

Before explosion, NASA knew aging Soviet engines could crack and leak fuel

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Years before an unmanned rocket erupted in a fireball in October, NASA officials knew the metal in its 50-year-old Soviet-made engines could crack, causing fuel to leak and ignite, government documents show.

As early as 2008, a NASA committee warned about the "substantial" risk of using the decades-old engines, and a fire during a 2011 engine test in Mississippi heightened the agency's concern.

The engines had a "fundamental flaw in the materials," said a top manager for NASA's contracted rocket builder, Orbital Sciences, in a 2013 interview with an agency historian. The Soviet engines were built in the 1960s and 1970s in a failed attempt to take cosmonauts to the moon.

"They were never designed to be in storage that long," said the Orbital manager, Ken Eberly, deputy director for the rocket program.

The explosion, just seconds after liftoff from a Virginia launch pad on Oct. 28, destroyed tens of millions of dollars in taxpayer-funded supplies, experiments and equipment, all bound for the International Space Station. The episode has raised questions about NASA's oversight of a new program to hire private contractors to carry cargo and astronauts to orbit, rather than operate the spacecraft itself.

The program aimed to encourage private industry to develop innovative,

safe and reliable spacecraft, and ideally save money. But NASA and Orbital officials knew the decades-old engines posed a danger before the agency awarded the company a \$1.9-billion deal to launch eight missions.

The company and NASA tried to address the risk by X-raying the engines to find cracks and patching them with welds.

NASA officials knew before the October explosion that the fix had not worked as well as intended. In May, an overhauled engine exploded during a test at NASA's Stennis Space Center in Mississippi.

Under NASA's contract with Orbital, taxpayers shoulder most of the risk of a catastrophe. The company receives as much as 80 percent of its fee for each launch - even if the rocket explodes.

NASA has not said how much the destroyed cargo was worth. The government will also spend up to \$20 million to repair damage the explosion caused to the Virginia launch facility, according to legislation approved in December.

Based in Dulles, Va., Orbital was co-founded by David Thompson, a former NASA engineer who is now its chief executive. Other top managers also came from NASA, including Executive Vice President Frank Culbertson, a former space shuttle astronaut.

NASA is allowing Orbital to lead the investigation into the disaster's cause.

The company said last month that preliminary evidence pointed to a failure in one of the two Soviet-era engines that powered the rocket. As a result, the company will switch to a newly manufactured Russian engine for future launches.

In response to questions from the Los Angeles Times, NASA said Orbital "took every effort" to make sure the flight was successful.

"Launching rockets is a very difficult engineering endeavor," said Stephanie Schierholz, a NASA spokeswoman. "NASA and its contractors do our best to mitigate risks, but we can never eliminate them entirely."

Barron Beneski, Orbital's vice president of communications, said the company should not be faulted for using the engines after risks were identified. The two engines on the rocket had passed all required inspections and tests before the launch, he said. And the same type of refurbished Russian engines was used in four previous launches with no problems, he said.

He added that it wasn't clear yet whether cracking in the aging metal led to the explosion. The company's investigation is continuing.

Orbital has completed just two of the eight cargo missions outlined in the deal - but it has already collected from NASA \$1.3 billion of the \$1.9-billion contract, according to the company's financial statements.

That is one reason Orbital executives have assured investors that the company's loss from the explosion is "minimal."

Agency officials made the advance payments to Orbital despite warnings last year from NASA's inspector general that they were risking hundreds of millions of taxpayer dollars. NASA told the inspector general that it was paying Orbital to build rockets for future missions included in the contract. The agency said it paid upfront because it wanted the company to be financially "healthy" and to have craft ready to go to the [space station](#) if a problem arose.

NASA has been an Orbital customer since Thompson co-founded it in 1982, providing as much as 80 percent of its annual revenues, according to the agency.

This was not the first time the company's rockets have failed, at massive expense to taxpayers.

In 2009, the nose cone on a rocket carrying the \$273-million Orbiting Carbon Observatory failed to release on time, destroying the satellite. NASA soon picked Orbital again, this time for a 2011 launch of a \$424-million climate satellite known as Glory - which was destroyed by a similar nose cone problem.

NASA's close partnership with Orbital was clear at the news conference three hours after the explosion, where Culbertson and agency officials answered questions. William Gerstenmaier, a NASA associate administrator, repeatedly told reporters that the agency had confidence in Orbital.

"We just feel for Orbital," he said. At another point, he said, "We'll go fly again at the right time with Orbital."

Since the October crash, NASA has given Orbital two new contracts: one valued at up to \$186 million to operate the agency's giant scientific balloons and another for \$56 million to launch a small satellite.

The problem-plagued engines had been stored in Russia for nearly 30 years when Sacramento, Calif.-based Aerojet purchased and imported dozens of them in the 1990s.

Aerojet refurbished the 12-foot-long, 2,700-pound engines and painted over their original NK-33 markings, renaming them the AJ-26. But Aerojet's initial buyer for the engines went bankrupt. Aerojet's parent

company, GenCorp, wrote off their cost, leaving them valued as worthless on its accounting books.

Orbital executives, however, saw an opportunity. In 2008, as they were writing a proposal for the NASA contract, they asked Aerojet about the engines' availability and bought them.

Even then, NASA officials knew the peril posed by the engines. An internal NASA committee ruled the engines represented "a substantial or significant risk" to Orbital's ability to deliver cargo to the space station, according to a Government Accountability Office review of the bidding process.

Orbital responded by saying that the engines had been stored in Russia in "humidity-controlled conditions with no documented stress corrosion cracking."

NASA's committee then changed its finding, saying the engines created an "ordinary" risk, according to the GAO report.

Aerojet said in a written statement that it is too early to blame the engines for the explosion because the investigation is not final.

Launching rockets can entail many risks. Yet when Orbital executives spoke to NASA in June 2013 for an oral history project, they spoke mostly of one risk: the aging metal in the engines. NASA catalogs the oral history interviews to provide firsthand accounts of many of its missions and programs.

In those interviews, Orbital executives spoke openly about their fears that the old Russian engines could crack. Culbertson mentioned the test failure in 2011, when an engine caught fire.

"The fuel manifold line basically split apart," Culbertson explained. "It turned out that that engine had a crack in it that was not detected by Aerojet. It resulted in stress corrosion cracking that grew under pressure."

Culbertson blamed the engines for Orbital's failure to find other customers for its rockets, such as companies needing to launch satellites.

"I think they're ... waiting to see for sure that our engines will work," he said, "because they are 40 years old."

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