SpaceX continuing to press toward Amos-6 failure root cause

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September 23, 2016 by Chris Bergin

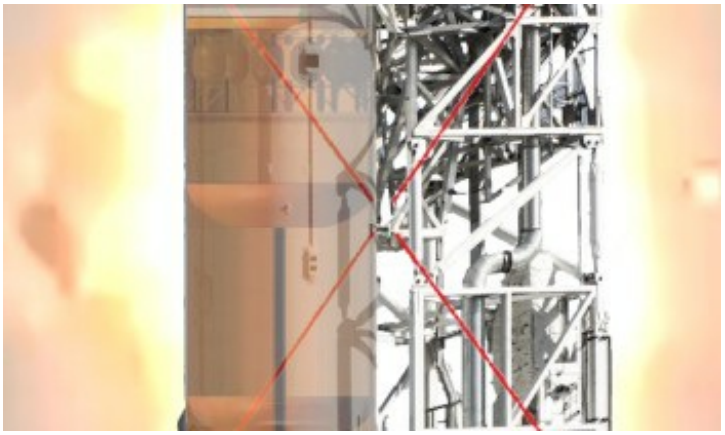
SpaceX is still working towards a root cause into the failure of its Falcon 9 during a Static Fire test. The failure, which resulted in the destruction of the rocket and the Amos-6 satellite, originated in the second stage LOX tank's helium pressurization system, although the specific cause of the anomaly is not yet fully understood. SpaceX is still hopeful it will be able to return to launch action in November.

The Unexpected Failure:

It's been over three weeks since SpaceX rolled its latest Falcon 9 out to the pad as a fully integrated rocket for its static fire test.

This test is carried out ahead of all Falcon 9 launches, allowing for a dress rehearsal for its launch team, along with a full countdown, prop loading and engine test of the rocket, with the results feeding into the Launch Readiness Review (LRR).

With the Falcon 9 just eight minutes away from engine ignition, an explosion occurred "in or around" the second stage – as initially noted by SpaceX – resulting in the loss of the vehicle and payload.



According to SpaceX, there was no warning of a problem with the rocket, at least from the standpoint of any controller being able to react.

"The timeline of the event is extremely short – from first signs of an anomaly to loss of data is about 93 milliseconds or less than 1/10th of a second," the company noted in an updated statement on Friday.

Closing In On The Root Cause:

While the "smoking gun" remains elusive, SpaceX and its partners involved with the investigation, do appear to be making progress into what actually failed.

"The Accident Investigation Team (AIT), composed of SpaceX, the FAA, NASA, the U.S. Air Force, and industry experts, are currently scouring through approximately 3,000 channels of engineering data along with video, audio and imagery," added SpaceX.

Working through that amount of data was always going to take time. However, so far that has only pointed to what the rocket was telling them before its demise.

Evidence is also being gathered via video footage of the failure. While the only public video is a recording provided by USLaunchReport, SpaceX also had its own cameras recording the test. The company has not released any footage from those views due to the ongoing investigation.

Physical evidence is also a major part of the investigation, with the remains of the Falcon 9 recovered from the launch pad now being examined in a hangar. It was initially thought some of the hardware was thrown well clear of the pad during the resulting explosion.

"The explosion of the SpaceX Falcon 9 vehicle that occurred at Space Launch Complex 40 on September 1st propelled debris far away from the Space Complex. Employees are asked to look out for debris from this anomaly," was one such example of a memo provided to KSC workers.

It was also reported that one piece of debris was recovered from the "north side of the Delta IV pad (LC-37)". However, it is unlikely this was from the Falcon 9, as SpaceX noted there has been no evidence of debris leaving the immediate area of LC-40.

"The majority of debris from the incident has been recovered, photographed, labeled and catalogued, and is now in a hangar for inspection and use during the investigation," SpaceX confirmed.

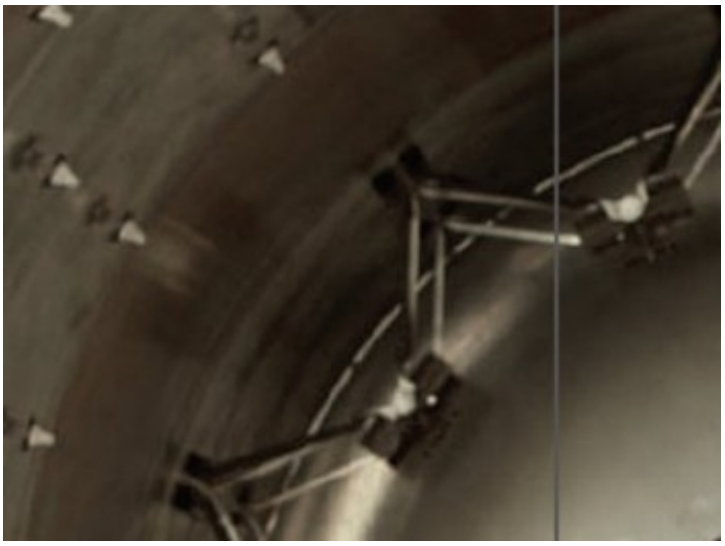
Potential Failure Candidates:

This was only the second failure of a Falcon 9, not including the "pushed to its limits" failure of the F9R Dev1 test vehicle at McGregor.

