



# NASA's Return On Investment Report

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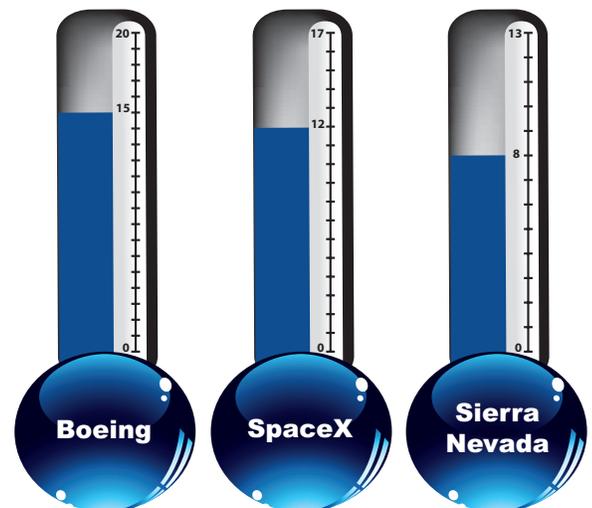


*This bimonthly newsletter of accomplishments, progress, and happenings in NASA's commercial crew and cargo development programs is distributed by the Commercial Spaceflight Development Division at NASA Headquarters.*

## CCiCap Partners Continue Progressing with Integrated Crew Transportation System Development

NASA's Commercial Crew integrated Capability (CCiCap) partners are relentlessly moving forward in the joint quest to reestablish U.S. human access to space. All the industry teams have been hard at work meeting their planned CCiCap milestones and maturing their crew transportation systems.

Boeing completed a number of crucial developmental and programmatic milestones in preparation for its integrated systems Critical Design Review (CDR) planned for later this year. Milestone 13, the Launch Vehicle Adapter CDR, confirmed that the launch vehicle adapter, which connects the CST-100 spacecraft to the United Launch Alliance Atlas V rocket, is suitable for production. The review also included wind tunnel tests verifying flight stability. The launch vehicle Emergency Detection System (EDS) Stand-Alone Testing, Milestone 14, was conducted to



CCiCap milestone completion status: Boeing: 15 of 20; SpaceX: 12 of 17; Sierra Nevada: 8 of 13.

better characterize integrated system performance using actual EDS software. The EDS monitors critical launch vehicle parameters, detects critical anomalies and provides abort status to the spacecraft to initiate escape in the event of an emergency.

Sierra Nevada Corporation (SNC) successfully completed milestone 10a, CDR Incremental Design Review #1. This review is the first in a series of reviews that will be conducted by the SNC team as it progresses toward its integrated system CDR. Additionally, SNC held the milestone 4a, Engineering Test Article (ETA) Flight Testing #1, review of aerodata and associated analysis obtained during the first free-flight of the ETA. Additional sensors installed on the vehicle for this flight provided the opportunity to better understand the aerodynamics and controllability of the Dream Chaser outer mold line configuration during the subsonic approach-and-landing phase through touchdown.

SpaceX successfully conducted milestones 15a and 15b, Dragon Parachute Tests, to validate that its new parachute design is capable of conducting a pad abort test, currently planned for this summer. Testing included dropping a full-scale Dragon article into the Pacific Ocean from a helicopter off the coast of Morro Bay, Calif.

In addition to continuing progress with CCIcap technical and programmatic milestones, all three industry partners have submitted the second set of Certification Products Contract deliverables. These deliverables include verification and validation plans and variances, alternate standards, and certification plans. The goal of this effort is to better ensure that industry's crew transportation system designs are consistent with NASA's safety and performance requirements.



A portion of the CST-100's integrated system testing was conducted atULA's System Integration Lab (SIL), which is used for hardware and software development as well as integration for Atlas and Delta launch vehicles.



The SNC Dream Chaser Engineering Test Article is transported to the company's Space Systems headquarters in Louisville, Colo., after its approach-and-landing free-flight test at Edwards Air Force Base.



In a SpaceX parachute drop test, the main parachutes control the descent of the Dragon spacecraft test article over the Pacific Ocean.

