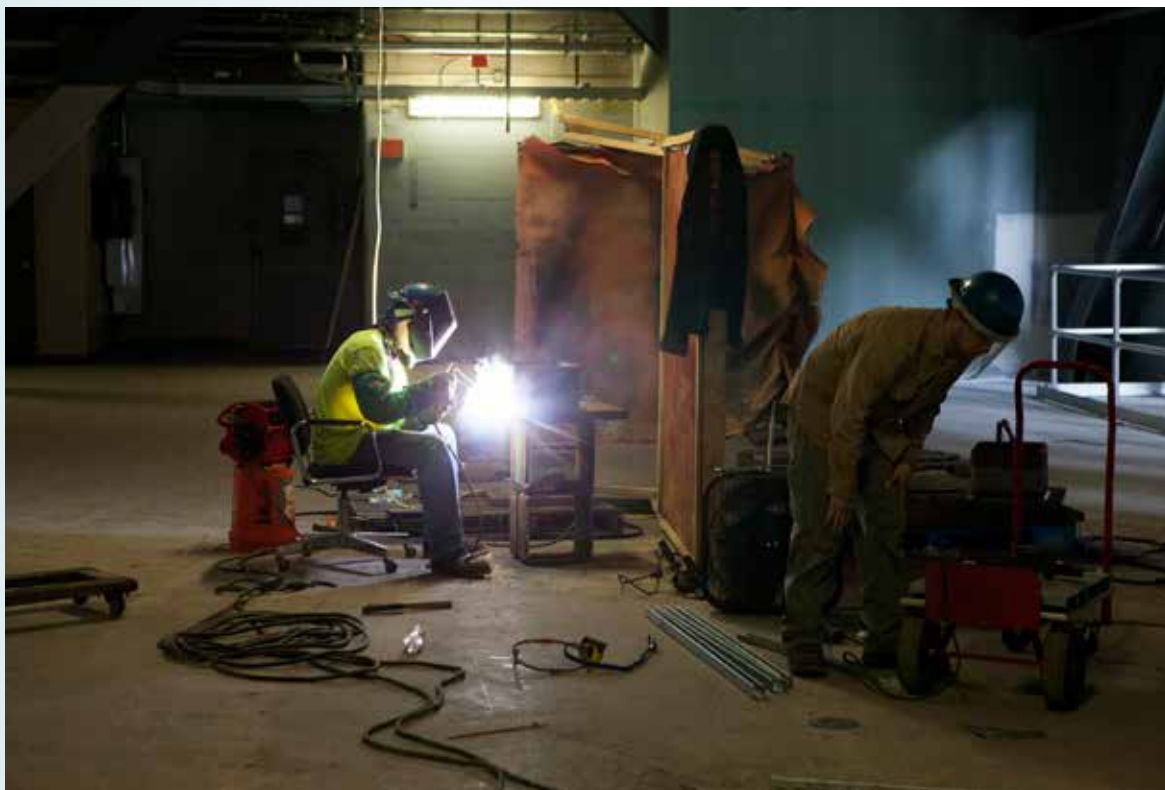
recovery techniques in the Neutral Buoyancy Laboratory (NBL) at NASA's Johnson Space Center in Houston.

About a month later, GSDO's Orion Underway Recovery Team completed Underway Recovery Test 5 (URT-5) in the Pacific Ocean, off the coast of California. The team included the Engineering Directorate, contractors with the Test and Operations Support Contract and Engineering Services Contract, Orion representatives, the team from the NBL, and the U.S. Air Force Detachment 3 from the 45th Space Wing at nearby Patrick Air Force Base. During URT-5, the team practiced recovering a test version of the Orion crew module and guiding it into the well deck of the USS San Diego. Over several days, the team demonstrated and evaluated new recovery processes, procedures, hardware and personnel that will be necessary to recover Orion after its first flight test on the SLS rocket.

GSDO continues to prepare for the first test flight of an uncrewed Orion spacecraft atop the agency's Space Launch System rocket. Upgrades and modifications continue on the center's heritage facilities and ground support equipment as the center looks forward to Exploration Mission-1, deep space missions and the Journey to Mars. ✨



▲ Inside the Rotation, Processing and Surge Facility high bay at Kennedy Space Center, a crane and lifting mechanism were used to lift the first of two pathfinders, or test versions, of solid rocket booster segments for NASA's Space Launch System rocket from a railcar on which they were delivered on Feb. 25, 2016. The Ground Systems Development and Operations Program and Jacobs, on the Test and Operations Support Contract, conducted a series of lifts, moves and stacking operations using the booster segments, which were inert, to prepare for Exploration Mission-1, deep space missions and the Journey to Mars.



▲ Construction workers weld metal parts together to support installation of work platforms in High Bay 3 of the Vehicle Assembly Building at Kennedy Space Center.

NASA's Vehicle Assembly Building at Kennedy Space Center in Florida was used to assemble and house American-crewed launch vehicles from 1968 to 2011. At 3,684,883 cubic meters, it is one of the largest buildings in the world by volume. Inside the facility, High Bay 3 is being upgraded and modified to support processing of the agency's Space Launch System rocket and Orion spacecraft.



ORION PROCESSING

The Orion production team of engineers and technicians achieved several major processing milestones during fiscal year 2016 as they prepared the Orion crew module for its flight test aboard the agency's first Space Launch System (SLS) rocket on Exploration Mission-1 (EM-1). The work was performed inside the Neil Armstrong Operations and Checkout Building (O&C) high bay at Kennedy Space Center.

In November 2015, technicians lifted the Orion crew module adapter for EM-1 for the first and only time during its processing flow. The adapter was prepared for secondary

structure outfitting.

The pressure vessel of the Orion crew module for EM-1 arrived at the center on Feb. 1, 2016. It is the internal pressure volume and structure of the spacecraft. The pressure vessel was secured on a test stand in the high bay as technicians and engineers with Lockheed Martin began primary structure outfitting and assembly. Orion continues to be outfitted with the necessary electrical and avionics systems and subsystems.

