FRCSE Saves Time & Money Locating Potential Aircraft Fuel Leaks

New Detection Capability Established for P-3 Orion

THE QUEST FOR an environmentally safe, cost-effective way to identify leaks in aircraft fuel cells has come to a close at the Fleet Readiness Center Southeast (FRCSE) in Jacksonville, Florida—at least where the P-3 Orion is concerned. FRCSE has implemented a new fuel leak detection capability for the P-3 Orion aircraft that has already reduced Turn-Around-Time (TAT) by 15 percent with a cost avoidance of nearly $20,000 per aircraft.

The Search for a CFC-113 Replacement

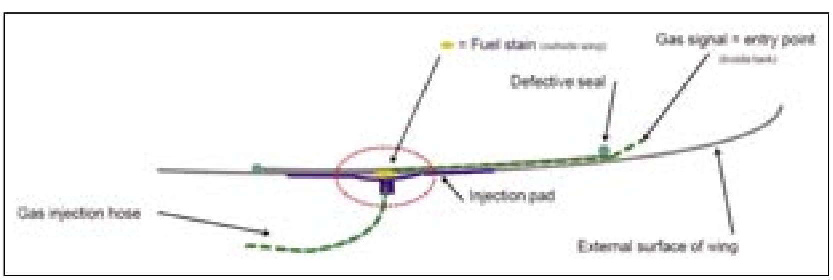
Since the use of chlorofluorocarbon (CFC) 113, a priority I ozone depleting substance, was banned in 1996, alternative methods of fuel leak detection have not proven adequate to identify all potential fuel leaks nor ensure the integrity of fuel systems. The result is frequent, unnecessary rework and retest of fuel tanks.

Leaks and leak paths which are frequently masked by seam sealers and paints can be readily identified and leaks repaired.

Leak identification and repair in aviation fuel systems are significant concerns that regularly impact maintenance and repair schedules, and increase cost. But more importantly, this maintenance issue can reduce the availability of critical Navy assets and negatively impact mission readiness. In addition, rework due to fuel leaks increases personnel exposure to fuel and hazardous materials, as well as harm to the environment if leaks go undetected or are not properly contained during fueling operations.

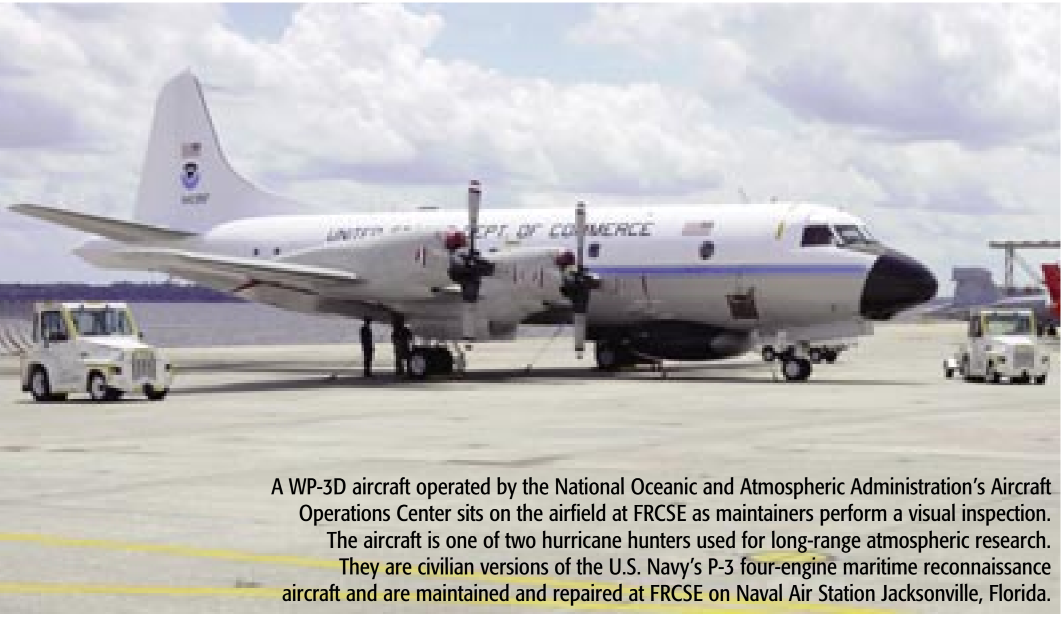
Since 2007, the Navy Environmental Sustainability Development to Integration (NESDI) program has supported FRCSE in their investigation of alternative fuel leak detection technologies to replace the capabilities lost with the ban of CFC-113. In recent years, commercial leak detection technologies have advanced and a variety of potential alternatives are available, including ultrasonic and infrared thermography, and several trace gas leak detection technologies.

