

FAA closes investigation into SpaceX Starship's double-explosion 2nd flight

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As SpaceX continues to gear up for flight No. 3 of its massive Starship and Super Heavy from Texas, the Federal Aviation Administration has closed the investigation into the second flight that resulted in explosions

of both the booster and upper stages back in November.

The FAA on Monday said the SpaceX-led investigation into what was classified as a "mishap," cited 17 action items that have to be addressed before any future launch licenses from SpaceX's Boca Chica, Texas launch site Starbase are approved.

Starship is SpaceX's replacement launch system for its Falcon 9 and Falcon Heavy rockets and is completely reusable. It's aiming to launch a third test flight as soon as next month if it can get approval.

The first launch of Starship and Super Heavy in April 2023 also ended in an explosion, but with the booster still connected to the upper stage. That launch also walloped the launch pad, and it took more than six months to close out that mishap investigation with 63 corrective actions.

The [second flight](#) performed much better despite the double combusive incidents mid-flight.

In an update from SpaceX on its website, it detailed what happened on that flight, which was part of the investigation overseen by the FAA with the help of NASA and the National Transportation Safety Board.

Changes to the [launch pad](#) including the introduction of a water-cooled flame deflector were among the most visible fixes between launches one and two, "requiring minimal post-launch work to be ready for vehicle tests and the next integrated flight test," SpaceX reported. That was one facet of SpaceX's testing that was of interest to the Space Coast as its future flight plans include launches potentially from Kennedy Space Center's Launch Pad 39-A, and NASA was concerned of damage to the adjacent pad from where SpaceX flies its human spaceflight missions to the International Space Station.

As far as other improvements, the Super Heavy booster's 33 Raptor engines stayed lit for the entire upward flight during which it generated near 17 million pounds of thrust, which is nearly twice that of NASA's Space Launch System rocket.

The second flight also saw successful stage separation, using a system called hot-fire staging that allows the upper Starship stage to light its engines while still connected to the Super Heavy booster so it can maintain upward thrust. It was after the stage separation that the two parts of the rocket saw their destructive ends.

As the Super Heavy booster performed a boostback burn designed to send it toward its return flight landing target, SpaceX lit back up 13 of 33 Raptor engines, but one of the engines "failed energetically, quickly cascading to a rapid unscheduled disassembly (RUD) of the booster."

That's the massive explosion seen on the live stream of the launch out over the Gulf of Mexico at about 56 miles altitude around 3 1/2 minutes after takeoff

"The most likely root cause for the booster RUD was determined to be filter blockage where [liquid oxygen](#) is supplied to the engines, leading to a loss of inlet pressure in engine oxidizer turbopumps that eventually resulted in one engine failing in a way that resulted in loss of the vehicle," SpaceX reported.

Changes since the launch include a shift in hardware inside the booster oxidizer tanks to help filter propellant, which would also "reduce slosh," according to the FAA.

As far as the upper stage Starship, which has six of its own Raptor engines, its demise was not seen on the live stream, but SpaceX reported it activated the self-destruct mechanism traveling near 15,000 mph at an

altitude of 93 miles, which meant it had passed the Karman line, the internationally recognized boundary for having made it to space, which was a first for Starship.

The destruction came about seven minutes into flight when it tried to vent excess liquid oxygen propellant, which had been loaded to simulate the weight the ship would have had had it been flying with a payload. SpaceX had to get rid of the propellant, though, before continuing its planned trajectory that would have brought it back down in the Pacific Ocean after traveling two-thirds of the way around the Earth.

It didn't get that far, though, because "a leak in the aft section of the spacecraft that developed when the liquid oxygen vent was initiated resulted in a combustion event and subsequent fires that led to a loss of communication between the spacecraft's flight computers."

The incident that the FAA reported as "several explosions and sustained fires" was seen by onboard cameras, video of which was not released to the public.

That led to a shutdown of the six engines before it reached the end of its ascent burn, "followed by the Autonomous Flight Safety System detecting a mission rule violation and activating the flight termination system, leading to vehicle breakup."

That was the second explosion.

For the upper stage Starship, SpaceX has made changes to "improve leak reduction, fire protection and refined operations associated with the propellant vent to increase reliability."

SpaceX has already for the second flight shifted control of its Raptor engines on the Super Heavy booster from a hydraulic steering system to

an entirely electric system, and for future Starship upper stage flights, the same changes are being made, something that "removes potential sources of flammability."

The FAA said of the 17 corrective actions needed, seven were for the Super Heavy booster and 10 for the [upper stage](#) Starship.

"The FAA has been provided with sufficient information and accepts the root causes and corrective actions described in the mishap reports," reads a letter from the FAA to SpaceX. "Consequently, the FAA considers the mishap investigation that SpaceX was required to complete to be concluded."

For the next planned test flight, SpaceX still has yet to complete its original mission plan, which is to have the booster splash down in the Gulf of Mexico without exploding and Starship splash down at the end of its suborbital flight in the Pacific Ocean about 90 minutes later north of Hawaii.

Eventually, plans are for both parts to make vertical safe landings as part of the spacecraft's reusable design. At a combined 397 feet tall, the fully-stacked rocket takes off from a 469-foot-tall launch integration tower, which SpaceX CEO Elon Musk refers to as "Mechazilla." It's designed to capture the Super Heavy booster on its return with the aid of two pivoting metal arms called the "chopsticks."

NASA has a vested interest in Starship becoming operational, as a version of it is slated to act as the human landing system for the Artemis III mission, which is slated for as early as September 2026. That's the mission that aims to return humans, including the first woman, to the lunar surface for the first time since the end of the Apollo missions in 1972.

Its completion is also eagerly awaited by the Department of Defense that is interested in its massive upgrade in cargo capacity over existing rockets. SpaceX's big plans for what it expects to be hundreds and then thousands of Starship launches a year are to send up larger versions of its Starlink satellites, several human spaceflights, and eventually send up hardware to allow for settlement of Mars.

SpaceX has applied for as many as nine launches from Starbase in 2024. Space Coast launches would not happen until Starship achieves several successful test flights, and could be years away.

"More Starships are ready to fly, putting flight hardware in a flight environment to learn as quickly as possible," SpaceX posted. "Recursive improvement is essential as we work to build a fully reusable launch system capable of carrying satellites, payloads, crew, and cargo to a variety of orbits and Earth, lunar, or Martian landing sites."

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