On April 21, the pressure vessel was moved into the proof pressure cell in the high bay and prepared for a series of pressure tests that were completed

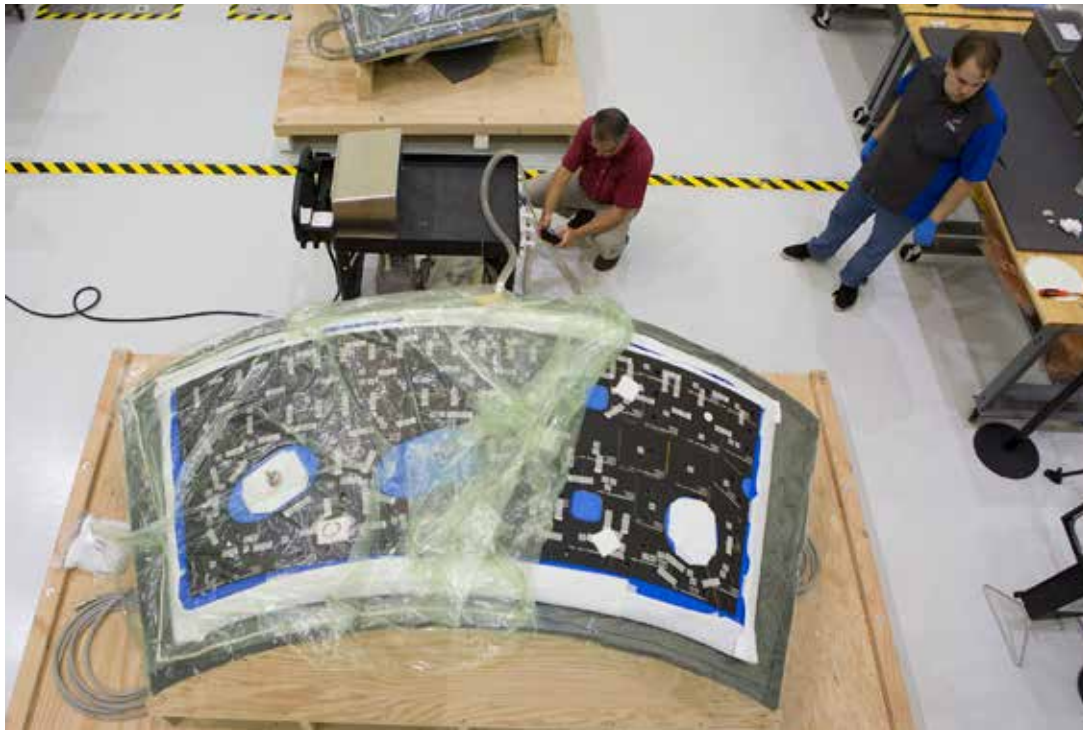
in May. The tests were conducted over several days and confirmed that the weld points of the pressure vessel were flight acceptable to withstand flight conditions and protect astronauts during launch, in-orbit, re-entry and landing phases during a crewed mission.

On July 8, technicians began bonding thermal protection system tiles on the nine panels that will cover NASA's Orion crew module. The tiles will help protect Orion from the approximately 5,000 degree Fahrenheit heat of re-entry from space.

The team achieved a processing milestone as the first propellant system



After arriving at Kennedy Space Center on Feb. 1, 2016, the Orion crew module pressure vessel was transported to the Neil Armstrong Operations and Checkout Building high bay. Members of the news media got an up-close look at Orion on Feb. 3.



Inside the Neil Armstrong Operations and Checkout Building high bay at Kennedy Space Center, technicians began bonding thermal protection system tiles July 8, 2016, on the nine panels that will cover the Orion crew module for the agency's first uncrewed flight test with the Space Launch System (SLS) rocket. While similar to those used on the space shuttle, Orion only requires about 1,300 tiles compared to more than 24,000 on the shuttle. The tiles, along with the spacecraft's heat shield, will protect Orion from the 5,000 degree Fahrenheit heat of re-entry during Exploration Mission-1, an uncrewed test flight.

tube welds on the exterior of the Orion pressure vessel were completed in August 2016. With the first tubes in place, X-ray specialists performed inspections of the welds for any imperfections.

The massive Orion heat shield for EM-1 arrived at the Shuttle Landing Facility aboard NASA's Super Guppy aircraft on Aug. 25, 2016. The heat shield was transported to the O&C where it was unpacked and secured onto a test stand to begin processing.

The first SLS mission, EM-1, will launch the uncrewed Orion spacecraft to a stable orbit beyond the Moon and bring it back to Earth for a splashdown in the Pacific Ocean. The 21-day mission will demonstrate the integrated system performance of the rocket, Orion spacecraft and the ground support teams prior to a crewed flight. ✨

Inside the high bay in the Neil Armstrong Operations and Checkout Building at Kennedy Space Center, the protective coverings were removed from the Exploration Mission-1 heat shield Aug. 26, 2016. The heat shield arrived aboard NASA's Super Guppy aircraft at the Shuttle Landing Facility, managed and operated by Space Florida, from Lockheed Martin's manufacturing facility near Denver.



EXPLORATION RESEARCH & TECHNOLOGY

The team in the Exploration Research and Technology Programs Directorate at NASA's Kennedy Space Center is continuing to advance new capabilities and cutting-edge developments. They create a pipeline that takes innovations from early-stage through flight and on to use in everyday life.

As NASA continues preparing for journeys to deep space, the technology now in development is expanding beyond the spacecraft and propulsion systems needed to get there. Agency scientists and engineers also are developing systems to harness abundant resources available in the solar system to support these pioneering missions.

One of the tools NASA is developing for this purpose is a simulated processing plant called MARCO POLO/Mars

Pathfinder. An integrated test took place this past year in the regolith bin of the Florida spaceport's Swamp Works laboratory. A mock-up of MARCO POLO worked together with the Regolith Advanced Surface Systems Operations Robot (RASSOR 2.0).

RASSOR excavated regolith and delivered sand and gravel to a hopper and mock oven. On the surface of Mars, mining robots like RASSOR will dig down into the regolith and take the material to a processing plant where usable elements such as hydrogen, oxygen and water then would be extracted for critical functions such as life support systems, rocket propellant, radiation shielding and plant growth. The excavated regolith also can be used as a construction material.



Dr. Luz M. Calle, the technical lead for Kennedy Space Center's Corrosion Technology Laboratory, checks out sample tiles at the Beachside Corrosion Test Facility.

The MARCO POLO/Mars Pathfinder spacecraft undergoes an integrated test of an in-situ resource utilization, or ISRU, system. The operation recently took place at NASA's Kennedy Space Center, in which a mock-up of MARCO POLO was put through an ISRU propellant production technology demonstration in a regolith bin with RASSOR 2.0, the Regolith Advanced Surface Systems Operations Robot. RASSOR excavated regolith and delivered sand and gravel to a hopper and mock oven.

The Swamp Works Granular Mechanics and Regolith Operations (GMRO) lab has developed a prototype large scale regolith concrete robotic three-dimensional (3-D) printer under a project called Additive Construction with Mobile Emplacement (ACME), which is able to 3-D print digital infrastructure element designs on demand.

Research into how to best excavate Martian soil includes efforts by teams of undergraduate and graduate students from across the nation. The annual Robotic Mining Competition took place at the Kennedy Space Center Visitor Complex with assistance from members of the Exploration Research and Technology team.

Students demonstrated their excavator robots, showing off technology which may prove valuable in NASA's Journey to Mars. The goal is to develop new designs and approaches to tele-robotically excavate regolith and simulated ice which is buried below the regolith surface.

