



BREATHING FREE?

By Brian W. Everstine, Pentagon Editor

The Air Force completed modifying the F-22 fleet this year, hopefully solving a vexing oxygen-supply problem.

A Raptor takes off from JB Elmendorf-Richardson, Alaska, in September 2011 after a four-month stand down while investigators studied reports of pilots experiencing hypoxia-like symptoms.

USAF photo by SSgt. Brian Ferguson

As the Air Force's F-22 force passed eight months of first-ever combat operations in April, Air Force Materiel Command completed a fix for oxygen system problems that had plagued Raptor pilots for years.

The Defense Department tasked the Air Force, on a short deadline, to respond to high-profile oxygen problems in the crown jewel of the military's fighter fleet in 2012. In several hypoxic incidents, Raptor pilots experienced oxygen deficiency that caused them to lose cockpit motor skills and, in some cases, black out at the controls.

The Air Force launched a large-scale investigation to find the cause, enlisting help from the Navy, NASA, and researchers and engineers across the service. The 2012 investigation identified a faulty valve in the pilot's life support system and a filter blamed for causing "Raptor cough" among pilots. In addition to replacing the valve, AFMC was given 180 days to design and install a backup oxygen system in a Raptor to prevent pilots from falling unconscious and losing control of the aircraft in the event of a failure in the primary oxygen system.

The first developmental system was installed and flown on a Raptor at Edwards AFB, Calif., 179 days later. By April 2015, every F-22 in the fleet had been retrofit with the system.

"This project is a great example of a great success for the pilots," said Matt Dansereau, systems engineer with the F-22 programs office's backup oxygen system development team at Wright-Patterson AFB, Ohio. "It was delivered on time, under budget, and had a direct impact on how we fly and the confidence the pilots have in the aircraft."

The F-22 team at the Air Force Life Cycle Management Center at Wright-Patterson worked alongside Lockheed Martin and Boeing to develop the current system from the ground up, Dansereau said.

Installation began in 2012, fostered by more than \$30 million through multiple contracts awarded to Lockheed Martin. Each Raptor required approximately 20 days for system installation, which was scheduled alongside other maintenance to limit the downtime, according to ACC.

"Aircraft were scheduled down, modified, operationally checked, and returned to service," ACC spokesman Ben Newell said. "However, no aircraft were grounded" for the retrofits.

Installation started in Alaska, where the F-22s assigned to the 3rd Wing at

Joint Base Elmendorf-Richardson were the first to receive the system. The Raptors needed the systems to return to NORAD aerospace alert there because they are tasked with covering more airspace than anywhere else, 3rd Wing commander, then-Col. David Nahom, said in a release at the time. Nahom is now ACC's one-star deputy requirements director.

Jets without the system were altitude- and distance-limited and restricted to within 30-minutes' flight time of a divert airfield, and while there wasn't a large-scale grounding, the restrictions affected the training and deployment of the aircraft.

The new system was designed to be transparent to the pilot, and automatically activates on rapid decompression, a shutdown of the environmental control system, or when manually engaged by the pilot. The system has a control panel in the cockpit within reach of the pilot. It is left in the automatic position and will provide 100 percent oxygen when activated.

"The system is now a background feature of normal operations, providing an extra layer of safety for our pilots," Newell said. The new system means a few new routine checks for maintainers, and a new checklist for pilots to make sure it is functioning, but does not entail large-scale changes to the jet or how it operates, Dansereau said.

The joint Air Force and contractor team at Wright-Patterson has now moved into a sustainment role and integrating the system into regular maintenance cycle of the aircraft. It is included in the overall cost of keeping the jet flying, said Michael Connolly, the original program manager for the automatic backup oxygen system in the F-22 system program office.

