

Re-Engining the BUFF 38 | Pilot Training Revamp 30 | Adaptable Munitions 46

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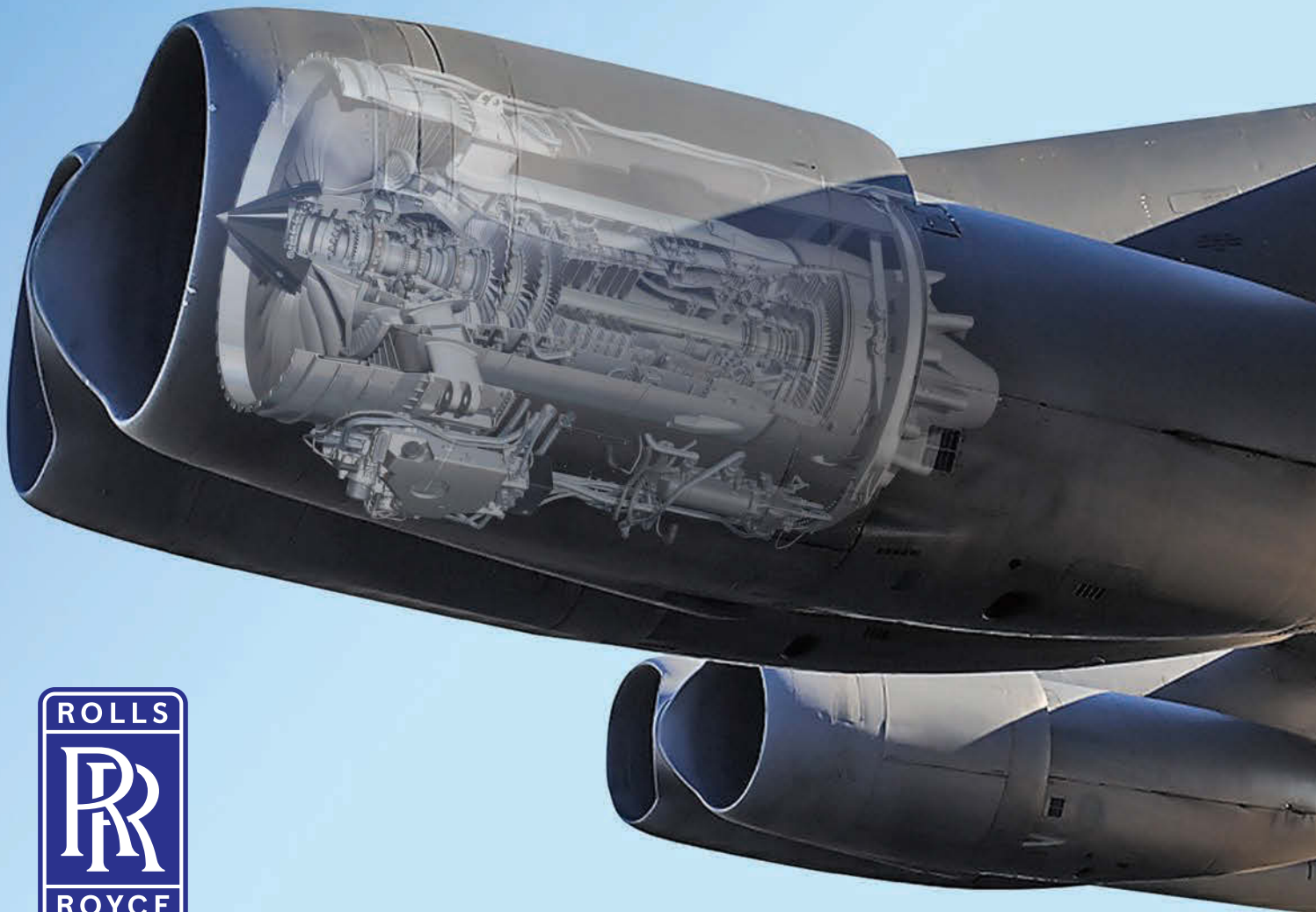




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DEPARTMENTS

2 Editorial: US Needs a Cyber Deterrence Plan

Effective cyber
deterrence
requires the will
and capacity
to respond to
cyber attacks
with an equal or
greater blow.

4 Letters

5 Index to Advertisers

8 Airframes

14 Verbatim

15 Aperture

Paying a high
price for the Air
Force we need.

17 Forward Deployed

Strengthening
ties in the Indo-
Pacific.

18 World: USAF accepts flawed tanker; Base in a Box; Mattis Farewell; and more ...

23 Faces in the News

60 AFA Elected National Leaders

61 Airman For Life: AFA Chapter News; B-24 crew deals with a nightmare at 16,000 feet.

64 Namesakes: McGuire

FEATURES

24 Red Air Rising

By Amy McCullough

Can contracting out the adversary air mission ease the pilot shortage and enhance combat training? An emerging industry says it can.

30 The Future of Pilot Training

By Brian Everstine

Low-cost simulators, new trainers, and Red Flag reforms aim to help USAF gear up for future great power conflicts.

38 Re-Engining the B-52

By John A. Tirpak

With the BUFF set to serve through 2050, new power plants are essential.

43 Saving a Blackbird

By Jennifer-Leigh Oprihory

Four Swedish pilots put themselves between a crippled USAF SR-71 and Soviet air-to-air missiles, potentially thwarting a lethal international incident.

46 Adaptable Munitions: Time for a Revolution

By Maj. Gen. Lawrence Stutzreim, Col. Matthew Hurley, with Marc V. Schanz

The Mitchell Institute argues for a new generation of weapons that can instantly tailor their effects to any given need.

51 From Cybernetics to Cyberspace

By Jason Healy

The roots of digital warfare date back to the birth of the US Air Force.

56 U-2 Down

By John T. Correll

"We have parts of the plane," Khrushchev said. "We also have the pilot." The US could no longer deny the truth about a lost spy plane.

SrA. Austin
McCullough
inspects a
B-52 engine at
Barksdale AFB, La.
See "Re-Engining
the B-52," p. 38.

Photo by A1C Sydney
Campbell

ON THE COVER



An A-4 Skyhawk
flown by Draken
International. See
"Red Air Rising,"
p. 24.

Photo by Javier
Rodríguez

US Needs a Cyber Deterrence Plan

Americans have a love affair with airplanes. We love their power and grace and marvel at their roar over air shows. We pay far less attention to rockets and satellites and even less to the invisible and dark art of cyber. These things are harder to see and understand.

They are every bit as important to the Air Force. As the US military ponders a future of peer competition, that future can be expected to meld air, space, and cyber. USAF's ability to exert power is predicated on our strengths in those other domains.

Since World War II, it's been Air Force doctrine that wars are won by taking the fight to the people. Attacking and disabling electric grids disrupts a society's ability to function. When societies can't function, they are more likely to give up. In both Kuwait and Kosovo, this was a key part of the US strategy.

At home, our own sensitivity to power outages is a major national weakness. "Surviving a Catastrophic Power Outage," a new report from the President's National Infrastructure Advisory Council, identifies the problems and offers a series of reforms to strengthen the resilience of that grid.

Until that's done, we can look forward to more events like these:

■ A local Ohio blackout in 2003 triggered a chain reaction that took out 21 power plants in three minutes, plunging Baltimore, Detroit, Cleveland, New York, Ottawa, Toronto, and other cities into darkness and sparking fears of a terrorist strike. It took two days for most locations to recover.

■ Hurricane Maria destroyed Puerto Rico's aging electric grid in 2017; the resulting power failure, which took 11 months to fix completely, was later blamed for as many as 3,000 deaths over the next six months.

■ Hurricane Michael flattened the Florida panhandle last fall, leveling Tyndall Air Force Base, and causing Air Force Chief of Staff Gen. David L. Goldfein to equate the storm with a surprise attack. That's a good way to think about these things.

Yet in an increasingly connected world, failure of our digital systems and networks is an even greater risk than power disruption. Today, almost every industrial system, from water systems and power plants to air-conditioning systems and elevators, is remotely controlled and monitored via computer software and hardware. Called SCADA, for Supervisory Control and Data Acquisition, these systems make up what might be called the industrial Internet.

In January, the *Wall Street Journal* documented in stunning detail how Russian hackers sought to penetrate the computer networks of US electric utilities by attacking not the utilities themselves, but contractors and subcontractors. The cyberattack targeted companies in 24 states, Canada, and Great Britain using deception to exploit business relationships and trickery to break into systems and plant malware to enable later attacks and disruptions.

Now think about what happens when those same techniques are used to attack government or financial systems, and not just to crash infrastructure, but to inject bad data into good systems, raising doubts about the accuracy and reliability of the very data we rely on to make decisions. Undermining confidence in economic data and creating fake identities with real credentials are

new twists on classic spy techniques and pose potentially serious risks to American economic and national security.

Consider the data breach at the Office of Personnel Management in 2014. The hackers got access to millions of records. But what worries intelligence insiders most was not what was taken. It was what might have been left behind that wasn't there before.

The uproar over Russia's influence campaigns before and since the 2016 elections provides an inkling of how fear and doubt can undermine trust in even the institutions most fundamental to our democracy.

In this digital age, where computers "in the cloud" help us make decisions and even find our way home, it's communications networks, rather than power, that are now preeminent. We can survive a power outage as long as we can charge our phones in the car. Shut down the web, however, and we're deaf, dumb, and blind.

Among our nation's greatest strengths are our robust, independent financial system and our dynamic, innovative technology sector. Together they have contributed to building the world's largest economy and among its most efficient. But our overwhelming reliance on both is our greatest vulnerability. No surprise then

that a recent Council of Foreign Relations' survey of 500 experts said the greatest threat facing the US homeland is "a highly disruptive cyberattack on US critical infrastructure and networks."

It's not the military's role to defend every civilian network. The line between military and civilian networks is getting thinner and grayer. The military increasingly relies on commercial satellites, technology, logistics, and network services. There are major national security implications to commercial infrastructure breakdowns.

Yet the United States has been vague about how it might respond in the event of a major cyber attack. Ambiguity has some advantages. If a rival doesn't know how you might act, he might not be willing to take the risk to find out. On the other hand, if the rival underestimates the potential response, the US could find itself mired in an otherwise avoidable conflict.

Cyber warfare is both offensive and defensive. Attackers will continue unrestrained unless they face a credible threat of retaliation. To be credible, however, US cyber warriors must be able to do two things: unambiguously assign blame and deliver an even more devastating blow in response to any attack.

Assigning blame in cyber is complicated. While practitioners exhibit signature moves and patterns, they also work hard to mask activities and their origins. US cyber warriors must get better and faster at attributing attacks, and the national leadership must be bolder and more willing to take action in response to attacks.

Just as nuclear deterrence is defined by the capability and clear will to respond in-kind quickly and decisively, effective cyber deterrence requires the will and capacity to respond to a cyber attack with an equal or greater blow. That suggests the US military should be more transparent about its cyber response plans. While it still makes sense to withhold from view some elements of strategic military power, one can hold back too much.

Adversaries can't fear what they don't know.



"Effective cyber deterrence requires the will and capacity to respond to a cyber attack with an equal or greater blow."

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A Fourth Leg for the Table

Your editorial in the December 2018 issue, entitled "The Air—and Space—Force We Need" [p. 2] was very interesting. It provides a light on the thinking behind the Air Force's position on the need for a Space Force. It is reminiscent of a piece that could well have been written in 1947 with regard to the need for an "Air Force."

I am certain that while the Army saw little need for the creation of a new service, it undoubtedly saw the likelihood for a reduction in size and mission after the end of World War II and realized that much of the new strategy would place an emphasis on air supremacy (especially the doctrine of massive retaliation). In light of the possibility of a threat from the Soviet Union, some of the statements in your critique could have been lifted verbatim from the Army's perspective on the need for an Air Force. For example, "The logic is that space (air) is a unique domain, that prior administrations underinvested there, and that a new bureaucracy is needed to guide development of space- (air) based capabilities," or "America does not need a Secretary of the Space (Air) Force. Adding a Space (Air) Force Chief of Staff will not increase the lethality of the US military. The Joint Chiefs will not become wiser with the addition of an eighth four-star general."

There are others, but why belabor the obvious? It is obvious that the Air Force is biased in favor of the air domain, just as the Army was of the land. It is organizationally incapable of providing a responsible estimate of the cost of creating a new service and it is not reasonable to ask organizations affiliated with the Air Force (such as RAND or the Air Force Association) to provide reasonable analyses as to the cost, or the need, for a new Space Force. The cost estimate from some are ludicrous (\$13B).

I have been employed by the Air Force in some capacity for 40 years, including duty as an ICBM crew commander, and I believe that it is indeed a great organization. It is not, and should not be, confused with having the needs of the space mission and capabilities

at its forefront. The services battle for missions, roles, and responsibilities, not to mention funding and allocation of personnel. The competition for funding for an F-35 with a SBIRS satellite will never be a fair one as long as pilots make the bulk of decisions as to where funds are to be allocated.

The future of this country will rely more and more on the ability of the Department of Defense to provide safe and secure space assets. Our adversaries are investing heavily in space in an attempt to overtake our advantages in air, land, and sea. Eventually the triad will require a fourth capability for the nation's defense, and it will be stationed in space.

It will take true visionaries to recognize that, as the Air Force came from the Army, the Space Force will come from the Air Force. It is inevitable if the nation is to survive. Don't wear these blinders too long.

P.S. If you want proof as to the bias against Space in the Air Force, take a look at your magazine in which this editorial was contained to see that there are no articles on the threat from space, or the history of space, or the acquisition of space weapons.

James H. Gill
Manhattan Beach, Calif.

A Day in the Life

The photo of the F-35 Elephant Walk in the Dec. 7 edition of the *Air Force Magazine Daily Report* ["F-35's Final Milestone Before Full-Rate Production"] evoked a strong memory of mine that I'd like to share.

Elephant walk is a USAF term for taxiing airplanes in close formation before takeoff, so you can launch the most planes in the least amount of time possible.

When I was an aggressor pilot flying F-5s, simulating Soviet air tactics at Clark AB, Philippines, circa '79-81, I remember a McDonnell Douglas F-4 elephant walk. I was driving home to my Carmenville housing area on the perimeter road, but I paused, and then escaped and evaded my lime-green BMW 2002 onto an airfield access road, and parked at the departure end

of the runway—probably no more than 150 feet from centerline and slightly past the overrun.

And watched, then stared, then stood stupefied as 44 F-4 Phantom IIs, nicknamed "Rhinos," rumbled in the distance—obscured at the other end of the runway by the heat haze shimmering above the runway—and then sent a rooster tail upward of black JP-4 aviation smoke as full afterburners were stroked, and the beasts started a slow surge down the concrete.

Each jet in slow motion emerged from the oily smoke-and-haze stew and took on the familiar F-4 "Double Ugly" look with hovered inlets, an ominous yet sleek humpback, a bit of curve on the wingtips, and then the chicken-leg landing gear slowly folding upward and seemingly securing the crew.

The three bags of petrol on the underside of airplanes were high drag, so these were 60,000 pounds of machine that hovered in ground effect until they captured enough speed to then limp into the sky; but really only making a sliver of altitude by the time they thundered by me.

Roiling acrid-stinky smoke descending upon my cranium while I shuddered into a continuous vibration as airplane after airplane—44 times—went by with two afterburners spitting 15-foot cylinders of flames against the afternoon backdrop of a darkened tree-green Mount Pinatubo.

Wow, what a privilege to watch. A marvel of man's making. Steel, pungent smells, roar of noise, tropical landscape, wonder of flight (how can that hunk of metal simply, slightly, lift off into the air?), and brotherhood. I was in love with it all, each separately and as a collective imprint upon my identity. But to this day I most cherish the unbounded feeling of kinship I had with the men inside those "Double Ugly" flying machines. I was on the ground, in a different squadron, and flew a different type of airplane with a different mission, but I knew I was their wingman. Fly safe, then and today. Always.

Carl Van Pelt
Falls Church, Va.



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Peaceful BUFFS

The article "Best Bargain in Military History" [December, p. 56] was very good and interesting. But after spending the majority of my 30 years in SAC, I was surprised to see the SAC motto had changed. I recall that the SAC motto was: "Peace Is Our Profession."

CMSgt. Jon R. Lindgren,
USAF (Ret.)

Converse, Texas

I enjoyed reading the history of the B-52. Truly it has served us well. Many of my classmates from the Air Force Academy (1969) flew it in combat from the base at which I also was stationed (U-Tapao AB, Thailand).

I do take issue with one point. On p. 58, Boyne and Handleman write that "... the US decided once and for all to remove Saddam from power." The "US" did not decide this; it was one man, then-President George W. Bush, who made that decision, despite his anti-terrorism czar, Richard A. Clarke, assuring him that Saddam had no WMD—which we learned later was the truth.

Capt. John C. Miller,
USAF (separated)
Fairfield, Iowa

Women and the Enlisted Ranks

I found your recent article, "Retaining Future Air Force Women Generals," [December, p. 38] to be thought-provoking. As a male, prior-enlisted, non-rated, married, and now-retired Air Force colonel, I felt a strange kinship. Many of the challenges listed in your article are similar for any other Air Force officer trying to be all that he—or she—can be in their Air Force careers.

