The Dream

Despite the recent SpaceShipTwo accident Virgin Galactic remains committed to its space tourism plan

Virgin Galactic has vowed to continue pursuing its dream of launching tourists on regular trips to the edge of space following the test flight accident that killed one pilot and seriously injured another at the end of October.

The company's trail-blazing rocket craft, SpaceShipTwo, was ripped apart in the accident high over California's Mojave Desert. An investigation is now taking place to establish the cause and suggest potential remedies.

George Whitesides, Virgin Galactic's Chief Executive Officer and President, told *AIR International* that work would continue on the second SpaceShipTwo which is now nearing structural completion.

"While the investigation is on-going we are allowed to proceed with work on our second SpaceShipTwo craft and expect to complete this within the coming six months," he said.

"We are heartened by the findings around the condition of the motor, and if the investigation does become focused around human procedure then there will be straightforward ways that we can deal with that to make sure it doesn't happen again.

"We fly every day on aeroplanes that have had accidents and we do that because they have been fixed," added Whitesides. "We are pioneering a new environment and a new set of vehicles and there are risks, but I believe the future of space is worth those risks."

Investigation

First signs that the US National Transportation Safety Board's (NTSB) investigation was shifting away from the rocket motor came when an analysis of telemetry and video recorded aboard the spaceplane revealed the craft's novel braking system had deployed earlier than scheduled.

SpaceShipTwo's distinctive rear-mounted feathering system is supposed to extend just before the ship descends back from space into the atmosphere, slowing its speed and putting the craft into a belly-down position during re-entry.

But during the October 31 test flight its twin tail booms rotated upward just seconds after the firing of the hybrid rocket motor following separation from the WhiteKnightTwo carrier aircraft at 50,000ft (15,240m).

Finding a Cause

Revealing on only the second day of the investigation that SpaceShipTwo's co-pilot Michael Alsbury had moved a lever inside the spaceplane's cockpit that unlocked the tail feathers, the NTSB's Acting Chairman Christopher Hart cautioned against jumping to early conclusions.

"We are a long way from finding a cause," he said. "And what I've said is a statement of fact and not a statement of cause. We still have months and months of investigation to do and there's a lot that we don't know. We have extensive data sources to go through."

The 39-year-old Alsbury, who was employed by Scaled Composites which manufactures SpaceShipTwo, died in the accident.

An NTSB statement said the pilot Peter Siebold, 43, had told investigators that "he was extracted from the vehicle as a result of the break-up sequence and unbuckled from his seat at some point before the parachute deployed automatically", surviving the 10 mile (16km) fall back to Earth.

"It will be regarded as one of the most amazing test flight survival stories of all time," Whitesides told *AIR International*. "It is truly unbelievable and we are all incredibly thankful that he was able to parachute safely to the ground." Siebold sustained a shoulder injury and was released from hospital a few days after the accident.

Hybrid Rocket Motor

The test flight marked the first time a new hybrid rocket motor – consuming a combination of nitrous oxide and a plastic-based solid fuel mix – was used on SpaceShipTwo since Virgin Galactic switched from a rubber-based to a plastic-based fuel. The rocket's engine ignited a few seconds after SpaceShipTwo's release from the carrier aircraft.

"About nine seconds after the engine ignited telemetry data indicated that the feather parameters changed from lock to unlock," Hart explained. A camera mounted

Continues

inside the cockpit showed Alsbury move a handle that unlocked the feather system as the rocket plane passed Mach 1.

While pistons would have held the tail wings flat at Mach 1.4 or even Mach 1.2, as on previous test flights, SpaceShipTwo was at that moment breaking the sound barrier and aerodynamic turbulence likely forced the pistons to deploy the feathers, causing a catastrophic break-up of the ship.

SpaceShipTwo was on its most ambitious test flight to date – the pilots were planning to push the craft higher than ever. To reach the edge of space the craft must fly under its own power for about 60 seconds – in its first three powered tests, the engine had a planned burn of no more than 20 seconds.