# NASA and the FAA Cooperate for the Future of Commercial Spaceflight

NASA and the Federal Aviation Administration (FAA) have complementary and interdependent interests in ensuring that commercially developed human space transportation systems for low-Earth orbit are safe and effective. The FAA regulates the U.S. commercial space transportation industry for public safety during launch and re-entry. NASA is enabling the development and demonstration of human space transportation systems via the Commercial Crew Program.

To facilitate these complementary interests, NASA and the FAA signed a Memorandum of Understanding (MOU) in June 2012 to coordinate standards for commercial space travel of government and non-government astronauts to and from low-Earth orbit and the International Space Station (ISS). The MOU was the first step in the process to provide a stable framework for the U.S. space industry, avoid conflicting requirements and multiple sets of standards, and advance both public and crew safety.

The MOU signed by the two agencies also established the policy for operational missions to the space station. Commercial providers will be required to obtain a license from the FAA for public safety. Crew safety and mission assurance will be NASA's responsibility. This approach allows both agencies to incorporate experience and lessons learned as progress is made.

Since the signing of the MOU, NASA and the FAA have been working closely together to implement its objectives and policies. The two agencies established a program-level working group with the responsibility to identify potential issues related to NASA astronauts flying on FAA-licensed vehicles. Additionally, a NASA-FAA legal "harmonization team" was established to address specific legal questions and issues identified by both teams.

The teams initially identified dozens of potential issues; some were minor clarification-related issues and others were more significant. More than 40 percent of those issues already have been closed to date. As an example, the FAA recently published an interpretation addressing the ability of NASA astronauts to perform operational functions during an FAA-licensed launch and re-entry. The FAA also published interpretations addressing waivers and international partner participation.

Late last year, NASA, in collaboration with the FAA, submitted to Congress a proposed amendment to the Commercial Space Launch Act (CSLA) to more fully address issues related to FAA-licensed missions providing space station transportation services for NASA astronauts by adding a "Government Astronaut" classification to the CSLA.



The NASA and FAA logos are shown side by side to represent the agencies working toward the common goal of a vibrant commercial spaceflight industry.



NASA Associate Administrator for the Human Exploration and Operations Directorate William Gerstenmaier, left, and FAA Associate Administrator for Commercial Space Transportation George Nield sign the Memorandum of Understanding for Achievement of Mutual Goals in Human Space Transportation June 4, 2012.

These NASA and FAA cooperative efforts are consistent with the National Space Policy of the United States of America (June 28, 2010), which directs federal agencies to “minimize, as much as possible, the regulatory burden for commercial space activities and ensure that the regulatory environment for licensing space activities is timely and responsive.” There still is work to be done, but the progress both agencies have made, and will continue to make, is helping to enable a robust commercial human spaceflight industry within the United States.

## CCiCap Milestone Change Process

NASA signed the Commercial Crew integrated Capability (CCiCap)–funded Space Act Agreements in August 2012. Over the course of these agreements, as with most contracts, modifications have been occasionally needed. The CCiCap agreements have evolved as development and test efforts have progressed, enabling our partners to refine their plans. These refinements have resulted in several changes to the milestones listed in the original agreements. NASA also made a determination in August 2013 to fund a small portion of the optional milestones to reduce risk, thus increasing the number of total milestones and agreement value. These refinements and updates are why the milestone totals shown above in the thermometer graphic have changed over time.

When a change to the initial agreement is needed, both NASA and the respective industry partner must agree to the change. On the NASA side, the Commercial Crew Program Office assesses all changes. For minor changes, such as changes to milestone dates, the Program Office can approve the change and a memo for record is generated to document the change. For more significant changes, such as the addition of optional milestones, the Program Office provides recommendations for approval to NASA HQ for final disposition. If approved by NASA HQ, an amendment is negotiated and posted at <http://commercialcrew.nasa.gov/page.cfm?ID=38>. Thus, the current agreement with

each partner is slightly different from the version that was initially signed a year and a half ago. To catch everyone up on the current status of partner milestones within each agreement, the below tables provide a snapshot of the current status.

