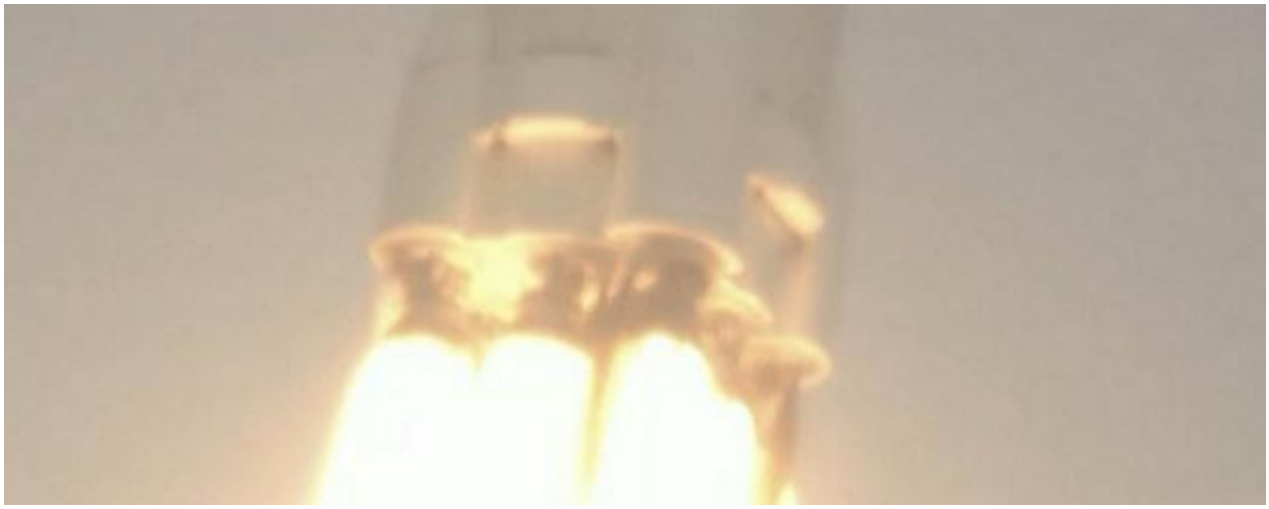
CRS-2: Dragon's tantrum subdued following Falcon 9 launch

written by William Graham And Chris Bergin | March 1, 2013



SpaceX conducted its tenth launch on Friday, sending the fourth Dragon spacecraft on a mission to resupply the International Space Station (ISS). The launch of CRS-2 (SpX-2) – which also marked the fifth flight of the Falcon 9 carrie rocket – occurred at 10:10 Eastern (15:10 UTC). However, a problem with the Dragon's thrusters required mitigation.

CRS-2/SpX-2:

The problem was noted after Dragon separation, with the anomaly reported at the point Solar Array deployment was expected.

This procedure was delayed due to a problem cited as with the Dragon's thrusters, which failed to initiate as planned – claimed to be related to a propellant valve.

SpaceX controllers used ground stations to send commands to override the inhibits, with the goal of bringing at least t the four thruster pods online. This was deemed to be successful, with SpaceX CEO Elon Musk using social media to con solar array deployment had been achieved.

related to thermal conditions and the bonus effect of the ar
stablizing the vehicle's attitude.

SpaceX and NASA issued a statement at 8pm UTC, confirmi
ISS rendezvous on Saturday was missed.

However, SpaceX did confirm they were back to two of the f
thrusters, with the remaining two returning to life shortly
afterwards. Three thruster pods are required for ISS rendezv
and berthing.

The root cause is still preliminary, but the initial data points stuck valve that was resolved by "jackhammering" it open and close to free it, or the potential of a blockage in the associated helium pressurization line.

On Saturday, NASA and SpaceX confirmed they are in a good stance to berth with the ISS on Sunday.

(You can keep up to date via the live Flight Day 1 thread for CRS-2, here: http://forum.nasaspaceflight.com/index.php?topic=31239.0) A full review of the issue and pre-berthing article will follow at the weekend.

Friday's launch was tasked with deploying Dragon on the the SpaceX CRS-2 mission; delivering 575 kilograms (1,268 lb) of cargo to the space station.

The mission will mark the Dragon's third visit to the ISS; the second operational flight under the Commercial Resupply Services (CRS) program, the first visit having been the spacecraft's second and final Commercial Orbital Transportation Services program.

