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KENNEDY SPACE CENTER'S

SPACEPORT magazine

SpaceX Launches Resupply Mission to Space Station

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SPACEPORT MAGAZINE

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The SpaceX Falcon 9 rocket with the Dragon cargo module climbs upward after liftoff from Space Launch Complex 40 on Cape Canaveral Air Force Station in Florida in the early afternoon on Dec. 5, 2019. Liftoff was at 12:29 p.m. EST. This is SpaceX's 19th Commercial Resupply Services (CRS-19) mission for NASA to the International Space Station. The Dragon cargo module delivered more than 5,700 pounds of science and research, crew supplies and vehicle hardware to the orbital laboratory and its crew. Photo credit: NASA/Tony Gray/Tim Terry/Kevin O'Connell

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KSC BLOG

Kennedy Space Center has its own monthly podcast. Welcome to the "Rocket Ranch."

Check out **Episode 17: Abort!** Rockets are dangerous. And before we strap our sailors in, we need to know there is a proven escape plan. Read the full transcript and catch up on missed episodes at https://www.nasa.gov/kennedy/rocketranch.

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Space Station Resupply

SpaceX successfully launches CRS-19 to orbital laboratory

BY DANIELLE SEMPSROTT

Critical supplies, equipment and material are on their way to the **International Space Station** following the successful launch of a SpaceX Falcon 9 rocket from Cape Canaveral Air Force Station in Florida. The company's uncrewed Dragon spacecraft lifted off atop the Falcon 9 at 12:29 p.m. EST from Space Launch Complex 40 on Dec. 5, 2019, for the 19th Commercial Resupply Services (CRS-19) mission.

"It's always great when we can get a new vehicle on its way to the space station, so we're very excited," said Kenny Todd, space station operations integration manager. "We're looking forward to getting the Dragon on board here in the next couple of days."

On this spacecraft's third trip to the space station, Dragon will deliver supplies and material that will directly support dozens of science and research investigations taking place during Expeditions 61 and 62. The spacecraft also is carrying the Japanese government's Hyperspectral Imager Suite (HISUI), a next-generation, hyperspectral Earth imaging system.

A little over two minutes after launch, the rocket's first stage successfully separated from the vehicle, returning to land on the drone ship "Of Course I Still Love You" in the Atlantic Ocean. Then, Dragon separated from the Falcon 9 completely. The spacecraft is now in orbit with its solar arrays deployed, which will help power it on its solo journey to the orbiting laboratory.

"We had a beautiful launch off Space Launch Complex 40 today," said SpaceX's Andy Tran. "All around it's been a successful mission so far."

Dragon arrived at the space station Dec. 8. European Space Agency's Luca Parmitano, **Expedition 61** commander, grappled the spacecraft, with NASA astronaut **Andrew Morgan** acting as his backup. The agency's **Jessica Meir** monitored telemetry during Dragon's approach.

Following spacecraft capture – scheduled for approximately 6 a.m. – mission control in Houston sent commands to the station's robotic arm to rotate and install Dragon to the Earth-facing side of the space station's Harmony module. Dragon will remain at the orbiting laboratory for about a month before returning to Earth with more than 3,800 pounds of research and return cargo. Upon its arrival, the spacecraft will splashdown in the Pacific Ocean off the coast of Baja California.

The SpaceX Falcon 9 rocket with the Dragon cargo module lifts off Space Launch Complex 40 on Cape Canaveral Air Force Station in Florida in the early afternoon on Dec. 5, 2019. Liftoff was at 12:29 p.m. EST. It was SpaceX's 19th Commercial Resupply Services mission for NASA to the International Space Station. Dragon delivered more than 5,700 pounds of science and research, crew supplies and vehicle hardware to the orbital laboratory and its crew. Photo credit: NASA/Tony Gray/Tim Terry/Kevin O'Connell

A Look Back

End of year brings NASA closer to Artemis launches

BY DANIELLE SEMPSROTT

As 2019 draws to a close, teams at NASA's Kennedy Space Center in Florida have been hard at work preparing for the agency's **Artemis I** launch – the first test flight of the **Space Launch System** (SLS) rocket to send the **Orion** spacecraft around the Moon. This mission is the first in a series designed to support NASA's Artemis program and broader **Moon to Mars** exploration approach.

NASA's **Exploration Ground Systems** (EGS) is actively working to modify the infrastructure and ground support equipment necessary to process the launch and recovery of SLS and Orion. The **mobile launcher** – the 380-foot-tall ground structure that will be used to assemble, process and launch SLS – has undergone integrated testing inside the **Vehicle Assembly Building** and at newly renovated **Launch Pad 39B**, validating it can communicate effectively with the facility systems and ground systems to perform appropriately during launch.

The EGS team responsible for carrying out launch operations – those individuals who will actually assemble the rocket and launch it – also has been getting some practice in. The launch team, led by Launch Director **Charlie Blackwell-Thompson**, has been performing training simulations inside **firing room 1** in Kennedy's Launch Control Center. These exercises will certify the team is ready for launch and can work through any type of issue in real-time.

"2019 was all about testing all of our systems and software to make sure that we're ready when the flight hardware gets here" said Mike Bolger, manager of the EGS program at Kennedy. "This was really our year to start the transition out of a development phase and to basically get ready for operations."

Engineers and technicians had the opportunity to practice offloading, maneuvering and stacking the 212-foot-long SLS core stage using a full-scale mock-up called a **pathfinder**. The pathfinder arrived at Kennedy on NASA's **Pegasus barge** Sept. 27 and remained at the Florida spaceport for about a month before making its return trip to the agency's Michoud Assembly Facility in Louisiana. Weighing 228,000 pounds, the pathfinder helped ensure the team is properly trained and certified before the actual core stage, slated to arrive in the summer of 2020, arrives for processing.

A fully functional Launch Abort System (LAS) with a test version of Orion attached, launches on NASA's Ascent Abort-2 atop a Northrop Grumman provided booster on July 2, 2019, at 7 a.m. EDT, from Launch Pad 46 at Cape Canaveral Air Force Station in Florida. Photo credit: NASA/Tony Gray and Kevin O'Connell

Charlie Blackwell-Thompson, left, launch director for Artemis 1, and Jeremy Graeber, right, chief NASA test director, monitor activities during the first formal terminal countdown simulation inside Firing Room 1 in the Launch Control Center at NASA's Kennedy Space Center in Florida on July 12, 2019. This was the first in a series of simulations to help the members of the launch team, including personnel with NASA's Exploration Ground Systems (EGS) and Jacobs Test and Operations Contract (TOSC), prepare for the launch of Artemis 1, the uncrewed first flight of the Space Launch System rocket and Orion spacecraft. Photo credit: NASA/Kim Shiflett

The Orion crew module for the uncrewed Artemis I mission was declared complete in July. After testing of the European service module – which will power the spacecraft – and the crew module, the two were structurally attached to complete the spacecraft. Teams then **transported** Orion to the agency's Plum Brook Station in Ohio in late November, where it will undergo environmental testing to verify it can handle the deep space environment.

"It has been a tremendous year for the Orion team at Kennedy with the completion of the Artemis I spacecraft. To see Orion atop the rocket soon and start the first mission in NASA's return to the Moon will be extremely rewarding," said Scott Wilson, Orion production operations manager. "But our work doesn't stop there. The team is deep in the trenches diligently preparing Artemis II, the first crewed mission using the Orion spacecraft."

Also, the spacecraft's launch abort system was put to the **test** in early July, demonstrating it can outrun a moving rocket and pull crew to safety in the unlikely event of an emergency abort during launch.

