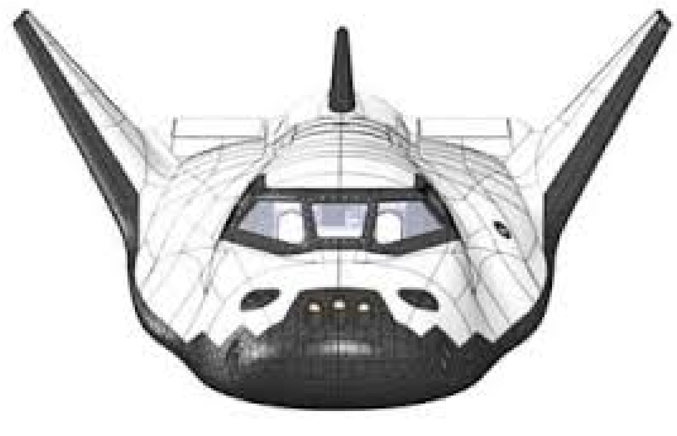
Dream Chaser

Manned Systems

Briefing



Dream Chaser is a proposed American manned reusable spaceplane. The winged vehicle is designed for vertical take-off and horizontal landing (on conventional runways). Its main mission would be to provide NASA a commercial service for transporting crew and cargo to and from the International Space Station (ISS) in low earth orbit (LEO), although at the moment an unmanned autonomous version of the vehicle has been contracted by NASA to provide only cargo transport.

Plans call for completing the first operational Dream Chaser—*Tenacity*—and launching the first flight demonstration mission (Demo-1) in March 2021. The first cargo mission to ISS is scheduled for the latter part of 2021. The designated launch site for Dream Chaser is NASA's Kennedy Space Center at Cape Canaveral, Florida.

Based on the design of NASA Langley Research Center's HL-20 spaceplane of the 1980s, Dream Chaser was first publicly announced on September 20, 2004 as a candidate for NASA's Vision for Space Exploration (VSE) initiative. It was also offered as a candidate for NASA's Commercial Orbital Transportation Services (COTS) competition in 2006, but was not selected. In February 2010, the Dream Chaser program did receive $20 million from NASA under the first phase of the Commercial Crew Development. Under the CCDev1, the program succeeded in developing its hybrid rocket engine. On April 18, 2011, the program received an additional $80 million from NASA for continued development work under the CCDev2 phase.

By February 2012, the assembly and delivery of the primary structure of the first Dream Chaser flight test vehicle had been completed. On February 7, 2012, as part of the Commercial Crew Integrated Capability (CCiCap) initiative, NASA solicited proposals to mature the design and development of an integrated crew transportation system (CTS). The Dream Chaser program received a $212.5 million under the CCiCap.

Sierra Nevada announced on January 30, 2014 that it had successfully completed the Incremental Critical Design Review (CDR) of the Dream Chaser vehicle, with the completion of Milestone 10a under its CCiCap contract with NASA. Under the CDR, NASA approved the critical design products, plans, and processes being used to develop Dream Chaser, including the spacecraft, Atlas launch vehicle, and mission and ground systems. On February 28, 2014, Sierra Nevada announced completion of Milestone 4a flight test for Dream Chaser under CCiCap. The test objectives included the collection of all nominal glide slope and other critical aerodynamic data. The results of the test validated the aerodynamic performance of the vehicle.

The CCiCap program was followed by the Commercial Crew Transportation Capability (CCtCap) program to provide crew launch services to the International Space Station (ISS) and back to Earth. Sierra Nevada submitted a bid proposal to NASA offering its Dream Chaser spaceplane. On September 16, 2014, NASA opted to award CCtCap contracts to Boeing (Atlas V/CST-100) and SpaceX (Falcon 9/Dragon V2) potentially worth $4.2 billion and $2.6 billion respectively. Sierra Nevada filed a protest of the CCtCap awards, but the protest was rejected.