My wife was a civil servant when we married and [she] accompanied me through four PCS assignments before she had to resign and become a full-time mother. We endured our share of family separations during two of my remote assignments and a long deployment.

INDEX TO ADVERTISERS

Collins Aerospace	32-33
GE Aviation	3
General Atomics	Cover IV
Mercer	7
Rolls-Royce	Cover II
USAA	Cover III
AFA Blue Skies	6
AFA Monthly Giving	37

As a nonrated-ops type, I had to go that extra mile to gain leadership experiences to make myself competitive for promotion. For example, I volunteered for a squadron operations officer position at Kunsan, thereby letting a previously tagged, rated, nonvolunteer off the hook. While my career was fairly successful, it took over 40 years to complete my Active Duty journey.

Over my career I had four female supervisors, two were O-6s. I can testify that there was no doubt of their competency or motivation as it led to professional success.

Bottom-line: It is the "Air" Force. Pilot wings seem to be the silver bullet toward promotion, both early and often. Historically, of 214 Air Force generals, only a generous baker's dozen ever attained that rank without being a pilot. Gen. [Ellen M.] Pawlikowski was spot on with her observation that female pilots got a late start but will be coming of general officer age soon. No doubt they'll catch up!

In the meantime, the likes of Martha McSally and Heather Wilson exemplify that the Air Force is truly a gateway to a great way of life.

Col. Bill Malec,
USAF (Ret.)
O'Fallon, Ill.

Nukes on the Table

With all due respect to my fellow Air Force Lieutenant Colonel (Lt. Col. Gerald P. Gilbert, "Letters: North Korea Nukes," October/November 2018 issue, p. 5), I disagree that President [Donald J.] Trump is inept in dealing with North Korea. Living in Hawaii, I can say that President Trump's initiatives, despite his roughshod tactics to show America's resolve to stop North Korea's threatening ICBM tests within bounds of Hawaii, were well appreciated. Whether or not Trump understood

WRITE TO US

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—The Editors

North Korea's intent to denuclearize, Trump's actions were necessary to bring the issue to the table and to pursue it. Previous administrations did not prevent North Korea from nuclearizing, and Trump now has no other choice.

Trump may discount daily intelligence briefings but he really does not like issues that are repetitive. Intelligence briefings should be just that, "brief," and just delve into issues that affect imminent presidential/CINC decision-making. His use of the display of US military capabilities effectively and speedily brought diplomacy to the forefront. Diplomacy alone is not an effective form of getting international issues resolved. The reduction of US military strength and readiness over the past administration was totally ineffective and put the US in a bind that required the US to break out of a losing diplomatic-only process.

Trump, giving Kim Jong Un an equal footing internationally, was the impetus needed to raise the issue of denuclearization to the highest level. Trump's tactics were instrumental in getting the UN's—including Russia and China—support for unprecedented sanctions against North Korea, for the first time ever. Nothing wrong with that.

If Kim does not start to denuclearize, the US should return tactical nuclear munitions and missiles to South Korea and Japan and post permanent nuclear subs and carriers in close proximity to North Korea. The US should encourage Japan to deploy defensive missiles to counter North Korean missiles. The US should also develop "launch on notification" procedures when North Korea prepares to launch missiles.

Lt. Col. Russel A. Noguchi,
USAF (Ret.)
Pearl City, Hawaii

Dancing in the Stars

Thanks for the excellent Chappie James article in your October/November issue ["The Chappie James Way," p. 70]. My father, Lt. Col. Arthur G. Beach, Jr., was stationed with General James at Clark Air Base in about 1950. I was told by both my father and mother about the prejudice shown to General James and his wife at the Officer's Club. Only a handful of officers and their wives would associate (much less dance) with the couple. Dad said that Chappie and Dorothy were very friendly and fun to be with. Mom and Dad enjoyed dancing with them, and

Dad said it was always a good time socializing with both Chappie and Dorothy. At the time, my father was on flying status, but not in fighters with Chappie. My father had flown mostly C-46s and C-47s out of North Africa during WWII, and he went on to become a SAC bomber/tanker pilot during the Cold War. I hope (and believe) my parents have renewed their friendship with the James couple and other Air Force friends in the wild blue afterlife.

Lt. Col. James Beach,
USAF (Ret.)
Albuquerque, N.M.

Straight Up Communications

While Mr. [Chris] Brown notes that the E-6 flies just above stall speed when deploying its trailing VLF antenna, it is not a consequence of straining at the drag of the massive antenna, but is done intentionally to result in as close to a vertical deployment of the antenna as possible ["Letters: Four-in-One," October/November, p. 8]. Slow-speed orbits result in a more vertical attitude of the antenna, which is optimal for communications in very low frequencies.

John L. Fenton
Kaneohe, Hawaii



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SSgt. Brooke Held, a 324th Training Squadron instructor at JBSA-Lackland, Texas, leads her basic training flight during practice for the graduation parade, when airmen pass in review and reaffirm their Oath of Enlistment. The Air Force recruited 29,831 enlisted airmen in Fiscal 2018.




A woman with long brown hair in a ponytail, wearing a black t-shirt, is seen from behind, painting a large mural on a wall. She is using a paintbrush to apply black paint to the tail section of a large, dark-colored aircraft. The aircraft is the central focus of the mural, set against a background of a sky with yellow, orange, and purple clouds. In the lower foreground, there are faint pencil sketches of two faces. To the left of the artist, there is a palette with various colors of paint and a small reference photo of an aircraft. To the right, another reference photo is visible. The overall scene is a creative workspace where a large-scale artwork is being developed.

TSgt. Maralene Scarpino paints a mural in the 910th Maintenance Group's heritage room at Youngstown ARS, Ohio. The finished artwork will emphasize the role of the 910th in the wing's airlift and aerial spray missions. The 910th operates DOD's only large-area, fixed-wing aerial spray capability to control disease-carrying insects, pest insects, undesirable vegetation, and to disperse oil spills in large bodies of water.

Photo: SrA. Juliet Louden



A large military transport aircraft, a C-17 Globemaster III, is parked on a tarmac under a clear blue sky. The aircraft's main cargo door is open, revealing a large quantity of cargo inside. The aircraft is positioned on the left side of the frame, with its long fuselage extending towards the right. The tail section is visible on the right, featuring the number '7703' and a tail code 'HMC'. A white pickup truck is parked near the tail of the aircraft, and a piece of ground support equipment is visible at the rear. The overall scene depicts a military logistics operation.

A C-17
Globemaster III
loaded with war
reserve materiel
rests on the
flight line at an
undisclosed
location in
Southwest
Asia. The cargo
supported
a coalition
exercise for the
sustainment,
morale, and
training of some
300 coalition
personnel in the
region. A single
C-17 can carry
18 pallets and
up to 170,900
pounds of
cargo.

Photo: TSgt. Robert Cloys

Mirror, Mirror ...

Connected fitness started out with apps, "then we went to trackers, and then connected cardio equipment. We're focused on the next layer, and that's intelligence."

Mirror-based, workouts also rely on intelligence, according to founder of Tonal, **Aly Orady** [Wired.com, Dec. 17].

AI Track Meet

"I would say we are not behind. Right now we are actually ahead; however, we are in danger of losing that leadership position."

Lisa Porter, deputy undersecretary of defense for research and engineering on the US in the AI arms race [C4ISRnet.com, Dec 14].

US Must Avoid Catastrophic Damage

"The time for research is running out; we have the data we need. It's time for bold action."

R. James Woolsey, former CIA director on preventing electromagnetic pulse attacks against America [Air University report, November 2018].

An unidentified satellite owned by a hostile, near-peer nation is shown here ramming a US GPS III satellite (bottom).

Staff Illustration/
Mike Tsukamoto



Look Out Above

"The most cost-effective and simplistic cyberattack in space, one with the intent to bring down a targeted satellite, is likely to use an older satellite now viewed as space junk that still has fuel and can respond to communications. Hackers could then use that satellite to ram or force targeted space assets out of orbit."

Jan Kallberg, research scientist at the Army Cyber Institute at West Point, in an opinion column [FifthDomain.com, Dec. 28].



Photo: SpaceX

Must Make Space for "Space"

"We will have to wait and see how the Congress actually vets it out. ... But on a fundamental basis, whether it's a [Special Operations Command] model, whether it's its own command, I definitely support the concept that we do need a center of excellence for Space."

Navy Secretary Richard V. Spencer supporting an organization dedicated to Space operations [Military.com, Dec. 6].



Run, Don't Walk

"Politically, the shutdown seems like a litmus test for everything else to come. If political leaders can't 'walk' through the mere process of keeping the government open, how can they ever hope to 'run' through more complex issues?"

William G. Gale, senior Fellow at the Brookings Institution on the ongoing government shutdown [Brookings.edu, Jan. 3].



Photo: Bryan
Bacon/USA

The Time is Now

"In the last year, China has tested more hypersonics weapons than we have in a decade. We've got to fix that"

Michael Griffin, undersecretary of defense for research and engineering [Defense News, Dec. 13].

GRADE "A"

"As far as we know, this is the first large stealth target drone. ... It has had cadet involvement in its evolution over several years. It's quite rare that a student design has evolved to the point of potential inventory use."

Thomas McLaughlin, USAFA's Aeronautic Research Center director, on cadets, aerospace instructors, and industry partners developing DOD's first large stealth target drone to test missile tracking systems [USAFA, Dec. 12].

How Much and How Much?



A B-2 Spirit takes on fuel over Andersen AFB, Guam. USAF's bomber fleet averages 42 years old, and the still-notional B-21 bomber is among the most-expensive new aircraft programs in the offing.

Photo: A1C Jazmin Smith

THE UNCERTAINTY FACTOR

Defense-watchers are anxiously awaiting the answers to two big questions when the Trump administration presents the Fiscal 2020 budget request: "How much?" and "How much?"

The first "How much?" is, of course, the budget top line: the grand total requested to fund the military services and Department of Energy nuclear weapon activities. At first, the services were promised \$733 billion to continue restoring readiness and recapitalizing force structure to be able to fight a high-end war against peer adversaries. Then, the President told the Pentagon to brace for a potentially lower budget. The Defense Department dutifully began building two budgets; one at the \$733 billion level, and another at around \$700 billion—which is less than the enacted Fiscal 2019 budget.

Then, the President tweeted that last year's enacted level of \$716 billion was "crazy"—meaning too high—and that the US didn't want to enter into an arms race with China. *Then*, he met with Republican members of Congress who explained to him why the higher levels are needed for military modernization. He promptly said he would support a \$750 billion defense budget.

This is exactly the kind of uncertainty that gives the US military fits. For years, the services have begged Congress to restore some predictability to the defense budget. Even if the appropriated amount is less than what's needed, the service chiefs have said, a number they can count on is better than yo-yo ups and downs, the destructive effects of sequester, and endless continuing resolutions that make managing programs a nightmare. A dozen reviews of defense acquisition in the past 20 years have singled out funding predictability as the single most important thing anyone can do to help the American military be more efficient and effective with the dollars it gets.

The second "How much?" concerns what it will take to fulfill the National Defense Strategy requirements. The NDS was unveiled one year ago to generally favorable reviews, saying for the first time in decades that, yes, the US is again engaged in a Cold War

(the NDS terms it "great power competition"), not only with Russia but also China, and must restore its ability to wage a "high-end" fight. Although the struggle against "violent extremists" is still in the mix, it's now a lower priority than being able to fight a great power war against an enemy that has much of the same kind of high-end gear the US has. The NDS recognizes that, after an atypical historical period of nearly three decades in which there was just one world superpower—the US—there are again challengers that must be deterred and possibly fought.

GOOD LUCK GETTING AN ANSWER

What defense watchers found lacking in the NDS, however, was a specific prescription for the types and numbers of forces needed to deter and, if necessary, defeat an enemy (or enemies) of the size and capability of China and Russia. The strategy did not specify numbers of ships, fighter squadrons, bomber squadrons, airlifters, tanks, troops, etc.—the nitty-gritty of "How much?"

Members of Congress and the denizens of Washington think-tanks clamor for numbers, because they provide something that is easy to measure, debate, and trade off. It's worth noting that when the NDS was released, the person most responsible for pulling it together, Vice Chairman of the Joint Chiefs, USAF Gen. Paul J. Selva, called "force-sizing constructs" a trap and an obsolete way of thinking.

The history of force-sizing shows "that's failed us," Selva told defense writers a year ago. One Quadrennial Defense Review after another established force sizes, he said, but "limited thinking." The numbers, he argued, became a way for the services to keep score on who was up and who was down in perceived importance. It didn't advance national defense.

The NDS aims instead for "dynamic force employment," Selva explained. It recognizes that the world is not static and that threats are not monolithic; today's force structure can become obsolete overnight. The key is to establish desired end states and work backward to establish the means necessary to achieve them.

Those goals will have monikers such as “assured force projection” rather than “anti-access/area denial,” a term Selva virtually banned because it describes a hurdle to overcome rather than an outcome.

The second “How much” question is therefore unlikely to be answered with the Fiscal 2020 defense budget, as Selva once again supervised the intellectual basis for the request.

The Air Force, however, took a stab at the second “How much?” answer in September, when it unveiled “The Air Force We Need” numbers. USAF said it needs about 25 percent more operational squadrons than it has now, for a total of 386, setting specific required levels of every capability it operates, from tankers to spyplanes. Service leaders such as USAF Vice Chief of Staff Gen. Stephen W. Wilson acknowledged late last year, though, that those numbers remain in flux and will be influenced by “new operating concepts” that may allow the service to tweak its requested new levels of fighters, bombers, tankers, ISR squadrons, and the like.

To get to “more,” though, USAF will have to ask for more money in Fiscal 2020, and for specific things. So, while the budget may not offer a definitive answer to “How much?” it will inevitably offer more specific hints.

STICKER SHOCK AND AWE

Getting to the Air Force the service thinks it needs—with a more youthful average equipment age and the latest capabilities—will come with a dauntingly high price in the coming decades, the Congressional Budget Office reported in December.

The bipartisan CBO, in a report titled “The Cost of Replacing Today’s Air Force Fleet,” forecast that retiring USAF’s old iron and replacing it with state-of-the-art aircraft will demand “\$15 billion a year in the 2020s,” followed by “\$23 billion a year in the 2030s,” before settling back to \$15 billion a year in the 2040s.

As the CBO pointed out, these figures are well beyond historical, inflation-adjusted spending. Between 1980 and 2017, USAF was appropriated, on average, “about \$12 billion per year” in 2018 dollars for recapitalization.

In gross numbers, the replacement bill comes out to \$530 billion over three decades, 47 percent more than the historical spending of \$360 billion, in apples-to-apples dollars. To carry out such a modernization, therefore, would require significant substantial spending increases.

The CBO recognized that some aircraft may be retired and not replaced, and that more capable aircraft may replace multiple older airplanes because they’re more reliable (and can fly more missions) and can accomplish multiple missions simultaneously. But the CBO also noted that some new classes of hardware may appear—think remotely piloted aircraft such as RQ-4 Global Hawks and MQ-9 Reapers—that don’t “directly replace any existing systems.”

A long-range projection “is nevertheless useful” because it can help the Air Force, Congress, and the Pentagon in “setting appropriate budgets for procuring new aircraft,” the CBO said. More importantly, “It can also identify key future issues—when too many programs might need procurement appropriations at the same time ... or when retained aircraft are growing too old” and give decision-makers enough time to address them.

The CBO forecast that USAF spending on new airplanes would have to peak at about \$26 billion in 2033. In that year, the service will be buying F-35 fighters, B-21 bombers, and a new Penetrating Counter-Air (PCA) successor/complement to the F-22 fighter. “Costs of procuring new aircraft would not fall below \$20 billion until 2039 and would remain above typical historical levels past 2045,” the agency said.

Historically, USAF spending on new airplanes peaked at \$29 billion in 1986 (using 2018 dollars), when the service was buying

hundreds of new F-15 and F-16 fighters, B-1 bombers, and C-5B transports.

THE SIX PRICIEST

The CBO figures that 35 types of new aircraft will be needed, but “six programs make up more than 85 percent” of the overall cost: The F-35A, the PCA aircraft, the KC-46 tanker, B-21 bomber, “a C-17 replacement cargo aircraft,” and the C-130J tactical airlifter. Of these, the F-35 fleet will cost the most, because of volume. The PCA, however would become “the most expensive [aircraft] until the late 2040s,” potentially costing \$300 million apiece—more than three times the cost of an F-35.

The PCA remains an undefined program, however; the Air Force is not even sure the PCA will be a single platform. It could instead be a “family of systems” that will enhance and complement the F-22 and F-35. USAF took this approach in abandoning the E-8 Joint STARS replacement. Nevertheless, the CBO guesses the PCA will be at least one new airframe.

Even if the PCA is taken out of the mix, aircraft purchases would still hit \$20 billion a year in 2033, the CBO forecast, saying the new super stealth jet alone would cost \$6 billion a year. The report’s authors suggested that an F-22/F-35 hybrid—with the F-22’s aerodynamic capabilities but the F-35’s more advanced avionics, as recently pitched to Japan—might cost less than the PCA without resorting to “a new advanced fighter aircraft.”