The Swamp Works GMRO regolith bin also was used to check out new spacesuits astronauts may wear while exploring the surface of the Red Planet. The suits are



designed to protect the person inside, supplying air and water and flexible enough so astronauts can dig samples and perform other tasks. Current suits are designed for use in microgravity where the astronauts float in orbit, but the new suits can be used to walk and work on a planetary surface in reduced gravity. Three prestigious NASA Innovative Advanced Concepts (NIAC) Phase I and Phase II contracts were awarded to the Swamp Works in Fiscal Year 2016.

Another Phase I NIAC project in collaboration with NASA's

Jet Propulsion Laboratory in Pasadena, California, designed a concept for reflecting sunlight from the rims of lunar polar craters into the dark permanent shadows in order to power resource mining equipment operating at the bottom of the crater. A Phase II NIAC project was awarded for a spacecraft coating that could enable long-term cryogenic storage while allowing passive high temperature superconductor operation in space.

Engineers from the University of North Dakota evaluated their suit, which really acts like a miniaturized spacecraft, and it has to be built in a way that is mobile, comfortable and lets an astronaut work while exploring Mars.

Another need for deep space traveling astronauts is food. Scientists in the space center's Exploration Research and Technology Programs are studying plant growth aboard the International Space Station.

During the past year, NASA astronauts initiated the Veg-03 experiment to grow lettuce on the station. As the work progressed on the space station, members of the Veggie team watched and gave instructions to the astronauts from their

consoles in the Experiment Monitoring Area located in the Space Station Processing Facility (SSPF) at Kennedy.

There are a number of different types of plants that can be grown. So far efforts have begun with produce that is fresh and can be picked and eaten. Other crops, such as potatoes, can be added depending on available time and resources.

Kennedy's SSPF is a world-class processing laboratory. All space station cargo and each experiment for the orbiting laboratory are prepared and checked out in there, a crucial part of a premier, multi-user spaceport.

During the past year, the Stratospheric Aerosol and Gas Experiment III, or SAGE III, instrument was prepared for launch to the space station. Because of the SAGE III's special optics, additional precautions during testing and processing were necessary. A super-clean tent was built in the SSPF high bay

Inside the Veggie flight laboratory in the Space Station Processing Facility at NASA's Kennedy Space Center, Dr. Gioia Massa, the agency's Veggie project lead, prepares plant pillows for the Veg-03 experiment. The Veg-03 plant pillows contain "Tokyo Bekana" cabbage seeds and lettuce seeds for NASA's third Veggie plant growth system.





to support preparations and checkout of SAGE III.

When companies around the world want to understand the energy efficiency of a particular system or material, they often call on Kennedy’s Cryogenics Test Laboratory. For the past 20 years, the lab has worked with industry partners not only to test materials, but to help establish international standards for such tests.

The cornerstone of the lab’s offerings is being one of the best in the world to advance and improve energy efficiency with wide-ranging benefits such as ensuring the most efficient and safer coatings and protections. Additionally, because fire, corrosion and cryogenic spills are all hazards that could jeopardize a rocket launch or a vessel at sea, breakthroughs can be applied to the space program as well as everyday life.

Scientists at Kennedy are continually looking for better ways to operate at the Florida spaceport. As technical lead for the center’s corrosion technology efforts, Dr. Luz M. Calle

In the Space Station Processing Facility (SSPF) at NASA’s Kennedy Space Center, operations are underway to close out processing of NASA’s Stratospheric Aerosol and Gas Experiment III, or SAGE III, instrument on May 16, 2016. An engineer is working in a super-clean “tent” built in the SSPF high bay to protect SAGE III’s special optics.

developed an environmentally friendly smart coating that could be used in the future to detect and stop corrosion in metal.

Scientists and engineers are not the only individuals developing ideas for better ways to work. NASA encourages all employees to dream about what could be. Each year Kennedy holds an Innovation Expo to highlight employee efforts.

The event showcases exhibits and presentations which highlight innovations in technology and aeronautics, as well as plans for exploring Mars, the solar system and beyond.

If innovation and creativity are the seeds of future technologies, NASA’s Kennedy Space Center is fertile ground continually cultivated by members of the Exploration Research and Technology Directorate. ✨

COMMERCIAL RESUPPLY SUPPORT



The ISS Utilization and Life Sciences Office in the Exploration Research and Technology Programs Directorate provided support for payload and hardware processing for several commercial resupply missions during Fiscal Year 2016.

The office provided technical assistance to Marshall Space Flight Center engineers in Huntsville, Alabama, for an in-orbit anomaly involving a faulty Expedite the Processing of Experiments to Space Station, or EXPRESS, logistics carrier controller that supplies power and communications to International Space Station external payloads.

Internal Thermal Control System (ITCS) fluid, that provides cooling to

space station pressurized payloads, was manufactured at Kennedy and shipped to Johnson Space Center in Houston. The ITCS fluid loop was used during processing of various payloads, including the DDevice for the study of Critical Liquids and Crystallization payload, or DECLIC, the Phase Change Heat Exchanger, and the General Laboratory Active Cryogenic ISS Experiment Refrigerator payload, or GLACIER.

Inside the Space Station Processing Facility (SSPF) intermediate bay, a new Class 10K clean room was procured and certified to handle the processing of contamination-sensitive space station external payloads. The 10K refers to the

Inside the high bay in the Space Station Processing Facility at Kennedy Space Center, technicians help guide a container of supplies for loading into the Orbital ATK Cygnus pressurized cargo module Oct. 19, 2015.

cleanliness of the air circulating inside the clean room. It signifies that there are less than 10,000 particles greater than 0.5 micron in any cubic foot of air. The air in the clean room provides an environment that is 10 times cleaner than the air inside the Space Station Processing Facility high bay, and 150 times cleaner than the air in the average living room.

An expert team of NASA and contractor engineers, scientists and technicians provided ground processing

support for a number of International Space Station external payloads, including the Bigelow Expandable Activity Module that was delivered to the space station aboard SpaceX's eighth commercial resupply services mission, and the Stratospheric Aerosol and Gas Experiment-III, or SAGE-III, that was delivered to the space station aboard SpaceX's 10th commercial resupply services mission.

The team also supported customers as they made final preparations of the flight samples and hardware for Orbital ATK's Cygnus cargo pressurized module on the company's fourth and sixth commercial resupply services missions to the space station.

A clean room facility with fluid services and crane support for hoisting activities, including proof loads, was provided.

Several laboratories in the SSPF were made available to customers who prepared their experiments for late loading into the SpaceX Dragon cargo module at the launch pad. The experiments ranged from those requiring cold stowage to NASA's Veg-03 plant growth experiment. Support was provided for NASA's Rodent Research-3 and the Japan Aerospace Exploration Agency's Mouse Handling Unit-1.