NASA is charged with landing the first woman and the next man on the Moon by 2024. The **Gateway** in lunar orbit will be a key part of the agency's architecture of returning to the Moon, developing a sustainable presence there and getting ready for missions to Mars.

After successfully arriving at Kennedy Space Center's Launch Complex 39B, Exploration Ground Systems' mobile launcher continues its journey atop crawler-transporter 2 up to the pad surface on June 28, 2019. Photo credit: NASA/Ben Smegelsky

Inside the Vehicle Assembly Building at NASA's Kennedy Space Center, a crane lifts the Space Launch System Core Stage pathfinder high up in the transfer aisle on Oct. 16, 2019. Photo credit: NASA/Ben Smegelsky

For deliveries to the Gateway, NASA will take a commercial approach– similar to the agency's commercial resupply services missions to the International Space Station in low-Earth orbit. Home to the **Gateway Logistics Element**, Kennedy will lead the acquisition of commercial deliveries to deep space. The first Gateway delivery will include supplies needed for landing people on the Moon. Future services may include deliveries directly to the lunar surface and elsewhere in deep space.

"Our deep space logistics approach will be on the cutting edge of new technologies as we work with domestic and international aerospace partners," said Gateway Logistics Element Project Manager Mark Wiese. "We are creating economic opportunity in a bold, new environment; simultaneously pioneering historic development on Earth and in deep space."

To accomplish this task, the logistics element team issued a solicitation request in August 2019 for a multi-award, firm-fixed price, indefinite delivery/ indefinite quantity contract for 15 years, with a maximum value of $7 billion. Contract awards are anticipated early next year.

Establishing a sustainable presence on and around the Moon under the Artemis program will ensure NASA remains at the forefront of human space exploration.

"With this program, NASA has another opportunity to write another chapter in the book of history," said Bolger.

A hawk perches on a tree branch at NASA's Kennedy Space Center. The center shares a border with the Merritt Island National Wildlife Refuge, consisting of 140,000 acres of land, water and marshes. Within the refuge, many species of birds, reptiles, fish, amphibians and mammals can be found. Photo credit: NASA/Ben Smegelsky

DeBary Elementary School students display their hand-created satellites with pride and joy. Photo credit: NASA/Tammy Long

Mark Wiese, at left, Gateway Logistics Element manager, holds a NASA flag as DeBary Elementary School teachers take turns signing it. The flag will fly in space as part of NASA's Artemis program. Photo credit: NASA/Tammy Long

Engaging the Artemis Generation

Moon dreams and rocket screams emanated from the second-grade classrooms at DeBary Elementary School in DeBary, Florida on Nov. 20, 2019. Kennedy Space Center's Gateway Logistics Element team, led by Manager Mark Wiese, brought the wonder and excitement of NASA's Artemis lunar exploration plan to the next generation of explorers with simulated Moon walking, Gateway aggregation and docking, storytelling and satellite model creation.

"Sparking the imagination of our future Mars walkers is a big part of why we work hard every day at NASA to inspire, educate and involve the youngest among us so that the exploration baton can pass seamlessly between generations," Wiese said.

Thank you to @volusiaschools DeBary Elementary School students, teachers and administration staff for an amazing day of exploration and imagination!

Going with the Flow

EGS team tests flow of cryogenic fluids at Launch Complex 39B

BY DANIELLE SEMPSROTT

With NASA's **mobile launcher** at **Launch Pad 39B** for final verification and testing, the agency's **Exploration Ground Systems** (EGS) team completed another critical set of tests, bringing the agency even closer to the first integrated launch of the **Space Launch System** (SLS) rocket and **Orion** spacecraft for the **Artemis I** mission. Over the course of two weekends, teams tested the flow of cryogenic fluids through the pad's infrastructure – those systems that will send liquid hydrogen (LH2) and liquid oxygen (LOX) to the rocket at the time of launch.

"This is the first time that we've flowed LOX and LH2 through the pad's systems with the mobile launcher at the pad and with all the interfaces connected," said Melissa Batis, NASA operations project engineer and EGS integration lead. "Everything worked perfectly. This test was huge in validating and verifying that the ground systems at the pad function with the mobile launcher as they were designed and will be able to support the SLS rocket."

During launch, LH2 and LOX will flow from storage tanks near the pad – each of which can hold more than 800,000 gallons of propellant – to the mobile launcher's **Tail Service Mast Umbilicals**. The umbilicals will connect to the SLS **core stage**, considered the backbone of the rocket, and contain all of the fluid lines for propellant loading. The cryogenic fluids will travel about 1,800 feet from the storage tanks to the umbilicals via piping referred to as cross-country lines.

In this view, the cross-country line that liquid hydrogen will flow through can be seen stretching from the storage tank to the mobile launcher at Launch Pad 39B on Nov. 8, 2019, at NASA's Kennedy Space Center. Photo credit: NASA/Ben Smegelsky

The LOX and LH2 storage areas include hardware that was developed for the Apollo program and the Space Shuttle Program, as well as brand-new hardware elements, such as the mobile launcher. These tests demonstrated that the newer and older systems could successfully work together to support fueling of the rocket.

"It was important to couple the two together as one unit – one large LOX unit and one large LH2 unit – and validate that we could provide cryogenic propellant to the umbilicals," said Kody Smitherman, a LOX system engineer on the Test Operations and Support Contract. "And that's exactly what we've done. We can say we would've successfully loaded the rocket if it were present at the pad."

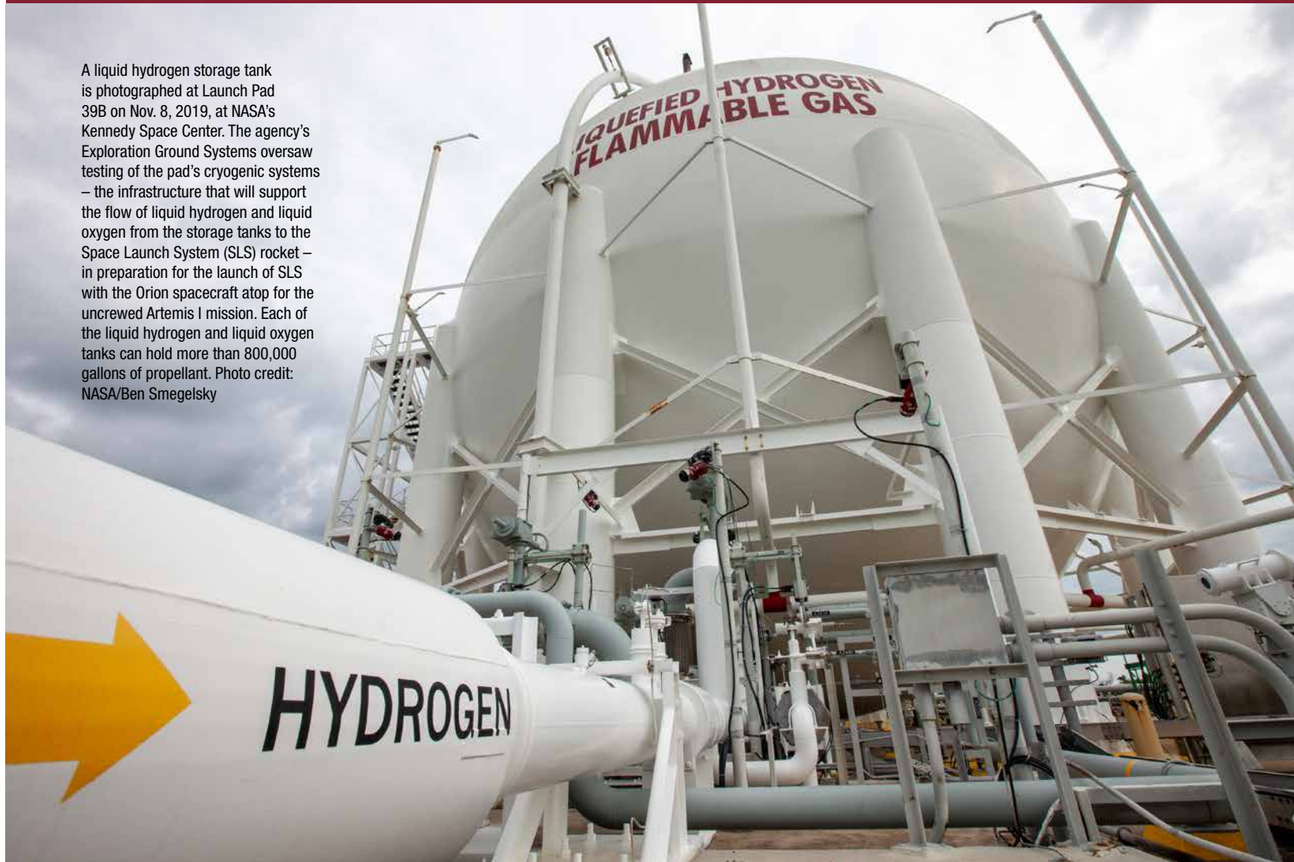
While LOX and LH2 share some similarities, such as the storage areas they come from and the lines and systems they'll flow through, they also have major differences. LOX is much heavier than LH2 – around nine-and-a-half pounds per gallon as opposed to half-a-pound per gallon – requiring the need for a pump to create the necessary pressure to push it from the tank to the rocket. The lighter LH2 will make its way up to the pad using gaseous hydrogen to pressurize the tank to begin the flow.

