

NASA's Return On Investment Report

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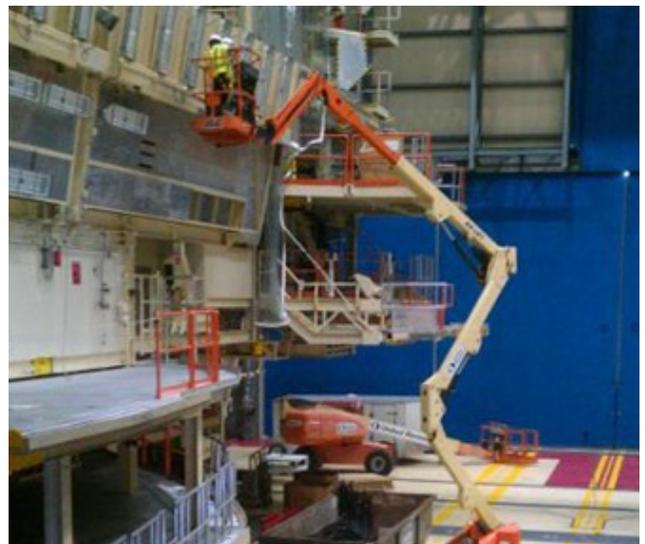
This bi-monthly newsletter of accomplishments, progress, and happenings in NASA's commercial crew and cargo programs is distributed by the Commercial Spaceflight Development Division at NASA Headquarters.

NASA's CCIcap PARTNERS OFF TO A FAST START

NASA awarded the Commercial Crew Integrated Capability (CCiCap) Space Act Agreements (SAAs) just over two months ago, and all three partners are already making substantial progress toward completing their designs and performing hardware testing. These partners have transitioned from CCDev2 to CCIcap without skipping a beat.

The Boeing Company already has completed a major milestone—an Integrated Systems Review (ISR). "The rigor of our design and development process enabled a fast start on CCIcap. We completed an ISR in August, establishing the firm configuration baseline for our Commercial Crew Transportation System and completing our first CCIcap performance milestone," said John Mulholland, Commercial Programs vice president and program manager for Boeing. The Boeing team is preparing to reach more milestones in October and November. These include a thorough safety review for the complete integrated transportation system, the preliminary design review (PDR) for ground software, and a production design review. The production design review will establish the baseline plan, equipment, and infrastructure for the CST-100 spacecraft. Demolition and construction have begun on facilities at NASA's Kennedy Space Center in Florida, that will transform heritage buildings from the Space Shuttle Program into facilities for the CST-100. Boeing also recently completed component PDRs for flight and systems management computers, and conducted a crew evaluation of the CST-100's internal layout.

Sierra Nevada Corporation (SNC) is making significant progress on its Engineering Test Article (ETA). "SNC is working very hard to complete the build of our ETA to



Demolition work underway on Boeing's Commercial Crew and Cargo Production Facility, formerly used for shuttle processing. Photo credit: Boeing



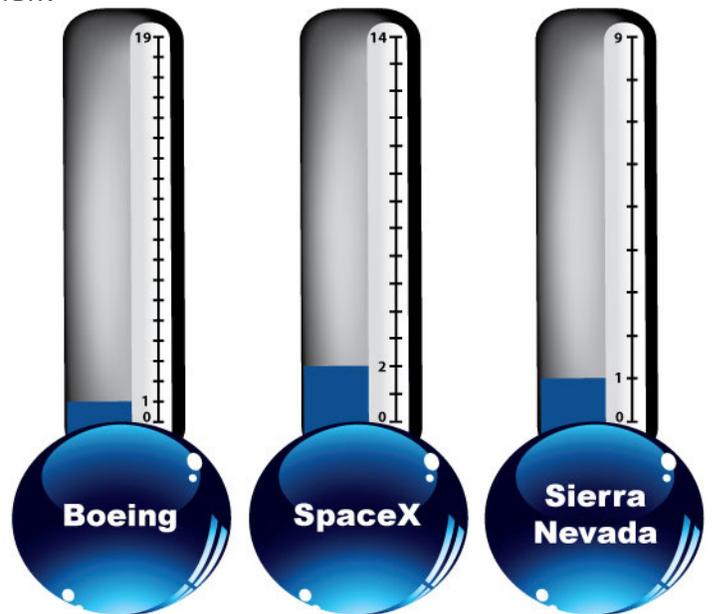
CST-100 crew evaluation. Photo credit: Boeing



