SPACEX

Space Exploration Technologies

Falcon 1 • Flight 4

PRESS KIT

FALCON

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Falcon 1 Flight 4 Mission

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Webcast Information

The SpaceX Falcon 1 Flight 4 mission will be webcast live from our Kwajalein Atoll (Omelek Island) launch facilities, with commentary from SpaceX corporate headquarters in Hawthorne, California.

Starting time for the webcast will be announced on the SpaceX website: **SpaceX.com**

During the webcast, SpaceX hosts will provide information specific to Flight 4, an overview of the Falcon 1 launch vehicle, and commentary during the launch and flight sequences.

Webcast Archive

Post Flight 4, webcast content will be available for repeat viewing on the SpaceX website: **SpaceX.com**

High Resolution Photo and Video Content

Images and Video from all SpaceX flights, including selected high resolution photos can be downloaded directly from the SpaceX website:
SpaceX.com/photo_gallery.php and
SpaceX.com/multimedia/videos.php

Media Questions

All media queries should be addressed to: Diane Murphy, VP Marketing/Communications, SpaceX (**diane@spacex.com**).

Additional Information

For general information on SpaceX and our product portfolio, please visit **SpaceX.com** or contact **media@spacex.com.**

Launch Status | Launch Date

Falcon 1 is on the pad at the SpaceX launch site on Omelek Island, where it has completed a successful static fire and is undergoing final checkouts for Flight 4.

SpaceX has two Range availabilities for Flight 4 launch: Sept 28 to Oct 1 and another in late October, with a daily launch window of 4:00-9:00 p.m. (PDT) / 7:00 p.m.-midnight (EDT).

The SpaceX website (**SpaceX.com**) will provide the most up-to-date information on launch date and time.

Lessons Learned

On August 2, 2008, Falcon 1, Flight 3 executed a picture perfect first stage flight, ultimately reaching an altitude of 217 km, but encountered a problem just after stage separation that prevented the second stage from reaching orbit. The origin of the problem arose due to the longer thrust decay transient of our new Merlin 1C regeneratively cooled engine. Unlike the ablative engine used previously by SpaceX in Flights 1 and 2, the regenerative engine had unburned fuel in the cooling channels and manifold that combined with a small amount of residual oxygen to produce a small thrust that was just enough to overcome the stage separation pusher impulse.

SpaceX was aware of and had allowed for a thrust transient, but did not expect it to last that long. As it turned out, a very small increase in the time between commanding main engine shutdown and stage separation would have been enough to save the mission. The fix was also very simple, requiring one line of code to be changed.

We made the fix and immediately began work on Flight 4. Less than two months later, Falcon 1 Flight 4 is now on the pad at Kwajalein, ready for flight.

During Flight 3, the performance of the Merlin 1C and overall first stage was excellent. The stage separation system worked properly, with all bolts firing and the pneumatic pushers delivering the correct impulse. The second stage ignited and achieved nominal chamber pressure and the fairing separated correctly.

The only untested portion of Flight 3 was whether or not we solved the main problem of Flight 2, where the control system coupled with the slosh modes of the liquid oxygen tank. We significantly improved the control logic, added slosh baffles to the second stage tank and will test the success of these improvements during Flight 4.

Payload | Mass Simulator

The Falcon 1 Flight 4 vehicle carries a payload mass simulator of approximately 165 kg (364 lbs), designed and built by SpaceX specifically for this mission. Consisting of a hexagonal aluminum alloy chamber 1.5 meters (5 feet) tall, the payload attaches to the standard Falcon 1 payload mounting structure. It does not separate, but remains attached to the second stage as it orbits the Earth.

Launch Site | Omelek Island in the Kwajalein Atoll

Falcon 1 launch facilities are situated on Omelek Island, part of the United States Army Kwajalein Atoll (USAKA), located in the central Pacific about 2,500 miles southwest of Hawaii.

During flight preparations and launch, SpaceX employs the extensive range safety, tracking, telemetry and other services provided by the Reagan Test Site (RTS) at USAKA.