Of these, industry development and growth of helium and hydrogen trace gas leak detection technologies have



By applying the tracer gas on the outside of the tank and using the hydrogen leak detector on the inside, leaks and leak paths can be readily identified and leaks repaired.

Courtesy of INFICON, Inc.



A WP-3D aircraft operated by the National Oceanic and Atmospheric Administration's Aircraft Operations Center sits on the airfield at FRCSE as maintainers perform a visual inspection. The aircraft is one of two hurricane hunters used for long-range atmospheric research. They are civilian versions of the U.S. Navy's P-3 four-engine maritime reconnaissance aircraft and are maintained and repaired at FRCSE on Naval Air Station Jacksonville, Florida.

Sheet Metal Mechanic Bryan Swafford inspects a P-3 Orion wing tank for potential fuel leaks using hydrogen leak detection technology at FRCSE. This new capability has reduced the TAT of aircraft wet check by 15 percent.

been substantial. Currently, both technologies are widely used in the automotive, as well as air conditioning and refrigeration industries, and have expanded into aviation use.

Based on market research and in collaboration with the U.S. Air Force, FRCSE contacted several commercial vendors to perform technology demonstrations at the military depot. From the P-3 fuel wing tank demonstrations, FRCSE determined that the hydrogen tracer gas technology was more user-friendly, accurate, reliable, and easier to maintain than the helium leak detector. Further, hydrogen leak detection provided a lower operational cost, as helium is a limited resource and very expensive.

How It Works

Hydrogen trace gas leak detection technology uses a 95 percent nitrogen/5 percent hydrogen mixture that is both inexpensive and inert (non-flammable). With the extreme sensitivity of the detector and ready dispersion in air, the low-level, hydrogen concentration gas works well for leak detection and is inherently safe.

The hydrogen trace gas is injected into the empty (closed) fuel tank, and the exterior of the tank is probed with a portable detector to find and locate leaks. When the probe detects hydrogen, the unit provides a visual LED light and audible alarm.

The hydrogen leak detector can detect extremely small leaks at leak rates (as low as 5x10-7 cubic centimeters per second) or it can be adjusted to sense leaks at greater levels as required.

Based on P-3 demonstrations, FRCSE engineering established a threshold level at which the smallest of actual fuel leaks would be detected. To validate this threshold, the team performed several tests on multiple aircraft using the hydrogen leak detector and verified that no fuel leaks were observed during initial fueling operations.

An added advantage of the tracer gas technology is the capability to apply the 'backflow leak detection' method to find the actual source of wing tank fuel leaks for the

FRCSE Continues to Improve F/A-18 Green Hornet Fuel Leak Testing

FRCSE PERSONNEL, WITH support from the NESDI program, also collaborated with the U.S. Air Force to improve aircraft fuel leak testing on the F/A-18 (A-D) Green Hornet Strike Fighter. The team performed vendor-supported, hydrogen leak demonstrations on uninstalled and installed F/A-18 (A-D) fuel cells.

The hydrogen leak detector was very effective in pinpointing leaks on uninstalled F-18 fuel cells in the shop, but it proved challenging on installed fuel cells due to the inability to seal the structural cavity vents. For this reason, the project team was unable to create sufficient pressure to pinpoint leaks.