On January 14, 2016, NASA awarded Commercial Resupply Services 2 (CRS-2) contracts to Orbital ATK (now Northrop

Grumman Innovation Systems), Sierra Nevada, and SpaceX. The total value of the three contracts is $14 billion from 2019 through 2024. The award (estimated at $2 billion to $2.5 billion) to Sierra Nevada is for use of Dream Chaser for six cargo delivery missions to ISS and return of research samples and other cargo from ISS back to Earth.

On July 19, 2017, Sierra Nevada selected United Launch Alliance (ULA) to launch the first two Dream Chasers aboard Atlas V rockets, although subsequently the missions were reassigned to ULA Vulcan/Centaur rockets, which are still under development.

In March 2019, NASA conducted its Integrated Review Milestone (IR5) of Dream Chaser to confirm that development of the vehicle was proceeding on schedule and approve it full production. IR5 tests, which were designed to validate the aerodynamic properties, flight software and performance of the spaceplane's control system, took place at Sierra Nevada's facilities Louisville, CO and NASA's Kennedy Space Center.

Recent Developments

In June 2020, the Thermal Protection System (TPS) tiles for Dream Chaser *Tenacity* were delivered to Sierra Nevada facilities in Louisville, CO. The tiles, which can withstand heat of 3,000° Fahrenheit, will serve to protect the spaceplane from the sun and upon re-entry into the Earth's atmosphere. They are bonded to the body of the vehicle by a room temperature vulcanizing (RTV) silicone.

In April, Sierra Nevada received delivery of the wings (Wing Deployment System) for *Tenacity* from Lockheed Martin.

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Specifications

Mass:	11,300 kg
Length:	9 m
Wing span:	7 m
Volume:	16 m^3
Crew:	7
Endurance:	210 days
Re-entry:	< 1 gs
Payload to LEO:	5,500 kg*

Payload from
LEO: 2,000 kg*

** With the attached Shooting Star cargo module.*

Subsystems

Airframe

Lockheed Martin Space Systems Co. of Littleton, CO is the manufacturer of the all-composite structure, including the foldable wings, for Dream Chaser vehicle at NASA's Michoud Assembly Facility near New Orleans, LA and facilities in Texas. The wing structure is built of carbon fiber and attached to the body of the spaceplane using titanium components. The vehicle has a Thermal Protection System (TPS) based on an ablative tiles developed by the *NASA Ames Research Center* at Moffett's Field, CA. The TPS consists of approximately 2,000 tiles, which are reportedly stronger than those used on the Space Shuttles.

Shooting Star

A 4.9-meter tall cargo module called *Shooting Star* can be attached to the rear of the spaceplane to provide an additional 4,500 kilograms of transport capacity. The module is expendable. It is designed to detach and disintegrate upon re-entry into Earth's atmosphere.

Propulsion

The spaceplane will be launched vertically atop a Vulcan/Centaur rocket, produced by *Lockheed Martin Space Launch Systems* of Denver, CO, so the Vulcan would essentially be the Dream Chaser's first stage. Once in orbit, the spaceplane would be powered by a pair of hydroxyl-terminated polybutadiene (HTBP) nitrous oxide (NOS) hybrid rocket engines, developed and built by *Sierra Nevada Corp*.

Guidance & Control

Control is provided by reaction control system thrusters. The thrusters burn an ethanol-based fuel.

Other Subsystems & Services

Teledyne Brown Engineering, Inc. of Huntsville, AL has been responsible for evaluating strategic and technical partnership opportunities for Dream Chaser. The company has also collaborated with NASA Marshall Spaceflight Center's *Missions Operations Laboratory* in Huntsville on developing mission concepts for the vehicle.

SAKOR Technologies, Inc. of Owosso, MI has supplied a test system to *Southwest Research Institute* (SwRI) of Rockville, MD for testing Dream Chaser's atmospheric flight control system.