Boeing CCIcap Milestones			
Milestone	Value (\$M)	Completed Milestone Actual Approval Date	Future Milestone Estimated Date
M1: Integrated System Review	\$50.0	September 2012	
M2: Production Design Review	\$51.7	November 2012	
M3: Phase 1 Safety Review Board	\$25.2	December 2012	
M4: Software Integrated Engineering Release 2.0	\$20.4	February 2013	
M5: Landing & Recovery Ground Systems/Ground Communication Design Review	\$28.8	February 2013	
M6: Launch Vehicle Adapter Preliminary Design Review	\$45.5	March 2013	
M7: Integrated Stack Buffet Wind Tunnel Test	\$37.8	April 2013	
M8: Dual Engine Centaur Liquid Oxygen Duct Development Test	\$21.5	May 2013	
M9: Orbital Maneuvering and Attitude Control Engine Development Test	\$50.2	September 2013	
M10: Spacecraft Primary Structures Critical Design Review	\$8.6		1Q CY2014
M11: Service Module Propulsion System Critical Design Review	\$7.5	December 2013	
M12: Mission Control Center Interface Demonstration Test	\$7.9	September 2013	
M13: Launch Vehicle Adapter Critical Design Review	\$13.5	December 2013	
M14: Emergency Detection System Stand-Alone Testing	\$13.8	December 2013	
M15: Certification Plan Review	\$5.8	December 2013	
M16: Avionics Software Integration Lab Multi-String Demonstration Test	\$24.9	December 2013	
M17: Pilot-in-the-Loop Demonstration	\$13.9		1Q CY2014
M18: Software Critical Design Review	\$15.1		2Q CY2014
M19: Critical Design Review Board	\$17.9		3Q 2014
M21a: Phase 2 Spacecraft Safety Review	\$20.0		3Q 2014
Total	\$480.0		

SpaceX CCIcap Milestone Dates			
Milestone	Value (\$M)	Completed Milestone Actual Approval Date	Future Milestone Estimated Date
M1: CCIcap Kickoff Meeting	\$40.0	September 2012	
M2: Financial and Business Review	\$20.0	September 2012	
M3: Integrated System Requirements Review	\$50.0	November 2012	
M4: Ground Systems and Ascent Preliminary Design Review	\$35.0	December 2012	
M5: Pad Abort Test Review	\$20.0	April 2013	
M6: Human Certification Plan Review	\$50.0	May 2013	
M7: On-Orbit and Entry Preliminary Design Review	\$34.0	July 2013	
M7a: Delta Ground Systems Preliminary Design Review	\$1.0		1Q CY2014
M8: In-Flight Abort Test Review	\$10.0	September 2013	
M9: Safety Review	\$50.0	November 2013	
M10: Flight Review of Upgraded Falcon 9	\$—	December 2013	
M11: Pad Abort Test	\$30.0		3Q CY2014
M12: Dragon Primary Structure Qualification	\$30.0		2Q CY2014
M13: Integrated Critical Design Review	\$40.0		2Q CY2014
M14: In-Flight Abort Test	\$30.0		3Q CY2014
M15a: Dragon Parachute Tests Phase I	\$15.0	December 2013	
M15b: Dragon Parachute Tests Phase II	\$5.0	January 2014	
Total	\$460.0		

SNC CCIcap Milestone Dates			
Milestone	Value (\$M)	Completed Milestone Actual Approval Date	Future Milestone Estimated Date
M1: Program Implementation Plan Review	\$30.0	August 2012	
M2: Integrated System Baseline Review	\$45.0	November 2012	
M3: Integrated System Safety Analysis Review #1	\$20.0	February 2013	
M4a: Engineering Test Article Flight Testing #1	\$7.0	February 2014	
M4b: Engineering Test Article Flight Testing #2	\$8.0		3Q CY2014
M5: SNC Investment Financing #1	\$12.5	June 2013	
M6: Integrated System Safety Analysis Review #2	\$20.0	November 2013	
M7: Certification Plan Review	\$25.0	December 2013	
M8: Wind Tunnel Testing	\$20.0		1Q CY2014
M9: Risk Reduction and Technology Readiness Level (TRL) Advancement Testing	\$17.0		2Q CY2014
M9a: Main Propulsion and Reaction Control System Risk Reduction and TRL Advancement Testing	\$8.0		2Q CY2014
M10a: Critical Design Review Incremental Design Review #1	\$5.0	December 2013	
M15a: Reaction Control System Testing- Incremental Test #1	\$10.0		3Q CY2014
Total	\$227.5		

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

*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/>.*