The Dragon was launched by SpaceX's Falcon 9 carrier rocket, flying in the v1.0 configuration for what is expected to be the final time.

Future launches are manifested to use the v1.1 configuration, which features significant modifications including a new first stage engine arrangement, more powerful Merlin-1D engines replacing the v1.0's Merlin-1Cs, and both stages being elongated several meters.

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Friday's mission is the fifth overall for the Falcon 9, which first flew on 4 June 2010 on a test flight successfully carrying t Dragon Spacecraft Qualification Unit, an inert demonstration payload intended to simulate the aerodynamic properties Dragon spacecraft, into low Earth orbit.

Following the success of its test flight, the Falcon 9 was reac launch the first functional Dragon spacecraft. This mi Dragon C1, or COTS Demonstration 1, was conducted in thre hours and 19 minutes on 8 December 2010.

occurred at 15:43 UTC from Cape Canaveral, with the spacecraft orbiting the Earth twice before reentering, and splashir down in the Pacific Ocean at 19:02. Unlike subsequent flights, the Dragon's Trunk Section was intentionally left attache the Falcon's upper stage, with the capsule performing its mission alone.

In addition to Dragon C1, eight other satellites were carried on the Falcon 9's second flight. These were SMDC-ONE 1 fo US Army, Mayflower for Northrop Grumman and the University of Southern California, QbX-1 and 2 for the US National Reconnaissance Office, and Perseus 000, 001, 002 and 003 for the Los Alamos National Laboratory.

These satellites were all deployed into Low Earth orbits which decayed quickly; Mayflower was the first of the secondary payl to reenter the atmosphere on 22 December. It was followed by four Perseus satellites; 000 and 002 on 30 December, with the two the next day.

QbX-1 decayed on 6 January 2011, with SMDC-ONE 1 reentering January, and finally QbX-2 on 16 January.

The COTS program had originally called for three test flights o Dragon, with the second mission rendezvousing with the ISS, a the third mission being the first to be captured and berthed wit outpost.

Following the success of the first flight, however, it was decided to merge the second and third flights into the Dragon C

The launch also carried the New Frontier payload for Celestis, which included samples of the cremated remains of 308 people. One of these was astronaut Gordon Cooper, who passed away in 2004 at the age of 77. One of the Merc ev Cooper flew aboard Mercury-Atlas 9, the final flight of the Mercury programme, and later commanded Gemini V. Anoth participant was actor James Doohan, who played Scotty in the original series of Star Trek.

This was the third time their ashes had been launched into space; having initially been flown on a suborbital flight usinc SpaceLoft-XL sounding rocket in 2007, organized due to considerable delays with the orbital mission. Their ashes were carried aboard the Explorers mission, which was lost in the failure of a Falcon 1 rocket in 2008; as a result of the failure replacement samples were included for free on New Frontiers.

Dragon C2+ successfully completed a series of rendezvous demonstrations on 24 and 25 May, the last of which culmi in its approach to within nine meters (30 feet) of the space station, where astronaut Donald Pettit captured the vehicl using the Canadarm2 remote manipulator system. Followi capture, the RMS was used to berth the Dragon spacecraft the nadir port of the Harmony module. Hatches between t spacecraft and the ISS were opened on 26 May.

Following the completion of tests with the Dragon berthec the ISS and the transfer of cargo between the Dragon and station, hatches between the two spacecraft were closed a departed the station on 31 May.

Canadarm2 was used for unberthing, and the Dragon was released to begin its descent to Earth.

Following a series of burns to depart the vicinity of the ISS, Dragon C2+ was deorbited, and splashed down in the Pacifi 15:42 UTC after a successful mission, completing Dragon's C demonstration objectives.

The success of the two COTS demonstration missions pave way for operational flights, which began last October with SpaceX CRS-1.

The third mission of the Dragon, and the second to visit the it lifted off atop a Falcon 9 on 8 October 2012. The secondary payload for this launch was the Orbcomm O2G-1 communications satellite; a prototype for Orbcomm's second generation constellation slated for launch on subsequent Falcon 9 missions.

While the CRS-1 mission was successful as a whole, the laur suffered an engine problem during first stage flight v resulted in the loss of the Orbcomm satellite.

The number 1 engine failed approximately 79 seconds after launch; being shut down by the onboard computer after it l pressure. Debris was seen falling from the rocket, believed part of a fairing designed to protect the engines from aerodynamic loads.