Dream Chaser ETA landing gear. Photo credit: SNC

support free flight testing in the first quarter of next year, currently installing landing gear, flight controls, brakes, hydraulics, and extensive instrumentation,” said Steve Lindsey, director of Flight Operations at SNC. “All of the ETA’s avionics are currently undergoing box to box bench testing, and the latest complete flight software version is now running successfully on the flight control computer. The flight control actuators and actuator controls are in final qualification testing and will be installed into our flight control integration lab within the next 2 weeks. Mission Control Center display development is in work, along with extensive flight test and integrated test planning.” The ETA will perform flight tests for both CCDev2 and CCIcap milestones. SNC also completed its first CCIcap milestone in mid August—a two-day program implementation review that established its management plans for executing the CCIcap SAA. In preparation for SNC’s next milestone in October, an integrated system baseline review, it has produced and released design documentation for the NASA partner integration team to review.

Space Exploration Technologies Corp. (SpaceX) completed its first two CCIcap milestones, a kick-off meeting and a financial and business review, in August. At these events, SpaceX presented the technical status of evolving its Dragon spacecraft and Falcon 9 launch vehicle into a crewed system, its schedule plans, its business and management approach, and insight into financial activities that enable its CCIcap work. SpaceX now is preparing for their third CCIcap milestone, an integrated system requirements review to ensure requirements and design concepts will satisfy the crew transportation mission.



CCIcap Milestone Completion Status

REUSABLE SPACECRAFT TO ENABLE CREW TRANSPORTATION AFFORDABILITY

The space shuttle was the world’s first reusable spacecraft, but it will not be the last. All three of NASA’s CCIcap partners are designing their commercial crew transportation vehicles to be reused after ferrying NASA astronauts and other customers to and from low Earth orbit.

According to Jim Voss, vice president for Space Exploration Systems and the Dream Chaser Program Manager at SNC, “The space shuttle is the only spacecraft ever to return to space because it had wings that allowed it to land softly on a runway. Our Dream Chaser human spacecraft is similar in design so it can fly many times to orbit. This will make



Sierra Nevada Dream Chaser spacecraft. Image credit: SNC

the flights cost effective since most of the vehicle is reusable and requires minimal maintenance between flights. When you don't need to build a new spacecraft for each flight, there is a much better business case for commercial transportation services to Earth orbit." The maintenance turnaround effort will be much quicker than the space shuttle. Dream Chaser's thermal protection system tiles cover only 1/17th the surface area of the shuttle, so it will require less maintenance time. Also, there are no hazardous propellants or commodities on board that require special precautions for processing. The Dream Chaser's hybrid rocket motors and one set of batteries are easily replaced, and the remainder of the vehicle is planned to be reused for multiple flights.



Artist's conception of SpaceX's crewed Dragon spacecraft. Image credit: SpaceX

Both Boeing's CST-100 and SpaceX's Dragon are capsules, which descend through the atmosphere on parachutes like the Apollo capsule. Unlike Apollo capsules, which were not reused after their missions, the CST-100 and crewed Dragon will land on land, facilitating reuse of the crew descent portions of the spacecraft. The Dragon will cushion the landing impact with rocket motors that double as abort engines. This will avoid the high impact loads and damaging affects of splashdowns in the ocean. Furthermore, Dragon's "PICA-X" heat shield, which already has been flight demonstrated on multiple orbital test flights, has been designed to be reusable.



Boeing's CST-100 capsule after an airbag test. Photo credit: Boeing

Boeing also plans to cushion the impact of its vehicle's land landings beyond that achievable by parachutes alone. The CST-100 includes an airbag system that absorbs landing shock such that the spacecraft structure and systems can safely be reused. These airbags already have been demonstrated through multiple tests during CCDev2. "Refurbishment and reuse of our crew modules – nominally for up to 10 missions – enables us to offer more affordable pricing for services, which is important for helping to ensure the growth of the commercial market that we envision." said John Mulholland, Commercial Programs vice president and program manager for Boeing.

Affordability of low Earth orbit crew transportation is one of the primary goals of the NASA's Commercial Crew Program and its industry partners, opening up the space frontier to a new and larger market of passengers. By designing major portions of the transportation system to be reusable, and avoiding the high recurring costs of manufacturing, assembly, and test of the most complex and expensive elements, the costs per seat will be reduced significantly.

Download the latest and greatest information here: <http://go.nasa.gov/commercial-documents>

- Ed Mango's presentation to the NASA Advisory Council Commercial Space Committee
- Phil McAlister's presentation to various NASA stakeholders
- New Commercial Crew Program poster

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

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