The group also provided support for several payloads scheduled for future commercial resupply services missions to the space station. These included the Neutron Star Interior Composition Explorer payload, or NICER, that launched atop the SpaceX Falcon 9 rocket on its 11th resupply mission, and the Cosmic Ray Energetics and Mass payload, or CREAM, that will be delivered to the space station on a future SpaceX resupply mission. ✨



Members of the International Space Station Human Factors Integration Team prepare the Advanced Colloids Experiment-Temperature control-1, or ACE-T-1, science payload for flight in the Space Station Processing Facility at Kennedy Space Center on July 14, 2016. From left are engineers Chen Deng, with Boeing, and Dena Donbrosky, with ZIN Technologies.



Operations are underway to close out processing of NASA's Stratospheric Aerosol and Gas Experiment III, or SAGE III, instrument May 16, 2016, in the Space Station Processing Facility at Kennedy Space Center. Engineers and technicians prepared the device for its launch aboard the SpaceX Dragon spacecraft on its 10th resupply mission to the International Space Station.

ENGINEERING

The team in the Engineering Directorate has continued to advance engineering and technology developments that firmly establish the center as a premier, multi-user spaceport, enabling research, processing and launch site operations for government and commercial customers.

Kennedy's engineering capabilities support all of the programs at the center. The skills and expertise of engineering are evident in the many successes over this past year for the Ground Systems Development and Operations Program. Engineering has had a banner year preparing for the ground equipment systems that will support the Space Launch System (SLS), NASA's new heavy-lift rocket. Never before has the Launch Equipment Test Facility had so many umbilicals and launch accessories being tested and delivered to ready for use at the same time.

Engineering also provided support to upgrade the load-carrying capacity of crawler-transporter 2 to support future

SLS operations and launch vehicle evolution. This effort primarily consisted of the design and development of new jacking, equalization and leveling (JEL) cylinders, and design and modification of critical structural components in the crawler transporter trucks. This work represents the most significant modifications to the crawler since its original construction in the early to mid-

1960s, and will enable the transporter to carry evolving configurations of the SLS launch vehicle as the program progresses.

The consolidation of the Construction of Facilities Integration Office (CoF) into Engineering last year has proved very successful. The CoF continues to provide superior leadership and technical prowess in both institutional facilities and



The Orion Service Module Umbilical (OSMU) lines were connected to Vehicle Motion Simulator 1 on Dec. 16, 2015, to begin a series of tests, including a simulated launch test, at the Launch Equipment Test Facility at Kennedy Space Center. The center's Engineering Directorate is providing support to the Ground Systems Development and Operations Program for testing of the OSMU and other umbilical lines.



programmatic support. In 2016, the thermal energy storage (TES) tank went into operation. The TES is a water tank filled with 2.8-million gallons of cooled water designed to collect thermal energy and use it later. This technology is already producing a rebate from Florida Power and Light. The rebate must be used for conservation/sustainable resources; Kennedy's Engineering and Florida Power and Light are collaborating on how the center can utilize the funds for the most efficient use of taxpayer's dollars.

Construction of the space center's Central Campus, including the new headquarters, a 190,000-square-foot building which consolidates 11 other facilities, continues to make significant progress and is expected to begin to house occupants in late fall of 2017.

In support of the International Space

Station Program, the Engineering team provided technical expertise for station utilization experiment testing, including Stratospheric Aerosol and Gas Experiment III, Cosmic Ray Energetics and Mass, Multiple User System for Earth Sensing, and Space Debris Sensor. Engineering support was provided for several experiments, including the VEGGIE plant growth system and Advanced Plant Habitat (APH).

Engineering continues to provide mission console and investigation support for VEGGIE. The APH was designed and developed utilizing both Orbital Technologies Corp. and Kennedy Engineering resources, and the first flight items were delivered to the space station aboard the Orbital ATK CRS-7 mission, as part of the space station's commercial

A large crane towered overhead July 11, 2016, as the new, seven-story headquarters building took shape in the Industrial Area at Kennedy Space Center. The 200,000-square-foot facility will anchor the spaceport's Central Campus and house about 500 NASA civil service and contractor employees.

resupply activities. The remaining APH components are manifested on SpaceX CRS-11.

The Commercial Crew Program continues to make progress toward restoring U.S. capabilities of launching astronauts to the International Space Station, and Kennedy Engineering continues to work with our commercial partners. Both commercial partners, Boeing and SpaceX, completed many qualification tests, such as Boeing's Starliner mock-up landing scenarios and SpaceX's spacesuit qualification trials and parachute development tests.



Engineers and technicians began preflight preparations of NASA's Stratospheric Aerosol and Gas Experiment III, or SAGE III, on Dec. 1, 2015, in the Space Station Processing Facility at Kennedy Space Center. SAGE III was delivered to the International Space Station aboard the SpaceX Dragon spacecraft on a commercial resupply mission.

Kennedy's Engineering supported milestones for component- and system-level preliminary and critical design reviews for the commercial crew providers, Boeing and SpaceX. The engineering team provided valuable design, test and operational inputs to ensure these vehicles are safe and reliable systems.

The Launch Services Program continues to show tremendous accomplishment. The successful launches of Jason III and OSIRIS REX demonstrated Engineering's technical contribution to the program helping ensure LSP meets its mission in providing on-time, on-orbit and on-cost launch services.

For more than five decades, Kennedy has been the epitome of innovation as technologies have evolved, new destinations have been charted, and the paradigm has shifted in how the agency works with private



partners. This year has, indeed, been a banner year. Engineering will continue to provide technical expertise and innovative ideas to ensure customer success so that NASA is prepared and postured for our future explorations by "Engineering the Future. Today." ✨

Inside the Payload Hazardous Servicing Facility technicians and engineers attach and inspect a solar array panel Aug. 2, 2016, on NASA's Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer, or OSIRIS-REx spacecraft.



A Great Blue Heron wades in a waterway at NASA's Kennedy Space Center in Florida. The center shares a border with the Merritt Island National Wildlife Refuge. The bird is one of more than 330 native and migratory bird species, along with 25 mammals, 117 fishes and 65 amphibians and reptiles that call Kennedy and the wildlife refuge home.

SPACEPORT INTEGRATION AND SERVICES

Kennedy Space Center's Spaceport Integration and Services Directorate (SI) manages critical infrastructure and institutional services across the spaceport and balances the needs of a diverse and changing roster of government and commercial users. The directorate supports each of the agency's programs based at Kennedy and provides every major customer a single hub to address concerns or arrange for services. SI manages the implementation of commercial tenant agreements, coordinates Kennedy's processing activities and center services for all spaceport customers, and maintains a master schedule for integrating commercial and government entities into center operations. This ranges from critical operational support, transportation, or even special event coordination.

