Electric X-Plane Nears Crucial Battery Test

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The future X-57 Maxwell is uncrated in July 2016 in California. NASA

NASA is preparing to test a redesigned lithium-ion battery module for its first electric propulsion demonstrator, the X-57 Maxwell, as it moves toward a maiden flight planned for early in 2018.

The ground test will replicate one performed in December that resulted in a destructive thermal runaway and required the packaging to be redesigned. That test involved deliberately initiating a short circuit in one battery cell to ensure the overheating did not spread to other cells—but it did.

The original battery design had eight modules, each built up from cylindrical lithium-ion cells. The new design has 16 modules, each with half the number of cells as the configuration tested in December. An aluminum honeycomb now separates the cells and distributes the heat from a single-cell failure.

“We’ve been working with the new design for a few months now and have conducted several subscale tests, with fewer than 40 cells, to verify the thermal models for individual cell interfaces are accurate,” says Sean Clarke, NASA principal investigator for the X-57. “Those tests have helped us tweak the details of the cell mounting within the enclosure and we will be taking that design to the next full-scale test of an entire module in the next month or so,” he says. “Once the full-scale test passes, with thermal runaway propagation managed, we will complete fabrication of the flight modules.”

Battery safety is critical, because the X-57 is all-electric and the modules are mounted in the cabin, behind the pilots. The X-plane is a Tecnam P2006T twin-engine light aircraft that is being modified in phases to demonstrate distributed electric propulsion.

Scaled Composites is now modifying the aircraft to the Mod II configuration in which it is to fly early in 2018. This replaces the P2006T's two Rotax piston engines with two 60-kW electric motors developed by Joby Aviation and mounted in the same location as the original engines.

The follow-on Mod III will replace the X-57's original P2006T wing with a new high-aspect-ratio wing and move the electric motors to the tips of the wing, where the propellers will operate within the wingtip vortices. This is expected to improve their propulsive efficiency.

The new wing will have much smaller area, to reduce cruise drag, and the as-yet-unfunded Mod IV phase will install 12 small electric-driven propellers along the leading edge to augment its lift, so that the X-57 can take off and land at the same speeds as the P2006T.

With Mod III, NASA aims to demonstrate a 500% in high-speed cruise efficiency over the baseline P2006T, with zero inflight emissions and lower noise through the combination of higher-efficiency electric motors, lower-drag wing and more-efficient wingtip propellers.

While the redesigned battery modules are heavier, "Weight is looking good for the Mod II flights in 2018; we have over 5% margin left pretty late in the integration phase, when much of the hardware has been built," says Clarke. "We are still getting all the detailed mass estimates for Mod III with the high-performance wing, but it looks like we will be able to close the design within our weight target of 3,000 lb."

The baseline P2006T has a maximum takeoff weight (MTOW) of 2,700 lb.