Washington Watch

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The Aging of the Fleet

The average age of USAF aircraft is rising steadily. With careful management, service leaders believe, they can operate the oldest fleet ever safely and effectively.

EVEN if Congress funds all the new airplanes now on the books, the Air Force will continue to see a steady increase in the average age of its flying machines for decades to come. Keeping old warbirds not only safe to fly but also effective for combat is among the top challenges facing USAF on the eve of the twenty-first century.

According to Defense Secretary William J. Perry's 1996 Annual Report to the President and Congress, the average age of USAF fighter and attack airplanes is now ten years. That compares favorably with the service's 1980s goal of maintaining a fighter and attack airplane average age of twelve years.

However, that low figure stems from the retirement of such 1960s- and 1970s-vintage airframes as F-4Gs and F-111s. From now until 2005, the bulk of the USAF fighter fleet will be composed of F-15s and F-16s built in the 1980s, and only a handful of new models will be bought to offset attrition. The twelve-year standard, moreover, has been discarded.

Only when the F-22 begins entering the fleet in significant numbers—anticipated for 2005—will the fighter/attack inventory break a nine-year rise and level off at an average age of just under twenty years per airplane. The average won't start down again until 2010—and only if the Joint Strike Fighter program begins delivering airplanes on time that year.

Dealing with old airplanes is nothing new for the Air Force. USAF's B-52Hs and C-135s both average about thirty-four years of service. The C-141 Starlifter fleet is not far behind, with nearly thirty years of duty, and the C-130 fleet averages almost a quarter-century. The Air Force calculates that the active inventory average age per airplane is 17.8 years; the Air National Guard average is 15.9. The figure for the Air Force Reserve is 19.3. This overall average is climbing steadily.

"We have never tried to manage a fleet this old," noted Dr. Eugene E. Covert of the Massachusetts Institute of Technology. Dr. Covert chaired an Air Force Scientific Advisory Board (SAB) review of the issue last year, a study that yielded a classified report titled "Life Extension and Mission Enhancement for Air Force Aircraft."

Many Air Force airplanes are serving "long past their design life," Dr. Covert said, but he sees "no reason to believe there's a crisis" in fleet safety or capability because of airframe age alone.

"Commercial aircraft are flying with 60,000-plus hours and [with more than] 45,000 takeoffs and landings," he pointed out. Such aircraft require increased attention and spare parts, he acknowledged, but he added, "If it weren't safe or cost-effective to fly airplanes that long, it wouldn't be profitable, and [the commercial carriers] wouldn't be doing it."

By comparison, he said, the Air Force flies similar airplanes "about a thousand hours a year" each, meaning that "they have a lot of life left in them."

Metal fatigue is the number one issue facing the commercial carriers, while corrosion—from long exposure to the elements—is the chief nemesis of Air Force "heavies," Dr. Covert said.

Though he could not discuss the findings of the SAB study in detail, he summed them up by saying "as long as you stay on top of it," the additional care needed by older aircraft "is manageable." But, Dr. Covert added, the SAB also determined that "the problem is not as well understood as it ought to be, and we probably better find some more money to deal with it."

Dr. Covert offered the C-141 airlifter as an example of the United States not managing an aging military airplane well. The venerable Starlifter was left to languish without careful attention to developing "age spots" in the late 1970s and early 1980s, mainly because the Air Force assumed that C-17s would soon be joining the inventory in large quantities and that the C-141 would soon be phased out.

Delays in the C-17 forced the C-141s to continue operating under a punishing load—including a stressful year building up to and carrying out the 1990–91 Gulf War—and led to huge numbers being grounded for stress fatigue, cracks, and corrosion.

The problem was "caught," Dr. Covert said, because Gen. Ronald R. Fogleman—then head of Air Mobility Command (AMC), now Air Force Chief of Staff—"directed [that] the appropriate resources [be applied] to deal with it." The C-141, Dr. Covert noted, is "by and large in better shape now than it was in the last fifteen years."

General Fogleman described the C-141 as a "textbook case" of "what happens when you don't pay attention to airplanes as they age."

Getting It Right

The B-52 is an example of where the Air Force got it right, Dr. Covert said.

The leaders of Strategic Air Command "did a great job managing the B-52," he said. "They took care of the engines, and when the time came, reskinned the wings." If the Air Force continues to take an active, aggressive approach, "it shouldn't be a problem" to keep the B-52s in service up to their currently planned retirement in the 2030s, when the bombers will be more than seventy years old, he said.

Despite their chronological age, B-52s and KC-135s spent much of their careers until now "sitting alert" and not accumulating tens of thousands of stressful flying hours, making them technically "younger" than some more recent types. But a change in their

use could accelerate the aging process, Dr. Covert said.

Airframe-life specialists are also determining, however, that airplanes that "just sit . . . often corrode more than airplanes you fly all the time," according to James L. Rudd, who leads the Aging Aircraft Customer-Focused Integrated Product Team (CFIPT) for Air Force Materiel Command (AFMC) at Wright Laboratory, Wright-Patterson AFB, Ohio. Especially if left in a warm, humid, and salty environment—Andersen AFB, Guam, or Hurlburt Field, Fla., for example—airplanes can corrode much faster than those in other locales.