To smooth out the spikes in aircraft recapitalization spending, USAF might stretch out some aircraft service lives, but that approach isn’t free, the CBO noted. Beside the fact that service life extension programs [SLEP] “can be expensive,” getting parts for old jets isn’t easy or cheap, and even a refurbished fleet “may not provide as many available and mission-capable aircraft” as a new fleet.

The CBO noted that USAF is studying SLEPs for the F-15, F-16, and A-10, but hasn’t yet decided whether to apply them, or in what quantities if it does. The CBO projects that all the 1980s jets will have to be retired not later than “the early to mid-2040s,” and keeping the last ones even that long will require life extension work. The CBO forecast of new aircraft purchases doesn’t include the cost of SLEPs.

The report’s authors noted that USAF could buy new versions of legacy airplanes, noting this would likely be cheaper than buying all-new systems and may produce more mission-capable aircraft. The drawback would be that the jets would lack the survivability of fifth generation airplanes such as the F-22, F-35, and PCA. Chief of Staff Gen. David L. Goldfein—and his last three predecessors—have all rejected buying “new-old” airplanes. The CBO said USAF could “delay a new system” and let the fleet shrink in the meantime, but that would fly in the face of the National Defense Strategy, which mandates a larger force to cope with high-end peer competitors.

Yet another possible approach suggested by the CBO was to “accelerate” purchase of new aircraft, or accept a mix of modern and “new-old” aircraft.

“Maintaining two different types of aircraft would be more costly than maintaining a single fleet, however,” the CBO pointed out, “because the Air Force would need to keep two different maintenance operations in place.”

The CBO noted that the bomber fleet averages 42 years old; the fighter fleet averages 26.4 years (even counting recent purchases of F-35A fighters); the airlift fleet is 24.7 years old; and the tanker fleet averages 53.7 years, with the oldest jet having served 60 years. Reconnaissance aircraft—ranging from nearly new remotely piloted MQ-9s to 53-year-old WC-135s—are the youngest overall, at an average of 14 years old. Trainer aircraft clock in at an average of 30.3 years of age, while helicopters and MV-22 tilt-rotors average 19.9 years. ★

Adding INDO to PACOM

When then-Defense Secretary Jim Mattis announced in May that US Pacific Command's name was changing to US Indo-Pacific Command, he noted the change was made "in recognition of the increasing connectivity between the Indian and Pacific oceans."

With an area of responsibility stretching from Bollywood to Hollywood, INDOPACOM commanders see the name change as recognition of a changing world in which India figures as a more significant force. The US and India have been building their defense partnership since 2005, when the two nations signed the New Framework for the US-India Defense Relationship. But there's more changing now than just the name of a command.

"As democracies bookending the Indo-Pacific region, the United States and India share an interest in advancing security and prosperity in the region and the world," said USAF Capt. Victoria Hight, a PACAF spokeswoman. During the Cope India exercise in December, she said, USAF airmen got a chance to put that to the test and "expand engagements with our Indian air force partners and showcase the US and India's efforts and commitment to a free and open Indo-Pacific."

Previously held in 2004, 2005, and 2009, the 2018 edition of the exercise marked the first time Cope India was at two separate operating locations. It included 200 USAF airmen, and F-15s from Kadena AB, Japan, and C-130Js from the Illinois Air National Guard, as well as Indian Air Force Sukhoi Su-30s, Jaguars, Mirage 2000s, and C-130Js.

Lt. Col. John DeLion, commander of the 67th Fighter Squadron, was among 145 airmen from Kadena who traveled to India for the exercise.

"It was amazing," he said. "The dinners they hosted for us, how they helped us overcome some logistics problems, backing us up, it was just fantastic."

"Obviously we have a lot in common," DeLion said. The two nations are "the world's oldest continually running democracy and the world's largest democracy," he said, so it's a "great opportunity for working on our interoperability."

The exercise afforded more than the usual opportunities for interaction, he explained, describing "driven interaction" designed to increase interplay between the two air forces. Airmen had more time to get out to the flight line to see the jets and sit in the cockpits, for example, and to compare notes on maintenance procedures.

Indian maintainers impressed their American counterparts with how resourceful and flexible they can be. "We used tractors, like actual Farmer John tractors, to move around equipment," said SSgt. Richard Bishop, an F-15 crew chief with the 67th Aircraft Maintenance Unit. Previously, "we never would think that was a viable option."

US airmen also worked with Indian airmen to put up a barrier for arresting jets in case of in-flight emergencies. A job that normally takes a week was done in half the time because the cooperative IAF shut down what was needed, Bishop said, and just "let us work."

Using a "building-block approach," the exercise began with smaller sorties and gradually grew until, over the last few days, the two air forces were combining for large force exercises, DeLion said. The focus was on interoperability, but not just in the air, he stressed.

"I would say it's much more encompassing than can we fight



Photo: SSgt. Hailey Haux

PACAF Commander Gen. Charles Q. Brown Jr., left, prepares for an orientation flight in an Indian Air Force Mirage 2000, during Cope India 2019.

or train together—it's can we do everything together," he said.

CMSgt. Spencer Ridgway, superintendent of the 67th Aircraft Maintenance Unit, called the high level of interaction between the two air forces "awesome," an opportunity to better understand how the two are alike and how they are different. Differences were "as simple as how do we sign out tools? How do we store them? Or what's our procedure before we let a jet fly on tool control?" he said. In India, for example, the pilot has to inspect the tool room and certify that all the tools are there before the jet can be declared airworthy. By contrast, USAF trusts airmen to do tool inventory as part of the daily maintenance routine.

For US Pacific Air Forces Commander Gen. Charles Q. Brown Jr., the exercise is "just one part of an ongoing effort to strengthen the relationship between the US Air Force and the Indian Air Force." He visited with US and Indian airmen during the exercise and completed an orientation flight on an Indian Air Force Mirage 2000. For the US military, it is part of a broader plan. Just two days prior, the US Navy and Indian navy discussed increasing exercises, exchanges, and port visits, and one US officer called the US-India partnership "more important today than ever before."

Still, PACAF said it is not planning to make Cope India an annual exercise. While Indian Defense Minister Nirmala Sitharaman recently termed US-Indian defense cooperation "the most significant dimension of our strategic partnership and ... a key driver of our overall bilateral relationship," the working relationship between the two remains tentative compared to more established relationships in other parts of the world.

If the exercise does happen again, the Kadena-based airmen said they would jump at the opportunity to go back to India. And the excitement seemed to be mutual: DeLion and Ridgway said the ritual patch exchange between the two sides was like nothing they had ever seen before.

"We were all traded out within the first 24 hours, and everyone wanted to continue trading," Ridgway said.

"I've never seen so many people from a different air force wear our patches," DeLion said, including the Indian Air Chief. "Almost all of our pilots and a lot of maintainers were wearing their patches," DeLion said. As for the Indian airmen, he said, everyone wanted his picture taken with an F-15.

"We would go back," DeLion said. "In a heartbeat."

Not Quite Perfect

USAF accepts new tanker despite known flaws.

A KC-46A takes off during a system evaluation at Yokota AB, Japan, on Oct. 25, 2018.



Photo: Yasuo Osakabe

By John A. Tirpak

The Air Force accepted the first KC-46A Pegasus tanker from Boeing for operational testing—two years behind schedule, with known deficiencies in the boom operator's vision system, and with the boom itself that could take years to resolve.

The decision to accept the jet, announced Jan. 10 in a short USAF press release, is a “major milestone for our next generation tanker,” the Air Force said, and allows the Air Force to begin operational testing and flight training on the aircraft. The service said the deficiencies “do not prevent the tanker from carrying out its primary mission.”

Delivery of the first aircraft to McConnell AFB, Kan., and an official ceremony to mark that occasion, was set for Jan. 25. Boeing said in a statement that nine more aircraft are undergoing Air Force acceptance testing, and four could be delivered to Altus AFB, Okla., as early as next month.

Boeing and the Air Force initially expected to take the first delivery of a KC-46 in early 2016, and the fixed-price contract called for 18 aircraft to be delivered by the end of 2017. The schedule has repeatedly slipped as deficiencies were discovered in testing.

The Air Force accepted the first aircraft with deficiencies in the “remote vision system” and the boom’s ability to properly sense “axial loads.”

“We have identified, and Boeing has agreed to fix at its expense, deficiencies discovered in devel-

“The Air Force has mechanisms in place to ensure Boeing meets its contractual obligations while we continue with initial operational testing and evaluation.”

—Air Force

opmental testing of the remote vision system,” the service said. “The Air Force has mechanisms in place to ensure Boeing meets its contractual obligations while we continue with initial operational testing and evaluation.”

The Air Force is withholding up to \$28 million per aircraft if the deficiencies are not adequately addressed. If this amount is applied to all 52 aircraft currently on contract, total withholding could be as high as \$1.5 billion, Air Force spokeswoman Capt. Hope Cronin said. This amount would be in addition to the \$3.2 billion Boeing has absorbed in cost overruns on the KC-46 thus far. It was not clear from the Air Force’s comments whether the \$28 million per jet would be paid to Boeing later or represented a permanent reduction in progress payments. A Boeing spokesman deferred all comment about penalties to the service.

The Jan. 10 event acceptance is known in the trade as a DD250, for the form the Air Force signs to accept an airplane. It is not uncommon for a DD250 to have deficiencies noted. A decision to accept an aircraft with defects is made at the service’s discretion.

The remote vision system is necessary on the KC-46 because, unlike the KC-135 or KC-10, the boom operator sits at the front of the aircraft, behind the cockpit. The series of cameras provide the boom operator with a three-dimensional view of the rear of the airplane, wingtip to wingtip, as refueling takes place. The cameras also allow the operator to see what’s going on in blackout conditions, using thermal cameras.

Two problems persist with the remote viewing system. Under certain lighting conditions, and when the sun is at a particular angle, the boom operator's view of refueling could be impaired. Also, boom operators couldn't tell during testing if the boom was scraping the receiving aircraft outside the protected area around the refueling receptacle. This problem could damage stealth coatings on a low-observable aircraft, ruining or degrading its ability to conduct its mission. Boeing has said a software update could address this issue.

Another issue involves the inability for the boom operator to detect additional loads put on the boom by the KC-46 pilot and sensing the stiffness of the refueling boom during initial contact.

The Air Force expects the implementation of solutions to these deficiencies to take "approximately 3-4 years to complete," though it does not project any delays to delivery schedules as a result of these solutions, Cronin asserted.

The decision to accept the aircraft was made by Ellen M. Lord, undersecretary of defense for acquisition. She made the call because Patrick M. Shanahan, Acting Defense Secretary, has recused himself from actions regarding Boeing, where he worked for 31 years before retiring as a senior executive.

Pentagon spokesman Lt. Col. Mike Andrews said in a statement that the Department is in "complete agreement" with the Air Force about the delivery of the aircraft. The Pentagon "remains committed to providing the most cost-effective platforms" for the taxpayer while also delivering the "best capabilities" to the military, Andrews said.

So far in flight testing, six KC-46s have completed more than 3,800 flight hours and off-loaded more than four million pounds of fuel to nine different aircraft in day, night, and covert flights, Boeing said in a release.

"This is an exciting and historic day for the Air Force and Boeing, as we hand over the first of many KC-46 tankers," Boeing CEO Dennis Muilenburg said in the release. "I'm proud of the dedication and commitment by our enterprise-wide team, and we're honored to provide this valuable and capable aircraft to our customer."

The Air Force said it expects the initial 18 aircraft to be delivered by the end of 2019.

The service in September awarded Boeing \$2.9 billion for 18 more KC-46s plus spares, support gear, spare engines, and wing air refueling pods. Contracts for the first two production lots—seven and 12 aircraft—were awarded in 2016 and the third—for 15 aircraft—was awarded in 2017. Delivery of 179 total aircraft is expected by the end of 2028.

The Air Force and Boeing recently finished Phase II of flight certification at Edwards AFB, Calif., and are beginning the next phase of testing focused on 11 total aircraft.

"We look forward to working with the Air Force, and the Navy, during their initial operational test and evaluation of the KC-46, as we further demonstrate the operational capabilities of this next generation aircraft across refueling, mobility, and combat weapons systems missions," Boeing Defense President Leanne Caret said in the release.

McConnell Air Force Base has been preparing for the arrival of the aircraft, having completed 16 military construction and facility projects at a cost of \$267 million since 2014. These include a fuselage trainer, hangars, and simulators, among others.

"We stand ready," Air Mobility Command boss Gen. Maryanne Miller said in October. "Aircrews are excited, we're excited to get it."



Photo: DOD

Mattis speaks to troops at Camp Jordania, Afghanistan, as head of USCENTCOM in 2011.

Mattis Bids Farewell to Troops

Secretary of Defense Jim Mattis resigned Dec. 20, one day after President Donald J. Trump's plans to withdraw troops from Syria became public. Mattis urged military members to remain focused on the mission, saying the Department of Defense remains in good hands.

"I am confident that each of you remains undistracted from our sworn mission to support and defend the Constitution while protecting our way of life," wrote Mattis in a farewell address to troops on Dec. 31. "Our department has proven to be at its best when times are most difficult. So keep the faith in our country and hold fast, alongside our allies, aligned against our foes."

Mattis, who led the department since January 2017, resigned citing multiple policy differences with the administration. He offered to stay on through Feb. 1, to ensure a smooth transition to the next Defense Secretary, but Trump days later announced that Deputy Defense Secretary Patrick M. Shanahan would temporarily assume the position until a new SECDEF, who has not yet been named, is confirmed.

The official transition took place Dec. 31 via a scripted telephone call between Mattis and Shanahan, according to a defense official. The department "is not authorized" to release a transcript of that call, but its purpose is to "ensure all members within the government know who is in command," according to the official.

Mattis is a retired United States Marine Corps general who served in the Persian Gulf War and the war in Afghanistan. His career included stints as commander of the US Joint Forces Command, NATO's Supreme Allied Commander Transformation, and the head of USCENTCOM. After retirement and before taking the job of SecDef, he served on the board of Theranos, a now-defunct health technology corporation.

Shanahan was a Boeing executive for more than 30 years and served as deputy defense secretary since July 2017. He oversaw many of the department's acquisition programs and the development of the plan for a separate military service for space.

On his first day on the job, Shanahan met with civilian military leaders and stressed the importance of the National Security Strategy, in particular its position on near-peer competitors such as "China, China, China." In a statement released that day, Shanahan said, "As Acting Secretary of Defense, I now look forward to working with President Trump to carry out his vision alongside strong leaders including the service Secretaries, the Joint Chiefs of Staff, the combatant commanders, and senior personnel in the Office of the Secretary of Defense."





Photo: DOD via National Archives

Harold Brown was a key figure in developing the nation's nuclear policies.



Brown (center), as Secretary of Defense, meets with President Jimmy Carter, Zbigniew Brzezinski, and Gen. Alexander Haig in the Oval Office.

Photo: USAF/AFA Library

Harold Brown 1927-2019

By John A. Tirpak

Harold Brown, Secretary of the Air Force from 1965-1969 and Secretary of Defense during the Carter Administration, died Jan. 4 in California at the age of 91. Brown also served as president of the California Institute of Technology and as an arms control negotiator under the Nixon Administration. He was a key figure in the development of the nation's nuclear arsenal and policies and defied attempts to label him as a "hawk" or "dove."

Perhaps the definitive "whiz kid" of the Kennedy Administration, Brown received a doctorate in nuclear physics from Columbia University at the age of 21, and went on to a distinguished career in nuclear weapons design, eventually becoming head of the Lawrence Livermore nuclear laboratories, a protégé of its former director, Edward Teller. He played an important role in the development of the Polaris nuclear missile during the 1950s.

Defense Secretary Robert S. McNamara brought Brown into the Pentagon at the age of 33 to serve as director of Defense research and engineering. In that role he oversaw the development of Multiple, Independently targeted Re-entry Vehicles (MIRVs) and pushed for an attempted multiservice combat aircraft called the TFX. Intraservice politics doomed it as a joint effort, but it succeeded in the Air Force as the F-111.

Elevated to Secretary of the Air Force in 1965 at the age of 38, Brown argued for and oversaw the bombing of North Vietnam during the Johnson Administration. After the change of administrations, President Richard M. Nixon appointed Brown to serve on the Strategic Arms Limitation Talks (SALT) I negotiating team, which led to an agreement between the US and Soviet Union to curtail the growth of their respective nuclear arsenals.

President Jimmy Carter appointed Brown Defense Secretary in 1976; the first scientist to hold that position. Though he had a mandate from Carter to reduce defense spending, Brown laid the technological groundwork for many of the "second offset" technologies that underwrote US military dominance in the period of the 1980s-2010s, such as stealth, cruise missiles, satellite guidance, advanced propulsion, and advanced sensors. He also persuaded Carter to seek a substantially larger defense budget in the last year of that administration. He was not persuaded of the effectiveness of the B-1 bomber, however, and canceled that program in favor of equipping B-52s with Air-Launched Cruise

Missiles and investing in the Advanced Technology Bomber, which became the B-2 stealth bomber. He also approved development of the M-X missile, intended to be the successor to the Minuteman, and persuaded NATO allies to accept the deployment of Pershing II and Griffin land-based theater nuclear missiles on their soil.

Under Carter, Brown also established the "countervailing" strategy for use of nuclear weapons, which went beyond the targeting of cities and industry to focus on "options to attack the targets that comprise the Soviet military force structure and political power structure and to hold back a significant reserve." Brown believed such a strategy to be more credible than the threat of attacking only civilians.