Still, another type of leak testing, pressure decay testing, was formally implemented as a result of hydrogen leak testing. In pressure decay testing, pressure in the fuel tank is raised to a target level. A pressure gauge is used to measure the pressure drop or pressure decay over a specified period of time. The acceptance criterion is typically zero drop corrected for temperature change. FRCSE developed test kits and performed pressure decay testing for F/A-18 (A-D) fuel cells #1 through #4.

Aircraft Mechanic Patrick Dodrill (from left), Mechanical Systems Engineer Patrick Papay, and Darvin Etienne monitor a pressure decay test to detect the presence of a fuel leak on an F/A-18 Green Hornet Strike Fighter aircraft at FRCSE.

Since January 2010, pressure decay testing has been required prior to the installation of internal fuel cell components including valves, pumps and tubing. Testing not only proves the integrity of the fuel cell but also verifies that the O-rings installed at all joints between the fuel cell and the cavity are not damaged.

To date, the pressure decay test has been performed on more than 26 aircraft. This has resulted in at least ten fuel cells, including six of the more complex (#4) fuel cells, being replaced prior to installing internal components and performing a final wet check. (Note: During a "wet check" artisans fill the fuel tank with a liquid (oil) then check the exterior for liquid leaks. The weight of the liquid can cause the wing tank to flex and a leak to be found.) Thus, a significant amount of rework has been avoided, TAT has been reduced by eight to ten days per aircraft, and no less than 200 man-hours per aircraft have been avoided by capturing the discrepancies prior to final wet check.

Currently, Naval Air Systems Command, Naval Air Warfare Center Lakehurst, Boeing and Northrop Grumman are in the process of fielding a combination test kit and universal plug kit to enable fleet maintainers to perform a pressure test of fuel cells on all F/A-18 aircraft including the Super Hornet and the EA-18G Growler aircraft.

The universal plug kit will provide a means to seal off all the fuel cell fittings and perform the pressure decay test. The kit will also seal off the problematic vent ports located in the cavity structure to create sufficient pressure across the fuel cell.

When the combination pressure test set and the universal plug kit are fielded to FRCSE, the team will resume efforts to further enhance the facility's capability to isolate fuel cell leaks with the very promising hydrogen leak detector.

P-3. Frequently, the fuel leak found on the outside of the tank does not provide any indication of the origin inside the tank. By applying the tracer gas through an injection pad on the outside of the tank and using the hydrogen leak detector on the inside, leaks and leak paths which are frequently masked by seam sealers and paints can be readily identified and leaks repaired. Currently, FRCSE is working to gain approval of the backflow method to provide yet one more tool in the toolbox for fuel leak detection.

FROM LEFT: Aerospace Engineer Dan Marlow, Environmental Logistics Engineer/Pollution Prevention Manager Tom Cowherd, Chemist Kellie Carney, P-3 Production Line General Foreman Greg Wallace, and Production Support Specialist Rodney Boone pose in front of a P-3C Orion Maritime Patrol and Reconnaissance aircraft at FRCSE. They were part of the team to implement the new hydrogen fuel leak detection process.

To implement this new process for the P-3 aircraft, FRCSE applied "lean" methodologies and released a Local Process Specification to eliminate more than half of the leak detection process steps to reduce TAT to the Fleet. (Note: Lean, a management philosophy derived mostly from the Toyota Production System, is centered on preserving value with less work.)

Environmental benefits of this process are:

1. A viable replacement to CFC-113 has finally been implemented.
2. Potential hazardous waste streams associated with active aviation fuel tank repair and leak testing have been substantially reduced.
3. The Hazardous Air Pollutants/Volatile Organic Compounds associated with fueling, defueling, de-puddle and gas-free testing due to rework have been reduced.
4. The risk associated with potential water runoff contamination due to leaking aircraft fuel tanks has been reduced.

For more information about this project, see the fact sheet on the NESDI program's website at www.nesdi.navy.mil/ProjectsCurrent_FS.aspx?ProjID=333. ⚓

Photos by Victor Pitts.

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