One other difference is how excess LOX and LH2 are handled. Any LOX left over from testing, or any that doesn't end up going into the rocket, flows to a basin and gets reabsorbed into the atmosphere. LH2 is very flammable and would ignite if released. Any excess LH2 travels to a new 60,000-gallon tank and then out to a flare stack to burn it off.

The test verified the disposal methods for excess fluids, checked for leaks, confirmed that the LOX pumps could perform appropriately and validated that piping on the mobile launcher could handle the extremely cold temperatures of LOX and LH2. The next time these systems are used will be about two months before launch for the wet dress rehearsal, during which the SLS rocket rolls out to the pad completely fueled and drained.

"Proving the ground systems work as expected under cryogenic conditions is critical, and completing this test continues our progress toward the Artemis I launch," said Charlie Blackwell-Thompson, EGS launch director.

The first in a series of complex missions, Artemis I will demonstrate the agency's ability to extend human presence to the Moon, paving the way for future missions to Mars. This test was a vital step in validating the infrastructure at Kennedy that will support those launches.



A liquid hydrogen storage tank is photographed at Launch Pad 39B on Nov. 8, 2019, at NASA's Kennedy Space Center. The agency's Exploration Ground Systems oversaw testing of the pad's cryogenic systems – the infrastructure that will support the flow of liquid hydrogen and liquid oxygen from the storage tanks to the Space Launch System (SLS) rocket – in preparation for the launch of SLS with the Orion spacecraft atop for the uncrewed Artemis I mission. Each of the liquid hydrogen and liquid oxygen tanks can hold more than 800,000 gallons of propellant. Photo credit: NASA/Ben Smegelsky

Aft Exit Cones for NASA's Space Launch System Arrive for Artemis I

The two Northrop Grumman-manufactured aft exit cones for the **Space Launch System's** solid rocket boosters arrived at NASA's Kennedy Space Center. The left aft exit cone (in the background) arrived Nov. 4 and the right aft exit cone (in front) arrived Dec. 9, 2019. Both were shipped by truck from Promontory, Utah. Upon arrival, the exit cones were transported to the **Rotation, Processing and Surge Facility** (RPSF) where they will be checked out and prepared for the **Artemis I** uncrewed test flight.

The aft exit cones sit at the bottommost part of each of the twin boosters and are attached to the nozzle. The exit cones help provide added thrust for the boosters, while protecting the aft skirts from the thermal environment during launch.

Other booster segment hardware currently at Kennedy are the forward assemblies which include: a forward skirt, frustum and nose cap, which house the avionics and the aft skirt assemblies, which contain the thrust vector control system. Each assembly also contains four booster separation motors. The forward and aft assemblies are nearing the end of assembly operations in the Booster Fabrication Facility and will be ready for integration in the RPSF soon.

Photo credit: NASA/Kim Shiflett

Mystery on the Mobile Launcher

BY LAURA AGUIAR

The **mobile launcher** that will launch the **Space Launch System** (SLS) rocket and **Orion** spacecraft to the Moon under the Artemis program is almost complete at NASA's **Kennedy Space Center** in Florida. Within its 355-foot tower of steel and 25-foot-tall base there is a busy hive of engineering and mechanical activity. Engineers are testing networks and systems, securing insulation and pressurizing valves. Hundreds of people play a part in the fabrication of the high-rise support structure, and some have left their mark

In many larger construction projects at Kennedy, it is traditional to have a final piece of the structure ceremoniously signed or personalized by the construction team as a way of finishing the project and stamping it with the pride of those involved in the process. In the case of the mobile launcher, contractor J.P. Donovan Construction selected several quotes as final touches to stand in place of signatures, subtly placed where few may see them.

Far below the crew access arm located at the 274-foot level, below the system that will control the loading of cryogenic fuel, is the mobile launcher's platform deck. Below that, electrical and support systems are tucked away inside the cavernous bowels of the mobile launcher's platform. When work is complete, eight haunch doors will be bolted in place to seal off access to the haunches, the area that helps provide base pressurization for launch. The haunches are structural support for the vehicle support posts that hold the rocket on the mobile launcher. They are accessed through the mobile launcher base into a cavity.

"My work takes me just about everywhere on center, and I heard about some carefully scripted quotes etched into the haunches," said Dan Newfang, a senior industrial hygienist/toxicologist. "I wondered if it was an urban legend."

Dan found time to take a closer look and let a few others know what he uncovered. A box of school chalk exposes the inscription:

"I came here to be part of something immense:
To work where Hero and Visionary congregate.
Not as a teaspoon of water to the Ocean
Rather, for my sweat and tears to be its salt.
Beyond a rivet in her silver hull
To the mettle she is made of."

A total of eight quotes are inscribed on the inside of each of the heavy metal doors that will guard and protect electronics from the extreme temperatures at launch.

"The United States was not built by those who waited and rested and wished to look behind them. This country was conquered by those who moved forward. And so will space." –John Fitzgerald Kennedy

The process for selecting quotes is a little different than signatures of the team. The quotes were chosen and written as a tribute to the spirit of space exploration and the hard work of past and future generations in achieving a lofty goal.

"When I first looked back at the Earth standing on the Moon, I cried." –Alan Shepard

"During our 2013 contract with NASA to fabricate and install the structural upgrades for the SLS mobile launcher, there were

A quote from astronaut Alan Shepard is etched into one of the eight haunch access doors located in the mobile launcher platform. Photo credit: NASA/Frank Michaux

Left: Each of the eight haunch access doors located in the mobile launcher platform contains an inspirational quote related to space travel. The quotes are from John F. Kennedy, H.G. Wells and Werner Von Braun, among others. The heavy metal doors will be bolted in place to protect electrical and support systems during liftoff of the Space Launch System rocket and Orion spacecraft. Photo credit: NASA/Frank Michaux

a few items which were left to the contractor to both design and fabricate," J.P. Donovan Lead Engineer Bill Layden said. "The haunch access doors were one of these items."