READY FOR ACTION

Since the backup system was installed, the F-22s have entered a new era of global operations. The Raptors saw their first combat operations in September 2014 as part of Operation Inherent Resolve in combat strikes in Syria, and saw their first deployment to Europe in August 2015. The jet's mission capable rates have risen to 67.4 percent in Fiscal 2015 up from 60.9 percent in 2010, before the oxygen issues came to the fore.

One of the jet's main bases, JB Langley-Eustis, Va., has deployed the 27th and 94th Fighter Squadrons to fight in Inherent Resolve and made history in the theater, said Col. Peter M. Fesler,

commander of the 1st Fighter Wing at Langley. The jet has performed "better than we imagined it would" both in strike packages and by using its sensor suite as a smaller-scale command and control aircraft.

"The rest of the strike package takes a lot less time wondering where the threats are," Fesler said. The F-22 helps identify targets on the ground so other jets can focus on the mission instead of on possible air-to-ground threats.

The first Raptor to drop a bomb in combat last year was a Langley F-22, and the base's most recent deployment earlier this year was the first time F-22s deployed to combat with the software upgrade allowing it to employ Small Diameter Bombs, Fesler said.

Langley F-22 crews stand down for two weeks after they return from deployment before returning to flight for training. In August, the base had its highest sortie generation rate since the jets first arrived, Fesler said.

While the backup system and changes to the life-support system have been implemented, the lingering issues of hypoxia-like incidents have not completely gone away. There were four such incidents in 2013, in jets without the backup system, and one each in 2014 and 2015 in jets with it. The number of recent hypoxia incidents are in line with historical rates of other aircraft, Fesler said.

While the new system is an example of "extra capacity" for jets, it hasn't changed how the pilots think about flying, Fesler said. There's a little more work for maintainers and one more switch in the cockpit, but other than that pilots are flying like they always have been.

A VEXING PROBLEM

Possible issues with the F-22's oxygen systems came under public scrutiny in late 2010, more than two years after Air Combat Command's safety section reported two hypoxia-related incidents.

On Nov. 16, 2010, F-22 pilot Capt. Jeffrey Haney was returning to JB Elmendorf-Richardson following a training flight when his aircraft experienced a bleed air leak malfunction. His oxygen cut off 20 seconds later, according to the accident investigation report. He rolled inverted, descending rapidly until, three seconds after apparently attempting to recover, he crashed into a mountainside and died instantly.

The Air Force investigation concluded that Haney was unable to recognize and respond to the emergency due to spatial



A Raptor pilot guides an F-22 over the Baltic Sea in September. USAF deployed Raptors and supporting airmen to Spangdahlem AB, Germany, to train in Europe.

USAF photo by TSgt. Jason Robertson

disorientation, channelized attention, and a breakdown of visual scan, according to ACC's accident investigation board report.

Some in Congress responded with derision to the Air Force's blaming a "complex emergency" for the crash, and some legislators accused the Air Force of covering a deficiency in their newest fighter by blaming the pilot instead of faulty equipment.

The Air Force found that Haney's focus on restoring oxygen flow by manually pulling the O-ring attached to his ejection seat distracted him from recovering the jet, but asserted that he suffered no lack of oxygen. A DOD Inspector General report reviewing the Air Force crash investigation found the service presented no evidence to support that presumption.

The 2013 report alleged that the service inadequately analyzed Haney's possible attempts to activate the jet's backup oxygen system or the physiological symptoms of a lack of oxygen.

Haney's family filed a wrongful death lawsuit against main contractors Lockheed Martin, Boeing, Honeywell, and Pratt & Whitney in 2011. The suit alleged that the F-22 was designed and manufactured "with a dangerous and defective oxygen backup system that did not automatically provide life support or breathable oxygen to the pilot in the event of a malfunction." Despite the fact that most legacy fighters require pilots to manually activate the emergency oxygen system, the contractors later settled the lawsuit for an undisclosed amount.

In 2011, the entire F-22 fleet was

grounded for four months due to unexplained oxygen-related incidents. Pilots reported 14 hypoxia-like incidents that year and another 10 in 2012.