Brown provided technical and security direction to the negotiations ultimately leading to the Camp David Accords between Israel and Egypt and was the key figure in developing the SALT II nuclear arms agreement between Carter and Soviet leader Leonid Brezhnev. His most notable failure, however, was the "Desert One" mission intended to rescue American hostages held in Iran. Brown later described the decision to undertake that risky mission as the "least bad" of the options available. The failure of the rescue mission was considered a key factor in Carter's overwhelming electoral loss in the 1980 election to Ronald Reagan.

In 1986, Brown, along with many other defense luminaries, successfully lobbied Congress to fund the public-private Sematech partnership to regain American competitiveness in the semiconductor industry, which Japan had begun to dominate. Brown argued that semiconductors were a critical enabling technology for all US weapons and a vital national need was served by ensuring American innovation and manufacturing capability in the field.

In later years, Brown served on many corporate boards and scientific advisory committees to the Air Force, Pentagon, and White House. He was a trustee of the RAND Corporation for more than 35 years and taught international relations at Johns Hopkins University. He was a member of the Trilateral Commission and a philanthropist.

Carter presented Brown with the nation's highest civilian award, the Medal of Freedom, while President Bill Clinton presented him with the Department of Energy's Enrico Fermi Award for achievements in science, technology, and national security. He received the Lifetime Achievement Award from the Air Force Association in 2008.

Soldiers memorialize the four military members killed by an IED in Afghanistan in November.



Photo: SSgt. Shaiyla Hakeem/USA

■ **First Airman Killed in Afghanistan Since 2015**

A USAF combat controller and two US Army Special Forces soldiers were killed in late November when an improvised explosive device struck their vehicle in Ghazni Province, Afghanistan.

The blast killed SSgt. Dylan J. Elchin, 25, of Hookstown, Pa., who was assigned to the 26th Special Tactics Squadron at Cannon AFB, N.M. He was the only airman killed in action in Afghanistan in 2018, and the first since a suicide attack killed six airmen near Bagram Airfield in late 2015.

The blast also killed Army Capt. Andrew Patrick Ross, 29, of Lexington, Va., and Sgt. 1st Class Eric Michael Emond, 39, of Brush Prairie, Wash. They were both assigned to 1st Battalion, 3rd Special Forces Group (Airborne) at Fort Bragg, N.C.—Amy McCullough

■ **USAF Lacks “Achievable Plan” for Base in a Box**

The Air Force failed to create an “achievable plan” to preposition base supplies and materiel in the European Theater, and it lacks a single program manager to oversee efforts from multiple organizations, both of which are causing delays, according to a Dec. 27, 2018, Defense Department Inspector General report.

US Air Forces in Europe was authorized \$797 million in Fiscal Years 2018 and 2019 for storage facility construction and procurement of the Deployable Air Base Kits, otherwise known as a “base in a box.” The massive kits include everything from riot-control gear for security forces to fuel trucks to mess tents. Basically, everything necessary to rapidly generate sorties and establish air superiority in a crisis.

“The program involves ... multiple organizations that are responsible for construction, management, and procurement; however, without a designated manager responsible for periodically updating the overall plan, [US European Command] and USAFE will not know when each of the 24 Deployable Air Base Kits will be available,” states the report. “As a result, USEUCOM and USAFE will have fewer options for airlift capability when rapidly responding to a contingency” within the theater, states the report.

The IG faulted the Air Force for failing to provide a date by which all 24 kits will be procured, noting the overall plan states that enough equipment should have been procured for the first five kits in Fiscal 2018, but officials in USAFE’s logistics division told auditors “they do not expect to have the equipment procured to fulfill the first complete Deployable Air Base Kit until FY 2020 or 2021,” according to the report.

During a visit to Germany this summer, officials declined to say how many kits it planned to procure or how many would be based at each location, citing operational security concerns.

The IG recommended the service designate a program manager “at least at the director level” for the Deployable Air Base Kits program. That program manager should review and update the overall plan “at least semi-annually.”

Air Force officials agreed with the IG’s recommendations. Supporting organizations met in October 2018 and agreed on the need for an overall program manager, but they have not yet decided what organization should fill that role. They plan to “continue their discussion” at the next meeting in February, according to the report. In addition, the Air Force said it will update Air Force Instruction 25-101 “to include a requirement to designate a program manager for US Air Force pre-positioned equipment.”

The IG said it now considers the recommendations resolved, though they will remain open until it receives the updated AFI.

For more about the Air Force’s “Base in a Box” concept and how it’s using EDI finds in the European Theater read “Deterrence in Europe” from the December 2018 issue of *Air Force Magazine*.—Amy McCullough

■ **Report Provides More Information into Laughlin Firings**

Three commanders at Laughlin AFB, Texas, were removed from their positions because of unsafe leadership, poor oversight of alcohol consumption at official events, and missed “opportunities to establish a culture of dignity and respect,” Air Education and Training Command said in a mostly redacted report.

AETC boss Lt. Gen. Steven Kwast removed Col. Charles Velino, commander of the 47th Training Wing, operations group commander Col. Robert Pekarek, and Lt. Col. Tom Allen, commander of a flying training squadron, from command in late October.

“The prior command team chronically failed to appropriately care for people and the mission,” Kwast said at the time. “They failed to correct an evolving situation that led to an environment where some airmen did not feel safe or respected.”

AETC released the report in late December, briefly detailing incidents of drinking at unit-sponsored events, incidents of sexism, and an allegation of a “frat boy” atmosphere among student pilots. Additionally, the report states Velino was largely absent as commander because he was away at another base and unable to integrate enough with the wing.

The report provided a total of 19 recommendations to improve the organizational climate at the wing, such as evaluating the use of alcohol at unit events, investing in quality-of-life programs, and developing anonymous feedback mechanisms.

■ US Space Command Announced

Vice President Mike Pence on Dec. 17, 2018, officially announced the recreation of US Space Command as the 11th combatant command in the US military, moving one step closer to the creation of a new separate service for space operations.

During a visit to Cape Canaveral AFS, Fla., for the launch of the first GPS III satellite, Pence said the new directive from President Trump creates the command, which will "integrate space capabilities across all branches of the military."

SPACECOM will be tasked with developing doctrine, tactics, techniques, and procedures to operate in space and its establishment marks a "new era of American national security" in space, Pence added.

US Space Command was first created in 1985, but was realigned under US Strategic Command 17 years later. The time line to re-establish the command was laid out in policy memos from the Pentagon, which stated that initially the commander of Air Force Space Command would be dual-hatted as the leader of SPACECOM. Pence has previously said the White House



Photo: Twitter via Mike Pence

Vice President Mike Pence and SpaceX President Gwynne Shotwell visit the company's Dragon 2 capsule.

wants the new Space Force to be created by 2020.

The Air Force Association believes the establishment of a US Space Command is the best way to address advancing threats to space.

"Re-establishing US Space Command is a logical and necessary step," AFA president, retired Gen. Larry O. Spencer, said. "AFA supports the creation of a new unified combatant command, the US Space Command, to lead the use of space assets in warfighting and accelerate integration of space capabilities into other warfighting forces."

■ DeFour, Lyle, Tuskegee Airmen Die

Wilfred DeFour, who served with the Tuskegee Airmen—a group including pilots, navigators, bombardiers, and maintenance and support staff who went through a US Army Air Corps training program to bring African-Americans into the war effort during World War II—was found dead Saturday Dec. 8, 2018, in his apartment in New York. He was 100 years old.



Photo: Anthony DiNoto/courtesy West Point AOG

Wilfred DeFour, Tuskegee Airman

DeFour attended a ceremony in November 2018 for the renaming of a Harlem post office in honor of the Tuskegee Airmen.

DeFour was an aircraft technician during World War II. After the war, he worked for the US Postal Service for 33 years.

Tuskegee Airman John Lyle, a World War II fighter pilot, died at the age of 98 on Jan. 4. Lyle died Saturday at his home on Chicago's South Side.

Lyle, who named his plane "Natalie" after his first wife, was credited with shooting down

a German Messerschmitt.

"We flew 500 feet above the bombers to keep enemy fighters from hitting our guys," he recalled in a 2012 interview with *Jet* magazine. "I loved flying, being up in the clouds, the scenery. I flew 26 combat missions, from southern Italy to Austria and southern Germany, over the Austrian Alps, Lyle told *Jet* magazine.

■ Air Strike Kills Operative Involved in Cole Bombing

An al Qaeda operative involved in the 2000 bombing of the USS *Cole* was killed in a precision strike on Jan. 1 in Yemen, US Central Command said. US forces confirmed the death of Jamal al-Badawi "following a deliberate assessment process," Capt. Bill Urban, a CENTCOM spokesman, said in a written statement. The *Cole* was refueling in Yemen when it was attacked on Oct. 12, 2000, killing 17 US sailors. President Trump on Twitter praised the "GREAT MILITARY" for delivering "justice for the heroes lost and wounded" in the bombing. "We have just killed the leader of that attack, Jamal al-Badawi. Our work against al Qaeda continues," he tweeted. Al-Badawi was wanted for the *Cole* bombing, had been indicted by a federal grand jury in 2003 and charged with 50 counts of terrorism offenses, and had been charged as a co-conspirator in an attempt to attack a US Navy vessel in January 2000, Urban said.

■ MQ-1B Lost in CENTCOM AOR

An MQ-1B Predator was lost while supporting a combat mission in the US Central Command area of responsibility on Sept. 4, 2017, after the satellite link connecting the mission control element to the aircraft failed and airmen were not able to re-establish contact, according to an abbreviated accident investigation board report released on Monday. However, officials could not determine what caused the link to break, citing "insufficient evidence of any substantially contributing factors," according to the report.

■ Light Attack Request for Proposals Delayed

The Air Force will not release its final request for proposals for its new light attack fleet this month as planned, and it does not have a time line for when the program will proceed. Chief of Staff Gen. David L. Goldfein said earlier this year the expected December release would occur after a dialog with industry following a series of draft requests. "The Air Force does not anticipate release of the final Light Attack Request for Proposal by the end of the calendar year as we complete additional analysis," Air Force spokeswoman Capt. Hope Cronin said in a statement. The light attack experiment began last year to see if the Air Force could quickly field an off-the-shelf aircraft to fly close air support missions in permissive environments. Two finalists, the A-29 Super Tucano and the AT-6 Wolverine, remain in the competition. The delay was first reported by *Defense News*. See also: "How the OA-X Might Change Air Force Acquisition" from the January 2018 issue of *Air Force Magazine*.—Brian Everstine

■ The War on Terrorism Casualties:

As of Jan. 9, a total of 63 Americans had died in Operation Freedom's Sentinel in Afghanistan, and 69 Americans had died in Operation Inherent Resolve in Iraq and Syria.

The total includes 128 troops and four Department of Defense civilians. Of these deaths, 58 were killed in action with the enemy while 74 died in noncombat incidents.

There have been 360 troops wounded in action during OFS and 75 troops in OIR.



Airmen are Slip Sliding Away ... to the Olympic Games

Two airmen within Air Force Special Operations Command were selected to compete with the USA Bobsled team this year. **Capt. Dakota Lynch**, a 34th Special Operations Squadron U-28A pilot, and **Capt. Chris Walsh**, a 24th Special Operations Wing special tactics officer, are push athletes who are ultimately competing for a spot on the US Olympic Team in 2022.

"It takes four years of commitment to make yourself better with every opportunity and even then you're never really quite there ... you have to keep grinding," said Walsh.

About bobsledding, Lynch said that "it's a metal and carbon fiber bullet, rifling down an ice track at speeds of 85-95 miles per hour. It's like a fast-moving jet with a monkey at the controls while getting in a fight with Mike Tyson, ... it can be incredibly violent."

Both airmen say that their time in AFSOC contributed to their success. "The qualities that special tactics fosters in individuals translates very well to bobsledding," said Walsh.



Lynch and Walsh, AFSOC airmen and members of the Air Force World Class Athlete Program.

Photo: SSgt. Ryan Conroy

Lynch and Walsh negotiated service commitments as Active Duty airmen with leadership support, and both were given permissive temporary duty by their respective commanders to vie for a chance at being accepted into the Air Force World Class Athlete Program, which WCAP provides Active Duty and reserve component members the opportunity to train and compete at national and international sports competitions with the ultimate goal of selection to the US Olympic Team while maintaining a professional military career.

USAF Academy Graduate Eager to Make Second Try for ISS

On Oct. 11, the Soyuz spacecraft sending **NASA astronaut Nick Hague** and cosmonaut Alexey Ovchinin toward the International Space Station (ISS) malfunctioned about two minutes after liftoff, forcing the two to make a treacherous, but ultimately successful, emergency landing on the steppes of Kazakhstan. The two, however, along with NASA astronaut Christina Hammock Koch, are gearing up for another launch, scheduled for Feb. 28, 2019.

Despite the harrowing aborted mission in October, in public statements Hague makes it clear that he is excited to launch in February and confident in the ability of NASA, Roscosmos (the Russian space agency), and the International Space Station program as a whole to keep he and his colleagues safe.



Nick Hague and Russian cosmonaut Alexey Ovchinin show solidarity before their ill-fated Soyuz launch.

Photo: Victor Zelentsov/
NASA

To the Rescue! USAF Cadets Aid Stranded Family

Returning from a weekend ski trip in Breckenridge, Colo., five Air Force Academy cadets saw the vehicle in front of them fishtail, turn perpendicular to the road, and slide off the ridge.

Cadets 3rd Class Connor Settle, Joseph Canoy, Karl Boerwinkle, Joel Krause, and Antonino Del Rossa were returning from a weekend ski trip in Breckenridge, Colo., when they witnessed the single-car accident.

Krause dialed 911 while the others maneuvered down the hill to locate the vehicle, which had plummeted more than 100 feet and landed upside down in the woodline. The rear of the vehicle was collapsed, but the cadets could hear the trapped driver honking the horn.

The cadets helped the driver and front seat passenger get free, but the driver kept shouting that his daughter was trapped in the back. Unable to pry the door open, Settle smashed the window in an attempt to locate and free her, but was unsuccessful. Eventually, she was able to crawl forward and escape through the same door as her parents.

The cadets lent their coats to the family and stayed with them until the paramedics arrived. The family escaped with minor injuries.



USAF Academy cadets, pictured with their commander, assisted a family involved in a car accident.

Photo: USAFA



Draken L-159Es are Aero Vodochody-designed single-seat, multi-role ADAIR fighter jets.

Photo: Jose Ramos/Draken International

Red Air Rising

Can outsourcing adversary air ease the pilot shortage and enhance combat training?
An emerging industry says it can.

By Amy McCullough

The Air Force is about to create a whole new industry: private adversary air (ADAIR). As soon as February, the service will award a 10-year, up to \$6 billion contract to multiple companies, changing the way fighter pilots train today—and possibly forever. While the new contractor aggressors complement, rather than replace, USAF's two in-house aggressor squadrons, the deals could pave the way for a permanent change in approach if the program proves successful.

Using private "Red Air" contractors to supplement military training is not new. Both the Air Force and Navy have done so sparingly in the past. But USAF's new initiative is unprecedented in scale and scope, covering adversary training at 21 bases across the United States and more than just over 50,000 hours of flight time—about 40,000-plus hours for adversary air at 12 fighter bases and nearly 10,000 hours to help train joint terminal attack controllers at nine Army bases.

USAF will award an indefinite delivery, indefinite

"Think of the IDIQ as a license to hunt."

—Russ Quinn, chief commercial officer at Top Aces

quantity (IDIQ) contract, opening the door for contracts serving specific bases over the next decade.

"Think of the IDIQ as a license to hunt," said Russ Quinn, chief commercial officer at Top Aces, one of four companies vying for a piece of the contract. "For us, it's a license ... to bring the airplanes into the country. That's important for us: If you're a named winner in the IDIQ, you now have the capability to compete for work."

The Air Force won't say who submitted proposals in October or even how many it received, but *Air Force Magazine* spoke with representatives from four firms that said they submitted bids: Top Aces, Draken International, Tactical Air Support, and Airborne Tactical Advantage Company.

Once the IDIQ contract is awarded, the selected companies can begin to compete for task orders to support individual bases, each of which has a unique set of requirements. USAF is looking for multiple kinds of capability, from category A, which calls for a very basic platform, to category C, which will mimic near-peer adversaries and provide training to USAF's fifth generation F-35 and F-22



Photo: Geert Van de Put/Top Aces

fighters. The contract will also include categories E and F, which covers close air support for JTAC training.

The Air Force expects companies to have aircraft flying within 12 months of award, or likely the first quarter of 2020.

AIRCRAFT IN HIGH DEMAND, SHORT SUPPLY

Once fully implemented, this will be the world's largest adversary air contract, and though companies have been gearing up for this for years, they still don't have enough aircraft to meet all of USAF's requirements.

"There aren't enough assets available in the contract world," said Scott Poteet, director of Air Force Programs for Draken, the only company currently under contract to provide "Red Air" to the Air Force. "We're working to get there as an industry, but we're definitely not there yet."

Poteet, a retired USAF lieutenant colonel with more than 3,000 hours flying the F-16, estimates it would take more than 150 aircraft flying 250 to 300 training hours per year to meet the 50,000-plus-hour requirement the Air Force wants to fill.

