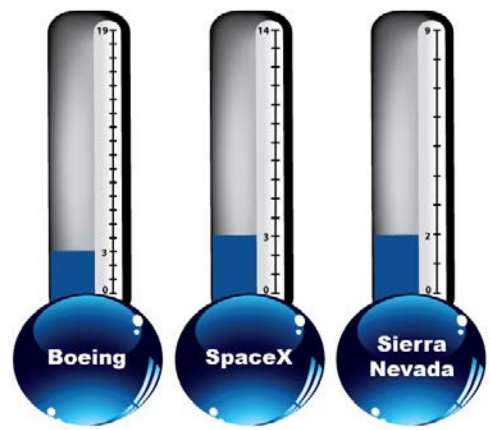
NASA's Return On Investment Report

Issue 10 **December 2012**

This bi-monthly newsletter of accomplishments, progress, and happenings in NASA's commercial crew and cargo development programs is distributed by the Commercial Spaceflight Development Division at NASA Headquarters.

Commercial Crew Progress Continues

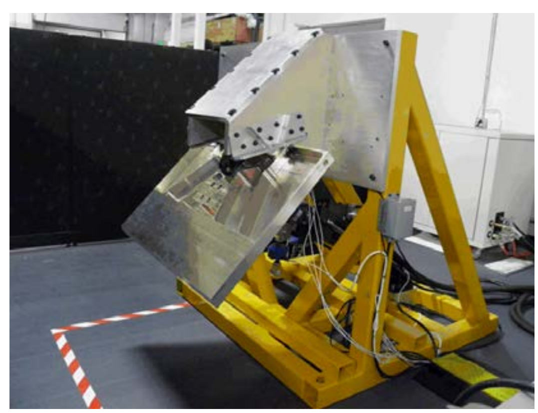
An integrated crew transportation system is a complex and difficult endeavor, and NASA's partners will inevitably experience challenges along the way. But, the success of the partners in satisfactorily completing their initial milestones is encouraging. Four months into the Commercial Crew Integrated Capabilities (CCiCap) Space Act Agreements (SAAs), NASA's industry partners have already completed a combined eight milestones.



CCiCap milestone completion status—Boeing: 3 of 19. SpaceX: 3 of 14. Sierra Nevada: 2 of 9.

In October, SpaceX conducted its Integrated System Requirements Review to evaluate its plans for system design, production, and operations and how well they will meet NASA's reference requirements. SpaceX also continued major subsystem design and testing, including testing of the company's SuperDraco launch abort engines. SpaceX's recent design efforts are in preparation for its next CCiCap Milestone—a ground system and ascent preliminary design review scheduled for later this month.

Sierra Nevada Corporation (SNC) successfully completed their second CCiCap milestone in October—an integrated system baseline review. This three-day event covered all elements of SNC's system including launch vehicle, ground and mission systems, and the Dream Chaser spacecraft. Testing of the Dream Chaser's non-toxic "green" reaction control system (RCS) also continues. The SNC team recently completed 12 successful test firings of the RCS. "The test series varied fuel and oxidizer valve timing combinations on the igniter and injector, as well as thruster ignition timing variability. These results are a significant accomplishment by the Dream Chaser propulsion team and our Aerojet teammates," said Bob Bell, SNC Propulsion Division chief. Progress also continues on the Engineering Test Article that will be used for approach and landing flight tests in the first quarter of 2013. Avionics and flight software testing is ongoing while final flight control systems are being tested and installed.



Dream Chaser body flap in testing.
Image courtesy of Sierra Nevada Corporation

CST-100 water drop test.
Image courtesy of Boeing

Boeing completed two major CCiCap milestone reviews. In October, the company held a production design review in Titusville, Florida, where Boeing personnel presented detailed plans for manufacturing, assembling and testing its CST-100 spacecraft using refurbished space shuttle facilities at NASA's Kennedy Space Center in Florida. In November, Boeing conducted a thorough safety review of its total system design. Called the "Phase I Safety Review," this event brought together Boeing, NASA, and independent safety experts for five days to study the controls for potential hazards that will ensure the CST-100, launch vehicle, and ground systems can fly humans safely to low-Earth orbit and back. In addition, Boeing recently conducted a series of water drop tests in Las Vegas to evaluate contingency landings in the ocean.

Blue Origin Completes CCDev2 with a Successful Pad Escape Test

Blue Origin pusher escape system test. *Image courtesy of Blue Origin*

In October, Blue Origin became the first Commercial Crew Program partner to successfully conduct a pad escape flight test. Using their pusher escape motor developed in-house, a full-scale capsule traveled to an altitude of 2,307 feet under active thrust vector control before descending safely by parachute to a soft landing 1,630 feet downrange. This test, conducted at Blue Origin's launch range in Van Horn, Texas, was the final milestone under its Commercial Crew Development Round 2 (CCDev2) SAA. The test simulated an abort from the launch pad, capable of transporting a crew safely away from a launch vehicle anomaly before lift-off.

