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Orion's heat shield gets upgrade

The next Orion crew capsule will have a redesigned heat shield made under a new industrial relationship between Orion's prime contractor Lockheed Martin and its partner, Textron. NASA hopes to avoid a cracking problem encountered during manufacturing of the shield tested on last year's unmanned Experimental Flight Test-1 mission. That shield performed well enough, but the next missions will be more challenging, NASA says.

For Orion's next flight, the unmanned Exploration Mission-1, tentatively scheduled for late 2018, contractors will affix the shield's Avcoat epoxy-resin material in a new manner.

"Instead of using honeycomb we're going to use blocks of Avcoat, and bond directly to the composite," says NASA's Mark Geyer, the Orion program manager. The block architecture will make for a stronger heat shield, he explains.

Lockheed Martin also will license the Avcoat from Textron. Each company will fabricate some of the Avcoat blocks on the EM-1 shield. Then, for EM-2 and beyond, Lockheed Martin will fabricate and install all of the Avcoat blocks itself. This is a switch from the EFT-1 shield. Lockheed Martin fabricated that structure, including the stringers and composite, and Textron installed the Avcoat.

"We knew if we didn't fix the strength issue [the heat shield] wouldn't work for EM-1," Geyer says.


Lockheed Martin

The Orion crew module arrived at Lockheed Martin Space Systems in Littleton, Colorado, after its first exploration test flight in December 2014. The space vehicle's heatshield held up well.

On EM-1, Orion will swing around the moon and slam into Earth's atmosphere at 24,000 mph, generating heat-shield temperatures of up to 4,500 degrees Fahrenheit, compared to 4,000 degrees for EFT-1. On that mission, Orion circled Earth twice, reaching a maximum altitude of 3,600 miles and entering at 20,000 mph.

During oven curing on the EFT-1 shield in 2013, cracks developed between the dish-shaped bottom, made of titanium and carbon fiber, and the honeycomb structure filled with Avcoat, an upgraded version of the Apollo-era epoxy resin material designed to shed heat by vaporizing or ablating.


Lockheed Martin

The American flag painted on one of the Orion's thermal protection tiles returned from the first exploration test flight with minor scratches.

The Government Accountability Office, in a 2014 report, cited the cracks as a chief concern. The cracks were repaired by bonding in Avcoat plugs. Then the shield was put through stress tests to assure it would hold up during EFT-1.

"On the [EFT-1] flight itself, [the heat shield] performed close to what we expected," Geyer says.

In addition to more strength, there should be cost savings to switching from honeycomb to the block structure: Every honeycomb had to be caulked by hand, a time-consuming, expensive process. The blocks will be easier to manufacture, Geyer says. Each can be tested individually, before it is bonded to the base. The honeycomb structure had to be tested all at once following assembly.

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