To meet that requirement, companies seeking a piece of that action have been busy shoppers:

■ **Draken**—Acquired 12 South African Atlas Cheetah supersonic fighters last year, and 22 F1s, mostly from the Spanish air force, which are being reassembled at its Lakeland, Fla., facility. In addition, Draken owns nine Aermacchi MB-339s, 27 MiG-21s, 21 L-159s, 13 A-4s, five L-39s, and one T-33.

■ **Textron Airborne Solutions**—(which bought ATAC in 2016)—Acquired 63 Mirage F1 aircraft formerly owned by the French air force, making it the world's largest private supersonic air force. Founded in 1994 and considered the pioneer in this industry, ATAC has flown about 50,000 hours of adversary air, mostly for the US Navy. Company officials said they plan to use 40 to 50 of the F1s to support USAF and use the remaining planes for spare parts and reserves should more aircraft be needed.

■ **TacAir**—Has 21 F-5E/F supersonic aircraft purchased from the Royal Jordanian Air Force and five Canadian CF-5Ds,

which are used mostly for training. The company recently survived a protest and won a five-year \$106.8 million contract to fly Red Air for the US Navy, beating out ATAC, which had held that contract since 1996. Mick Guthals, senior manager of business development, said TacAir plans to have five F-5 Advanced Tiger aircraft at Naval Air Station Fallon, Nev., during support periods, but that requirement could grow to as many as 10 aircraft depending on the Navy's needs.

Guthals said the Navy commitment doesn't significantly impact the company's ability to support USAF. "However, the biggest impact is reduced risk and proven Day One capability for the US Air Force," he said. "TacAir's ability to field and refine highly advanced, innovative technologies in a training environment like TOPGUN and the Naval Air Warfare Development Center, well prior to ACC task orders, allows us to provide the most capable and proven commercial adversary fighters to the United States Air Force immediately, without development or aircraft delay challenges affecting training."

■ **Top Aces**—Has 16 Dornier Alpha jets and 10 Douglas A-4 Skyhawks, most already committed to Canada, Germany, and Australia under contracts supporting close air support training. To compete for Air Force programs, the company is counting on a signed purchase agreement with an undisclosed foreign country to buy 29 early block F-16s, which it hopes would help it nab the high-end training piece of the Air Force's contract. Top Aces, which recently surpassed 75,000 hours of adversary air training, said it could start bringing the fourth generation fighters to the US as soon as the new Air Force contract is awarded.

All of the companies continue to scout additional fleets, and several said they are negotiating to buy or lease more aircraft. "There's a misconception on what industry can provide right now with regard to capacity as well as capability," Poteet said, adding that "to go through the acquisition, procurement, mobilization, regeneration, operations, and sustainment" process takes years.

Red Air Rising: World's Largest Air Contract

The Air Force is looking to contract out just over 50,000 hours of adversary air support and joint terminal attack controller training. Once fully implemented it will be the world's largest adversary air contract.

Here's a break down of the Red Air request:

CRATER LAKE-KLAMATH REGIONAL ARPT. KINGSLEY FIELD, ORE.

MAJCOM: Air National Guard, Air Education and Training Command, F-15 training.
DESIRED SORTIES: 1,828
TYPICAL NUMBER OF SORTIES PER DAY: Two goes with four sorties each.
MAXIMUM NUMBER OF SORTIES PER DAY: Two goes with four sorties each.
AVERAGE DURATION: 1.5 hours
Contractors will operate on base.

HILL AFB, UTAH

MAJCOM: Air Combat Command, Air Force Reserve Command with F-16s and F-35s.
DESIRED SORTIES: 768
TYPICAL NUMBER OF SORTIES PER DAY: Eight in the first go and six in the second.
MAX NUMBER OF SORTIES PER DAY: 10 in the first go and eight in the second.
AVERAGE DURATION: 1.5 hours
Contractor will operate on base.

NELLIS AFB, NEV.

MAJCOM: Air Combat Command, with various aircraft, home of US Weapons School.
DESIRED SORTIES: 7,500
TYPICAL NUMBER OF SORTIES PER DAY: 16 sorties in the first go and 14 in the second.
MAX NUMBER OF SORTIES PER DAY: 20 sorties in the first go and 18 in the second. During Red Flag contractors will fly roughly 30 percent more sorties.
AVERAGE DURATION: 1.5 hours
Contractors will operate on base.

FORT IRWIN, CALIF.

Joint Terminal Attack Controller training.
ON-RANGE HOURS: 1,080
TYPICAL NUMBER OF SORTIES PER DAY: Two goes with two sorties each.
MAX NUMBER OF SORTIES PER DAY: Two goes with two sorties each.

LUKE AFB, ARIZ.

MAJCOM: Air Education and Training Command, USAF's only Active Duty F-16 training wing and one of two F-35 training wings.
DESIRED SORTIES: 1,472
TYPICAL NUMBER OF SORTIES PER DAY: Four in the first go and four in the second.
MAX NUMBER OF SORTIES PER DAY: Two goes with four sorties each.
AVERAGE DURATION: 1.5 hours
Contractors will operate on base.

TUCSON INTERNATIONAL ARPT., ARIZ.

MAJCOM: Air National Guard, F-16 training.
DESIRED SORTIES: 960
TYPICAL NUMBER OF SORTIES PER DAY: Two goes with two sorties each.
MAX NUMBER OF SORTIES PER DAY: Four goes with four sorties each.
AVERAGE DURATION: 1.2 hours
Contractors will operate off base.

JB PEARL HARBOR-HICKAM, HAWAII

MAJCOM: Pacific Air Forces, Air National Guard, operating F-22s.
DESIRED SORTIES: 2,930
TYPICAL NUMBER OF SORTIES PER DAY: Six in the first go and four in the second.
MAX NUMBER OF SORTIES PER DAY: Eight in the first go and six in the second.
AVERAGE DURATION: 1.3 hours
Contractor will operate on base.

FORT CARSON, COLO.

Joint Terminal Attack Controller training.
ON-RANGE HOURS: 1,080
TYPICAL NUMBER OF SORTIES PER DAY: Two goes with two sorties each.
MAX NUMBER OF SORTIES PER DAY: Two goes with two sorties each.

HOLLOMAN AFB, N.M.

MAJCOM: Air Education and Training Command, Air Force Reserve Command operating F-16s.
DESIRED SORTIES: 2,640
TYPICAL NUMBER OF SORTIES PER DAY: Six sorties in the first go and four in the second.
MAX NUMBER OF SORTIES PER DAY: Eight sorties in the first go and six in the second.
AVERAGE DURATION: 1.2 hours
Contractors will operate on base.

FORT BLISS, TEXAS

Joint Terminal Attack Controller training.
ON-RANGE HOURS: 1,080
TYPICAL NUMBER OF SORTIES PER DAY: Two goes with two sorties each.
MAX NUMBER OF SORTIES PER DAY: Two goes with two sorties each.

KELLY FIELD ANNEX, TEXAS

MAJCOM: Air National Guard operating F-16s.
DESIRED SORTIES: 580
TYPICAL NUMBER OF SORTIES PER DAY: Four sorties in the first go and two in the second.
MAX NUMBER OF SORTIES PER DAY: Two goes with four sorties each.
AVERAGE DURATION: 1.3 hours
Contractors will operate on base.



FORT RILEY, KAN.

Joint Terminal Attack Controller training.

ON-RANGE HOURS: 720**TYPICAL NUMBER OF SORTIES PER DAY:** One go with two sorties each.**MAX NUMBER OF SORTIES PER DAY:** Two goes with two sorties each.**FORT DRUM, N.Y.**

Joint Terminal Attack Controller training.

ON-RANGE HOURS: 1,080**TYPICAL NUMBER OF SORTIES PER DAY:** Two goes with two sorties each.**MAX NUMBER OF SORTIES PER DAY:** Two goes with two sorties each.**JB LANGLEY-EUSTIS, VA.**

Support for trilateral exercise with French and British air forces.

MAJCOM: Air Combat Command flying F-22s.**DESIRED SORTIES:** 3,840**TYPICAL NUMBER OF SORTIES PER DAY:** Three goes with eight sorties each.**MAX NUMBER OF SORTIES PER DAY:** Three goes with eight sorties each.**AVERAGE DURATION:** 1.2 hours

Contractor will operate on base.

SEYMOUR JOHNSON AFB, N.C.

Support for Exercise Razor Talon.

MAJCOM: Air Combat Command operating F-15E.**DESIRED SORTIES:** 2,590**TYPICAL NUMBER OF SORTIES PER DAY:** Eight in the first go with six in the second.**MAX NUMBER OF SORTIES PER DAY:** 10 in the first go and eight in the second.**AVERAGE DURATION:** 1.5 hours

Contractor will operate on base.

FORT BRAGG, N.C.

Joint Terminal Attack Controller training.

ON-RANGE HOURS: 1,440**TYPICAL NUMBER OF SORTIES PER DAY:** Two goes with two sorties each.**MAX NUMBER OF SORTIES PER DAY:** Two goes with two sorties each.**FORT STEWART, GA.**

Joint Terminal Attack Controller training.

ON-RANGE HOURS: 720**TYPICAL NUMBER OF SORTIES PER DAY:** Two goes with two sorties each.**MAX NUMBER OF SORTIES PER DAY:** Two goes with two sorties each.**TYNDALL AFB, FLA. ***

Support for Sentry Savannah.

MAJCOM: Air Combat Command operating F-22s.**DESIRED SORTIES:** 3,084**TYPICAL NUMBER OF SORTIES PER DAY:** Three goes with eight sorties each.**MAX NUMBER OF SORTIES PER DAY:** Three goes with eight sorties each.**AVERAGE DURATION:** 1.2 hours

Contractors will operate on base.

NOTE: ACC told *Air Force Magazine* it is too early to say how, or if, recent damage to the base by Hurricane Michael will affect plans to bring contract air to the base. For now, the base's F-22s are operating out of Eglin AFB.

* Contractors supporting Joint Terminal Attack Controller training will operate off base.

Land-based training areas have been enlarged for viewing purposes and are not to scale.
Overwater training areas are approximately to scale.

FORT POLK, LA.

Joint Terminal Attack Controller training.

ON-RANGE HOURS: 360**TYPICAL NUMBER OF SORTIES PER DAY:** One turn with two sorties.**MAX NUMBER OF SORTIES PER DAY:** One turn with two sorties.**FORT HOOD, TEXAS**

Joint Terminal Attack Controller training.

ON-RANGE HOURS: 1,440**TYPICAL NUMBER OF SORTIES PER DAY:** Two goes with two sorties each.**MAX NUMBER OF SORTIES PER DAY:** Three goes with two sorties each.**EGLIN AFB, FLA.**

Support for Combat Hammer.

MAJCOM: Air Combat Command operating multiple variants. Also home of the F-35 graduate flying and maintenance wing.**DESIRED SORTIES:** 2,140**TYPICAL NUMBER OF SORTIES PER DAY:** Six in the first go with four in the second.**MAX NUMBER OF SORTIES PER DAY:** Eight in the first go with six in the second.**AVERAGE DURATION:** 1.2 hours

Contractor will operate on base.

An ATAC Mirage at the company's Adversary Center of Excellence in Texas.



Photo: ATAC

When Draken bought its L-159 fleet, which is currently flying at Nellis AFB, Nev., supporting the USAF Weapons School and Red Flag, it was essentially a brand-new fleet. Each airframe had flown just 50 hours, out of an 8,000-hour life span. Yet it still took four years to get the aircraft on contract.

"One of the things I think nobody in this industry really appreciated up front is how long it takes to source jets, acquire them, import them, ... certify them, and ... upgrade them if they have to be upgraded," said Guthals, a retired USAF colonel, former B-1 pilot, and former vice commander of ACC's Operational Test and Evaluation Wing. "One of the good things is we're finding that we're much faster than DOD because we don't have those DOD restrictions on us, but it still takes a long time."

To field planes faster, some are looking at leases. "It really depends on how long the contract is going to last," said Russ Bartlett, president and CEO of Textron Airborne Solutions, and former commander of the US Navy's Blue Angels Flight demonstration team. "If somebody owns some airplanes that are eligible and we don't, then maybe there's a good solution there where we lease them for the duration of the contract. It's just another option."

When the Air Force decided to add 10,000 hours of close air support to the larger adversary air contract last year, it gave industry more opportunities to put aircraft to work, Bartlett said. But it also sent everyone scrambling to acquire new capabilities.

"We have a couple other fleets of aircraft that are not releasable just yet, but we have other aircraft lined up, either through acquisition or lease for the rest of the categories," said John Zentner, ATAC director of business development.

"Nobody in this industry really appreciated ... how long it takes to source jets, acquire them, import them, and then certify them."

—Mick Guthals, senior manager of business development, TacAir

Draken's Poteet added: "The lease we all have on the front of our mind is a business-to-business lease, but it is possible that we can lease from some other countries. We are looking at some of those opportunities, but those are a little farther away from reality."

FROM CONCEPT TO REALITY


The Air Force first started seriously considering contracted Red Air in December 2015 when it awarded Draken a one-month, \$8 million proof-of-concept deal to support USAF aggressors at Nellis with six A-4 Skyhawks.

It didn't take long to see the benefits. Contracting for adversary air "helps reduce the burden on active operational units, who currently fill the majority of the Red Air requirements across the Combat Air Forces," Air Combat Command spokeswoman Capt. Carrie Volpe told *Air Force Magazine* last year. Contracting for Red Air sorties enables the service to increase fighter pilot production at the unit level "by allowing them to provide more dedicated Blue Air sorties."

Draken's deal was modified three times and extended three times before the contract was opened to competition, under a program dubbed Nellis ADAIR II.

While the Air Force never specified a platform, it wanted aircraft capable of flying Mach 1.5 or better, a 45- to 60-minute fight endurance, and equipped with fire-control radars capable of detecting, tracking, and simulating ordnance against an opposing aircraft. It also wanted up to 18 sorties a day, split between 10 sorties in the first round followed by eight in the second. Combined, that added up to about 5,600 hours a year.

One of the most important requirements, however,



TacAir's F-5Es are single-seat, twin-engine all-weather tactical fighters. TacAir imported Jordanian F-5s in 2017 and adapted the jets to fourth generation aggressor capabilities.

Photo: Tactical Air Support

was that there be no down time between when Draken's contract ended and when ADAIR II began. Draken, which already had aircraft on the ramp, won the \$280 million contract in June 2018 and will continue flying adversary air at Nellis through December 2023. That contract is seen as an interim solution until the larger ACC contract takes over.

"One of the catalysts for our ability to get so much work is the fact that we brought radar-equipped aircraft to the fight, the Skyhawk and Honey Badger," said Poteet. "Having a radar-equipped fighter truly fulfills the requirements and needs of the Air Force."

FINDING PILOTS

One of the goals of contracted adversary air is to make life easier for USAF's operational fighter pilots who are often tapped to fill in Red Air gaps at major exercises such as Red Flag.

The 40,000-plus hours of contracted Red Air is not expected to decrease the number of hours USAF aggressor pilots fly, but it will allow operational pilots to spend more time training the way they would actually fly in an air-to-air combat scenario.

Heather Penney, a senior resident fellow at AFA's Mitchell Institute for Aerospace Studies and a former F-16 pilot, said it's important for the service to maintain its own adversary air expertise, but contracting out additional support hours is likely to provide a much higher level of training for pilots.

When regular operational pilots are tasked with flying Red Air, Penney said, "They aren't jazzed up. They want to fly the Blue Air training." While USAF's aggressor squadrons spend countless hours studying the enemy and how they fight, the same cannot be said for operational fighters who play those roles on a part-time basis. "The contract Red Air can provide a more realistic threat scenario or more demanding threat presentation," Penney added.

It's still not clear what impact the growing industry will have on USAF's pilot force. Senior Air Force leaders acknowledge it will be a challenge to have all these companies recruiting pilots at the same time as the commercial airlines while USAF tries to get a handle on its own pilot shortage. However, they maintain the pilots going to industry would have gotten out anyway, so at least the service can still benefit from their experience and expertise.

TacAir, for example, proudly touts its collective expe-

rience on its website, noting that it employs 52 weapons school graduates and 17 former weapons school instructors. Company officials say the fighter ethos the Air Force is looking for is already ingrained in their culture.

But TacAir is not unique on that front. All the companies were formed and are led by former fighter pilots, and all have been actively recruiting and say they are getting a lot of interest from former or outgoing military pilots, but most are holding off on hiring until the IDIQ is awarded. Each of the companies are looking for something slightly different, based on the type of aircraft in their fleet and what piece of the contract they are going for—higher-end or lower-end training.

"Our core pilot is more or less a retired lieutenant colonel or colonel, who's elected not to pursue an airline job or may be part-time at an airline and wants to maintain flying military aircraft," said Poteet. "It's a balancing act because, prior to Nellis ADAIR II, no one knew what the future held. Now that we have stability, we are in the process of hiring."

EVOLUTION OF AN INDUSTRY

Even though the Navy has been contracting for adversary air for decades, the scale of the Air Force program means it will set the requirements by which this industry is being built. For its part, the fledgling industry doesn't seem to buy Air Force arguments that contracting for adversary air will be temporary. While USAF officials insist the capability will eventually return to in-house status, industry is betting that won't happen. They just need to prove they can deliver what the Air Force needs.