While the Air Force stressed physiological incidents were extremely rare, occurring approximately once every 9,000 sorties, public confidence took another hit in May 2012. Two Virginia Air National Guard F-22 pilots—Maj. Jeremy Gordon and Capt. Joshua Wilson—openly refused to fly the jet.

PILOTS FEEL UNSAFE

Gordon and Wilson told the television press they had experienced hypoxic inflight incidents and felt unsafe flying the Raptor. "There's a mechanical risk or even an enemy threat where I'm trained to deal with that threat," Gordon told the CBS newsmagazine "60 Minutes." "But this is something strapped to my face under which I have no control what's coming through that tube, which means there may be a point when I don't have control over myself when I'm flying."

During the 2011 grounding, the Air Force convened a Scientific Advisory Board to investigate the cause of the incidents and find ways to avoid similar issues in the future. The board, including several retired Air Force general officers, spent seven months investigating the issue before releasing a 238-page report in February 2012.

The board did not identify a single "smoking gun" causing pilots' reported oxygen problems but pinpointed several contributing factors, most notably a flaw in the pilot's life support vest. The Combat Edge vest was designed to inflate

during high-G maneuvers to maintain blood flow to the pilot's body. However, a quirk with a valve occasionally kept the vest inflated when it shouldn't be, restricting pilot's breathing and causing lightheadedness and dizziness. The vest, and other issues with filters and tubes in the life support system, created a "mosaic" of problems that fed hypoxic incidents, ACC Operations Director Maj. Gen. Charles W. Lyon, said when briefing the board's findings in August 2012.

"When we start to affect a human's breathing cycle, physiologically they will start to get some symptoms," Lyon said. "It may be lightheadedness. It may be tingling. It may be a bit of numbness. That's what we found, ... that the pressurization schedule with the F-22 inflates this prematurely. So we've removed this," he explained.

The move to install an automatic backup oxygen system on the F-22 undid a decision made early in the jet's development. The original life support system on the F-22 had a self-regenerating standby oxygen system, but engineers decided to remove it during development to save weight.

"The logic behind the decision was that the [manual emergency system] provided adequate backup in the event of an OBOGS shut down," the advisory board's report stated, referring to the on-board oxygen generation system. "That decision saved approximately 15 pounds and was approved by the F-22 Life Support System Integrated Product Team in 1992."

Engineers at the time made the decision based on the availability of the



A1C Emmanuel Marioni, a technician of low observable materials, inspects the skin of an F-22.

USAF photo by SrA. Joan King

A brand-new F-22 takes off from Lockheed Martin's Marietta, Ga., facility on its way to its new home at JB Langley-Eustis, Va.

Lockheed Martin photo by Damien A. Guarnieri



emergency system and the assumption that an oxygen system failure “would be an unlikely occurrence.”

Instead, “shutdowns have occurred more frequently than was anticipated,” the SAB wrote. Designers at the time also worked on a modification that would have released stored, 95 percent oxygen into the life support system if a failure occurred, but that feature was

not adopted in the final design.

The SAB, in its report, observed the F-22 was the only jet in the Air Force's entire inventory whose pilots experienced a high rate of hypoxia. Although the fighter's existing, manually activated emergency oxygen system was deemed adequate, the F-22 was also the only aircraft outfitted with an on-board oxygen generation system that did not have either a backup

oxygen system or a plenum-reservoir to provide breathable air in case the pilot is unable to activate the emergency system.

“A review of safety incident data showed that the F-22 aircraft was the only aircraft with an abnormally high rate of hypoxia-like incidents whose cause could not be determined,” the board report stated. “All aircraft experienced low rates of incidents caused by a hardware failure, a hose obstruction, or mask failures; however, the F-22 was the only mission design series with a high rate of unknown cause incidents.”