Contract Briefs

Date	Source	Value	Details
Lockheed Martin, Space Systems			
03/25/2014	Sierra Nevada		Contract to develop and manufacture the composite structure, including wings, of the Dream Chaser spaceplane.
Sierra Nevada			
02/02/2010	NASA	$20,000,000	Contract to help fund development (including manufacturing tooling and hybrid engine) of the Dream Chaser spaceplane under the Commercial Crew Development 1 (CCDev1) program.
04/18/2011	NASA	$80,000,000	Contract for continued development work of the Dream Chaser spaceplane under the Commercial Crew Development 2 (CCDev2) program.
02/07/2012	NASA	$212,500,000	Contract for continued development of the Dream Chaser spaceplane under the Commercial Crew Integrated Capability (CCiCap) initiative to mature the design and development of an integrated crew transportation system (CTS).
01/14/2016	NASA	$2,000,000,000+	Contract for six cargo delivery missions to the International Space Station (ISS) and return of research samples and other cargo via the Dream Chaser spaceplane.

Costs

Estimated cost of developing Dream Chaser is more than $1 billion. Given Dream Chaser's use of a Vulcan/Centaur rocket as its first stage, the per launch mission price for the system should be about $250 million, with the spaceplane portion estimated at $50 million.

Teal Group Evaluation

Dream Chaser is an attractive space vehicle many within the space industry would like to see succeed. The program has managed to survive during the past two decades by winning just enough NASA support and funding to see its way near to completion, despite losing out on several major competitions, including the COTS competition in 2006 and the one for the CCtCap in 2014.

The CCtCap loss particularly stung because carrying astronauts to and from the ISS seemed like a perfect fit for Dream Chaser, given the notion by many that NASA really wanted to go with a spaceplane in order to carry on the spaceplane tradition started by the Space Shuttle rather than be solely reliant on expendable rockets and capsules that resembled more Apollo era technology.

The loss of the CCtCap, however, should not have come as a huge surprise to Sierra Nevada. Although Dream Chases did offer unique advantages, they were not strong enough for NASA to justify rejecting SpaceX's Falcon 9/Dragon V2 proposal and Boeing's Atlas V/CST-100. SpaceX was an obvious choice, given its stellar and prolific launch record, and NASA needed at least legacy company with whom it an established partnership in the event SpaceX (still not an establishment player at that point) did not work out. Had there been room for a third program under the CCtCap, we feel certain that slot would have gone to Dream Chaser.

Ultimately, Dream Chaser's big break came with the CRS-2 contract in 2016 for six cargo supply missions to the ISS. NASA's decision to make room for a third supplier of ISS cargo services was a good move, in our view. It gives Dream Chaser an excellent opportunity to prove itself as an unmanned vehicle and keep alive the possibility that NASA may someday opt for using it in its originally envisioned manned role. What NASA will be observing closely in Dream Chaser is the ability to control the vehicle and dock with the ISS.

NASA may actually come to depend more on Dream Chaser for cargo services than on the

SpaceX and Northrop Grumman CRS-2 vehicles (Falcon 9/Dragon and Antares/Cygnus), notably with regard to bringing back sensitive scientific experiments from the ISS that require as soft a landing as possible, for which Dream Chaser, which is able to land horizontally on a runway, is better suited than its competitors which rely on capsules parachuting to Earth. The fact that it was designed precisely to ensure a smooth ride has long been one of the major selling points of Dream Chaser. According to Sierra Nevada, an advantage of what is referred to as a "lifting-bodying spacecraft" is that the gravitational forces are much lower during re-entry than on a capsule.

For now, Sierra Nevada has only one Dream Chaser spaceplane, *Tenacity*. The company's goal is to build a fleet of spaceplanes and to eventually expand into the space tourism business. To convert Dream Chaser into a cargo transport vehicle, Sierra Nevada only had to change about 20% of the spaceplane's interior space. Converting Dream Chaser back to its original design for passenger transport would not be so difficult.

Launch Forecast

(launch units)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Dream Chaser	—	1	2	2	1	2	2	2	4	4