"It wasn't but 10 years ago when I was the deputy commander of the adversary tactics group," said Quinn, a former F-16 pilot who racked up more than 3,000 hours in the aircraft. "We were standing up a brand-new aggressor squadron. At the time, that was the Air Force's vision, to do all the aggressor work in house."

Then declining budgets and the move to a fifth generation fighter fleet changed the equation, opening the door to industry.

"Commercial Red Air is happening," Quinn added. "This is a real sea change. It's a completely different way of looking at things. It's difficult for the US Air Force leadership. It's difficult for a lot of people on the outside to get their arms around. ... But the difference makes it both very exciting and also very challenging."



THE FUTURE OF PILOT TRAINING

Can low-cost simulators, new trainers, and Red Flag reforms help USAF prepare for potential great power conflicts?

By Brian W. Everstine

The Air Force's pilot training command must simultaneously answer two urgent, yet contradictory requirements: Train more pilots, but to a higher standard. Even better, invest less to train each pilot—and do it in less time.

USAF is short about 2,000 pilots today across all components and commands from its total requirement of about 20,000. But because the Air Force has been losing pilots at an accelerating pace in recent years this is not a problem that can be solved quickly. Best case, officials say, the service will reach 95 percent pilot manning by the end of Fiscal 2023.

At the same time, growing concern about China and Russia has Air Combat Command calling for more experienced fighter pilots, and Air Mobility Command is shedding more

than 400 pilots per year.

To catch up, Nineteenth Air Force is pursuing multiple solutions, including:

- Overhauling the training syllabus
- Introducing low-cost simulation using consumer-grade headsets at the start of training to more rapidly develop entry-level skills
- Investing in new training aircraft, largely the \$9.2 billion contract with Boeing to supply the new T-50 trainer for the T-X, and as small as a couple hundred dollars on off-the-shelf headsets, each has the potential to improve how a pilot learns to fly.

"The first requirement is: We've got to produce better aviators in the future," said 19th Air Force Commander Maj. Gen. Patrick J. Doherty, addressing a pilot training conference in December. "Quality has got to come higher. They're going to need to be a different warrior in the future,



The Air Force's Pilot Training Next project accelerates learning with Virtual Reality headsets. Here, instructor pilot 1st Lt. Jay Pothula tries out a VR flight simulator.

Photo: John Ingle/USAF

working autonomously on their own, solving their own problems, and not going through six levels of 'Mother may I?' to make a simple, tactical-level decision."

The Air Force needs a "sense of urgency to get its competitive spirit back," Doherty said. The future threat will be radically different and more challenging than the permissive environment the Air Force has faced since 9/11.

"We have got to be hungry and competitive reaching forward," Doherty said.

GOING HIGH TECH

The pilots preparing for that more competitive future are already in the pipeline now, said Lt. Col. Matthew D. Strohmeyer, commander of the 560th Flying Training Squadron at JBSA-Randolph, Texas. In future combat, they can expect to be under threat not just in the far corners of the world, but also wherever they may be operating.

"That completely changes the story on how you train pilots on Day 1," Strohmeyer said. As good as US pilot training may be today, it is "having diminishing returns right now based on the improvements China and Russia are making."

To compete with the Russians and Chinese and to operate in contested skies, future pilots must be capable of independent thought and decision-making. Future syllabi—still to be developed—shape initial training in a way that enables pilots to think independently without relying on command and control to tell them what to do.

"How can I get an F-35 airman to make an operational risk decision, a good one, if they're never trained to think operationally and think strategically?" Strohmeyer said. "If we just go with the current syllabus, we'll never get to have the competitive advantage."

HIGH TECH, LOW COST

Perhaps the most dramatic change in pilot training is taking shape now in Austin, Texas, where the Air Force is experimenting with low-cost consumer technology to develop initial pilot skills well before anyone actually begins to fly. Pilot Training Next (PTN) started in February 2018 with 20 students. Four months later, 13 had graduated early, having cut two months out of the training schedule.

All 13 graduates met or surpassed the skills of their peers

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Photo: USAF

T-6 Texans on an Elephant Walk at JBSA-Randolph, Texas.

in the conventional 24-week course, Doherty said, and six others went on to be fighter and attack aircraft qualified. Even the lowest-rated of those is now “absolutely crushing” defensive basic fighter maneuvers, he said. “That shows you the acceleration we were able to achieve.”

The key to their success: consumer-grade HTC Vive headsets and gaming computers coupled with flight simulator software, which supplemented academics and replaced up to 80 flight hours in a T-6. Students were provided simulator headsets to use in their private quarters and were encouraged to practice as much as possible. All told, the equipment cost about \$10,000.

January 2019 is when a second class will begin the PTN program, this time with further modifications based on lessons learned from 2018’s test. The program was so successful the concept is now being adapted to train maintainers at Sheppard AFB, Texas, Doherty said.

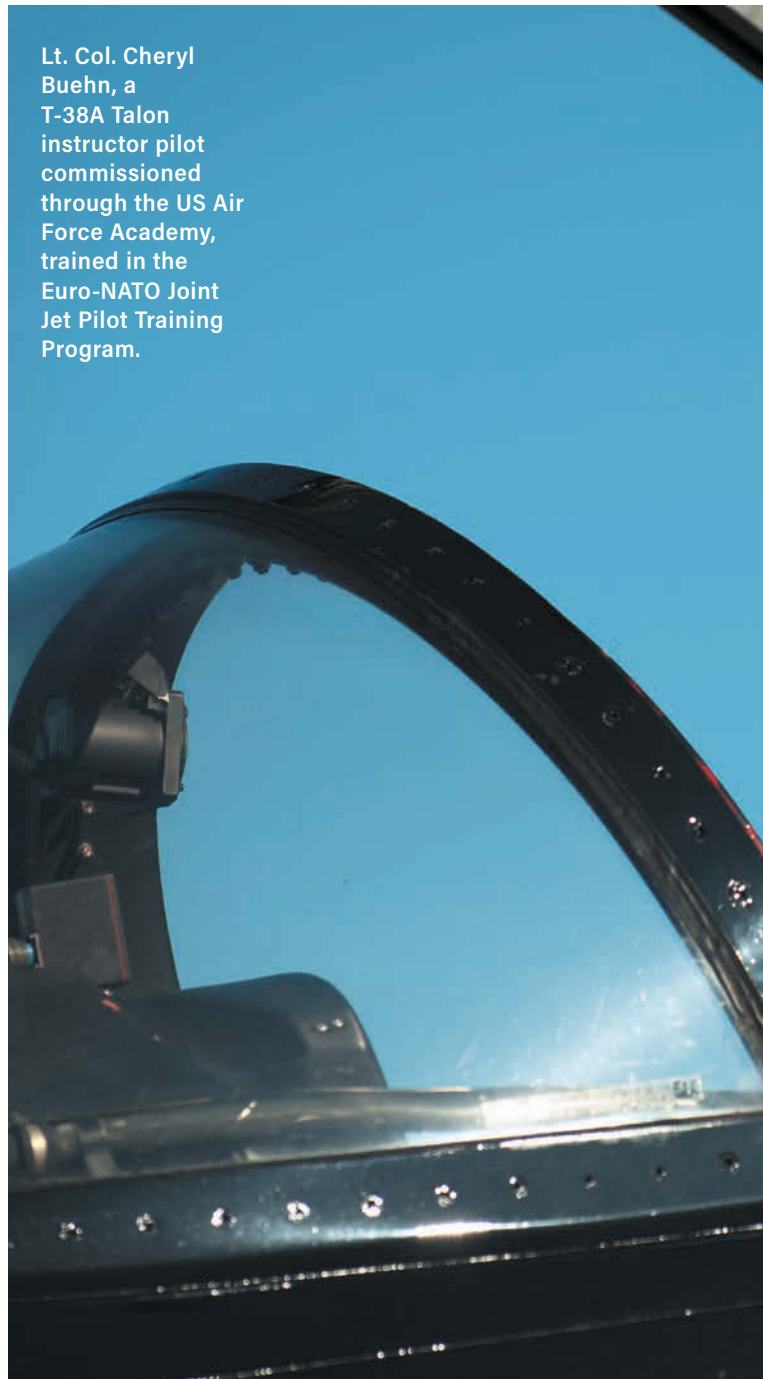
More reliance on simulators is a trend sweeping across USAF and allied air forces. The USAF/NATO joint pilot training wing is running a similar test aimed at increasing pilot training throughput and quality.

The 80th Flying Training Wing’s Euro-NATO Joint Jet Pilot Training Program at Sheppard AFB, Texas, in November stood up a strategic initiatives directorate, which will begin testing its ideas with a T-6 class in February, said Lt. Col. Jason Turner, the unit’s director of strategic initiatives. The directorate purchased 600 iPad Mini electronic flight bags, 10 T-6 virtual reality devices, 10 T-38 and T-6 switchable mixed reality devices with the ability to GPS-track the simulated flight and provide a 360-degree video of in-flight maneuvers, and track live air traffic control in the simulated flight.

Turner predicts it will only take “three months to deliver massive changes to the way we do business.”

With still greater ambitions, the wing is now turning to industry for help. In particular, Turner said the wing wants biometric feedback on its virtual systems to gauge

Lt. Col. Cheryl Buehn, a T-38A Talon instructor pilot commissioned through the US Air Force Academy, trained in the Euro-NATO Joint Jet Pilot Training Program.



how pilots feel about specific maneuvers, a cloud-based training system to enable training from across multiple locations, a gamified syllabus to promote competition between pilots, and an app for feedback. All that must be accomplished on a narrow budget. “We don’t have millions,” Turner noted.

Cadets at the Air Force Academy are also getting exposure to low-cost simulators. The Academy selected 13 cadets in November to start using eight virtual reality sets to train on takeoffs, flight maneuvers, communication, and landings. Instructors will put their charges through a simulated “check ride” after two weeks to evaluate how well they remember checklists and can perform specific steps. Ultimately, USAF officials anticipate using such technology with Reserve Officer Training Corps cadets, and even JROTC high school students as a means to en-



Photo: TSgt. Natasha Stannard

sure cadets arrive at pilot training with a greater level of understanding, Strohmeyer said.

NEW TRAINERS

Simulators only take trainees so far. Eventually, pilot candidates have to fly real aircraft, and the training jets now in use are aging. Older T-38s have been crashing at an increased rate, with five accidents in the 10 months from November 2017 to September 2018.

The T-6 Texan II turboprop used for initial pilot training has also had its troubles. The T-6s were grounded for months in the spring of 2018 after a string of apparent hypoxia incidents. The groundings left USAF 200 student pilots short at graduation, Doherty said.

USAF's principal jet trainer, the T-38C Talon, dates from the 1950s; a "dinosaur" compared to the fifth generation

F-35 and F-22 combat jets students may eventually fly.

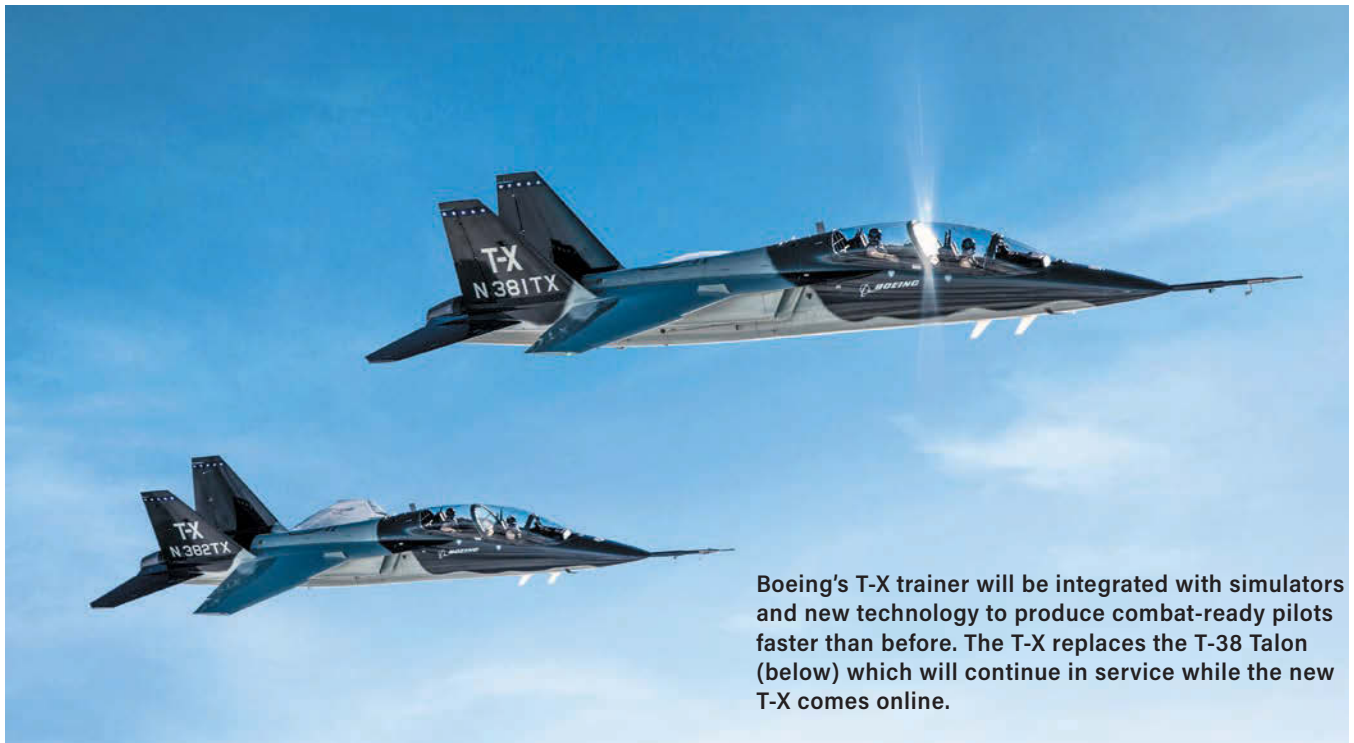
In September, the Air Force awarded Boeing and Saab a \$9.2 billion contract for 351 T-50A trainers to replace the Talon fleet.

The T-50 has "incredible potential to radically change" how pilots are trained, said Doherty, who in late November became the first airman to fly in the aircraft. With flight characteristics that seem like a cross between an F-16 and an F/A-18, the T-50 will be a vast leap forward from the T-38, the first aircraft won't go into service until at least 2023.

"We need that T-X, yesterday," he said. "We need it right now. ... The time line is not acceptable for what the Air Force needs."

RED FLAG OF THE FUTURE

Once pilots reach operational units, they begin to hone



Boeing's T-X trainer will be integrated with simulators and new technology to produce combat-ready pilots faster than before. The T-X replaces the T-38 Talon (below) which will continue in service while the new T-X comes online.

Photo: John Parker/Boeing

their skills against adversaries.

Air Combat Command plans to outsource adversary air to private contractors, therefore cutting costs, saving pilots, and increasing training (see "Red Air Rising," p. 24). It costs \$32,000 per hour to fly an F-35 and \$25,000 per hour to fly an F-16, but private firms flying A-4 Skyhawks can operate for \$5,000 to \$7,000 per hour and \$11,000 per hour in a Mirage, said Maj. Gen. Scott L. Pleus, the director of plans, programs, and requirements at Air Combat Command. Outfitted with jamming pods to simulate fifth generation threats, they can make "training much more realistic," he said.

Pleus also anticipates reinventing Red Flag, ACC's major air-to-air training events held multiple times each year at Nellis AFB, Nev. The Red Flag of the future is less about Nellis than it is today," Pleus said, adding that the 15,000-square-mile range is not as large as is needed for the kind of combat flight training the US could face in a peer-to-peer war. While the Nevada Test and Training Range is big, he said, "I need the state of Nevada."

Existing constraints mean fighters and command and control all to take off alongside simulated threats, such as an S400 missile system. That's not how the Air Force fights in real life, however. "We would never do that," Pleus said. "We don't take off into that threat."

Instead, he imagines that future Red Flags could span a greater distance. For example, E-3 Sentry Airborne Warning and Control Systems might fly over range space in Utah or North Dakota to more accurately reflect the standoff distance command and control aircraft would need to operate safely in a denied environment, Pleus said.

Red Flag exercises could also change the way threat emitters are placed to better reflect the range of modern systems, Pleus said. For instance, simulated anti-aircraft radars could be placed at China Lake in California, better reflecting the standoff distance of modern threats and giving F-22s and F-35s more space to operate in the Nevada range.



Photo: TSgt. Natasha Stannard

Increased use of simulators is also in the offing. For some fifth generation platforms, "I don't want to fly in open air" yet, Pleus said. "I don't want other people to know the capabilities of the airplane."

He did not specify which aircraft he put in that category.

Air Force Chief of Staff Gen. David L. Goldfein has said Red Flag and other exercises must do a better job integrating with space and cyber assets to more realistically portray multi-domain operations.

From pilots' first sorties to high-level exercises at the peak of their training, the Air Force must ensure focus on all domains and "mirror deployed operations, so we rehearse the daily battle rhythms needed" for real world, joint operations, Goldfein said in September 2018.