Wings

The spaceplane is shaped like a swallow, its two wings stretching back towards its tail. The wing booms are held in place by safety hooks. Once the hooks are unlocked, a second handle at the controls should set in motion two pistons that push the wings upwards, transforming the SpaceShipTwo's profile from a sleek line to an L-shape. The manoeuvre is designed to happen just before the craft begins its descent.

By this time, the engine would have stopped burning and the momentum propelling SpaceShipTwo higher would have run out. The feathering system is designed to right the craft, so that it drifts back down belly first. On final approach, the wings would straighten again, allowing the ship to land like a glider, without the help of an engine. Unlocking the wings too near to Mach 1 would have been disastrous because, as objects reach this speed, the aerodynamic forces around them become unpredictable.

SpaceShipTwo has no ejector seats but there is a door immediately to the rear of the pilot seats and an emergency hatch near the middle passenger window.

Debris Field

Investigators combing the 5 mile (8km)-long debris field found SpaceShipTwo's rocket motor and propellant tanks to be intact and showing no sign of burn-through or breaching, indicating the craft's rocket motor performed normally until the tail feathers were extended.

Hart said six video cameras and six data recorders aboard SpaceShipTwo will be providing crucial information to the investigation, along with footage from WhiteKnightTwo, the ground-based imagers and eyewitness accounts.

Virgin Galactic had planned to introduce its commercial sub-orbital service in 2015, ferrying wealthy tourists to an altitude of more than 62 miles (100km) above Earth, the internationally recognised boundary of space, at three-and-a-half times the speed of sound.

Passengers at that altitude would be able to unstrap from their seats and float around the rocket plane's six-person cabin for a few minutes before the glide back to Earth for landing on a runway.

The NTSB's full report will likely take many months to produce and one line of inquiry will be to ascertain whether the pilots were getting the correct information on their cockpit displays throughout the critical rocket-firing period.

"We would anticipate taking as long as 12 months to complete an analysis that would end up with a probable cause determination, as well as recommendations to prevent an incident like this again," said Hart.

Confirming its desire to continue with its commercial space venture, Virgin Galactic stated it was committed to full and open co-operation with the NTSB.

"While this has been a tragic setback, we are moving forward and will do so deliberately and with determination," Virgin Group Chairman Sir Richard Branson said in a statement released on November 4.

"We are continuing to build the second SpaceShipTwo (serial number two), which is currently about 65% complete and we will continue to advance our mission over the coming weeks and months.

"With the guidance of the NTSB and the assurance of a safe path forward, we intend to move ahead with our testing programme and have not lost sight of our mission to make space accessible for all."

Prior to October 31, SpaceShipTwo had undergone a total of 55 flights which included 30 glide flights, two cold flow flights (which involved running oxidizer through the propulsion system without igniting the motor), 18 captive carry flights (during which the craft was carried by WhiteKnightTwo without being launched) and three rocket-powered supersonic flights.

Spaceport

Virgin Galactic's Mojave-based The Spaceship Company (TSC) will be responsible for building a fleet of vehicles for Virgin Galactic operations as well as supporting on-going spaceline operations.

New Mexico Spaceport Authority (NMSA) has funded the world's first purpose-built spaceport, complete with a 12,000ft (3,657m) runway, at Las Cruces, New Mexico and it's from here that Virgin Galactic plans to launch its initial commercial flights. In view of the on-going accident investigation the company has been unable to issue a revised timetable for the start of these operations.

Main image: ***SpaceShipTwo on a rocket-powered supersonic test flight.*** *Mars Scientific and City Centre Observatory, via Virgin Galactic*
Top right: ***NTSB investigators observing the WhiteKnightTwo launch aircraft during their investigations.*** *NTSB*
Opposite bottom: ***SpaceShipTwo during its first rocket-powered flight.*** *Virgin Galactic*