CorrDefense DoD News about Preserving Military Assets

Volume 3, Number 1
Spring 2007
Feature

Air Force Looks at the Benefits of Using CPCs on F-16 Black Boxes

By Cynthia Greenwood

During a U.S. air strike northeast of Baghdad on June 7, 2006, two Air Force F-16s killed Abu Musab Al-Zarqawi, the Jordanian Al Qaeda leader based in Iraq. They destroyed the terrorist's safe house using two 500-pound bombs.

With its single engine and versatile tactical capability, the F-16 Fighting Falcon was built to serve critical U.S. missions such as this one. Since the early 1980s, F-16s owned by the United States, NATO (North Atlantic Treaty Organization), Israel, Pakistan, and the Netherlands have participated in numerous military conflicts worldwide, especially in the Middle East.

Traditionally, the aircraft has had an M61 Vulcan cannon in the left-wing root and one Sidewinder missile on a dedicated rail on each wingtip. Newer F-16 versions might carry the Slammer—the AIM-120 Advanced Medium-Range Air-to-Air Missile—on the rails and other air-to-air missiles and air-to-ground missiles, rockets, or bombs under the wings.

Nicknamed the "Viper" by pilots at Hill Air Force Base (AFB), the F-16 is matchless as a dogfighter and distinguished for its ability to sustain g-force turns as high as 9.

A three-ship formation of F-16C Fighting Falcons carries AIM-120 and AIM-9 air-to-air missiles near the southern Florida coastline. The F-16s belong to the 482nd Fighter Wing/93rd Fighter Squadron at Homestead Air Reserve Base. Photo by M.Sgt. Joe Cupido, U.S. Air Force.

As 4,000 F-16s have been produced by General Dynamics/Lockheed Martin for the Air Force and 24 other countries since 1976, it is one of the most successful lightweight fighter aircraft ever built. Its notable design features include a frameless canopy that allows a clear field of vision during combat and a heads-up display (or HUD) that clearly shows the flight controls while the pilot is engaged.

This "electric jet" sports a computerized fly-by-wire system. The onboard computer provides automatic control over the flight so the pilot can focus on air defense. When F-16 pilots say, "You don't fly an F-16; it flies you," they refer to the seemingly magical oversight of the electronic system.

But the F-16's electronic system is only as effective as the electrical connectors and cables within it. As the aircraft ascends, changes in air pressure move the air inside the connectors to the outside, and as it descends, moist air is driven back into the connectors. Although the connectors are "hermetically sealed," they are still vulnerable to moisture and contaminant intrusion. This intrusion may cause corrosion, which can, in turn, lead to short circuits and/or intermittent events, according to an Air Force Project Plan submitted to the Office of the Secretary of Defense (OSD) Corrosion Policy and Oversight Office in 2004.

The F-16 Fighter is a marvelous flying machine, but corrosion within its 'black box' electrical connectors has been proven to degrade its mission rate, reliability, safety, and effectiveness," according to the Air Force project plan. These effects are not unique to the F-16 but apply to most any electrical system, whether airborne or ground-based.

"The degradation on these connectors is the effect of very thin films that are often below the limits of visual detection," explained Bill Abbott, the program manager at Battelle Columbus who oversees a contract for Hill AFB to evaluate how corrosion prevention compounds (CPCs) might benefit the performance of F-16 black boxes.

"This is not the kind of corrosion that is visible to the naked eye," he said. "That is why there is an occasional misperception that there is no corrosion problem on these boxes. But that does not mean the corrosion isn't there." For the pilot or avionics flight specialist who tests the electronic system after a problem occurs, the effects of such corrosion may take the form of an intermittent glitch. At other times, though, the technician may find that the faulty part works fine after it is removed from the aircraft.

An F-16 Fighting Falcon flies over central Turkey during Exercise Anatolian Eagle, conducted at Konya Air Base. The two-week exercise ended November 17, 2006, and gave Turkish and American forces the opportunity to work side-by-side during the joint training. Photo by M.Sgt. Ron Przysucha, U.S. Air Force.

An F-16 Fighting Falcon fires an AIM-9 missile off the coast of South Korea during a live-fire exercise on August 18, 2006. The F-16 is assigned to the 80th Fighter Squadron at Kunsan Air Base, South Korea. Photo by Tech. Sgt. Jeffrey Allen, U.S. Air Force.

Hill AFB Raises Questions about a Corrosion Problem on the F-16

Because the F-16 is critical to the Air Force fighter-bomber fleet of approximately 1,400, the importance of protecting the fleet's avionics connectors from corrosion is clear.

In 1992 officials at Hill Air Force Base (AFB), an Air Force Materiel Command base in northern Utah, looked into a problem involving an uncommanded engine shutdown believed to be caused when the main fuel shut-off valve closed in several F-16s. Engineers wondered whether moisture and corrosion might have caused power to short circuit from the "open" pin to the "close," which energized the "close" windings and caused the valve to close.

"The F-16 Fighter is a marvelous flying machine, but corrosion within its 'black box' electrical connectors has been proven to degrade its mission rate, reliability, safety, and effectiveness."