General Fogleman said he believes that the aging aircraft issue is getting the attention it deserves at the highest levels of the service.

"I think we're more prepared today—and will be in the future—to handle the issue of aging airplanes than we were in the past," the General said. "There's a higher level of understanding and knowledge about the dynamics" of how airplanes are stressed under various conditions and what it takes—technically and financially—to keep them airworthy.

However, General Fogleman added, " 'Aging aircraft' is a term that people want to associate with big airplanes" because the "thirty-plus-years airframes have gotten a lot of attention. . . . The fact of the matter is, in the era that we're living in, 'aging aircraft' takes on a new significance when you've got to look at keeping fighters in the inventory twenty-five to thirty years."

The small numbers and rapidly increasing age of the fighter/attack force are unprecedented in USAF's history, and General Fogleman said the Air Force leadership is keenly aware that fighters endure much more stressful operating conditions than large airplanes, which don't do heavy maneuvering.

"We're very cognizant" of the unique circumstances facing the fighter/attack inventory, he said, adding that budget constraints rule out fixing the problem by simply buying new airframes.

"We've got to . . . keep our fighter force alive . . . through the year 2010," said General Fogleman. To do it, the Air Force has "put in place . . . monitoring programs, maintenance data collection programs, . . . things that we didn't have twenty to twenty-five years ago," he continued. "We've put a lot of effort into this."

The monitoring programs collect information about where airplanes tend to be stressed and whether the fatigue is something tolerable or must be addressed by a strengthener or fix of some kind. But it is understood that fighters cannot be kept "like new" indefinitely.

"Little by little, all the airplanes develop problems as they age," Mr. Rudd said. "We've had five review teams this year," teams that make in-depth, multidisciplinary, multi-department studies of specific airplanes that are starting to show their age or are becoming "more and more expensive" to maintain properly.

The Air Force is aware that budget constraints rule out fixing the problem by simply buying new airframes.

"Unique" problems, he added, were found in each airplane type reviewed this year—including the KC-135, C-141, B-1B, F-16, and C-130.

The CFIPT works with the various major commands and AFMC's Air Logistics Centers (ALCs) to "find out what the customers need from us, . . . so we're pushing in the right directions" to provide technologies that can help keep the airplanes flying, Mr. Rudd said.

In addition to the strain of dogfight maneuvers, fighters and bombers experience other stresses not shared with transports or station-keeping airplanes, he noted.

"There are severe dynamic loads on twin-tail fighters, there's the oscillation of stores hanging on weapon stations, and there's the acoustic stress of the air blowing over an open weapons bay," he said. Some of these are "just beginning to be understood."

In the case of the F-16, use has been "far more severe" than originally expected and rougher than the airplane was designed for, Mr. Rudd noted. Alternating between dogfighting and low-level ground-attack missions has caused tremendous stress on key components.

"The load paths are putting more loads into certain areas" that weren't expected to endure such high strain, he said. The fuselage bulkheads are cracking under the fatigue of repeated high-G loading.

AFMC's Aeronautical Systems Center (ASC), also based at Wright-Patterson AFB, is working on various fixes, "including doublers, patches, . . . all the way to redesign of the bulkhead," Mr. Rudd noted.

But he also said that no airplane can be built to take all the stresses being inflicted on today's fleet.

"You don't want to design an airplane so it never has a problem," he said. The weight of building break-proof structures would mean "you'd never get it off the ground."

Performance vs. Durability

USAF, he said, has a "damage-tolerance design philosophy," which trades off performance for durability and vice versa to get the best balance of combat airplane possible. This philosophy depends on designing structures to last "only as long as they need to," which translates to a design life. The F-16 was designed to hold up under heavy stress for 8,000 hours and is now being asked to make it to 12,000.

The F-16 is also one of the first airplanes to make widespread use of composites, and there is still a lot to learn about how composites hold up under long use, Mr. Rudd said.

Though many are made of non-metallic materials, "composites can actually corrode" if the graphite fibers in them are in contact with corroding metal, he noted. The big challenge with composites is detecting "low-velocity impact damage . . . where some guy drops a toolbox" on a composite part, causing delamination deep inside the structure without any betraying surface faults.

Composites also see use as patches on metals and on other composites, and their useful life expectancy is still "a hard thing to predict," Mr. Rudd admitted. "The analysis techniques for composites are not as far along" as in metals research, he said.

It is difficult to quantify just how much money is being spent on technologies that will keep aging aircraft aloft, Mr. Rudd acknowledged. The funding is scattered among Defense Department, FAA, and NASA projects. In DoD, the money is distributed among the basic, exploratory, and advanced development accounts and under the Air Force Office of Scientific Research.

The departments share the labor and their findings, so the lessons learned can be distributed throughout the commercial and military aviation communities.