Flight 4 | Timeline

Major Events	T+secs	T+hh:mm:ss	Comments
Liftoff	0	0:00:00	Vehicle is released from launch mount
Tower clear	4	0:00:04	Falcon 1 clears the umbilical tower
Transonic	56	0:00:56	Mach 1 - the vehicle becomes supersonic
Max-Q	68	0:01:08	Max-Q - the time of maximum dynamic pressure on the vehicle
Inertial Guidance	140	0:02:20	Vehicle switched to inertial guidance mode
Pressurize Stage 2	145	0:02:25	Stage 2 pressurized to pre-ignition levels
MECO	157.50	0:02:37	Main Engine Cut-off - “MECO”
Stage Separation	162.5	0:02:42	Stage separated and pushed apart
2nd Stage Ignition	165.5	0:02:45	Kestrel ignition
Past 100 km altitude	168	0:02:48	Falcon 1 crosses the boundary into space - 100 km (62 miles)
Stiffener jettison	173 (approx.)	0:02:53 (approx.)	Jettison of Kestrel nozzle stiffeners
Fairing Separation	195.5	0:03:15	The two halves of the “nose cone” separate and fall away, revealing the payload to space.
Terminal Guidance	529.4	0:08:49	Vehicle enters terminal guidance mode
Passing 7.5 km/s	574	0:09:34	Falcon 1 has reached orbital velocity
SECO	579.37	0:09:39	2nd stage engine cut-off - “SECO”
Settling thrusters	597.37	0:09:57	Second stage settling thrusters operating
Expect loss of signal	618	0:10:18	“LOS” occurs as the vehicle sinks below the horizon as viewed by the launch range’s receivers

Falcon 1 is a two-stage, liquid oxygen and rocket grade kerosene (RP-1) powered launch vehicle. It is designed in-house from the ground up by SpaceX for cost efficient and reliable transport of satellites to low Earth orbit.

Length:	**21.3 m** (70 feet)
Width:	**1.7 m** (5.5 feet)
Mass:	**27,670 kg** (61,000 lbs)
Thrust on liftoff:	**347 kN** (78,000 lbf)

Performance data above reflects the updated Falcon 1 vehicle only, not the Falcon 1e

Falcon 1 Flight 3 lifts off from the SpaceX Omelek island launch site on 2 Aug 2008 (UTC).

First Stage

The primary structure is made of an aluminum alloy, graduated monocoque, common bulkhead, flight pressure stabilized architecture developed by SpaceX. The design is a blend of a fully pressure stabilized design, such as Atlas II, and a heavier isogrid design, such as Delta II. As a result, Falcon 1 first stage is able to capture the mass efficiency of pressure stabilization, but avoid the ground handling difficulties of a structure unable to support its own weight.

A single SpaceX Merlin 1C regeneratively cooled engine powers the Falcon 1 first stage. After ignition of the first stage engine, the Falcon is held down and not released for flight until all propulsion and vehicle systems are confirmed to be operating nominally.

Stage separation occurs via redundantly initiated separation bolts and a pneumatic pusher system. All components are space qualified, having flown previously on other launch vehicles.

Second Stage

The tanks are precision machined from plate with integral flanges and ports, minimizing the number of welds necessary. A single SpaceX Kestrel engine powers the Falcon 1 upper stage.

SpaceX Merlin 1C Regeneratively Cooled Engine

The main engine, called Merlin 1C, was developed internally at SpaceX, drawing upon a long heritage of space-proven engines. The pintle style injector at the heart of Merlin was first used in the Apollo Moon program for the Lunar Excursion Module (LEM) landing engine, one of the most critical phases of the mission. For this flight of the Falcon 1, the Merlin 1C performance is as follows:

Sea Level Thrust:	**78,000 lb**
Vacuum Thrust:	**138,400 lb**
Sea Level Isp:	**255 s**
Vacuum Isp:	**304 s**

Performance data above is for the Falcon 1, not the Falcon 1e.

Propellant is fed via a single shaft, dual impeller turbo-pump operating on a gas generator cycle. High pressure kerosene fuel flows through the walls of the combustion chamber and exhaust nozzle before being injected into the combustions chamber. This provides significant cooling, permitting the engine to operate at a higher level of performance. The turbo-pump also provides the high pressure kerosene for the hydraulic actuators, eliminating the need for a separate hydraulic power system. Additionally, actuating the turbine exhaust nozzle provides roll control during flight. Combining these three functions into one device, and verifying its operation before the vehicle is allowed to lift off, provides significant improvement in system-level reliability.

With a vacuum specific impulse of 304s, Merlin is the highest performance gas generator cycle kerosene engine ever built, exceeding the Boeing Delta II main engine, the Lockheed Atlas II main engine and on par with the Saturn V F-1.

SpaceX Kestrel Pressure Fed Engine

Kestrel, also built around the pintle architecture, is a high efficiency, pressure-fed vacuum engine.

Vacuum Thrust:	**6,900 lb**
Vacuum Isp:	**320 s**

Kestrel, also built around the pintle architecture, is designed to be a high efficiency, low pressure vacuum engine. It does not have a turbo-pump and is fed only by tank pressure. Kestrel is ablatively cooled in the chamber and throat and radiatively cooled in the nozzle, which is fabricated from a high strength alloy. An impact from orbital debris or during stage separation would simply dent the metal, but have no meaningful effect on engine performance. Thrust vector control is provided by electro-mechanical actuators on the engine dome for pitch and yaw. Roll control (and attitude control during coast phases) is provided by helium cold gas thrusters.