The previous "mission" Falcon 9 to fail was during first stage flight on the CRS-7 Dragon mission.

The 19th mission of the Falcon 9 ended abruptly 2 minutes 19 seconds after liftoff when a failure of the second stage resulted in the loss of the launch vehicle, Dragon and her cargo.

The fault was related to a strut that held one of the Composite Overwrapped Pressure Vessels (COPVs) – as they were named during the Shuttle era – in place inside the Second Stage. These "bottles" contain the helium that is used to pressurize the tanks.



While SpaceX has been keen to note they do not see any commonality between the CRS-7 failure and the Falcon 9 anomaly on the pad, that would not technically rule out a COPV failure, given the "smoking gun" on CRS-7 was the failed support strut.

The almost instantaneous failure of the rocket, as noted via the 93 milliseconds timing in the data, also points to a dramatic failure that could be the result of a COPV failing.

However, sources note they are extremely sceptical a COPV could be at fault, due to the amount of focus placed on them after the CRS-7 failure. A number of COPVs are understood to have been recovered from the debris of the Falcon 9, which will aid the investigation.

This lack of a smoking gun at this stage may, in part, explain why Elon Musk is classing this as the "most difficult and complex failure" in 14 years.

However, SpaceX does appear to be now focused on the pressurization system in the Second Stage LOX tank, which points to progress in the investigation.

"At this stage of the investigation, preliminary review of the data and debris suggests that a large breach in the cryogenic helium system of the second stage liquid oxygen tank took place," the company added.

"All plausible causes are being tracked in an extensive fault tree and carefully investigated. Through the fault tree and data review process, we have exonerated any connection with last year's CRS-7 mishap."

Other items of interest may include the associated plumbing in the helium system, such as the lines that feed the helium into the LOX tank itself.

SLC-40's Condition – Heading to 39A:

When SpaceX concludes the investigation and begin the process to return to launch action, SLC-40 is unlikely to be ready to take part in hosting that next mission.

The pad suffered obvious damage during the failure, although SpaceX provided a positive overview for a number of critical pad systems on Friday.

“The teams have continued inspections of LC-40 and the surrounding facilities. While substantial areas of the pad systems were affected, the Falcon Support Building adjacent to the pad was unaffected, and per standard procedure was unoccupied at the time of the anomaly,” noted the latest SpaceX statement.

“The new liquid oxygen farm – e.g. the tanks and plumbing that hold our super-chilled liquid oxygen – was unaffected and remains in good working order. The RP-1 (kerosene) fuel farm was also largely unaffected. The pad’s control systems are also in relatively good condition.”

Sources had noted they initially estimated SLC-40 will be out of action until next Summer. However, the positive overview may provide hope the pad could return to action by the Spring.

In the meantime, SpaceX is expected to bring its new facility at LC-39A online in time for a mission as early as November.

Expected to be the Falcon 9 launch of the CRS-10 Dragon, the use of the hugely historic pad will return it to launch operations for the first time since Shuttle Atlantis launched on her – and the program’s – final mission, STS-135.

“SpaceX’s other facilities, from the Payload Processing Facility at the Cape, to the pad and hangar at LC-39A, are located several miles from LC-40 and were unaffected (by the failure),” per SpaceX’s statement.

“Work continues at Pad 39A in preparation for bringing it online in November.”

The company is continuing to produce hardware to be in the best possible position to push through its busy manifest, with which utilize both 39A and its facility at Vandenberg, prior to the addition of SLC-40 when it returns to action.

“At SpaceX headquarters in Hawthorne, CA, our manufacturing and production is continuing in a methodical manner, with teams continuing to build engines, tanks, and other systems as they are exonerated from the investigation.

“We will work to resume our manifest as quickly as responsible once the cause of the anomaly has been

identified by the Accident Investigation Team. Pending the results of the investigation, we anticipate returning to flight as early as the November timeframe.”

(Images: SpaceX, USLaunchReport, NASA and L2 – including Amos-6 Failure Evaluation video by Jay Deshetler and photos by Derrick Stamos, Marek Cyzio and Bennett Scarborough)

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