This test builds on accomplishments by Blue Origin during both CCDev1 and CCDev2. Under those SAAs, Blue Origin's pusher escape system design was matured and ground tested to demonstrate and evaluate performance. Additionally, Blue Origin manufactured and conducted testing of its composite pressure vessel cabin that became part of the final pad escape flight test vehicle. "The progress Blue Origin has made on its suborbital and orbital capabilities really is encouraging for the overall future of human spaceflight," Ed Mango, manager of NASA's Commercial Crew Program said. "It was awesome to see a spacecraft NASA played a role in developing take flight."

Blue Origin is implementing an incremental development approach to mature crewed low Earth orbit crew and payload transportation capabilities by using suborbital tests to characterize systems and retire development risks. The pusher escape system was designed and developed to allow crew escape in the event of an emergency during any phase of ascent for its suborbital "New Shepard" system. The results of this test will shape the design of the escape system for the company's future orbital spacecraft. Blue Origin's long-term goal is to develop an innovative, safe and affordable commercial orbital space transportation capability.

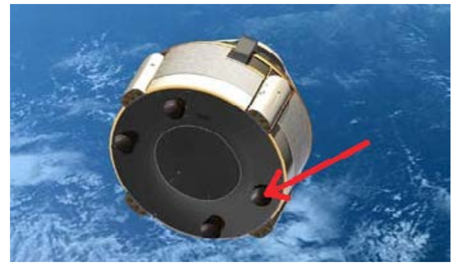
Commercial Crew's Innovative Approaches to Launch Abort

Many human spacecraft—Mercury, Apollo, Russia's Soyuz, and China's Shenzhou—include tower abort systems that "pull" the crewed capsule away from a failing rocket. Although its design has proven to be reliable, it comes with inefficiencies. Rather than depending on this heritage design, NASA's commercial crew partners are developing innovative alternative approaches that not only will allow crews to reliably escape from a launch vehicle accident, but also should prove less costly for missions to low-Earth orbit.

Previous and existing abort systems consist of independent rockets and thrusters that extend above a capsule. Used only during an emergency abort, these systems provide the thrust needed to rapidly remove a crewed capsule from the dangerous vicinity of a rocket accident and orient the capsule for a controlled descent and landing. During a nominal ascent, once past the point where the tower is needed for a potential

Test flight of Apollo's tower abort system.
Image courtesy of NASA

abort, the entire system is jettisoned and discarded since the spacecraft are not designed to carry excessive weight all the way to orbit and back to Earth. Thus, every launch requires a brand new abort tower complete with fuel, control systems, and support structure. For some applications, this is the necessary solution because of the combination of acceleration required for the ascent profile and the spacecraft's weight. For example, NASA's Orion Multi-Purpose Crew Vehicle will include a tower abort system due to its higher mass for beyond Earth exploration missions. It offers the opportunity to shed mass that is not needed for the beyond Earth operations. NASA's CCiCAP partners, on the other hand, are able to optimize for the low Earth orbit mission. They are designing systems that share functionality with other systems on the spacecraft, and in some cases will be reusable.



Artist's conception of CST-100 in flight, showing Launch Abort Engines on the aft side of the service module.
Image courtesy of Boeing

Boeing's CST-100 includes four dedicated launch abort engines (LEAs) on the aft end of the service module that work in conjunction with the nominal orbital maneuvering and attitude control thrusters. These LEAs are based on heritage designs from the Atlas II program, and are fed by the same fuel system as the rest of the service module's propulsion. When an abort is not performed, the unused propellant becomes available for use during other phases of the mission. By sharing functionality and fuel in this manner, the abort hardware is simplified and mass is minimized relative to the heritage tower approach. "Our use of previously flight-proven hardware, and an optimally integrated design approach, ensures this critical CST-100 safety system will safely return the crew if required with minimal penalty to nominal mission capabilities," said John Mulholland, Commercial Programs vice president and program manager for Boeing.

SuperDraco hot fire test.
Image courtesy of SpaceX

The abort system for the SpaceX crewed Dragon capsule will consist of eight "SuperDraco" engines attached to the side of the spacecraft. These engines use the same fuel and oxidizers as the Draco thrusters currently flying on the cargo Dragon, but produce greater thrust that is needed for abort escape from the Falcon 9 rocket in an emergency. If no abort occurs, the reusable engines will provide thrust to cushion Dragon's landing. To date, the SuperDraco engines have undergone 58 hot-fire tests for a total run time of about 117 seconds. According to SpaceX Project Manager Garrett Reisman, "The SuperDraco development and test effort is indicating that this newly designed engine will surpass our original requirements."

Dream Chaser hybrid motor test firing.
Image courtesy of Sierra Nevada

To download the latest information on the Commercial Crew Program, visit:
http://go.nasa.gov/commercial-documents

To download Phil McAlister's recent presentation to the NASA Advisory Council's Human Exploration and Operations Committee, visit: http://go.nasa.gov/STEsm4

To download the latest Commercial Crew overview briefing for public awareness, visit:
http://go.nasa.gov/12nsvrD

For more information on any of the articles in this report, contact Joshua Buck, Rachel Kraft, or Trent Perrotto in NASA's Public Affairs Office at 202-358-1100. To review NASA's other commercial space accomplishments, visit: http://www.nasa.gov/commercial/