Experiment decreases space-launch damage

KIRTLAND AIR FORCE BASE, N.M. – New technology that counteracts vibrations produced during a rocket launch may help limit damage to space-bound payloads, thanks to Air Force Research Laboratory scientists.

Known as active isolation and acoustic mitigation, this new technology uses something like a home stereo speaker to counteract damaging engine vibrations and sound waves, according to Dr. Kyle Henderson, the lab's advanced spacecraft mechanisms program manager.

The technology was successfully tested Aug. 20, when a rocket carrying the Vibro-Acoustic Launch Protection Experiment was launched from Wallops Island Flight Facility off the coast of Virginia.

Aerospace engineers have searched for better ways to protect payloads from the violent engine vibrations transmitted through the rocket body during launch since Sputnik first circled the earth nearly half a century ago, Henderson said. In some cases, satellites have actually been shaken apart before reaching orbit.

This is not only costly, but ruined payloads can be potentially disastrous to national defense in wartime when rapid response to orbit has to be done right every time, he said.

"Much of our work in the space vehicles directorate during the past few years has dealt with controlling unwanted launch vibrations that damage sensitive spacecraft components," Henderson said. "In the past, we developed … (a) passive isolation system for launch vehicles … which reduced vibration disturbances at a ratio of 5-to-1."

But hybrid active-passive vibration isolation is a more advanced process, Henderson said, and such systems may reduce vibrations at a ratio of 10-to-1.

"An active isolation system, like today's experiment, improves on … passive technology by actively pushing and pulling to provide better isolation performance," he said.

To do this, the hybrid isolation system on the current experiment uses a voice-coil actuator, Henderson said.

For example, in a stereo speaker a sub-woofer's cone actually moves in and out, keeping time, so to speak, with the base tones. This is that foot-tapping "beat." Driven by a magnet, the speaker cone pumps in and out to alternately compress and decompress the air, spreading the sound throughout the room.

Henderson said the new technology uses the same principle to move the payload actively. A similar device, called the adaptive Vibro-Acoustic Device, pushes against the air inside the payload shroud and compensates for harmful oncoming sound waves created at launch.

In effect, the technology dampens the harsh environment considerably by counteracting ambient vibration and "noise" and prevents payload damage, he said.

Another type of coil-based isolation system that was part of the recent experiment is a power source called regenerative electronics, Henderson said. This converts motion to the energy needed to provide active isolation during the shock of separating rocket stages during the flight to orbit.

In 1971, some researchers estimated nearly half of all payloads that failed in the first 24 hours came from vibro-acoustic stresses during launch, Henderson said. Consequently, spacecraft designers had to beef up their work and, in some cases, added nearly 40 percent worth of structural bulk to a spacecraft just to survive launch.

Lab officials have spent about $1 million on the current experiment, an investment they said may help put an end to payload losses by using technology that also reduces the mass and weight of a spacecraft. Weight-saving is a key contributor to lowering the cost of access to space, especially when it costs about $10,000 to put one pound of payload into orbit.

"I suppose what we are really doing is 'quieting' the air all around our payload," Henderson said. "And it is this protective cushion that has the potential to save our industry millions of dollars every year by getting payloads into orbit safety and cheaply."

(Courtesy of Air Force Materiel Command News Service)