During fiscal year 2016, SI continued to provide outstanding stewardship of Kennedy facilities, utilities and infrastructure, executing facility modification and repair projects supporting center programs, and providing systems engineering expertise to assure mission readiness, long-term sustainability and quick resolution of any system anomalies or other operational support issues. The directorate supported ongoing modifications in support of Ground Systems Development and Operations (GSDO) Program, Exploration Research and Technology Program, Launch Services Program, and other government and commercial customers. SI delivered significant support to facility systems that

directly serve Exploration Missions (EM)-1 and EM-2, including providing engineering expertise in support of GSDO's platform modifications in the Vehicle Assembly Building, serving as the office of primary responsibility for facility systems on the mobile launcher, and supporting the design and development of the ignition overpressure and sound suppression system at Launch Complex 39B.

SI led the conversion of the Institutional Services Contract from a cost-plus award fee to a firm fixed price contract for the remaining three option years (FY16-FY18), providing significant overall savings to Kennedy and predictable costs for all users. The conversion scope included operation and maintenance of facilities, systems, equipment and utilities; system and design engineering services; logistics; and laboratory services.

The directorate continues to handle procurement of propellants, gases and other specialized fluids on behalf of

Representatives of Goodwill Industries were at Kennedy Space Center on Nov. 10, 2015, to support America Recycles Day activities. Employees were given the opportunity to turn in no longer needed household items on center, saving them from the landfill, and thereby, protecting the environment. From left are John Ryan and Adrienne Valek.





A gopher tortoise crosses a road at NASA's Kennedy Space Center in Florida. Kennedy shares a boundary with the Merritt Island National Wildlife Refuge. The Refuge encompasses 140,000 acres that are a habitat for more than 331 species of birds, 31 mammals, 117 fishes, and 65 amphibians and reptiles. The marshes and open water of the refuge provide wintering areas for 23 species of migratory waterfowl, as well as a year-round home for great blue herons, great egrets, wood storks, cormorants, brown pelicans and other species of marsh and shore birds, as well as a variety of insects.

the agency. During the past fiscal year, that included providing propellants support to SpaceX as the company began launching its Falcon 9 vehicle from Launch Complex 39A.

One of SI's critical infrastructure functions is the management of the center's security assets, teams and technologies in order to uphold the safety of spaceport personnel and property. The Space Coast Fire Chiefs Association awarded two of the center's fire officers with its highest honors, Fire Chief of the Year and Fire Marshal of the Year. Kennedy's helicopter pilots and the Emergency Response Team also assisted during a real-life incident to recover a fleeing suspect, and the Melbourne Regional Chamber recognized them with Life Saving Medals and Awards of Merit.

Kennedy shares its boundaries with the Merritt Island National Wildlife Refuge, which offers an array of habitats for more than 1,500 species of animals and plants. SI oversees the center programs and partnerships necessary to protect this unique environment and manage vital resources for the future. SI published Kennedy's 5-Year Sustainability Plan that addresses success stories, and performance against goals from Executive Order 13693, Planning for Federal Sustainability in the Next Decade. The center also met or surpassed eight of the 10 goals on its Sustainability Scorecard.

The directorate completed its Final Programmatic Environmental Impact Statement (PEIS) for centerwide operations during FY 2016. The PEIS evaluates the potential

environmental impacts from proposed operations, activities and facilities for a two-decade planning horizon described in the Kennedy 2012 to 2032 Center Master Plan. It considers a range of future scenarios for repurposing existing facilities and recapitalizing infrastructure.

SI held several outreach activities to increase sustainability awareness. Featured events were Energy Awareness Day, America Recycles Day and an Earth Day celebration hosted on center and at the Kennedy Space Center Visitor Complex.

NASA Headquarters conducted its triennial Environmental and Energy Functional Review at Kennedy in March 2016, recognizing the spaceport's excellent environmental program and best overall combined scorecard in the agency to date.

A technology used by NASA to protect crews working around hazardous gases soon could be called on for a number of life-saving applications, as well as the agency's new human spaceflight endeavors. Kennedy's Cryogenic Refuge Alternative Supply System (CryoRASS) and a smaller liquid air-filled backpack under development in SI's Biomedical Lab have the potential to store more than twice the amount of breathable air than traditional compressed-gas systems and provide cooling to the user. In 2016, SI's contractor won a follow-on project from the Office of Mine Safety and Health Research to develop and test a third prototype, which could lead to a certified commercial product.

As Kennedy continues its march into the next chapter in spaceflight, SI stands ready to meet the varied and complex needs of America's premier multi-user spaceport. ✨

EDUCATION PROJECTS AND YOUTH ENGAGEMENT

Fiscal Year 2016 was rewarding for Kennedy Space Center's Education Projects and Youth Engagement division, engaging with more than 61,000 students, educators and members of the general public. The office maintained its ambitious pace with a steady stream of local events while managing two agency programs: the Established Program to Stimulate Competitive Research (EPSCoR) and the Minority University Research and Education Program (MUREP) STEM Engagement (MSE).

EPSCoR

NASA is among five federal agencies conducting EPSCoR programs. EPSCoR establishes partnerships between government, higher education and industry to effect lasting improvements in the competitiveness of a state or region that has not participated equably in aerospace-related research and development.

One successful FY2016 EPSCoR project was the University of Nebraska's Detector for the Analysis of Solar Neutrons, or DANSON. Designed to detect radiation damage and materials fatigue, the sensor was launched on the Orbital ATK CRS-5 mission and is now at work aboard the International Space Station.

MUREP

MUREP is committed to sustaining NASA's diverse workforce by helping recruit underrepresented and underserved university students for careers in science, technology, engineering and mathematics, the STEM fields.

One signature MUREP STEM Engagement event in FY 2016 was the NASA Swarmathon's inaugural competition, which saw 24 teams from 26 Minority Serving Institutions (MSIs) develop robust and adaptable search algorithms for robotic swarms that act like foraging ant colonies.



Students in the My Brother's Keeper program get an inside look at NASA Kennedy Space Center's iconic Vehicle Assembly Building from the transfer aisle March 2, 2016. The Florida spaceport is one of six NASA centers that participated in My Brother's Keeper National Lab Week. The event is a nationwide effort to bring youth from underrepresented communities into federal labs and centers for hands-on activities, tours and inspirational speakers. Photo credit: NASA/Cory Huston



Students and faculty from Florida International University follow the progress of their robots during the opening round of the Swarmathon competition April 20, 2016. In the spaceport's first annual Swarmathon, students from 12 colleges and universities across the nation were invited to develop software code to operate these innovative robots known as "Swarmies" to help find resources when astronauts explore distant planets, such as Mars. Photo credit: NASA/Kim Shiflett

STEM Outreach

Outreach activities were supported by Education Team visits into the community or by hosting participants at the center.