The F-22's original emergency system required the pilot to manually pull a ring on the ejection seat and descend to altitudes where he could breathe unassisted as soon as possible. In addition, the ring could be difficult to pull under certain conditions and if not activated in time, the pilot could lose consciousness and likely crash, since the jet lacked automatic ground avoidance.

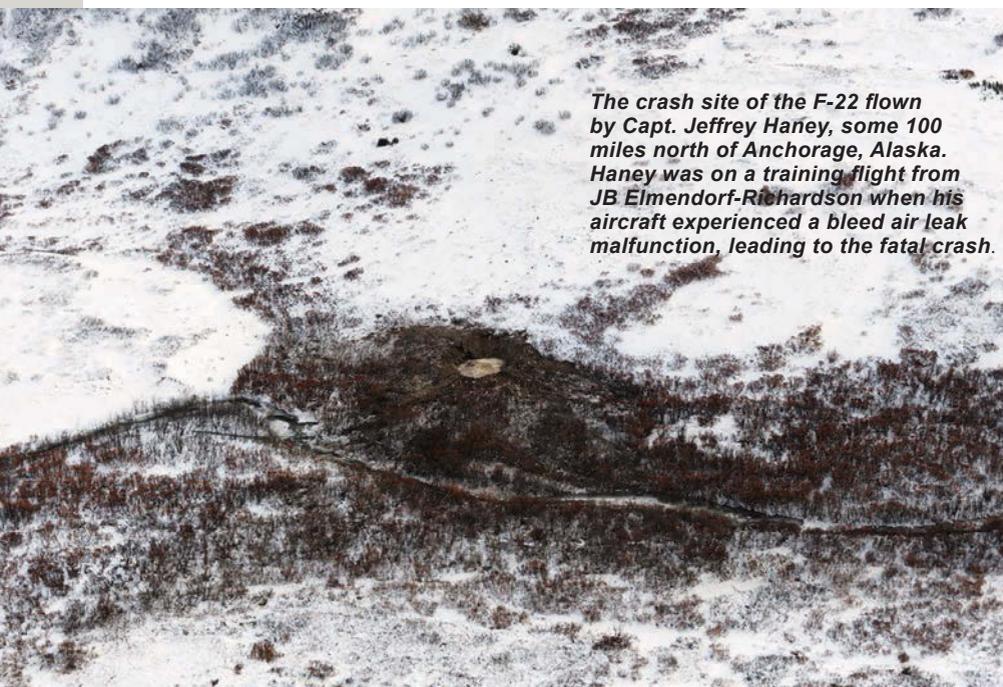
The service's top priority going forward needed to be the installation of the backup system, according to the SAB. When the report was released, then-Defense Secretary Leon E. Panetta gave the service the 180-day deadline to develop and install the system, beginning in May 2012.

The Air Force hopes its newest stealth fighter, the F-35, will avoid these early issues when it hits initial operational capability in August 2016.

Unlike the F-22, the F-35's on-board oxygen generation system is complemented by an automatic, seat-mounted backup source, according to the advisory board's report. Like the F-22 and other fighters, the F-35's emergency oxygen system also automatically activates if the pilot ejects.

With the F-35 fleet already equipped with automatic systems, the Air Force's entire fifth generation fighter fleet now flies with automatic backup oxygen sources. ✪

In 2012, two Virginia ANG F-22 pilots—Capt. Joshua Wilson (l) and Maj. Jeremy Gordon—publicly refused to fly the F-22. They told a “60 Minutes” interviewer they had experienced hypoxic inflight incidents and felt unsafe flying the Raptor.



The crash site of the F-22 flown by Capt. Jeffrey Haney, some 100 miles north of Anchorage, Alaska. Haney was on a training flight from JB Elmendorf-Richardson when his aircraft experienced a bleed air leak malfunction, leading to the fatal crash.

USAF photo by MSGT. Jeremiah Erickson



“60 Minutes” photo