ON SPACE

SpaceX: Engine Anomaly Overview

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Posting this as background to our June 17 story in AW&ST:

In a Feb. 14 briefing to congressional oversight committees, SpaceX explained what went wrong with the Oct. 8, 2012 Falcon 9 launch that successfully delivered a Dragon cargo vessel to the ISS, but which left a secondary payload launched for Orbcomm in the wrong obit. Note that SpaceX has since launched a Falcon 9 mission that ultimately sent Dragon to the space station in March. In addition, the company is expected to debut a new, more powerful version of the Falcon 9 Merlin 1C engine - the Merlin 1D -- this year.

Engine Anomaly Overview

An exhaustive review of all available data by both SpaceX and NASA suggests the engine anomaly experienced on CRS-1 was likely the result of an undetected material flaw in the engine chamber jacket.

The material flaw was most likely introduced during engine production. For Merlin 1C, the engine chamber jacket is formed by an electroplating process, and this particular chamber required extra plating cycles during production. This re-plating process is not uncommon, but does have the potential to introduce flaws in the jacket that can be difficult to detect.

In addition, during testing, the main combustion chamber on this engine experienced a unique combination of environments as compared to the other engines. While none of these observations exceeded demonstrated qualification margins, the combination of these environments likely exacerbated the material flaw on the engine's main combustion chamber jacket.

During flight, the data suggests this material flaw ultimately developed into a breach in the main combustion chamber. This breach released a jet of hot gas and fuel in the direction of the main fuel line causing a secondary leak and ultimately a rapid drop in engine pressure. As a result, the flight computer commanded shutdown of engine 1 and Falcon 9 continued on its path to ensure Dragon's entry into orbit for subsequent rendezvous and berthing with the ISS.

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These findings correspond with what was observed by long range tracking cameras during the launch. The video shows the nacelle panels that enclosed engine 1 as well as adjacent panels being jettisoned from the engine section of the first stage. These panels are designed to relieve pressure if necessary, as would be in the event of an engine chamber breach.

Falcon 9 did exactly what it was designed to do. Like the Saturn V (which experienced engine loss on two flights) and modern airliners, Falcon 9 is designed to handle an engine out situation and still complete its mission. No other rocket currently flying has this ability.

For the upcoming CRS-2 flight, SpaceX reviewed samples with known defects to supplement existing inspection techniques and re-inspected the CRS 2 engine chambers for possible issues. No critical flaws were discovered. In addition, the engines for CRS 2 have not seen as strenuous environments than the engines flown on the CRS 1.

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