Off Center

- * NASA Night (fourth consecutive), Dreamflight's annual "Holiday of a Lifetime," Orlando.
- * Fall 2016 STEM Day, University of Central Florida, Orlando (with Astronaut Scholarship Foundation).
- * American Heroes Air Show, Oviedo, Florida (with Kennedy Flight Operations).
- * Annual University of Scouting, Edgewater High School, Orlando.
- * AstroCamp, Boys & Girls Club, Cocoa, Florida.
- * Annual Tom Joyner Family Reunion, Kissimmee, Florida.

On Center

- * Sixth annual KSC Fall Festival (free to center employee families and guests) featured hands-on STEM activities.
- * FIRST Robotics and CubeSat teams participated in nationwide Digital Learning Network (DLN) event with release of the film "The Martian."
- * Seventh annual NASA KSC Community Day attracted more than 5,000 guests.
- * 2016 Florida Student Astronaut Challenge added middle schools to high school teams' competition.
- * Inspiring Girls through STEM (for Women's History Month) drew girls in grades 4-12 to daylong event.
- * Month-long Launching to Learn targeted rising college freshmen and sophomores.
- * Daytona State College's STEM Scholars toured KSC operational areas and labs to learn about NASA internships, fellowships and scholarships.



Funded by Human Exploration and Operations (HEO) Mission Directorate

- * Eighth annual Robotic Mining Competition attracted 46 college teams whose self-designed and -built diggers could contribute to NASA’s future space missions.

Funded by STEM Education and Accountability Project (SEAP)

- * The First Nations Launch Competition (FNL) marked the first of its three-year funding with more than a dozen tribal colleges and universities represented.
- * Network of States joined with Florida’s Department of Education and the Panhandle Area Education Consortium for three weeklong workshops for K-12 educators in the Florida Panhandle.
- * Fairchild Tropical Botanical Garden partnered with NASA for Growing Beyond Earth, where 100 Florida middle and high school classrooms conducted bona fide research to help KSC’s VEGGIE team determine which edible plants might grow best aboard the International Space Station.
- * Astrocamp summer sessions inspired second through 10th graders about STEM and NASA’s future missions of space exploration. ✨



Students from the Miami-Dade area in Florida participated in the Green Cuisine challenge where they had to create a dish fit for an astronaut. Photo credit: Fairchild Tropical Botanic Garden



Participants in NASA’s 7th annual Robotic Mining Competition (RMC) uncrate a robotic excavator as the team prepares for practice runs and competition May 16, 2016, at the Kennedy Space Center Visitor Complex in Florida. The RMC is set up for college students to design and build a mining robot that can travel over a simulated Martian surface, excavate regolith — or Mars dirt — and deposit as much of it as possible into a bin, all within 10 minutes. The competition focuses on technologies necessary to extract consumables such as oxygen and water to support human life and provide methane fuel to spacecraft.



Launch vehicles used by NASA in its history of exploring space are displayed in the "Rocket Garden" adjacent to the new Heroes and Legends attraction at the Kennedy Space Center Visitor Complex.

COMMUNICATION & PUBLIC ENGAGEMENT

NASA's Communication and Public Engagement Directorate serves as the world's window into work at the agency's Kennedy Space Center in Florida. During Fiscal Year 2016, a vast array of media was used to tell the story of the premier, multi-user spaceport.

The eyes of the world focus on Kennedy each time a rocket launches, whether to Earth orbit or a distant destination in the solar system. During the year, NASA Communications hosted scores of news and social media representatives for two missions by the Launch Services Program (LSP) and four Commercial Resupply Services trips to the International Space Station.

While a rocket launch is always dramatic, Kennedy's Communications team also invited media to numerous events highlighting work at the center.

- Oct. 16, 2015 - NASA's Innovation Expo highlighted Kennedy's technology that is driving the advances needed to send humans farther into the solar system than ever before, including the ambitious Journey to Mars.
- Jan. 22, 2016 - News media were invited to see the Orion crew module pressure vessel for NASA's Exploration Mission-1 when it arrived. Opportunities also were provided to interview key managers about the important milestone toward exploration beyond low-Earth orbit.
- Feb. 25 - Members of the news media were given an opportunity to tour solid rocket booster processing facilities for the Space Launch System rocket that will launch the Orion spacecraft.
- April 20-21 - Students from minority-serving



A ceremonial ribbon is cut Sept. 18, 2016, for the opening of the new Destination: Mars experience at the Kennedy Space Center Visitor Complex. From the left are Therrin Protze, chief operating officer of the visitor complex, Center Director Bob Cabana, Apollo 11 astronaut Buzz Aldrin, Kudo Tsunoda of Microsoft, and Jeff Norris of NASA's Jet Propulsion Laboratory. Destination: Mars gives guests an opportunity to "visit" several sites on Mars using real imagery from NASA's Curiosity Mars Rover.

universities and community colleges around the country demonstrated their skills programming "Swarmie" robots.

- April 21-22 - NASA celebrated Earth Day with a variety of live and online activities.
- May 16-20 - During NASA's Robotics Mining Competition, teams of undergraduate and graduate students from throughout the nation demonstrated their excavator robots.
- Aug. 13 - News media watched as the Starliner crew access arm and white room were installed on the launch umbilical tower at Cape Canaveral Air Force Station's Space Launch Complex-41.
- Aug. 20 - Members of the news media were invited



NASA and industry leaders speak to media in Kennedy Space Center's Press Site auditorium at a post-launch news conference following the liftoff of NASA's Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer spacecraft, or OSIRIS-REx. OSIRIS-REx lifted off atop an Atlas V rocket from Space Launch Complex 41 on Cape Canaveral Air Force Station in Florida on Sept. 8, 2016.

Collaboration, May 9-12, 2016. A total of 800 were reached at the American Board of Bioanalysis Business Services Symposium in Poland on Sept. 15, 2016. At a

to get a close-up view of NASA's Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer spacecraft, or OSIRIS-REx, prior to its launch to the asteroid Bennu on Sept. 8, 2016.

During Fiscal Year 2016, Kennedy Communications not only invited news and social media to the Florida spaceport, exhibits were taken to 65 activities around the country. These included Daytona Speed Week, South by Southwest in Austin, Texas, the USA Science and Engineering Festival in Washington, D.C., and the Chicago Air & Water Show. The total audience for these events was more than 3,295,000.

Kennedy's Speakers Bureau provides employees with an opportunity to be ambassadors for NASA and the center. Over the past year, more than 80,600 heard presentations at 301 events. Highlights included an audience of 5,000 at the U.S. Virgin Islands Montessori School

Puerto Rico Department of Labor event on Aug. 26, 2016, the audience was 500.

Kennedy Communications also oversees the contract and collaborates with Delaware North to manage the Kennedy Space Center Visitor Complex and its facilities. In 2016, more than 1.5-million were guests for the bus tours, IMAX movies and its exhibits, including Space Shuttle Atlantis.

