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By Jeff Newman and MC1 Josue L. Escobosa

Already safer than it has ever been thanks to new technology that reduces workload on naval aviators as they approach an aircraft carrier, the task of recovering Navy aircraft will only get easier following recent successful flight testing aboard USS Abraham Lincoln (CVN 72).

In conjunction with Lincoln's carrier qualifications, Naval Air Warfare Center Aircraft Division (NAWCAD) air vehicle engineers and pilots with Air Test and Evaluation Squadron (VX) 23 showcased two new developments during three days of testing beginning March 21, the first being a software update to the Precision Landing Modes (PLM) flight control system that accounts for failed aerodynamic surfaces.

Using the updated PLM software, VX-23 pilots successfully completed 157 touch-and-go approaches across 20 flights roughly split between F/A-18E-F Super Hornets and EA-18G Growlers. On each approach, the aircraft had a disabled horizontal tail surface, aileron, asymmetric leading edge flap or engine. In every case, the PLM software was able to account for the failed surface or engine while maintaining precision landing performance, said Buddy Denham, senior scientific technical manager for NAWCAD's air vehicle engineering division.

"The flight control computer basically redistributes control to the other flight control surfaces that are still healthy," he said.

The successful showing also came amidst rough sea states, with wave heights between 8 to 13 feet during testing. Naturally, Denham said, the test team treated the subsequent deck motion as an opportunity to further test PLM.

"It's not where you really want to start out. You want a smooth deck, but you get a test window that opens on certain days and you don't choose your weather, it chooses you," Denham said.

The test team flew approaches into wave-offs to make sure the aircraft weren't behaving differently than during shore testing. Once the team was confident the aircraft were performing as expected, they began touching down.

"The fact that we got all of that done in adverse conditions kind of answered all of our questions. If the ocean were just a mirrored lake out there with the ship on it, you'd wonder whether it could handle high sea states and weather," Denham said. "Well, we were out there with high sea states and weather and the airplane handled it very well, so in the end we were

U.S. Navy photo by Buddy Denham

U.S. Navy photos by MC1 Josue Escobosa

Aboard USS Abraham Lincoln (CVN 72), from left, Cmdr. Bryan Roberts, officer in charge of the U.S. Navy Landing Signal Officer School, and Air Test and Evaluation Squadron (VX) 23 test pilots Lts. Christopher Montague and William Bowen man the control station of the Aircraft Terminal Approach Remote Inceptor, or ATARI, during a March 22 demonstration of the system, one of several options being considered as a backup plan to recovering unmanned aircraft should their primary landing systems falter.

fortunate we had very rough conditions. It's like we went straight to the graduation exercise."

The testing was a key step toward the final PLM software release scheduled for next year, which will be fully redundant and allow the fleet to rely on the system during all approach failure conditions. Introduced to the fleet in fall 2016, the initial release of PLM software is programmed to shut down should any failed surfaces be detected.

Denham said VX-23 pilots told him after their flights that they would rather fly a degraded test aircraft with PLM than a healthy jet using manual stick and throttle control. Previously called MAGIC CARPET—short for Maritime Augmented Guidance with Integrated Controls for Carrier Approach and Recovery Precision Enabling Technologies—PLM allows an approaching pilot to focus on flight path while the software accounts for the myriad other aspects that cumulatively made landing on an aircraft carrier one of Naval Aviation's most daunting tasks.

LSOs Prove Capable of Remote Recovery

VX-23 pilots also demonstrated a potential alternative landing system that would allow landing signal officers (LSOs) on the flight deck to take remote control of an approaching unmanned aircraft should its primary landing system become degraded.

The primary recovery system for the future autonomous, carrier-based MQ-25 Stingray, the Joint Precision Approach and Landing System (JPALS) essentially draws a flight path for an aircraft to follow during approach, Denham said. JPALS is also installed on the manned F-35 Lightning II fighter, which was flown by Strike Fighter Squadron (VFA) 101 and VFA-125 pilots as part of Lincoln's carrier qualifications, he said.

In traditional manned aircraft, landing systems are there to aid the pilot. Autonomous, carrier-based aircraft will be fully flown by software, so contingencies are needed in case that system falters, Denham said.

"What we were looking at is, in the event we have a casualty with JPALS, what other options would we have to recover unmanned aircraft?" he added.

The first of several options tested, the non-coincidentally named Aircraft Terminal Approach Remote Inceptor—or ATARI, after the iconic video game company—would give LSOs the ability to remotely take over an aircraft from up to five miles away and land it on a carrier by observing and fixing errors in its glideslope and lineup.