A highly reliable and proven TEA-TEB pyrophoric system is used to provide multiple restart capability on the upper stage. In a multi-manifested mission, this allows for drop off at different altitudes and inclinations.

DESIGNED FOR MAXIMUM RELIABILITY

The vast majority of launch vehicle failures in the past two decades can be attributed to three causes: engine, stage separation and, to a much lesser degree, avionics failures. An analysis of launch failure history between 1980 and 1999 by Aerospace Corporation showed that 91% of known failures can be attributed to those subsystems.

Engine Reliability

It was with this in mind that SpaceX designed Falcon 1 to have the minimum number of engines. As a result, there is only one engine per stage and only one stage separation event per flight.

Another notable point is the SpaceX ‘hold-before-release’ system - a capability required by commercial airplanes, but not implemented on many launch vehicles. After the first stage engine is ignited, Falcon 1 is held down and not released for flight until all propulsion and vehicle systems are confirmed to be operating nominally. An automatic safe shut-down and unloading of propellant occurs if any off nominal conditions are detected.

Stage Separation Reliability

Here Falcon takes advantage of simplicity, by having two stages and therefore only one stage separation event - the minimum practical number. Moreover, the stage separation bolts are all redundant initiated, fully space-qualified, with a zero failure track record in prior launch vehicles.

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SpaceX | Company Overview

In an era when most technology based products follow a path of ever-increasing capability and reliability while simultaneously reducing costs, launch vehicles today are little changed from those of 40 years ago. SpaceX aims to change this paradigm by developing a family of launch vehicles and spacecraft which will ultimately increase the reliability and reduce the cost of space access by a factor of ten. Coupled with the emerging market for private and commercial space transport, this new model will re-ignite humanity's efforts to explore and develop space.

Our company is based on the philosophy that simplicity, low-cost, and reliability go hand-in hand. By eliminating the traditional layers of internal management, as well as external sub-contractors, we reduce our costs while expediting decision-making and delivery. Likewise, by keeping the vast majority of manufacturing in-house, we reduce costs, keep tighter control of quality, and ensure a tight feedback loop between the design and manufacturing teams. Additionally, by focusing on simple, proven designs focused on reliability, we reduce the costs associated with complex systems operating at the margin.

Established in 2002 by Elon Musk, founder of PayPal and Zip2 Corporation, SpaceX has developed two launch vehicles, the Falcon 1 and Falcon 9, established an impressive launch manifest, and was awarded Commercial Orbital Transportation Services (COTS) funding by NASA to demonstrate delivery and return of cargo and potentially crew to the International Space Station. To support that contract, SpaceX has built the Dragon, a free-flying reusable spacecraft, capable of hosting pressurized and unpressurized payloads. Supported by a strong investment base and initial manifest, SpaceX is on sound financial footing as we move towards volume commercial launches.

Drawing upon a rich history of prior launch vehicle, spacecraft and engine programs, SpaceX is privately developing the Dragon cargo and crew capsule and the Falcon family of rockets from the ground up, including main and upper stage engines, the cryogenic tank structure, avionics, guidance & control software and ground support equipment.

With the Falcon 1, Falcon 9 and Falcon 9 Heavy launch vehicles, SpaceX offers a full spectrum of light, medium and heavy lift launch capabilities to our customers, delivering spacecraft into any inclination and altitude, from low Earth orbit to geosynchronous orbit to planetary missions. The Falcon 9 and Falcon 9 Heavy are the only US launch vehicles with true engine out reliability. Falcon 9 has nine Merlin engines clustered together. This vehicle will be capable of sustaining an engine failure at any point in flight and still successfully completing its mission. This actually results in an even higher level of reliability than a single engine stage. The SpaceX nine engine architecture is an improved version of the architecture employed by the Saturn V and Saturn I rockets of the Apollo Program, which had flawless flight records despite losing engines on a number of missions.

As a winner of the NASA COTS competition, SpaceX is in a position to fill the gap in US spaceflight when the Space Shuttle retires in 2010. Under the existing contract, SpaceX will conduct three flights of its Falcon 9 launch vehicle and Dragon spacecraft for NASA, culminating in Dragon berthing with the International Space Station (ISS) and as the only reusable offering, returning to Earth. NASA also has a contract option on Falcon 9 / Dragon to provide crew services to the ISS after Shuttle retirement. The first Falcon 9 will arrive at the SpaceX launch site Complex 40 at Cape Canaveral by the end of 2008.

SpaceX design and manufacturing facilities are located near the Los Angeles International Airport, leveraging the deep and rich aerospace heritage and talent pool available in Southern California. Our extensive propulsion and structural test facilities are located in Central Texas. We currently have launch complexes available at Vandenberg Air Force Base, the Kwajalein Atoll and Cape Canaveral, where we have begun developing Space Launch Complex 40.

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