These events highlight the ways Kennedy's Communication and Public Engagement Directorate continues to share the value of NASA's mission, unique capabilities and contributions, helping inspire the next generation of explorers. ✨



Members of the news media receive a briefing on a forward skirt that will be used on a solid rocket booster for NASA's Space Launch System (SLS) rocket on March 1, 2016, in the Booster Fabrication Facility at Kennedy Space Center. The Orion spacecraft will launch on its first uncrewed test flight atop the SLS on Exploration Mission-1.

KENNEDY BUSINESS REPORT

The Kennedy Space Center Fiscal Year 2016 budget was \$2.6 billion. The center also performed \$184.2 million in reimbursable work with other government and commercial entities.

During FY 2016, the Commercial Crew Program (CCP) and partners, Boeing and SpaceX, continued to make significant progress toward a human-rated certification. Through the utilization of the Commercial Crew Transportation Capability contracts, the partners executed many key technical and critical design review milestones that aided in demonstrating the advancement of their certification strategy. CCP worked diligently with each partner to ensure successful completion of each certification milestone through a robust public-private partnership model. As a result, the partners continued to demonstrate technical maturity in the design, development and testing of their critical launch systems. CCP also worked to award the partners additional Post Certification Missions (PCMs) and issued Authority to Proceed on two PCMs for both Boeing and SpaceX (for a total of four PCMs). The ultimate goal of the program is to ensure crew rotation services are available for transporting our astronauts to and from the International Space Station aboard a U.S.-made vehicle. The success of this program leads to the Florida Spaceport becoming a premier launch complex for human spaceflight.

In FY 2016, the Launch Services Program supported two successful mission launches: Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer (OSIRIS-REx), from Cape Canaveral Air Force Station in Florida, and Ocean Surface Topography Mission (OSTM-Jason-3) from Vandenberg Air Force Base in California. The program also procured launch vehicle services and other support for several manifested missions scheduled to launch in FY 2017 and beyond.

The Ground Systems Development and Operations Program budget included both Exploration Ground Systems and the 21st Century Space Launch Complex. In support of the modernization and compatibility efforts for the Exploration Mission-1 launch of the Space Launch System rocket and the Orion spacecraft, key accomplishments included continuation of the mobile launcher ground support equipment installation, Vehicle Assembly Building platform construction, Launch Complex 39B flame trench construction, development of the Spaceport Command & Control System, and successful completion of Booster Pathfinder operations in the Rotation Processing and Surge Facility. In addition, enhancements for the 21st Century Space Launch Complex continued for the development of ground operations infrastructure to facilitate the activities of future customers and stakeholders, including government agencies, commercial industry, and current and future NASA programs.

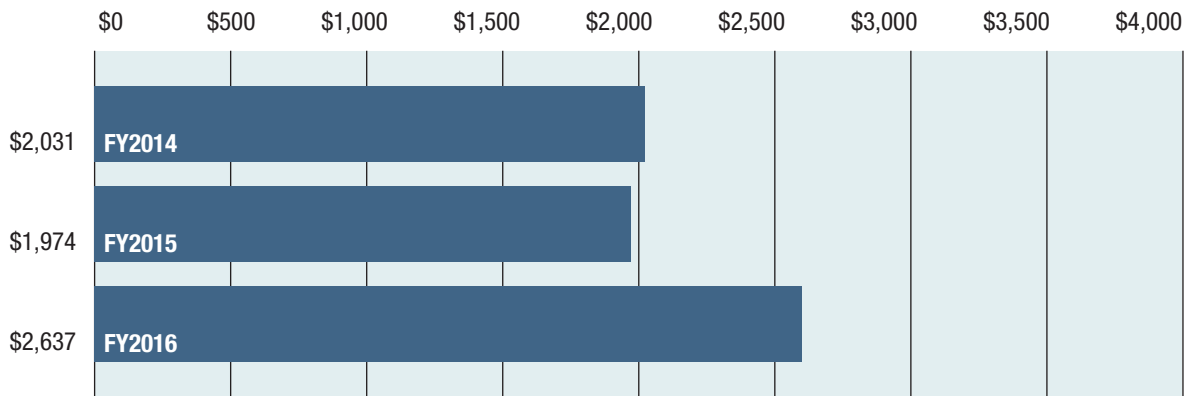
The International Space Station Program allowed for continued success toward achieving and maintaining the space station program mission of fully utilizing a permanent human outpost in space. Kennedy mission efforts afforded provisions for ground processing support for experiment hardware, as well as orbital replacement units needed to maintain the space station. The budget also provided for ongoing development of hardware intended to promote full utilization of the space station through the establishment of fundamental biological research capabilities.

Kennedy's Center Management and Operations maintained the center's essential infrastructure, its core technical capabilities, and sustained necessary safety and engineering technical authorities to support NASA's mission and enable multi-user spaceport readiness.

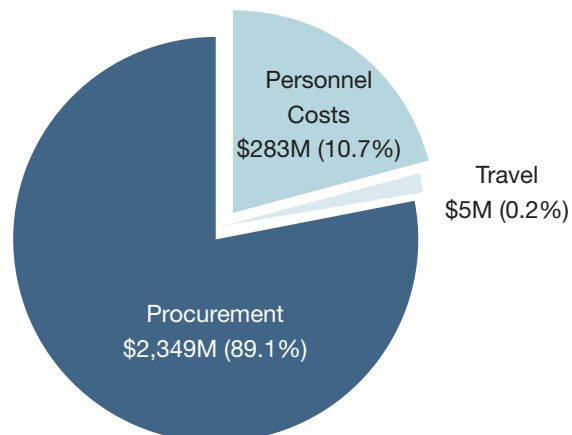
Kennedy Space Center FY 2016 Budget Authority (\$ in Millions)

Commercial Crew Program	\$1,180
Launch Services/Science	\$341
Ground Systems Development and Operations	\$412
Space Station	\$91
Center Management & Operations	\$345
Other	\$268
Total KSC	\$2,637

NASA/KSC Budget Authority Summary FY 2014 through FY 2016 (\$ in Millions)



FY 2016 KSC Budget by Element (\$ in Millions) Total \$2,637M



WORKFORCE OVERVIEW

Kennedy Space Center is the most broadly based, complex and successful spaceport in the world. Both NASA and contract personnel working at the center are essential to the success of Kennedy.

The workforce includes people with many skills who are dedicated to supporting the nation’s space program and NASA’s future explorations to destinations including the Journey to Mars. To accomplish the agency’s various missions, these individuals fulfill a multitude of tasks.

At the end of each year, the center takes a snapshot of its workforce. This picture includes all federal and

contractor employees chartered to work for Kennedy. Other organizations, such as the European Space Agency and Patrick Air Force Base, have roles here but are not reflected in these numbers.