"If seeds in the black earth can turn into such beautiful roses, what might not the heart of man become in its long journey towards the stars?" –G.K. Chesterton

As lead engineer, Layden sent his drawings for the haunch access doors to the fabrication shop. They were to be some of the final pieces sent to the job site, and the fabrication manager approached Layden with a suggestion.

"He asked me to dig up some short, inspirational quotes related to space travel," Layden said.

The fabrication manager did the same and they each came up with a quote of their own.

"Life forever dying to be born afresh, forever young and eager, will presently stand upon this Earth as upon a footstool, and stretch out its realm amidst the stars." –H.G. Wells

The fabrication manager programmed the words into the plasma cutting and etching machine. After applying NASA's required protective coating, the words are almost, but not quite, invisible.

"Safely stagnant shallows
comforting to some
vast oceanic cosmos
calling those who dare." –WHL

A Werner Von Braun quote is found on one of the eight haunch access doors located in the mobile launcher platform. Photo credit: NASA/Frank Michaux

"At times, over these past many years, we have gravitated towards a quote from Werner Von Braun more than some of the other, more eloquent ones," Layden said.

"Our two greatest problems are gravity and paperwork. We can lick gravity, but the paperwork is overwhelming." –Werner Von Braun

Layden figured no one else would know about the words and it would be a quiet contribution to the project.

"To me, the quotes seemed to be a small, but heartfelt talisman for the safety of future astronauts who might leave Earth from the very structure we had worked so hard on," Layden said.

Practicing Booster Pathfinder Stacking Operations

Teams from NASA's **Exploration Ground Systems** and **Space Launch System** (SLS) practice SLS booster stacking with pathfinders inside Kennedy Space Center's **Vehicle Assembly Building**. The goal of the training, which took place Nov. 18 through Nov. 20, was to practice booster segment mate. Using overhead cranes and booster handling activities, the teams focused on procedures for mating a center segment onto a cylinder that simulated another segment. The exercise was performed around the clock, operating three shifts per day. SLS will launch the first woman and next man to the Moon by 2024 through the **Artemis** program. For more information, click **here**. Photo credit: NASA/Kim Shiflett

The Boeing CST-100 Starliner spacecraft is seen after it landed in White Sands, New Mexico on Dec. 22, 2019. Photo credit: NASA/Bill Ingalls

NASA, Boeing Complete Successful Landing of Starliner Flight Test

Boeing's CST-100 Starliner spacecraft completed the first land touchdown of a human-rated capsule in U.S. history on Dec. 22, 2019 at White Sands Space Harbor in New Mexico, wrapping up the company's uncrewed Orbital Flight Test as part of NASA's **Commercial Crew Program**.

Starliner settled gently onto its airbags at 7:58 a.m. EST (5:58 a.m. MST) in a pre-dawn landing that helps set the stage for future crewed landings at the same site. The landing followed a deorbit burn at 7:23 a.m., separation of the spacecraft's service module, and successful deployment of its three main parachutes and six airbags.

"Congratulations to the NASA and Boeing teams on a bullseye landing of the Starliner. The hardest parts of this orbital flight test were successful," said NASA Administrator Jim Bridenstine. "This is why we conduct these tests, to learn and improve our systems. The information gained from this first mission of Starliner will be critical in our efforts to strengthen NASA's Commercial Crew Program and return America's human spaceflight capability."

Although Starliner did not reach its planned orbit and dock to the International Space Station as planned, Boeing was able to complete a number of test objectives during the flight related to NASA's Commercial Crew Program, including:

- Successful launch of the first human-rated United Launch Alliance (ULA) Atlas V rocket
- Checked out the Starliner propulsion systems
- Tested space-to-space communications
- Confirmed Starliner tracker alignments using its navigation system
- Tested Starliner's NASA Docking System
- Validated all environment control and life support systems
- Completed a positive command uplink between the International Space Station and Starliner

"Today's successful landing of Boeing's CST-100 Starliner spacecraft is a testament to the women and men who have dedicated themselves to ensuring Starliner can safely transport crews to low-Earth orbit and back to Earth," said Boeing Senior Vice President of Space and Launch Jim Chilton. "The Starliner Orbital Flight Test has and will continue to provide incredibly valuable data that we, along with the NASA team, will use to support future Starliner missions launched from and returning to American soil."

"This mission has only strengthened the resolve of the NASA, ULA, and Boeing teams," said NASA Deputy Administrator Jim Morhard. "Systems were tested, but more importantly, the teams were tested. The hardest parts of this mission were a tremendous success. The Commercial Crew Program is strong. But keep in mind, this is a great reminder that human exploration is not for the faint of heart. We are just getting started!"

The Starliner that landed Sunday will be refurbished for Boeing's first operational crewed mission, following the Crew Flight Test. NASA astronaut Suni Williams, who will fly on that mission, dubbed the spacecraft "Calypso" after the ship of famed explorer Jacques Cousteau.

"I love what the ocean means to this planet," said Williams. "We would not be this planet without the ocean. There's so much to discover in the ocean, and there's so much to discover in space."

The uncrewed Starliner spacecraft launched on the ULA Atlas V rocket at 6:36 a.m. Friday, Dec. 20, from Space Launch Complex 41 at Cape Canaveral Air Force Station in Florida.

Learn more about NASA's Commercial Crew Program at **https://www.nasa.gov/commercialcrew**.

The Boeing CST-100 Starliner spacecraft lands in White Sands, New Mexico on Dec. 22, 2019. The landing completed an abbreviated Orbital Flight Test for the company that still met several mission objectives for NASA's Commercial Crew Program. The Starliner launched on a United Launch Alliance Atlas V rocket at 6:36 a.m. on Dec. 20 from Space Launch Complex 41 at Cape Canaveral Air Force Station in Florida. Photo credit: NASA/Aubrey Gemignani

‘Shooting Star’ Revealed

Kennedy Space Center welcomes new cargo module mockup

BY JIM CAWLEY

A “Shooting Star” was unveiled Nov. 19, 2019 at Kennedy Space Center.

During a media event held in the Florida spaceport’s Space Station Processing Facility high bay, former NASA astronaut and current Senior Vice President of Strategy for Sierra Nevada Corporation (SNC) Space Systems Steve Lindsey revealed the name of the cargo module that will attach to the back of the company’s Dream Chaser spacecraft: Shooting Star.

“It’s an exciting day for us,” said Lindsey, a veteran of five NASA shuttle missions.

Shooting Star is a 15-foot-long cargo module that will attach to the back of the 30-foot-long Dream Chaser. It will be used to deliver more than 12,000 pounds of supplies and other cargo for NASA to the International Space Station as part of the Commercial Resupply Services-2 (CRS-2) contract. Its first flight is scheduled to launch from Kennedy in fall 2021.

“Sierra Nevada Corporation is excited to be expanding our footprint here at Kennedy Space Center,” said Kimberly Schwandt, senior communications manager for SNC Space Systems.

Dream Chaser will fly back to Earth and land on the runway at Kennedy’s Launch and Landing Facility, formerly the Shuttle Landing Facility. Shooting Star will have a different fate. It will carry unwanted cargo from the space station, disposing of it while burning up upon re-entry into Earth’s atmosphere. The process of “burning up” is where the Shooting Star name came from, Lindsey explained.