It was important to recognize that the main fuel shut-off valve connectors involved a unique material combination of gold-plated pins mated to tin-plated sockets. This combination is known to be susceptible to a form of degradation known as fretting corrosion. While a lubricant was eventually shown to be very effective in reducing or eliminating this degradation, this material combination is believed to be unique to this application, in contrast to the more usual use of gold-gold pins and sockets in avionics.

To learn more, Hill AFB officials hired Battelle, a science and technology company that works closely with federal agencies, to study the problem and conduct long-term testing. In particular, they wanted to learn more about the effectiveness of CPCs on the reliability of the more common avionics connectors (gold-gold). At that time CPCs were seldom being used on the F-16 (or most other military equipment), because there were little supporting data to verify the benefits of the products permitted by existing military technical data.

"These efforts by the Air Force to provide some technical basis for using selected CPCs has been pioneering work," said Abbott. While the "best" CPCs for optimum performance of black boxes—known as line replaceable units or LRUs—were identified using the F-16 as the demonstration platform, the results can be applied to virtually any air- or ground-based electronics system. The Air Force/Battelle study has also identified a few CPCs considered to be unacceptable or high risk, even though they may be on the military's current QPL or qualified products list.

A KC-135 Stratotanker connects with an F-16 Fighting Falcon over Iraq to offload more than 20,000 pounds of fuel on October 23, 2006. The F-16 then resumed its close-air-support mission. Photo by M.Sgt. Scott Wagers, U.S. Air Force.

Battelle first conducted laboratory and flight tests on connectors identical to those used in the main fuel shutoff valve. During this process the contractor flew test connectors, treated and untreated with a CPC known as Super Corr B.† This effort eventually led to an Air Force Technical Order to treat the main fuel shut-off valve connectors. Then the Air Force asked Battelle to undertake a second research project to evaluate the broader use of CPCs on connectors. That was a ground-based study that identified two CPCs that appeared to offer considerable benefits with no known risks. The ground-based initiative quickly led to a third project that was a large-scale flight-test study. The two CPCs selected for that study were Lektrotech's Super Corr B (MIL-L-87177A) and Zip-Chem's D-5026NS† (MIL-C-81309E). These flight tests produced very positive results, as measured by no adverse effects on normal flight operations, reduced LRU removal rates, and the product's ease of application. Both materials proved to be equally effective, and these results also agreed with those of the ground-based study.

Currently Battelle is spearheading a fourth project for Hill AFB to evaluate one specific CPC, known as Super Corr A,† a more environmentally friendly version of Super Corr B, in an even larger-sized sample of aircraft and LRUs. At this stage of the project Battelle is training base-level maintenance managers and technicians about why, when, and how the Super Corr A treatment should be used on F-16 LRUs. The company is also analyzing the data involving how LRUs are performing. The OSD Corrosion Policy and Oversight Office has lent financial support to this project.

"This is not the kind of corrosion that is visible to the naked eye. That is why there is an occasional misperception that there is no corrosion problem on these boxes."

To fulfill its responsibility, Battelle has worked with Hill AFB to introduce the project to all F-16 bases worldwide. By April 2006, Battelle reports that all F-16 bases have been contacted. "The lubricant has been distributed and presumably this work is being initiated at all of the participating bases," according to a Battelle report submitted to Hill AFB in December 2006.

"This lubricant is extremely cheap and simple," said Abbott. "This stuff can be applied on the flight line with very little burden on base personnel. But these products are not being widely used yet." To apply the lubricant, all the technician has to do is take the connectors apart, spray on the material, put the connectors back on, and the aircraft is ready to fly. "It's as easy as spraying something with bug spray," explained Abbott.

To help increase awareness of the lubricant's existence and make headway on the project, Battelle is providing the lubricant to those willing to give it a try. Homestead Air Reserve Base (ARB) avionics flight specialists, who appear enthusiastic about the lubricant's effectiveness and the project aims, are using the CPC. Homestead ARB, which operates in southern Florida's severe coastal environment, has had the longest experience using the CPC. "Because their failure rates with LRUs and SRUs (shop replaceable units) have been so high, the benefits of using this CPC were immediate and across-the-board," said Abbott.

Shaw AFB technicians are also optimistic about the CPC's performance. Thirty other Air Force bases have also agreed to participate. While aircraft engineers at Hill AFB remain positive about the CPC's current effectiveness on exposed electrical connectors, officials who manage the project will draw further conclusions when all data and testing are complete, said Michael Risen, the F-16 electrical equipment specialist at Hill AFB.

Officials in the Air Force Corrosion Office remain convinced that the widespread use of these lubricants by F-16 avionics flight specialists across Air Force bases would make the aircraft safer and save considerably on costs.

[†]Trade name

This article is the first to report on a broad-based effort by Hill AFB, Battelle, and Air Force corrosion experts to study the merits of using a specific CPC on F-16 black boxes. The project is being funded by the Air Force and OSD's Corrosion Policy and Oversight Office. Look for more reports in future editions of CorrDefense*.*