"Victory," he said, "must be planned for, properly resourced, trained for aggressively, fought for, and eventually won in the unforgiving crucible of combat." ★



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Re-Engining the B-52

The B-52 is supposed to serve through 2050. To last that long, it needs new power.

By John A. Tirpak

The last B-52 rolled off the production line in 1962. If Air Force plans hold up, the B-52 will be approaching nearly a century of service by 2050. To keep the airplane flying, the service plans to equip each B-52 with new engines, which are expected to be so much more maintainer-friendly and efficient that they'll pay for themselves in just 10 years.

The Air Force is also looking at the B-52 re-engining as a pathfinder program to explore ways to speed up contracting. Instead of an elaborate, paper-intensive comparison of candidate engines—in which the government makes educated guesses about capability—the service plans to conduct a “digital fly-off” between power plants, using computer simulations. This virtual fly-off will compare engines for fuel efficiency, maintenance requirements, and performance under a wide variety of conditions.

“I think we’re going to learn a lot from this program.”

—Air Force acquisition chief William Roper.

“I think we’re going to learn a lot from this program,” Air Force acquisition chief William Roper said in September. “Digital engineering is a much better way to assess [options] than a paper input with a lot of government expertise trying to fill in the gaps. Let’s just simulate the system and pick.”

Roper said streamlined contracting and the digital fly-off will cut 3.5 years from the original 10-year time line between setting requirements and the decision to proceed to production.

“I’m much more likely to believe” the data derived from a digital comparison than what could be gleaned from a “paper ... analog” evaluation,” he said.

In October, USAF decided an upgrade of the existing Pratt & Whitney TF-33 power plants—original equipment when the B-52Hs were manufactured in 1962—is off the table.

“Refurbs are no longer being considered,” a Global Strike Command spokesman told *Air Force Magazine*. As recently as September, Pratt & Whitney was pushing to refurbish the existing B-52 en-



Two B-52s over the Pacific Ocean on Aug. 2 as part of US Indo-Pacific Command's Continuous Bomber Presence in the region. New engines could expand range and enhance fuel efficiency.

Photo: A1C Gerald Willis

gines, adding new technology to increase their efficiency and reduce maintenance, as a lower-cost alternative to buying new.

However, “the Air Force has decided that the existing engines are not viable” for a service life that will take the B-52Hs into their 90th year of service, AFGSC chief of B-52 requirements Maj. Gerald Isabelle, said in an interview.

The re-engining plan is funded at \$1.5 billion through the five-year Future Years Defense Program, Isabelle noted, but an overall cost has not been publicly released. A former AFGSC commander, Gen. Robin Rand, told this publication in March 2017 that initial estimates pegged B-52 re-engining as costing about \$7 billion.

USAF’s “Bomber Vector” plan, which rolled out in early 2018, estimated the cost of B-52 service life extension—including the re-engining other capability improvements—at \$22 billion, less savings resulting from the re-engining work. The report forecast the savings at \$10 billion, saying the equipment “pays for itself in fuel, depot and maintenance costs, and maintenance manpower in the 2040s,” according to the document.

Officially, the project is called the B-52 Commercial Engine

Replacement Program (CERP), and the Air Force has already hosted a number of industry days to discuss it at Barksdale AFB, La., most recently in mid-November. The stated goal: Obtain a “commercial, off-the-shelf, in-production engine,” according to a FedBizOpps (Federal Business Opportunities) announcement regarding the industry day.

The Air Force wants to buy a replacement for each of the eight TF-33s on all of its 76 B-52s, or around 608 engines in all (plus some attrition spares in case of accidental damage). Similar to the existing engines, they’ll be housed in twin-engine pods.

Isabelle said the Air Force is looking for 25 to 30 percent better fuel efficiency and as much as 40 percent improvement in range. USAF has also expressed a desire for a cleaner-burning power plant, producing less greenhouse gases than the existing engines.

Increasing fuel efficiency by 25 to 30 percent is “huge,” Roper said, paying off not only in cost savings, but also in range or time on station.

Computer models will help evaluate the trade-offs between cost and capability as the competition runs its course, Roper said. “If one vendor can provide 30 percent fuel efficiency,



Airmen fix the cover on a BUFF's J57 jet engine at Offutt AFB, Neb., in the late 1950s. The Pratt & Whitney power plant was the first engine installed on the venerable bomber. The TF-33 equipped later models starting in 1961.

Photo: USAF via AFA library

but their engine is more expensive, and another has less [efficiency], but their engine is cheaper, that's an interesting trade," he explained. "It's not clear what the right answer is."

The Air Force considered re-engining the B-52 in 2007, when it looked at using the aircraft for theater-wide electronic warfare. The B-52 Standoff Jammer, or SOJ, concept would have kept the bombers on station after releasing standoff weapons to provide wide-area jamming in the battlespace, leaving jamming escort duties to the Navy EA-6 and EA-18. New engines were needed to increase the bombers' range and to power the jamming equipment. But the SOJ concept was never put into effect.

In late 2014, having learned how commercial airlines were saving on maintenance and fuel costs with modern engines, then-Lt. Gen. Stephen "Seve" Wilson resumed the push as head of Global Strike Command. Now USAF Vice Chief of Staff, Wilson and his successor at AFGSC, Gen. Robin Rand, floated the idea of leasing the engines as an alternative way to fund the project.

The Air Force has also considered replacing the B-52's eight engines with four large turbofans, as is typical on commercial airliners. Engineering challenges made that approach nonviable. Potential interference with flaps and control surfaces, ground clearance issues, yaw effects, the need for extensive new flight testing and weapon separation evaluations, the need to replace large sections of the cockpit and throttles, and to redesign the rudder ruled out such a change. USAF has opted to stick with eight engines of the class that typically powers large business jets.

Modern engines are so much more reliable than the TF-33s that were once installed, the new engines will probably never have to be removed. The meantime between overhauls for that class of engines is typically around 30,000 hours—greater than the number of hours the service plans to fly the bombers for the rest of their service lives.

Despite their age, the B-52s have high mission-capable rates, can carry a huge diversity of weapons, and can perform effectively—as long as the enemy lacks elaborate air defenses. Even in a higher-end fight, the B-52 can still launch missiles from well outside enemy air defenses. It is the only US bomber that can launch nuclear cruise missiles, and it will be the initial platform for the new Long-Range Stand Off missile, or LRSO.

The B-1 and B-2, which are at least 22 and 30 years younger, respectively, will retire before the B-52 for a range of reasons, according to the Bomber Vector study:

- The B-52 has in recent years racked up mission capability rates of 60 percent, far above that of the B-1 and B-2, which are at about 40 and 35 percent, respectively

- The B-52 costs about \$70,000 per flying hour, roughly half that of the B-2—even before it gets more efficient engines.

- The B-52 "has good bones," Rand said, noting that the B-52H spent most of its service life on ground alert for nuclear operations, and still has many thousands of hours of airframe life remaining.

Not all of the modernization plans for the B-52 are funded so far. "We are working through our leadership to develop a strategy on how to approach the acquisition," James Hun-

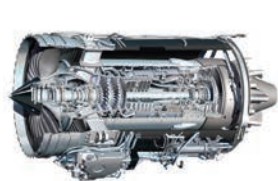


Photo: A1C Sydney Campbell

SrA. Austin McCullough inspects a B-52 engine at Barksdale AFB, La., in January 2018. USAF declared an upgrade or refurbishment of the existing engines off the table.

How the engines compare

Three companies so far have said they will pursue the B-52 re-engining competition. Here are a few of USAF's options.



Rolls-Royce BR725

THRUST: 16,100 pounds
FLYING ON: USAF RQ-4 Global Hawk and E-11 BACN

The BR725 (military designation F130) is already in the Air Force inventory, and has 200,000 combat hours, plus more than 22 million hours overall. Rolls claims 21 percent reduced toxic emissions, four decibels quieter, and better fuel burn than current generation engines.



GE Aviation CF34-10

THRUST: 20,360 pounds
FLYING ON: Embraer E-series, Comac ARJ21

The CF34-10 flies on business jets with an on-wing time of 14,000 or more hours. Combined with earlier versions it has racked up 26 million flight hours.



GE Aviation Passport

THRUST: 18,900 pounds
FLYING ON: Bombardier Global 7000/8000

Developed by GE Aviation for large business jets, the Passport engine first flew in 2015. It has more than 4,000 hours of testing since 2010 and features an 8 percent better fuel burn than other engines in its class.



Pratt & Whitney PW815

THRUST: 16,000 pounds
FLYING ON: Gulfstream G600

Pratt claims 40 percent less on-wing maintenance than previous engines in this class and is touted as 75 percent quieter and producing 50 percent less toxic emissions than the existing engines.

Sources: Rolls-Royce, General Electric, Pratt & Whitney; graphic by Mike Tsukamoto

sicker, AFGSC's deputy chief of bomber requirements, told *Air Force Magazine* in an interview. "We are working to get those approved by the [AFGSC] commander and, ultimately, by Dr. Roper, who has been interested in how we're going to attack that problem."

Asked if the B-52 can make it to 2050, Hunsicker said, it "would surprise you at how sound" the aircraft's sheet

metal and structural components remain after five decades. However, "modernization [means] keeping up with the environment it will fly in," he added. "There are things that will always have to be dealt with because they will age out, and radar and engines are two of the main areas you always want to keep current and capable."

Planning for a radar replacement is well along, Hunsicker

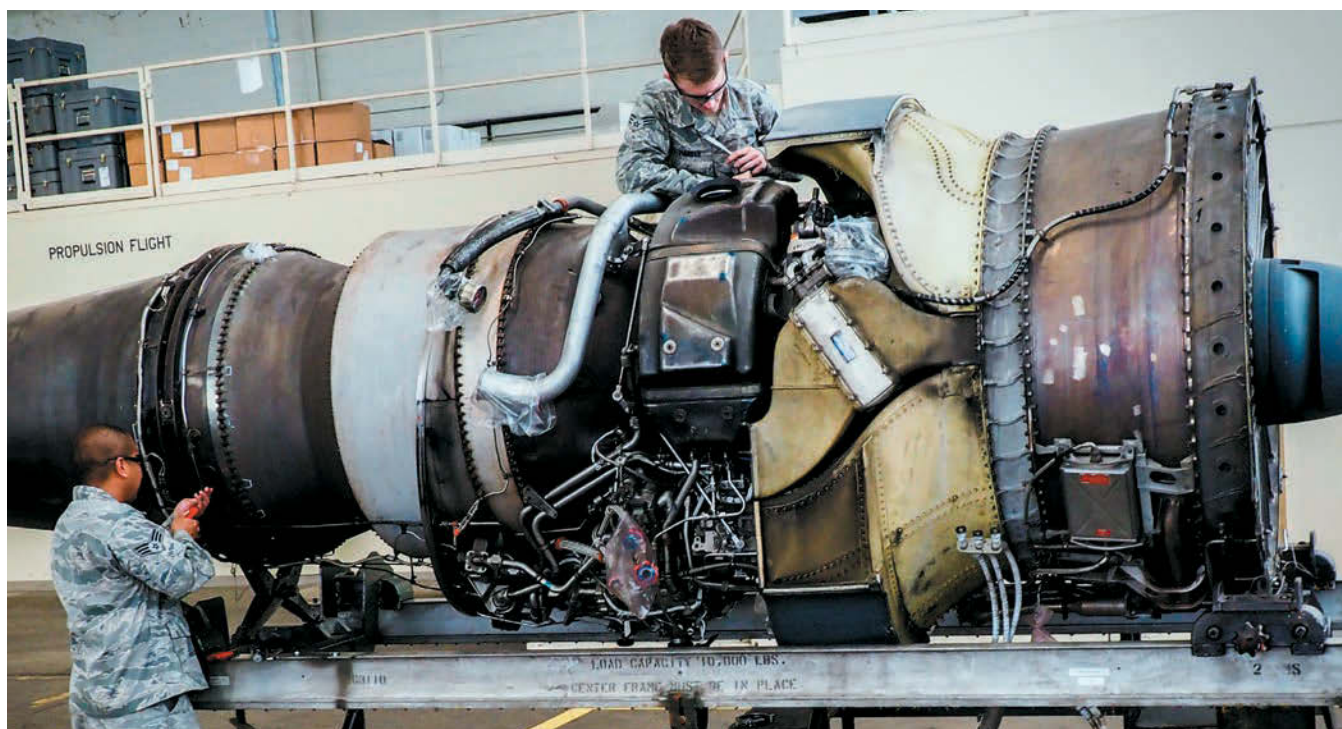


Photo: SrA, Mozer Da Cunha

said, and “defensive systems will have to be kept as capable as possible.” There will also need to be frequent avionics refreshes.

“We will continue to monitor ... what needs to be updated,” he asserted. “That’s true of all airplanes, and the B-52 is no different.”

Indeed, B-52 updates have been underway for some time. Installation of Link 16 is being accomplished, and the CONECT “digital backbone”—one of the most extensive capability improvements in decades—is being finished. New VLF and AEHF radios are being installed, the 1760 Internal Weapons Upgrade Bay is complete, and “another increment to follow” has been mapped out, Hunsicker explained.

CHOOSING AN ENGINE

Boeing, the original manufacturer and a chief supporter of the B-52, will be the integrator on the re-engining effort, but the Air Force will choose the engine and supplier, Boeing will advise the Air Force on the impact each potential engine would have on the B-52’s flight profile and weapons carriage.

A Pratt & Whitney spokesman said that if the Air Force opts not to refurbish the TF-33, “the best solution” would be a modified PW815, the engine Pratt supplies for Gulfstream’s G600 business jet.

“We know this aircraft’s engine and power requirements like no one else,” a Pratt spokesman told *Air Force Magazine*. “We are confident that the options we offer will address propulsion, fuel burn, and power generation (including APU) requirements for the B-52 to 2030 and beyond.”

GE Aviation has two offerings that could play in the B-52 derby: The CF34-10 and the new “Passport” engine. Karl Sheldon, a manager in GE’s aviation manufacturing division, said the final requirements will determine the best choice between the two.

“The CF34 offers proven reliability,” he said, having racked up 26 million flight hours, while the new Pass-

SrA. Jovie Abaya (top) and SrA. Bradley Hardee work on a TF-33 engine trainer at Barksdale. The engine type is “nonviable” to take the B-52 into its 90th year of service, USAF says.

port offers unprecedented “fuel burn, range, or time on station.” The company will settle on an offering as soon as it’s clear which one will best match USAF’s stated requirements.

Rolls-Royce jumped into the re-engining contest before it was even announced, touting its BR725 power plant—military designation F130—as the ideal candidate as early as September 2017. Company officials said their offering would cut carbon emissions by 95 percent while handily meeting USAF’s notional-range and fuel-efficiency requirements.

The F130 powers the RQ-4 Global Hawk, the E-11 BACN, and the new Compass Call aircraft, which is a special-mission version of the Gulfstream 650, so it’s already in the Air Force inventory.

Despite rumors to the contrary, Isabelle said the Air Force is not looking for substantially better physical performance from the new engines—for example, in time to climb or top speed—although that may turn out to be a welcome by-product.

Lt. Gen. Arnold W. Bunch Jr., (then-USA’s top uniformed acquisition official, nominated to head AFMC at press time), said the competition will look across a wide range of cost considerations.

The question is not just “how often do I have to take it off the wing?” Bunch said. More significantly, it is also “do I still have to have the depot?”

The TF-33 depot is at Tinker AFB, Okla., and costs to maintain the engine have risen sharply in the past 11 years. Operationally, Bunch said—and this will be a factor in the ultimate choice—“How far back from the war can the aircraft be and still be effective in an A2AD [anti-access/area denial] environment? All of those are things that weigh into how we look at this.”

Hunsicker predicted that within six months—after revelations in the Fiscal 2020 budget—the Air Force will have a solid plan about what will need to be done to the B-52 to keep it a credible, safe, and capable bomber for its newly extended service years. ✪

SAVING A BLACKBIRD



Photo: SSgt. David Nolan

Four Swedish pilots put themselves between a crippled USAF SR-71 and Soviet air-to-air missiles, potentially thwarting a lethal international incident.

By Jennifer-Leigh Oprihory

The US Air Force doesn't typically award air medals to pilots from neutral countries for assisting in combat missions, but in November it did: Four former Swedish Air Force pilots were presented the awards in a Stockholm ceremony, spotlighting an incident that had been a Cold War secret for 31 years.

On June 29, 1987, during a routine flight to surveil Soviet activities in the Baltic Sea, a US Air Force SR-71 Blackbird—a triple-sonic, super-secret spyplane—blew one of its two engines. The crew instantly recognized they were in serious trouble; the spyplane's high operating altitude and extreme speed were its only defenses. Down an engine and near Soviet airspace, they could still fly, but had to descend in speed and altitude.

Now Soviet aircraft could reach and catch them.

An SR-71 from RAF Mildenhall, UK, in 1988. The supersonic jets were prone to engine troubles.



Photo: SrA. Kelly O'Conner

Left to right: Retired Swedish Air Force members, Col. Lars-Eric Blad, Maj. Roger Möller, and Maj. Krister Sjöber, wearing US Air Medals, and retired USAF Lt. Col. Tom Veltri with a painting depicting the Swede's daring action.

The Blackbird risked being shot down or forced to land, its crew moments away from capture, the frigid waters of the Baltic, or even death.