“The cargo module is really interesting because it’s kind of the unsung hero of the whole Dream Chaser cargo system design,” Lindsey said, while standing in front of a Shooting Star testing mockup. “It has a very unique shape — notice how it angles in as you go higher. It’s shaped to handle external and internal payloads.”

Payload capability includes pressurized and unpressurized cargo. Though it was designed specifically for cargo resupply services to the space station, Shooting Star can have many other applications, Lindsey said, including carrying crew, operating as a free-flying satellite and going from low-Earth to lunar orbit.

“It’s a pretty versatile system,” Lindsey said, “and the more we worked on it, the more we realized there are multiple applications for it.”

The Shooting Star mockup was recently delivered to Kennedy from SNC’s facility in Colorado. It will remain at the Florida spaceport, Lindsey said, for testing, processing and training of flight controllers.

NASA selected Dream Chaser for the CRS-2 contract, which involves launching six cargo missions to the space station by 2024.

A look at a testing mockup of Sierra Nevada Corporation’s Shooting Star cargo module in the Space Station Processing Facility high bay at Kennedy Space Center on Nov. 19, 2019. Shooting Star will attach to the back of the company’s Dream Chaser spacecraft. Photo credit: NASA/Frank Michaux

Highlighting Innovation

Employees showcase latest technologies during Innovation Days event

BY DANIELLE SEMPSROTT

Nearly 50 exhibitors gathered in the Neil Armstrong Operations and Checkout Building's Mission Briefing Room at NASA's Kennedy Space Center in Florida to demonstrate new technologies and innovations. Hosted by the Office of the Chief Technologist, the Nov. 19 showcase was part of the center's Innovation Days, aimed at fostering and encouraging an innovative culture at Kennedy.

In addition to the showcase, the center had guest speaker Lisa Watson-Morgan, NASA's Human Landing System (HLS) program manager, take part in Innovation Days. Watson-Morgan gave a presentation about the HLS program and answered questions from the audience.

Showcase participants included individuals from multiple directorates, programs and organizations across the multi-user spaceport, as well as the 2018 and 2019 winners of **Innovation Without Boundaries** – an annual forum for NASA and contractor employees to present new and inventive ideas for a chance to receive funding to put those ideas in motion at Kennedy. Innovations Days is one of several events throughout the year that highlights how employees at the multi-user spaceport are always looking for new solutions to the challenges they face as they work to accomplish the agency's missions.

"Innovation Days is an extraordinary opportunity for all of us to take time out of our busy schedules, and stop and get to understand, appreciate and get hands-on with what our teammates are doing here at KSC," said Tammy Long, who participated in the event for the first time, representing the center's **Gateway Logistics Element**.

Also a first-time participant was Melanie Pickett, a post-doctorate researcher at Kennedy working with Luke Roberson, a NASA research scientist, on developing an Algae Membrane Photobioreactor. The device would eliminate the need for sending pre-treated water – used to break down urine – to the **International Space Station**, reducing the amount of toxic chemicals that people are interfacing with.

"Because there's so much going on, it's really hard to know what other people are working on – even if those people are located just across the hall," she said. "To showcase it like this and get an overview really quickly of a lot of cool stuff is awesome."

Melanie Pickett, a post-doctorate researcher at Kennedy Space Center, participates in an innovation showcase on Nov. 19, 2019. A first-time participant, Pickett presented information on an Algae Membrane Photobioreactor she and others are developing that would eliminate the need for sending water treated with toxic chemicals – currently used to break down urine – to the International Space Station. Photo credit: NASA/Frank Michaux

Roberson pointed out that this also provides employees working on the frontline a venue to showcase technologies to members of management who may not be aware of the multitude of projects in place at Kennedy. The two-hour event was open for all Kennedy employees to attend. Center Director Bob Cabana and Assistant Director, Technical, Kelvin Manning also were in attendance, perusing the different technology demonstrations and conversing with the exhibitors to learn more.

"It never ceases to amaze me when I see the level of innovation here at KSC," said Cabana. "Innovation is the future. And I just want to thank all of you for all that you do to help KSC remain not just the best center at NASA, but one of the most innovative centers at NASA."

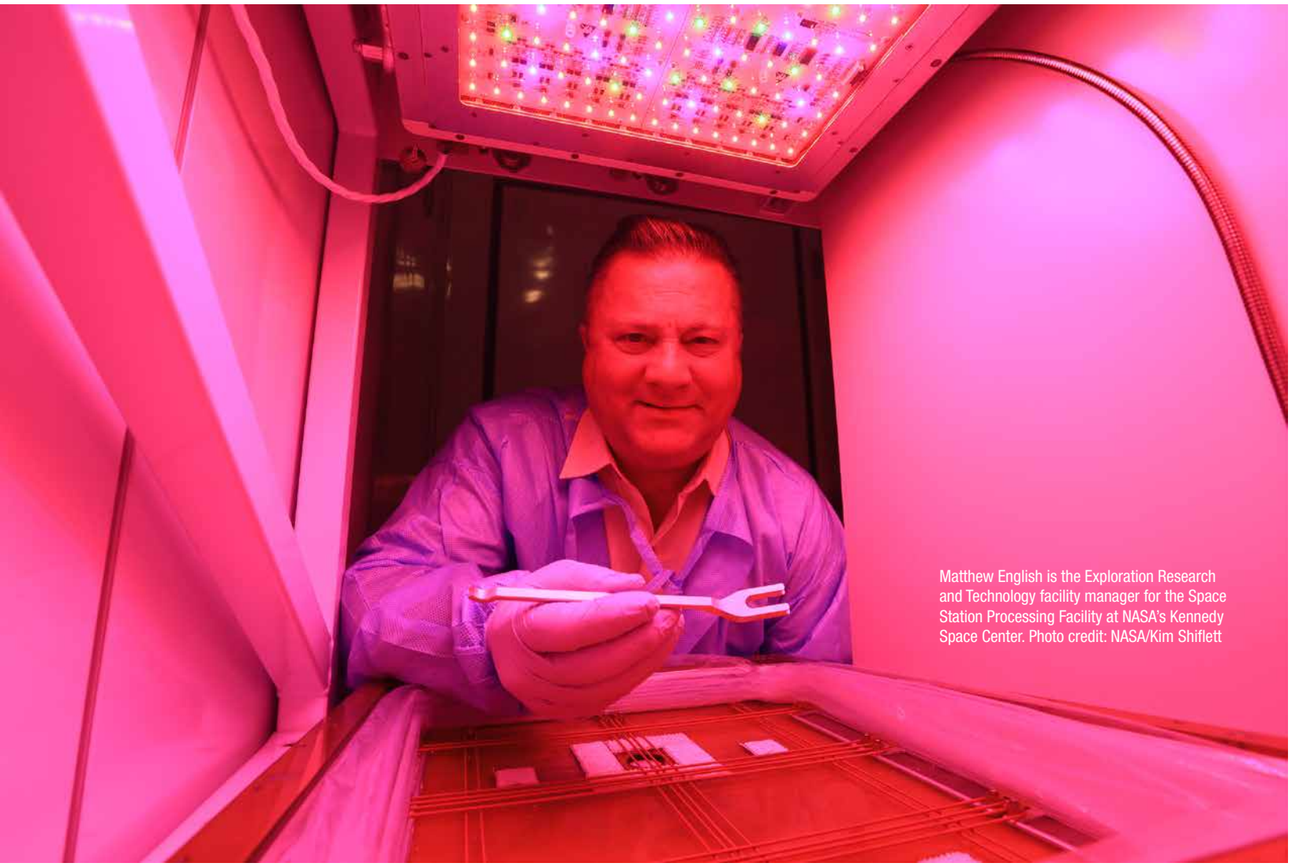
Two Kennedy Space Center employees engage in conversation during an innovation showcase on Nov. 19, 2019. Showcase participants included individuals from multiple directorates, programs and organizations throughout the center. Photo credit: NASA/Frank Michaux

Kelvin Manning, Kennedy Space Center associate director, technical, tries out a virtual headset during an innovation showcase on Nov. 19, 2019, in the Florida spaceport's Neil Armstrong Operations and Checkout Building Mission Briefing Room. Photo credit: NASA/Frank Michaux

Innovation is the Future

NASA's Kennedy Space Center
Innovators' Launchpad:

Matthew English



Matthew English is the Exploration Research and Technology facility manager for the Space Station Processing Facility at NASA's Kennedy Space Center. Photo credit: NASA/Kim Shiflett

Please explain your job in a single sentence.