As of Sept. 30, 2016, the total Kennedy population was 8,574. This includes 1,949 NASA civil servants, 110 NASA Pathways interns, 4,298 on-site contractor employees, 113 off-/near-site contractor employees, 1,537 tenants and 567 construction workers. The civil servant skill mix includes those in science, technology, engineering and mathematics positions and those in professional administrative and clerical positions.

Kennedy Space Center Workforce Profile (through 9/30/16)

Civil Servants	1,949*
NASA Pathways Interns	110
Total Civil Servants	2,059
*includes 7 part-time permanent employees	
Civil Servants Skill Mix	
Scientific, Technology, Engineering and Mathematics	68%
Clerical and Professional Administrative	32%
On-site Contractor Employees	4,298
Off-site/Near-site Contractor Employees (Excludes construction workers)	113
Total Contractor Employees	4,411
Total Construction Workers	567
Total Tenants	1,537
TOTAL KSC POPULATION	8,574

PROCUREMENT REPORT

Industry Partners at a Glance

The companies listed below were some of Kennedy Space Center's top support or launch services contractors in terms of dollars obligated in Fiscal Year 2016. Following is a brief description of their work for the agency:

The Boeing Company

The Boeing Company continued development and certification work under the Commercial Crew Transportation Capability (CCtCap) contract to develop safe, reliable and cost-effective spacecraft and rocket systems for missions to and from the International Space Station launched from the United States.

Space Exploration Technologies Corp.

Space Exploration Technologies Corp. (SpaceX) continued development and certification work under the Commercial Crew Transportation Capability (CCtCap) contract to develop safe, reliable and cost-effective spacecraft and rocket systems for missions to and from the International Space Station launched from the United States.

United Launch Services LLC

United Launch Services, or ULS, is a subsidiary of United Launch Alliance, a joint venture between The Boeing Company and Lockheed Martin Commercial Launch Services. ULS provided commercial launch services to NASA using the Delta and Atlas launch vehicles under the NASA Launch Services (NLS) II contract. Principal location for the Delta and Atlas vehicle assembly is Decatur, Alabama. Both vehicles launch from Cape Canaveral Air Force Station in Florida and Vandenberg Air Force Base in California.

Vencore Services and Solutions Inc.

Vencore provided engineering products and services to Kennedy's Engineering Directorate and other center and agency operational customers. Support also included laboratory and developmental shop maintenance and operations, technical

services, spaceflight systems engineering and engineering development. Vencore also provided technology outreach to foster awareness and utilization of Kennedy's unique capabilities.

URS Federal Technical Services Inc.

URS Federal Technical Services provided base operations support for Kennedy. URS Federal Technical Services was responsible for operations, maintenance and engineering for specific Kennedy facilities, systems, equipment and utilities. URS Federal Technical Services also was responsible for calibration and propellants handling at the center.

Jacobs Technology Inc.

Jacobs Technology Inc., prime contractor for the Test and Operations Support Contract (TOSC), is responsible for the overall management and implementation of ground systems capabilities, flight hardware processing and launch operations at NASA's Kennedy Space Center. Specific services provided by Jacobs Technology under TOSC include launch vehicle, spacecraft, and payload integration and processing; operations and development of associated processes for ground systems to support integration, processing and launch; servicing and testing of flight hardware; and launch of development and operational flights at Kennedy.

Abacus Technology Corp.

Abacus Technology Corp. provided communications and information technology services under the Information Management and Communications Support, or IMCS, contract. Abacus supported the majority of these requirements at Kennedy, which included support to agency programs, payloads and launch services. Services provided include hardware and software integration development, computer administration and maintenance, voice and data transmission, library, graphics, publications, printing and reproduction, and IT security.

Your Procurement Dollars at Work

Geographical Distribution by State

(Fiscal Year 2016 Obligations)

STATE	TOTAL DOLLARS	STATE	TOTAL DOLLARS
ALABAMA	9,858,695	MISSOURI	16,912
ARIZONA	1,220,125	NEW HAMPSHIRE	139,896
CALIFORNIA	571,416,476	NEW JERSEY	195,555
COLORADO	384,470,777	NEW MEXICO	43,000
CONNECTICUT	3,298,972	NEW YORK	1,822,750
DELAWARE	9,485	NORTH CAROLINA	56,549
DISTRICT OF COLUMBIA	61,587	OHIO	995,378
FLORIDA	146,668,125	OKLAHOMA	12,382,256
GEORGIA	7,888,875	OREGON	67,275
ILLINOIS	307,696	PENNSYLVANIA	17,307,734
INDIANA	2,307,395	SOUTH CAROLINA	29,773
IOWA	6,369	SOUTH DAKOTA	315,306
KANSAS	62,000	TENNESSEE	125,350,674
KENTUCKY	7,188	TEXAS	728,619,743
LOUISIANA	1,407,283	UTAH	80,627
MARYLAND	225,488,807	VIRGINIA	232,907,194
MASSACHUSETTS	200,737	WASHINGTON	233,443
MICHIGAN	725,735	WEST VIRGINIA	30,000
MINNESOTA	38,750	WISCONSIN	4,348,151
MISSISSIPPI	4,093	TOTAL	\$2,490,250,081

Top 25 KSC Business Contractors for FY 2016

Contractor	Dollars
THE BOEING COMPANY	721,523,330
SPACE EXPLORATION TECHNOLOGIES CORP.	566,910,704
UNITED LAUNCH SERVICES LLC	379,756,587
VENCORE SERVICES AND SOLUTIONS INC.	146,446,155
URS FEDERAL SERVICES INC.	126,795,337
JACOBS TECHNOLOGY INC.	116,137,163
ABACUS TECHNOLOGY CORP.	57,468,030
J.P. DONOVAN CONSTRUCTION INC.	31,708,882
AI SOLUTIONS INC.	28,691,056
CHENEGA SECURITY & SUPPORT SOLUTIONS INC.	26,511,804
ORBITAL SCIENCES CORP.	22,802,092
INTEGRATED MISSIONS SUPPORT SERVICES LLC	18,112,946
MILLENNIUM ENGINEERING AND INTEGRATION CO.	17,026,111
FLORIDA POWER AND LIGHT COMPANY INC.	12,423,738
PRECISION FABRICATING & CLEANING COMPANY INC.	11,739,158
WICHITA TRIBAL ENTERPRISES LLC	10,770,784
AIR PRODUCTS AND CHEMICALS INC.	9,427,730
AIR LIQUIDE LARGE INDUSTRIES U.S. LP	8,423,813
ASTROTECH SPACE OPERATIONS INC.	7,788,443
A. WEST ENTERPRISE LLC	7,577,512
A-P-T RESEARCH INC.	7,502,635
HENSEL PHELPS CONSTRUCTION CO.	7,399,099
PRECISION MECHANICAL INC.	6,876,803
BREVARD ACHIEVEMENT CENTER INC.	6,586,503
BRPH ARCHITECTS ENGINEERS INC.	6,094,379
TOTAL	2,362,500,794



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