While the failure was within the Falcon 9's engine-out capal it resulted in the second stage burning more propellant thar originally been planned in order to reach the planned orbit Dragon deployment.

As a result the stage failed a propellant mass check at engine cut-off, and the Orbcomm satellite was dumped into this orbit that the Dragon had been deployed in, so as not to put the ISS at risk should a planned second burn to reach the Orbcomm deployment orbit not be completed successfully.

The CRS-1 spacecraft arrived at the space station on 10 Oct and following a successful berthed mission, it was unberth on 28 October at 11:19 UTC.

Splashdown occurred a little over eight hours later at 19:22 following successful separation maneuvers and a deorbit b

The fifth Falcon 9 launch is the tenth overall for SpaceX, wl also conducted five launches of the smaller Falcon 1 rocket which has since been retired from service.

Its first mission, which carried the US Air Force Academy's FalconSat-2 satellite, launched on 24 March 2006 from Ome Island; part of Kwajalein Atoll in the Marshall Islands.

The launch ended in failure after the base of the first stage caught fire due to a corroded nut, with the engine cutting ou seconds after liftoff.

The vehicle fell into the Pacific, however the satellite was thrown free and came down back at its launch site, falling thr the roof of the building in which its shipping crate was being stored.

The second flight on 21 March 2007 fared little better. While first stage flight was completed, the vehicle underperforme

Despite this, the second stage continued towards orbit, how
it began to oscillate, causing fuel sloshing which led to the engine cutting out prematurely around seven and a half min
into the flight.

The rocket, which was carrying an inert demonstration payload for NASA and DARPA, failed to achieve orbit. The launcl
carried two NASA experiments designed to operate during ascent, one of which monitored the rocket and the other tes
communications with the Tracking and Data Relay Satellite System (TDRSS).

The Falcon 1's third flight debuted a new Merlin-1C first stage engine, in place of the Merlin-1A used on the first two fligh

It lifted off on 3 August 2008, carrying the Trailblazer satelli
the US Department of Defense's Operationally Responsive
Space (ORS) office, the PRESat and NanoSail-D CubeSats fc
NASA, and the Explorers space burial payload for Celestis.

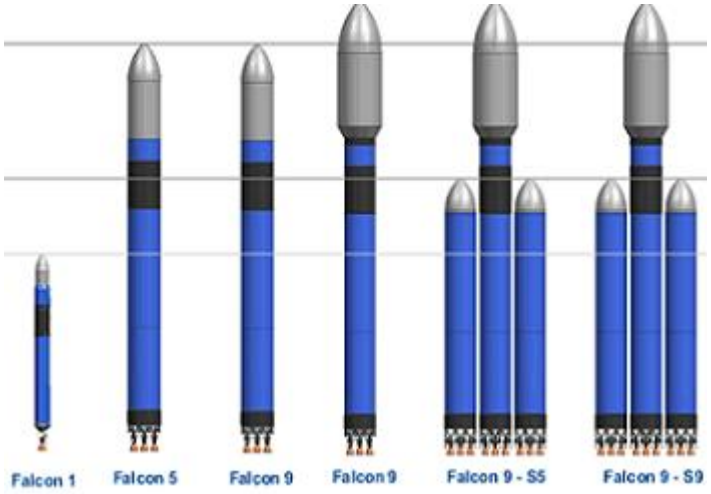
An unexpected consequence of the change of engine was
residual thrust following burnout, which resulted in severe
recontact between the first and second stages following
separation. The second stage ignited while its engine was s
inside the interstage section, and control of the rocket was
quickly lost.

SpaceX quickly determined the cause of the failure, and were ready for another launch attempt less than two months la

The fourth Falcon 1 carried a 165-kilogram (364 lb) inert payload named RatSat. On 28 September 2008, it was placed i
low Earth orbit as the Falcon 1 completed its first successful flight. RatSat remains in orbit, as does the Falcon 1's upper
stage, to which it is attached.

retired in favor of a stretched and more capable version, th
Falcon 1e; however this never flew and has since bee
abandoned.

Launches from Omelek have ceased, and SpaceX plans to
launch Falcon 1-class payloads on Falcon 9 rockets, along v
larger payloads. It remains unclear how the Falcon 9's failu
deploy the Orbcomm satellite during its last mission will a
this in the long term.



Falcon 1 and Falcon 9 were originally to have been joined by a third rocket, the Falcon 5. This was similar in design to th
Falcon 9, however optimized for smaller payloads, with only five first stage engines.