I ensure that the **International Space Station** teams in the Space Station Processing Facility (SSPF) have the facilities, tools and capabilities they need to support their launch customers and are able to push the boundaries of research and design discoveries here at NASA.

What do you find most exciting about your job as the Exploration Research and Technology (ER&T) facility manager for the SSPF at NASA's Kennedy Space Center?

I love working for NASA. I feel very blessed to be a part of the team that processes hardware, then launches that hardware into orbit to support research on the space station. I also respond to the needs of NASA's future and expanding missions, including the **Commercial Lunar Payload Services** initiative and many others.

What is a typical day like for you?

Facility management affects everyone who works in the SSPF, so I face different challenges each day. From personnel moves to major facility modifications and continuous facility maintenance, as well as upgrading our capabilities to accommodate the center's needs and preparing for future needs, I provide whatever support our teams need. **Kennedy Space Center** is a multi-user spaceport, and there is always something exciting going on here.

How does your job contribute to NASA's effort to go forward to the Moon and to Mars?

Kennedy and ER&T have adapted the SSPF to continue supporting space station operations. We are also presently facilitating new customers in the SSPF including commercial and international partners that will be instrumental in our missions to the Moon as part of the **Artemis program** and to Mars. ER&T has several agreements and has offered commercial enterprises and government entities with the specialized work space they need in our low bay, high bay and our lab areas to support these endeavors.

On a personal level, I created a tool that astronauts use when working with the **Veggie** growth chamber that makes it easier for them to complete plant experiments. I feel a sense of accomplishment because they told me it has improved their lives.

What is your educational background and why did you choose to study those areas?

I have always been amazed by what makes aircraft work and aerodynamics. My education is in aircraft maintenance technology and management from Georgia Military College with FAA certifications in airframe and power plant maintenance, plus flight engineering.

What motivated you to want to work for NASA?

In 1984 I was a very young soldier and my platoon leader had an autographed picture of Robert Stewart. He was the U.S. Army's first astronaut to fly on the space shuttle. Ever since then, I set my sights on NASA as a career goal.

Why does conducting research and developing new technology matter to you?

I feel that no matter what job you are in, you can have ideas that can make a difference or improve on a product or process. We can all innovate to improve something around us.

How do you think your NASA research or the agency as a whole benefits people on Earth?

As far as how NASA **benefits people**, it's endless. NASA technology is everywhere. From **spinoff technologies** to scientific, research, and medical advancements, all the while seeking to explore every corner of our galaxy and to expand our knowledge of the universe. The NASA mission requires new technologies and we will continue to expand our knowledge of space, improve life on Earth and inspire the next generation of explorers.

The heat shield and back shell for the Mars 2020 rover are unboxed inside the Payload Hazardous Servicing Facility at NASA's Kennedy Space Center on Dec. 13, 2019. The two integral pieces of equipment, which were flown to the Florida spaceport from Lockheed Martin Space in Denver, Colorado, will protect the rover during its passage to Mars. The Mars 2020 rover is being manufactured at NASA's Jet Propulsion Laboratory in California. When completed, the rover will be delivered to Kennedy in mid-February 2020, with the mission scheduled to launch in the summer of 2020. Photo credit: NASA/Ben Smegelsky

FOCUS ON SAFETY

ERT places in top 10 at annual SWAT Round-Up International Competition

BY LINDA HERRIDGE

NASA Kennedy Space Center's Emergency Response Team (ERT) members finished in the top 10 overall during the 37th Annual SWAT Round-Up International at the Lawson Lamar Firearms and Tactical Training Center in Orlando. A team of eight of Kennedy's ERT members competed during the Round-Up held Nov. 10-15, 2019.

The team competed in five tactical challenges that were physically and mentally demanding: hostage rescue/barricade operations; officer/citizen rescue operations; high levels of physical fitness and proficiency with multiple weapons systems; use-of-force decision-making and positive target identification; and a thorough understanding of SWAT tactics and principles.

Members of NASA Kennedy Space Center's Emergency Response Team (ERT) check their firearms before competing in the 37th Annual SWAT Round-Up International at the Lawson Lamar Firearms and Tactical Training Center in Orlando, Florida. The competition was held Nov. 10 to 15, 2019, and featured five different tactical challenges. Special pellets, rather than real bullets, were used during the competition. Kennedy's ERT members exchanged best practices and competed with more than 50 teams from the U.S. and around the world. Photo credit: NASA/Frank Michaux

The family of one of NASA Kennedy Space Center's Emergency Response Team members prepares to watch the 37th Annual SWAT Round-Up International on Nov. 13, 2019, at the Lawson Lamar Firearms and Tactical Training Center in Orlando, Florida. Photo credit: NASA/Frank Michaux

A member of NASA Kennedy Space Center's Emergency Response Team switches position as he works his way along a rope above water during one of the tactical challenges at the 37th Annual SWAT Round-Up International at the Lawson Lamar Firearms and Tactical Training Center in Orlando, Florida. The competition was held Nov. 10 to 15, 2019. Photo credit: NASA/Frank Michaux

A member of NASA Kennedy Space Center's Emergency Response Team takes aim at a target during the sharpshooter tactical challenge at the 37th Annual SWAT Round-Up International at the Lawson Lamar Firearms and Tactical Training Center in Orlando, Florida on Nov. 13, 2019. Photo credit: NASA/Frank Michaux

ERT members keep up their skills by training on a regular basis. They train at the center's NASA Protective Services Training Facility, which includes multiple shooting ranges, a rappel tower and a live-fire shoot house that provide a challenging environment for the team to test and update the skills necessary to be prepared for any threat.

"The ERT's top priority is to ensure the safety of all Kennedy employees and the tens of thousands of tourists that visit the center and the visitor complex each year," said Nathaniel Moore, Emergency Response Team commander with Chenega Infinity LLC. "We conduct weekly shift level training and full team training sessions annually to maintain proficiencies in tactical responses to all types of high risk incidents."

These risks include active shooter scenarios, hostage rescue scenarios and barricaded gunmen scenarios. The ERT attends nationally recognized training conferences and seminars, including the SWAT Round-Up International training conference and competition.