Denham said LSOs make for a natural first option to take over a distressed aircraft because they already oversee carrier approaches from the time an aircraft is three-quarters of a mile away until it touches down. Working in teams of two, LSOs monitor a pilot's deviations from glideslope and centerline, call up corrections to the pilot as needed, and grade the pilot's performance during debrief.

"They're always working to improve touchdown performance and safety, so we can capitalize on the fact that they can see deviations and correct errors," Denham said.

Much like the gaming system it's named after, the ATARI features a joystick that an LSO uses to control an aircraft.

"You're effectively using small joystick controllers to guide a 40,000-pound airplane, and it's almost like you're playing a video game," Denham said.

Wanting to quickly demonstrate ATARI's capability, NAWCAD engineers worked with Boeing last year to outfit a VX-23 Super Hornet with a surrogate UAV capability, allowing the manned jet to receive the ATARI's flight-control signals from a carrier deck. It marked the first time a Super Hornet has had a full stick-and-throttle surrogate capability installed into its flight control system, Denham said.

This proved a quicker developmental option because the F/A-18s would have a safety pilot from VX-23 onboard who in the case of an emergency could take back control of the aircraft, Denham said.

"Being able to rely on the safety pilot

U.S. Navy photo by Buddy Denham

VX-23 test pilot Lt. Christopher Montague checks the control station of the ATARI prior to the March 22 demonstration of the system aboard USS Abraham Lincoln (CVN 72).

U.S. Navy photos by Buddy Denham

From left, VX-23 test pilots Lts. John Marino and Christopher Montague, who are also landing signal officers, monitor an F/A-18 Super Hornet with degraded ailerons as it successfully lands aboard USS Abraham Lincoln (CVN 72) during March 21 testing of the Precision Landing Modes flight control system, which has been updated to account for failing aerodynamic surfaces.

was integral," he added. "It allowed us to move more rapidly."

Originally tested in 2016 on a Learjet performing shore-based approaches, the ATARI system underwent further shore testing and quality assurance with the retrofitted Super Hornet, at which point VX-23 felt confident enough to test the system at sea.

Aboard Lincoln, the ATARI demonstration endured the same high sea states as the PLM testing.

"There was some nervousness because the sea state was so bad. Back on the airfield, testing was benign," said Lt. John Marino, the VX-23 pilot who flew the outfitted F/A-18, and the first aviator to land on a flight deck using ATARI. As during the PLM testing, Marino first had to perform three approach-to-wave-offs to ensure all conditions and surrogate systems were safe and that the ATARI system could indeed take over the aircraft while at sea. Beginning with the fourth approach, Marino and the LSOs performed roughly 40 touch-and-goes.

"I was really impressed with the LSO's ability to get me to touch down," Marino said. "The conditions were difficult, and it was impressive the system worked the way it did. On a calm day, it would have been a little bit boring, but this was definitely more challenging."

"The deck was pitching significantly and yawing and rolling," Denham said. "It was particularly difficult to land that day, and we showed it's possible to use this system even when the conditions aren't ideal. So I guess we were fortunate to end up in high sea states. All in all, a successful trial."

A fully self-contained van outfitted with the ATARI system and a data link up to the outfitted Super Hornet was brought aboard Lincoln and set up behind the LSO platform so engineers could watch the approaches in real-time, monitor safety-of-flight data and ensure passes were going smoothly. The van recorded flight data for engineers to analyze later and allowed VX-23 to test their systems without having to install them aboard the carrier.

Though not intended to be a primary method for recovering aircraft, ATARI would provide a relatively inexpensive backup system in the case an LSO needs to step in and use their expertise and training to safely guide an aircraft.

"We don't have unmanned carrier-based vehicles in the fleet today, but they are coming soon," said Dan Shafer, a NAWCAD air vehicle engineer. "This is a potential alternative landing method, and our system performed well."

Even though it tested well, Denham said the ATARI is merely the first alternative landing system his team has developed, and by no means the one that ultimately will be pursued for fleet-wide implementation. His engineers will now analyze the data collected aboard Lincoln and make adjustments for further at-sea testing.

"The question was, is it even feasible for the LSOs to land an aircraft from their location, and the answer was most definitely yes," Denham said. "We can put that in our options for emergency backups and say we know we can do it from the LSO station."

Denham called the ATARI system the "lowest-tech option" of those being considered, and said the others would aim for a more autonomous approach using aircraft sensors.

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