For instance, Mr. Rudd said, the FAA is in charge of investigating fuselage fatigue, while USAF has responsibility for wings.

"What we do is try to transition the technology from the labs to the ALCs," Mr. Rudd said. His shop coordinates new applicable technologies then tries to turn them into low-cost processes, techniques, or equipment that can directly search for problem areas or fix them.

"Corrosion is the hardest problem," he said, because it remains impossible to predict. A "significant amount" of funding is being applied to developing models or predictive methods that can indicate when and where corrosion will occur.

Other innovations are taking place in radiographic procedures, in which parts are X-rayed, and in acoustic testing, which can locate stress zones or cracks.

Research thrusts center on structural integrity, avionics and propulsion, subsystems, and nondestructive evaluation and inspection (NDEI).

NDEI holds promise for both cost-effectiveness and safety because the technologies created will make it "unnecessary to do some disassembly that is too expensive and time-consuming to do very frequently," Mr. Rudd noted. A nondestructive procedure pays off by reducing the time required for an overhaul—getting the airplane back in service faster—and increasing the number of times an inspection can be performed, which increases the odds of finding serious problems in their infancy.

In the "subsystems" category, technical orders are being revised to require inspections of parts that were never inspected before because, when the airplane was built, it was assumed the airplane would wear out before the part did.

"Look at the design assumptions," said Anthony J. Wall, director of Engineering in ASC's Aircraft Program Support Office. "If you had a fuel pump that had a design life of 50,000 hours, and the airplane had a design life of 25,000 hours, then no one has looked at it before. And we are starting to . . . go through the original blueprints looking for those kinds of things. . . . I think we catch most of them."

Though "there's a good paper trail" at ASC that can help identify such parts and subsystems, "it's not a consistent one," and the records might be scattered among the ALC and the manufacturers. "In some cases, the factory is out of business," Mr. Wall noted.

To better monitor structural integrity, Wright Laboratory is developing sensors to detect corrosion, stress fatigue, or cracks and alert maintenance crews who otherwise might not catch a problem until a more thorough periodic inspection.

It's important not to lose sight of when it's necessary to stop patching up an old warplane and move on to a new system.

The CFIPT also is working on a family of predictive models that will enable AMC to do a "life assessment" on the KC-135 in 2000 to see how much longer the old tankers can remain in service, Mr. Rudd noted.

"We will hand them an analysis tool," which may be applicable to other airplanes as well, he said. The Stratotanker suffers mostly from corrosion stress and crevice corrosion, which can only be "ground out and patched so many times," he pointed out. AMC wants to keep the KC-135 in service until about 2040.

Replacing Old Parts

Not all of the aging aircraft initiatives focus on patching or reinforcing. Some parts simply have to be replaced, such as old, worn-out, or obsolescent items, including those using transistors or primitive computers. There are also initiatives under way—such as developing a battery that can go twenty years without maintenance—to reduce maintenance needs so that man-hours can be spent on critical repairs instead of avoidable routine. Labor-intensive systems, such as hydraulic actuators, can be replaced with highly reliable electric models. The time and money these initiatives could save can defray the expense of repairing or rehabilitating structural components, such that maintaining an old aircraft need not become prohibitively expensive.

In the case of old engines, technologies are being explored that can reduce or eliminate high-cycle fatigue. The use of a fuel called JP-8 +100, which burns at 100° hotter than regular JP-8, can cut down the amount of residue left in an engine, reducing failures and maintenance. Corrosion-resistant bearings are being developed that can provide similar benefits.

Mr. Rudd says there is no "bow wave" of structural or obsolescence problems facing the Air Force's aging fleet in the outyears.

"I don't think we'll have any major surprises coming down the road," he said. "To be honest, I think we're getting a pretty good handle on it."

General Fogleman said that while maintaining "legacy" systems is important, it's also important not to lose sight of what capabilities are truly required and when it's necessary to stop patching up an old warplane and move on to a new system.

"Quite frankly," said the General, "I'm not so sure that we're not spending more money on [modifications] than we ought to be. We may have to be more ruthless about cutting off upgrades to certain systems sooner. . . . I can only continue to upgrade something so long. And I ought to cut my losses at some point."

For the next five years, he said, "I think we're going to whip anything that's out there with what we have, basically," and the Air Force can afford to forgo some improvements in order to apply the funds to needed modernization.

Why, he asked, should the Air Force "pump $4 million a copy, say, into upgrading F-15Cs and Ds if, in fact, I'm going to replace them starting in 2005 to 2010?" While "everybody would like to have an upgrade," he said, "I really need to go look at that, look at that hard. . . . If I can't afford the next airplane because I'm spending too much money [on the existing one], then I'm being very shortsighted."

Nevertheless, a lot of today's inventory is going to be around for a long time, General Fogleman acknowledged, and he believes that the tools are in place to keep them capable.

"What was a big problem in the past," such as on the C-141, "will be a manageable problem in the future. At least, that's what we're betting the future on, anyway." ■