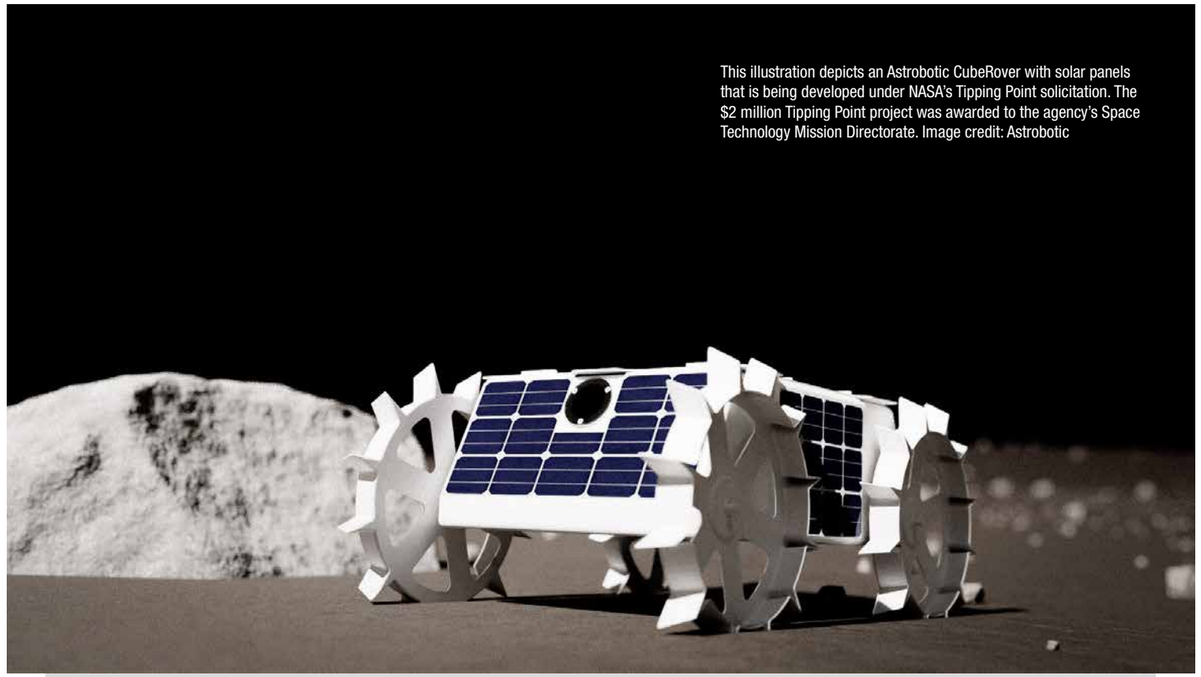
During the Round-Up, ERT members also engaged in specialized training and operational debriefs, met to discuss common issues and challenges facing law enforcement, compared training and operational methods, and continued to build on relationships with neighboring agencies that can support each other during real-life critical incidents.

They competed with more than 50 teams from the U.S. and around the world. International competitors included teams from Brazil, Estonia, Germany, Hungary, Jamaica and the United Arab Emirates.

Some of the family members of the ERT team attended to help support and cheer them on during the challenges.

"It is rare that family members have the opportunity to watch SWAT officers train," said ERT Lieutenant Clint Knowles. "It is always cool to see the kids out here supporting their mother or father and the law enforcement community."

LOOK ONLINE



This illustration depicts an Astrobotic CubeRover with solar panels that is being developed under NASA's Tipping Point solicitation. The $2 million Tipping Point project was awarded to the agency's Space Technology Mission Directorate. Image credit: Astrobotic

NASA Small Business, Tipping Point Contracts Advance Small Moon Rover

BY JIM CAWLEY

A partnership involving NASA and a Pittsburgh-based space robotics company and university will let us explore the lunar surface in new ways. The project to develop a shoebox-sized rover is part of a multifaceted approach to mature commercial space capabilities that benefit future NASA missions under the **Artemis** program.

"One of the many benefits of this project is CubeRover will be solar-powered," said Jim Mantovani, a senior physicist at NASA's Kennedy Space Center who is part of the **Swamp Works** team. "If it relied on just the battery, it would have to go back to the lander to recharge. So, this makes it a very versatile mobile platform."

Working with Kennedy, Astrobotic started to apply the idea behind CubeSats — small, low-cost satellites built to standard dimensions — to develop commercial rovers as light as five pounds. The partnership began in August 2017 when Astrobotic received NASA funding through a Small Business Innovation Research (SBIR) contract to establish the technical merit of the concept. The company received a follow-on SBIR award for research and development.

"We are very interested in companies developing exploration technologies that are commercially viable," said Mike Vinje, small business technology manager in the SBIR/Small Business Technology Transfer (STTR) Office at Kennedy. "Astrobotic was able to take the commercial potential of their NASA work and, along with the Swamp Works folks, really knock it out of the park."

In September 2019, NASA's Space Technology Mission Directorate awarded Astrobotic a $2 million **Tipping Point award** to ready CubeRover for the Moon. Partners include Carnegie Mellon University, Kennedy and NASA's Jet Propulsion Laboratory in Pasadena, California.

Read the full story at **https://go.nasa.gov/33QVj0u**.

Awesome Participation

Kennedy celebrates America Recycles Day with annual event

BY JIM CAWLEY

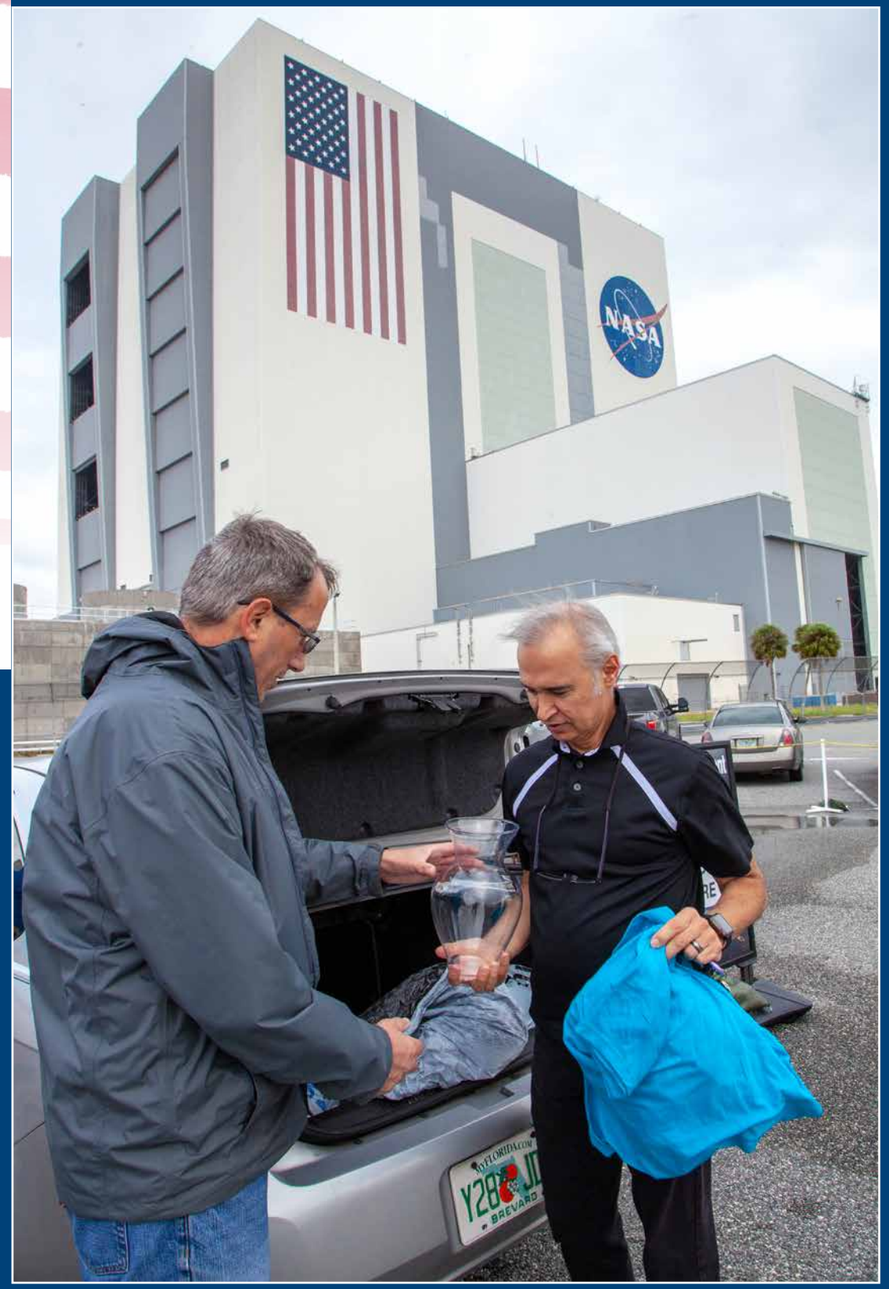
Kennedy Space Center employees dropped off everything from batteries and electronics to clothes, toys and housewares as part of the Florida spaceport's annual support of America Recycles Day.

