



NASA's Return On Investment Report

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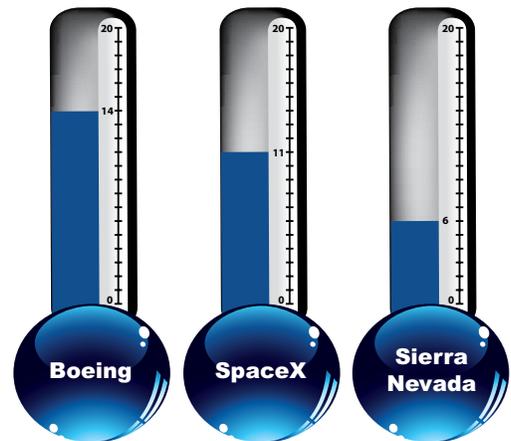
This bi-monthly newsletter of accomplishments, progress, and happenings in NASA's commercial crew and cargo development programs is distributed by the Commercial Spaceflight Development Division at NASA Headquarters.

Commercial Crew Systems Continue to Mature

NASA's Commercial Crew Program partners continue to meet all scheduled milestones, bringing the nation closer to its goal of having a U.S. capability for human access to space and ending reliance on foreign vehicles.

SpaceX recently completed five milestones:

- The Human Certification Plan Review, which laid out SpaceX's plans for certification of the design of the spacecraft, launch vehicle, and ground and mission operations systems.
- The On-Orbit and Entry Preliminary Design Review, which successfully demonstrated that the overall system preliminary design for orbit, rendezvous and docking with the ISS and entry light regimes met the company's requirements with acceptable risks and within schedule constraints.
- The In-Flight Abort Test Review, which demonstrated the maturity of the in-flight abort test article design and the concept of operations for the abort test.
- The Safety Review, which demonstrated the crew transportation system design and SpaceX processes.
- The Falcon 9 Flight Review, which demonstrated Falcon 9 launch vehicle performance, including structures, dynamics, propulsion, avionics and software.



CCiCap milestone completion status: Boeing: 14 of 20; SpaceX: 11 of 17; Sierra Nevada: 6 of 12.

Sierra Nevada Corporation (SNC) recently completed three milestones:

- The Engineering Test Article Flight Test, which was SNC's final Commercial Crew Development Round 2 (CCDev2) milestone (see next article).
- The Integrated System Safety Analysis Review #2, which demonstrated that the Dream Chaser Space System Safety documentation maturity had advanced to a post-preliminary design review level.
- The Certification Plan Review, which defined SNC's top-level certification strategy and detailed verification and validation planning.



The Boeing Engineering Simulator.

Boeing recently completed six milestones:

- The Dual Engine Centaur LO2 duct test, which characterized subsystem functionality and will inform the overall system design.
- The Orbital Maneuvering and Attitude Control Engine Development test, which supports component, subsystem and integrated spacecraft development efforts.
- The Mission Control Center Interface Demonstration Test, which demonstrated data links between the Johnson Space Center Mission Control Center and Boeing's Avionics Software Integration Facility as a precursor to future integrated simulation capability for flight operations training.

- The Certification Plan Review, which enabled Boeing to define its strategy leading to a crewed flight test.
- The Avionics Software Integration Lab Multi-String Demo Test, which successfully demonstrated the closed loop Guidance, Navigation and Control flight software for the ascent flight phase.
- The Service Module Propulsion System Critical Design Review, which tested the complex system of thrusters, engines and control network for production and integration with the CST-100 spacecraft.

Blue Origin, which extended its CCDev2 agreements with NASA on an unfunded basis earlier this year, completed the Engine Mission Duty Cycle test milestone. This test demonstrated that the primary launch vehicle propulsion can support all phases of flight, including launch, coast phase and engine relight for launch vehicle landing.

The Dream Chaser Flies!

On the morning of October 26, Sierra Nevada Corporation (SNC) performed its first free-flight approach-and-landing test of the Dream Chaser spacecraft. The spacecraft is specifically designed for atmospheric test flights in order to obtain experience and data on flight characteristics that will inform the final Dream Chaser design. Following months of preparation, including three captive-carry tests and several tow tests, the spacecraft was lifted to an altitude of 12,500 feet above sea level by an Erickson Sky Crane helicopter. The helicopter crew first performed several practice runs over the dry lakebed at Edwards Air Force Base in California, and then released the spacecraft at approximately 11:10 a.m. local time.