This was cancelled around 2007, in favor of the Falcon 9.

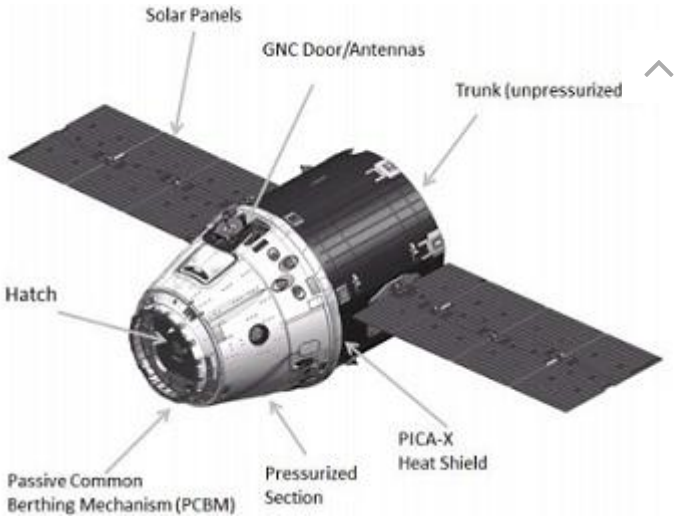
Two additional variants of the Falcon 9 had also been announced; the Falcon 9S5 and 9S9, which would have featured
boosters, based respectively on the first stages of the Falcon 5 and Falcon 9.

The 9S9 grew into the Falcon 9 Heavy, and subsequently the Falcon Heavy which is currently under development.

The Falcon Heavy is derived from the Falcon 9, with improvements to the first stage which will also be introduced on th
Falcon 9 with the v1.1 configuration; Merlin-1D engines, stretched stages and an octagonal engine layout replacing the v
square format.

Two strap-on boosters based on its first stage are mounted on either side, giving a similar configuration to the Delta IV
Heavy, with its three Common Booster Cores.

With a claimed payload capacity of 53 tonnes (51 imperial tons) to Low Earth orbit, the Falcon Heavy will surpass the De



Dragon is a 5.9-metre (19.3-foot) long spacecraft, which has a diameter of 3.66 meters (12 feet), and is capable of carryi to 3,310 kilograms (7,296 lb) of cargo to the International Space Station. It can carry pressurized cargo to the ISS in a 2.' metre (9.5-foot) long capsule, which also provides 2,500 kilograms (5,500 lb) of downmass for returning supplies to Ea

Its trunk section, which holds its solar arrays, can also accommodate unpressurized cargo for delivery to the station, an also carry 2,600 kilograms (5,732 lb) following departure from the station, allowing its use to dispose of non-recoverab payloads when it burns up during re-entry.

The spacecraft is powered by two solar arrays mounted on the Trunk, while Draco thrusters, burning monomethylhydra oxidised by dinitrogen tetroxide, will be used to provide attitude control, manoeuvring in orbit, and to deorbit the Drag the end of its mission.

The nose of the spacecraft houses a Common Berthing Mechanism, used to attach the Dragon to the Harmony module International Space Station.

The 575 kilograms (1,268 lb) of cargo aboard CRS-2 contai supplies for the crew, scientific experiments, tools and sta hardware and parts. For transport, it is contained in 102 kilograms (225 lb) of packaging. In all, 81 kilograms (179 lb upmass is dedicated to crew equipment, including "crew c packages", clothes, food and hygiene equipment.

Scientific equipment and experiments take up 348 kilogra (767 lb) of cargo capacity, and while most of the equipmer for NASA, experiments for the European and Canadian Sp Agencies are also aboard, as are supplies for JAXA experi already aboard the ISS.

Other supplies include Carbon Dioxide Removal Assemblies for the station's life support system, crew healthcare equipment, batteries and a charger, computer hard drives and disc cases, a serial port adaptor for one of the cor rs a gyroscope cable for the Russian segment.

Upon its return to Earth, the Dragon will be carrying 1,210 kilograms (2,668 lb) of cargo, not including its packaging, whi takes up a further 160 kilograms (353 lb) of mass. This consists of 90 kilograms (210 lb) of used crew equipment such as containers, preference items and care equipment; 660 kg (1,455 lb) of experiments and scientific hardware for NASA, C ESA and JAXA; 38 kg (84 lb) of EVA equipment, and 417 kg (911 lb) of station hardware.