The 2019 event was stretched over two days — Nov. 13 and 14 — featuring seven-hour stints near the Vehicle Assembly Building (VAB) and farther south in Kennedy's Central Campus area. This year, employees accounted for 211 drop-offs totaling approximately 5,500 pounds.

"The main goal was to remind employees to keep recycling their stuff and not to throw it out," said Jeanne Ryba, an Environmental Sustainability Program specialist who coordinated the events. "We add different collections; we just try to improve it every year."

Kennedy partnered with Goodwill Industries and several other local organizations, making it a win-win for all involved. Employees were able to quickly and easily unload items with the assistance of volunteers. Their donations will be recycled, resold or repurposed, all while reducing pollution.

Left: In the parking lot of the Vehicle Assembly Building at Kennedy Space Center, employees turn in used household material for recycling as part of America Recycles Day. This year, Kennedy partnered with Goodwill Industries and several other local organizations to receive donated material such as gently used household items, personal electronic waste, greeting cards and serviceable eyeglasses. Photo credit: NASA/Kim Shiflett



Above: Household items are dropped off in the Vehicle Assembly Building parking lot at Kennedy Space Center on Nov. 13, 2019, as part of America Recycles Day. Photo credit: NASA/Ben Smegelsky

"The employees love it; some collect all year long for this," Ryba said. "It's convenient — they load up their car and just pull in on their way to work or during a break."

Hypergols engineer Patrick Murr is one who had been "saving up stuff for this event." Clothes, CDs, batteries and cards were among his donated items.

"I've been wanting to clear out some clutter, and I figured this is a good opportunity," Murr said. "I kind of go toward the minimalist thing, where the less I have the better because it's less holding me down. And I feel like if I'm not using it, someone can use it."

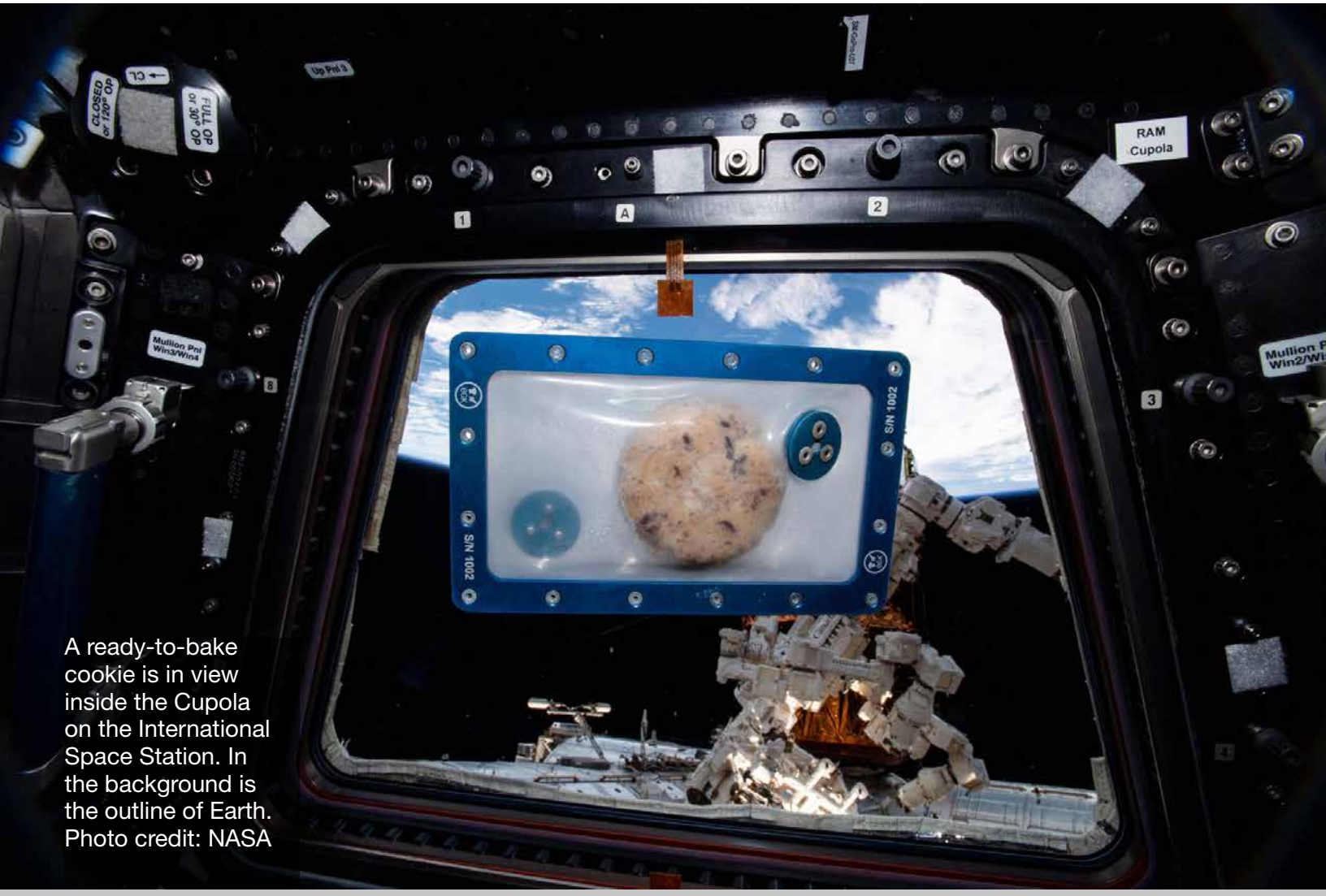
Mechanical engineer David Doerman recently bought a house, and the previous occupants left several items behind. The Kennedy event proved to be the perfect solution. Doerman, whose donations included old electronics, stuffed animals and blankets, had a main goal in mind.

"Mainly that it avoids the landfill," he said. "Beyond that, if something can go to somebody to help them, that's great. If it has to be broken down and recycled into other things, then that's good, too."

Training specialist Cindy Silvestri dropped off electronic equipment that her family was no longer using. A first-time participant, she said she greatly appreciated Kennedy's participation in America Recycles Day.

"I think it's awesome because a lot of people, like me, don't know what to do with this stuff," she said. "It's a nice outlet and people can benefit from it."

Created in 1997, America Recycles Day celebrates and promotes recycling in the U.S. Since 2009, it has been an integral part of Keep America Beautiful, the largest community improvement organization in the country.



A ready-to-bake cookie is in view inside the Cupola on the International Space Station. In the background is the outline of Earth. Photo credit: NASA

Cookies in Space

National Aeronautics and Space Administration

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