Following release, the Dream Chaser entered a steep dive to build speed such that the flight control surfaces could become effective. Its automated flight control system then gently steered the vehicle to its intended glide slope. Less than a minute later, the Dream Chaser smoothly flared and touched down on Edward's runway 22L, right on the centerline. The high-quality data obtained during this test



The Dream Chaser spacecraft shortly after its release from the Sky Crane helicopter.



The “pilot’s eye” view from the Dream Chaser Spacecraft on final approach to runway 22L.

will allow SNC teams to continue refining their spacecraft design as planned.

The spacecraft experienced an anomaly with the left landing gear deployment prior to touchdown, resulting in some damage to the spacecraft. The landing gear SNC used was intended to gather initial data for the test, but will not be used for future flights. SNC has formed two special teams: one to understand the anomaly and another to assess repairs and possible reuse of the spacecraft for future tests.

“NASA was very pleased with the flight portion of the Dream Chaser drop test. The vehicle performed very well and SNC will have lots of test data to use for its future development efforts,” said Phil McAlister, NASA’s director of Commercial Spaceflight Development. “The anomaly experienced during the landing was unfortunate. However, NASA is confident that SNC will learn from this test and continue to advance the Dream Chaser design.”



This flight test was the final milestone under SNC’s Commercial Crew Development Round 2 (CCDev2) Space Act Agreement with NASA. With the flight data obtained, all milestone criteria were met and NASA has accepted the milestone as completed.

The Dream Chaser spacecraft in flight, just before touchdown on runway 22L.

“CCDev2 was a critical activity for NASA by enabling us to stimulate efforts within the private sector to develop and demonstrate crew transportation systems that could reduce the gap in U.S. human spaceflight capability,” said Bill Gerstenmaier, Associate Administrator for Human Exploration and Operations.

The Innovative Commercial Cargo Program Concluded

Orbital Sciences successfully concluded its Commercial Orbital Transportation Services (COTS) demonstration flight to the International Space Station (ISS), culminating with a planned destructive entry into Earth’s atmosphere on October 23, 2013. The demonstration flight successfully accomplished all the test objectives for the flight and also transported 1,500 pounds of cargo to the ISS. This mission brings the Orbital Sciences development and demonstration effort to a close, having successfully completed all the pay-for-performance milestones in the Space Act Agreement with NASA. Orbital Sciences’ next mission, currently planned for mid-December, will be the company’s first under its Commercial Resupply Services contract to supply



Orbital Sciences' Antares rocket with the Cygnus spacecraft launching from Wallops, Virginia.

cargo transportation services to the ISS. "Orbital's successful completion of the COTS program, including two launches of the new Antares rocket and the first mission to the International Space Station by the Cygnus cargo logistics spacecraft, was the direct result of the outstanding collaboration between the NASA and Orbital engineering and program management teams," said Frank Culbertson, executive vice president and general manager of Orbital's Advanced Programs Group. "The unique structure of the COTS initiative, under which NASA's technical expertise, experienced human spaceflight workforce and well-honed safety operations standards provided the overall framework, enabled Orbital to bring the energy, innovation and discipline of the commercial sector to the program, resulting in a reliable and cost-effective resupply service."

Orbital Sciences' successful COTS demonstration mission to the ISS also brings the COTS program to a successful completion, with SpaceX completing all its milestones last year. NASA's director of Commercial Spaceflight development, Phil McAlister commented on the successful completion of the COTS program, saying: "Since its beginning in October 2005, the program has enabled two new globally competitive launch vehicles to be developed and available to international customers and the U.S. These vehicles are beginning to bring U.S. and international launch service customers back to the United

States. The program also enabled development of two new U.S. spacecraft, capable of delivering cargo to and from low-Earth orbit and the International Space Station, following Space Shuttle retirement in 2012." According to a recent SpaceNews article, COTS has been "an unqualified success story in U.S. Civil space policy." COTS program manager Alan Lindenmoyer summed up the program by stating: "Through the trusted partnerships we have forged with our industry colleagues, a new era in commercial spaceflight begins."



Orbital Sciences' Cygnus spacecraft approaching the ISS.

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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/>