The Falcon 9 which launched CRS-2 is a two-stage vehicle. T first stage is powered by nine Merlin-1C engines arranged ir 3 square. A single vacuum-optimized Merlin-1C propels the second stage. Both stages burn RP-1 propellant, using liquic oxygen as an oxidizer.

During the countdown to launch, powerup of the Falcon 9 a Dragon occurs around thirteen and a half hours before the scheduled liftoff. Oxidiser loading will begin three hours an minutes ahead of launch, with propellant loading beginning minutes later.

Three and a quarter hours before liftoff, both of these proce will be complete, however topping off of the oxidiser tanks will continue until the final stages of the countdown, as liqu oxygen tends to boil off.

The terminal count begins around ten minutes before launch, with the Dragon switching to internal power at L-8 minut and the flight computers beginning the final automated sequence at L-6 minutes.

At L-5, the carrier rocket will transfer to internal power. The launch pad's "Niagara" water deluge system will be activate seconds before the countdown reaches zero, with propellant tanks pressurising at L-40 seconds.

The command to ignite the first stage engines will be issuec three seconds before liftoff, and when the countdown reach zero the Falcon 9 will begin its ascent into orbit for its fifth mission.

Around 85 seconds later, the vehicle will encounter the area maximum aerodynamic pressure, and around this time it wil pass through Mach 1, the speed of sound. Three minutes into

about five seconds afterwards. Seven seconds after staging, the second stage will ignite.

Around 40 seconds into the second stage burn, the protective covering over the Dragon's berthing port will be jettison order to reduce the vehicle's mass, and avoid placing unnecessary debris into orbit. The second stage burn is expected last about 359 seconds, with MECO coming about nine minutes and eleven seconds after liftoff. Spacecraft separation occur about half a minute later.

Two minutes after SECO, the Dragon will deploy its solar ar Two and a quarter hours after this, it will open its guidance, navigation and control bay door. Around this time the Dracc thrusters will be used to circularize the spacecraft's orbit.

Rendezvous and berthing with the ISS is expected to occur Flight Day 2, with hatch opening the day afterwards.

The spacecraft will perform an R-bar approach to within 10 metres (66 feet) of the station, where the crew will use Canadarm2 to capture it, and maneuver it for berthing with nadir port of Harmony.

Canadarm2 will also be used for unberthing when the Dragon is ready to return to Earth.

Falcon 9 launches from Cape Canaveral use Space Launch Co 40. Originally built in the 1960s for the Titan IIIC rocket, the la of SpaceX CRS-2 is the sixtieth launch from the pad. Fifty five rockets; Twenty six IIICs, eight 34Ds, four Commercial Titan III seventeen Titan IVs; flew from the complex.

The final Titan launch from SLC-40 occurred in April 2005 whe rocket's penultimate flight overall deployed a Lacrosse radar imaging satellite for the US National Reconnaissance Office.

The pad was subsequently converted for use by SpaceX, and I supported all Falcon 9 launches to date. Another former Titan launch pad, Space Launch Complex 4E at Vandenberg, is currently being modified for use by the Falcon 9, and this is expected to see its first Falcon launch later this year.

The launch of CRS-2 is the eleventh confirmed orbital launch attempt of 2013, of which all but one have been successful failure being a Sea Launch Zenit-3SL mission carrying the Intelsat 27 satellite, which came down in the Pacific on 1 Febr

2 the twelfth orbital launch attempt of the year.

Friday's launch was SpaceX's first of 2013, and the United States' third. America's next launch is expected around 20 Ma when an Atlas V 401 will deploy the SBIRS-GEO 2 missile detection satellite in a launch from Cape Canaveral.

Orbital Sciences Corporation is expected to make its first att to reach the International Space Station, with a Cygnus spac flying a COTS demonstration mission in July, following a test flight of the Antares carrier rocket which is scheduled for 4 A

If this is successful, Cygnus is slated to begin CRS missions i October or November.

SpaceX's next launch is currently scheduled for 18 June, whe Falcon 9 v1.1 will make its maiden flight deploying the Canad Cassiope satellite, and several secondary payloads, in the company's first launch from Vandenberg Air Force Base.

The next Dragon mission, CRS-3, is currently scheduled to launch on 2 October.

(Images: via NASA, SpaceX and L2's SpaceX Dragon Mission Special Section – Containing presentations, videos, image (Over 2,700MB in size and exclusive), space industry member discussion and more).

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