Lt. Col. Tom Veltri, now long retired, was in the back seat. Copilot Lt. Col. Duane Noll was in the front. "We were ... three seconds from our turn point," Veltri said. He recalls this with certainty because he was counting the seconds down "in case the airplane didn't turn itself, because otherwise we're going to go right over sovereign [Soviet] airspace."

"I'm counting down '5, 4,' and the right engine explodes," he recalled.

Then the left engine had to adjust to the loss of the right engine—called an unstart—to ensure the jet remained under control, Veltri explained. Without that, "the supersonic air comes around the compressors" and there would have been insufficient rudder authority to handle the aircraft's asymmetric "tricks and thrust."

Blackbirds couldn't fly Mach 3 at 80,000 feet on a single engine, and speed wasn't their only problem. The engine explosion shut off the aircraft's generators, causing the cabin to lose pressure and triggering the full inflation of both pilots' pressure suits, making it hard to move around and keep the aircraft airborne.

The aircraft plunged, dropping 40,000 feet in one minute. At half the usual cruising altitude, it became safe to make a southward turn, so Veltri and Noll decided to head toward the Baltic island of Gotland—Swedish territory—where they might land.

"We knew that they were gonna treat us better than the Soviets," he said.

Veltri also decided to expose the aircraft to



QRA pilot Lars-Eric Blad



Viggen pilot Krister Sjöberg



Viggen pilot Roger Möller

Photos courtesy of Lars-Eric Blad and Krister Sjöberg

air-traffic control by switching on squawk. While this wasn't standard procedure—it made the jet easily visible to the Soviet air force—Veltri called it "probably the best thing I ever did that day."

Though its speed, altitude, and reduced radar cross section made the Blackbird great at sneaking into an area, its distinct sonic boom and the massive infrared signature of its engines made a stealthy exit nearly impossible.

"Come on, who are we fooling at this point?" he thought. "Let's hope the ... cavalry comes before the bad guys."

They leveled the aircraft at 25,000 feet and an airspeed of about 380 knots, hoping they could make it to a safe airfield, because there wasn't enough fuel to get back to RAF Mildenhall, UK, nor enough time to connect with an aerial tanker, Veltri said.

Then, he spotted two dots approaching from the east—the direction of the Soviet Union—through his left window.

The two pilots decided they would "point the nose down and bail out" if they saw a missile "coming off the rail" of a pursuing jet.

"Not the greatest plan in the world," Veltri admitted, but his options were few.

But as the dots got closer, he realized they were not Russian jets, but Swedish Viggen fighters.

The Viggen pilots had been on a training mission when their controllers asked them to check out the SR-71, identify it, and evaluate whether it was a threat.

Recalling the incident in a phone interview, retired Swedish Air Force Maj. Krister Sjöber said he could hear tension in the controller's voice when he got that call, so he knew something unusual was up. As they kept flying east, the controller informed Sjöber and the other Viggen pilot, retired Swedish Air Force Maj.

Roger Möller, that the aircraft in question was a Blackbird, “and that it had violated Swedish airspace and ... was low level at this time.”

Although the Americans didn’t know it, their repetitive and predictable pattern of flights across the Baltic was well-known to the Swedes, who’d nicknamed it “the Baltic Express,” and the Flygvapnet used them as training opportunities.

“We knew when they were coming,” Möller said. They “always [flew] the same path: in the South of Bornholm—a Danish island—going for the East Coast, or the eastern part of the Baltic, make a 180-[degree] turn in the northern part of [the] Baltic, and then came on the southbound, heading

just between the island Öland and the island Gotland.”

“Suddenly, [the Blackbird] came out of kind of a misty sky and into a clearer sky, and then he was slow and low,” Sjöber said. It “was in distress.”

—Swedish Air Force Maj. Krister Sjöber

The Swedes flew training intercepts “To see ... are we able to have a radar lock on him, will our missiles maybe hit if we had to” shoot, Möller said.

Sjöber recalled throttling up and going supersonic once he and Möller were over water to reach the Blackbird as quickly as they could.

“Suddenly, [the Blackbird] came out of kind of a misty sky and into a clearer sky, and then he was slow and low,” Sjöber said. They immediately saw the Blackbird “was in distress.”

It was “obvious to us that he was on one engine only, so we stayed there as long as we could, basically to see that he was all right, and if he wasn’t all right—if they had to bail out—we could pinpoint the position of the pilots,” Sjöber said.

Then things got dicey. A Russian MiG-25 Foxbat pulled alongside the Viggens. Veltri would later learn that the National Security Agency, which

tracks international communications, had concluded the Russian plane was under orders “to force us to land or shoot us down,” Veltri said.

The Foxbat left after a few minutes. Veltri said it was the only Russian aircraft the USAF pilots detected visually, though the NSA later informed them that “at least 20 Soviet aircraft were launched as we continued our journey past Lithuania, Poland, and East Germany.”

“We didn’t see any other Soviet aircraft, but they continued to launch, waiting for the Viggen pilots to peel off,” Veltri said. “And if they had an opening, then they were gonna be able to come in on us.”

None of the Swedish pilots interviewed by *Air Force Magazine* actually saw Soviet aircraft; indeed, they didn’t learn that part of the story until “this ceremony we had up in Stockholm,” Sjöber said.

When the the escort ran low on fuel, two quick-response Viggens were launched to replace the initial two jets.

“As soon as we got into the aircraft, we were ordered to scramble as fast as we could,” said retired Swedish Air Force Col. Lars-Eric Blad, one of the QRA (quick reaction alert) pilots who tag-teamed with the initial Viggens to ensure the Americans’ safety.

Since Blad and his fellow QRA pilot, now-retired Lt. Bo Ignell, were technically coming in from the wrong coast, he said, they flew over southern Sweden at Mach 0.98—

just below sonic speed—then accelerated as soon as they reached water.

Blad and Ignell stayed with the Blackbird until it reached Danish territory, where American F-15s based in West Germany met and escorted the SR-71 to Nordholtz Air Base where it landed safely.

The 1987 incident was the third Blackbird engine explosion Veltri survived. In a previous incident over Cuba, his proximity to Key West, Fla., made a safe landing much simpler.

Veltri posited that the SR-71’s quick evolution from drawing board to operations may have been a factor in its susceptibility to engine failures, but he said his confidence in the aircraft was never shaken.

“I felt that I was trained to such a degree that, even if something did happen, we could handle any emergency,” Veltri said.

Over the next three decades, Veltri tried to identify and locate the Swedish pilots who came to his rescue that day.

For years after leaving the Air Force, his work as a lobbyist occasionally brought him into contact with Swedish defense professionals, with whom he’d share the story of his unknown rescuers.

“And I said, ‘Someday, I really want to find these pilots. Someday, I really owe it to them to shake their hand and thank them.’”

In 2017, he got his wish. A representative from the Saab company of Sweden at an Air Force Association conference recognized the story immediately. He was a former member of the Viggen squadron and offered to make the introduction.

Retired Air Force Lt. Gen. Charles R. Heflebower suggested the Swedish pilots be formally recognized for the mission, Veltri said. Heflebower linked Veltri up with the staff of Heidi Grant, USAF’s deputy undersecretary for international affairs. Once the details were verified, it was

“How many people get to meet somebody who saved their life?”

—Lt. Col. Tom Veltri

possible to award the Swedes US Air Medals, Veltri said.

“I can tell you for a fact they will cherish [the medals] until the day they die,” Veltri said.

Three of the four retired Swedish pilots involved received the US Air Medal in person on Nov. 28, 2018, in Stockholm. The fourth, Ignell, couldn’t attend because he was on a scientific expedition in Canada, Blad said.

The citation praised the pilots for recognizing the emergency situation and deciding to support the Blackbird “by defending it from any potential third-party aircraft that might have tried to threaten it” and for staying with the jet past Swedish boundaries to ensure its safe recovery.

Noll was unable to attend the ceremony, Veltri said, but he thanked the pilots via a video message played during the event.

“Your obvious skills and judgement were definitely demonstrated on that faithful day many years ago. I want to thank you for your actions,” Noll said. “We will never know what would or could have happened, but because of you, there was no international incident. The US Air Force did not lose an irreplaceable aircraft, and two crew members’ lives were saved.”

Veltri savored meeting his benefactors. “It’s rare,” he said. “How many people get to say they got to meet somebody who saved their life?”



Adaptable Munitions: Time for a Revolution

21st Century Combat Success Cannot Depend on 20th Century Bombs.



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By Maj. Gen. Lawrence Stutzriem, USAF (Ret.), Col. Matthew Hurley, USAF (Ret.), and Marc V. Schanz

America's airpower arsenal is long overdue for a revolution in munition effects. Even as the US military's combat aviation inventory continues to evolve into a robust fifth generation force with the steady employment of the F-35—and soon the new B-21—these aircraft are still delivering dated munitions with limited, fixed effects. Modernizing these munitions and the combat effects they produce is a growing, if under-appreciated, priority for the US Air Force and Department of Defense (DOD).

Modern airpower has never been more capable, yet the weapons they deploy have not kept pace. The basic aerial bomb body, a steel shell filled with explosive material, has hardly changed since its first use over a century ago. Some



An F-35 drops a GBU-12 laser-guided bomb over the Utah Test and Training Range in 2016. Laser-guided munitions have increased accuracy, but more flexibility is needed.

Photo: Jim Haseltine/USAF

70 years after its initial deployment and use, the Mk 82 general-purpose bomb, a 500-pound, TNT-based explosive encased in steel, remains the air-to-ground workhorse munition of the Air Force and the other US military services.

To be sure, precision guidance technology has enabled a single B-2 to achieve the same effect as 1,000 B-17 Flying Fortress bombers in World War II. Yet in effect, the same “boom” from World War II-era bombs today is simply more precise. Aside from the addition of Global Positioning System kits and laser guidance capabilities to enhance the accuracy of those weapons, the actual munition effects—heat, blast, and fragmentation—are essentially unchanged.

Real-world requirements now demand a broader range of options for a given munition’s kinetic effect. Combat operations in Iraq, Afghanistan, Syria, and beyond have repeatedly highlighted the need to limit collateral damage when attacking targets near friendly forces, innocent bystanders,

or targets located in urban areas. At the same time, with near-peer military power competition on the rise, aircrews need the ability to bring extra kinetic power against aimpoints that may be hardened or buried underground. Moreover, the rise of real-time targeting in combat operations means aircrews today do not routinely know the kind of targets they will attack before bombs are loaded onto their aircraft. Without the ability to modify a munition’s explosive effect in flight, aircrews must often choose not to engage a target: Air component commanders tell us that as many as 70 percent of potential target opportunities go untouched for want of a suitable munition at a given time and place.

To address these challenges, we see four terms of reference for munition design:

- Variable yield effects—allows a real-time scaling of the power of the detonation, from a puff to the maximum possible yield.

- Adjustable effects—enables the shape and yield of the explosive envelope to be dynamically programmed for a broad range of targets and environments.

- Adapted effects—incorporates new concepts for addressing unique needs, such as targets in urban environments.

- System-of-employment effects—optimizes all aspects of the munition and its system of delivery. Examples of this methodology show that against certain target categories, a munition can yield the same kill effect as an Mk 82, but at a fraction of the size. Such design can add vastly more munition loadout to aircraft, such as the remotely piloted MQ-9 Reaper.

The Air Force Research Laboratory (AFRL) has translated warfighting priorities of the US combatant commands (COCOMs) into focus areas over the last several years. This effort yielded the carbon-fiber BLU-129 munition, an adapted-effects design for targets with high-collateral-damage potential or for supporting US troops in close proximity to adversary forces. The BLU-129 is a pathfinder for expanded development of munitions to meet greater warfighting needs through new design concepts

Another key driver behind the need for enhanced munition effects options is that combat aircraft are increasingly high-demand, low-density assets. The Air Force is currently operating the smallest and oldest aircraft inventory in its history. Additionally, current mission capable rates on many aircraft are low, and pilots are in increasingly short supply. To best meet COCOM requirements amid these constraints, it is crucial that each sortie flown and every bomb dropped achieves maximum potential. The margins simply do not exist to repeat missions that could have been successfully executed the first time had there been a more flexible regime of munitions available. New munition effects could mitigate the results of a smaller US Air Force by increasing both munition flexibility and aircraft loadout.

To fully realize the potential of a munition-attained revolution, investment will be required in several key areas: advanced energetics, additive manufacturing (AM), and advanced developmental test and evaluation (DT&E) technology. Additive manufacturing is particularly important as an enabler of effects designs that were previously impossible to manufacture. It also promises to accelerate development and test cycles.

REALIZING NEXT GENERATION EFFECTS: RECOMMENDATIONS FOR ACTION

Some efforts are already underway. Air Combat Command (ACC) and AFRL have rightly engaged with industry to en-



Photo: TSgt. Robert Cloys

Col. Henry Rogers runs a preflight inspection on an F-16 carrying a BLU-129 bomb before a sortie from Bagram Airfield in Afghanistan. The carbon-fiber munition was designed for targets with high-collateral-damage potential.

sure munitions research and development is aligned with warfighter requirements. Advancements will only occur if all stakeholders work together. Prioritization and coordination must also occur on the Air Staff; the Air Force Warfighting Integration Capability (AFWIC) and others must incorporate the potential of advanced munitions development into the broader vision of aerospace power.

Policymakers should consider the following recommendations and focus areas to advance the near-term development of enhanced munition effects:

■ **Research and Development.** First, incentives and resources must be prioritized to capitalize on developments in additive manufacturing. This technology must be stimulated through targeted investment, acquisition incentives, and adaptation of commercial innovations. The Air Force must craft a state-of-the-art template for weapons DT&E infrastructure, in order to support more rapid deployment of advanced munitions. While the service should protect and accelerate current resourcing for modernization at key facilities, such as Eglin AFB, Fla., more funding is needed. AFRL should set up a cross-functional infrastructure and capability design team that will be geared toward producing a next generation template for munitions DT&E activities.
























■ **Culture.** High performance munitions that afford flexible effects will not take hold culturally in military operational planning unless the Air Force first changes the way weaponeers and aircrews execute planning. This will require forethought, as these munitions enter service and eventually become routine tools in modern warfare. Training will undoubtedly be necessary, and Air Combat Command should begin experimenting with the value of flexible-effects munitions and prepare resources needed to adapt training and planning to exploit the value of these new designs to the fullest extent.

■ **Education.** Top-level commanders and decision makers must learn the value potential new effects could offer, how they could be employed in combat, and how they could help close important capability gaps. Numbered Air Force commanders, who are tapped as combatant command air component leaders, should work with the Air Staff, AFRL, and COCOM officials, who otherwise may not understand the potential of these effects designs enough to factor them in when assembling priority lists to send to the Pentagon. COCOM staffs also should be informed about munition improvements that could answer the call for challenging operations against near-peer adversaries and offer greater effects flexibility in lower-end operations.

In addition to educating the COCOMs about the potential of new munition effects, it should be emphasized to these commanders that new effects designs could also mitigate the shortage driven by inventory and force reductions the Air Force and other services have faced since the passage of the 2011 Budget Control Act. Within the Air Force, especially ACC, the service is grappling with what is being dubbed an “effects crisis”—expected to last years—as not only the overall inventory has shrunk but buys of modern fifth generation aircraft are now under threat of being pared back. Fifth generation aircraft, such as the F-35 and F-22, have limited internal weapons carriage capacity, and any reduction in the force structure or planned buy of these aircraft exacerbates the effects crisis—fewer aircraft mean fewer weapons, and fewer actions that can be brought to bear on adversaries. The development of lighter, more compact, and more flexible weapons that can approximate or improve upon the effects of existing bombs (not just building smaller munitions) will assist in mitigating the shortage of overall munitions carriage capacity. While increased investment is important

Requirements and Munition Effects

Developing weapons that can adapt to changing mission requirements increases flexibility and efficiency. How effects design matches up against operational requirements:

<div>Operational Requirement</div> <div>Effects Design</div>	<div>Flexibility of effects:</div> <div>Yield, directionality, fragmentation pattern, and lethality radius</div>	<div>Suitability for Dynamic Tasking</div> <div>Ability to create desired effect for given situation</div>	<div>Availability for Dynamic Tasking</div> <div>Presence of munitions when needed</div>	<div>System-of-employment</div> <div>Fixed effects, variable yield, or adjusted effects</div>	<div>Effects per ATO Cycle</div>	<div>Option for Max Energy Detonation</div>
Variable Yield	MED 	HIGH 	HIGH 	LOW 	MED 	YES 
Adapted Effects	LOW 	HIGH  (for limited target, CD, or mission niche)	HIGH  (for limited target or CD niche)	MED  (for limited target, CD, or mission niche)	MED  (depending on share of niche targets)	N/A
Adjustable Effects	HIGH 	HIGH 	HIGH 	LOW 	HIGH 	YES 
System of Employment	LOW 	MED 	LOW 	HIGH  (VERY HIGH for long-dwell RPA)	HIGH 	YES 

AN-M64 General Purpose Bomb

The 500-pound bomb was used extensively in World War II by US and Allied forces. The unguided munition had a main fuse in the nose and an auxiliary fuse in the tail. It detonated on impact. A tail fin package completed the bomb. In 1943 only 16 percent of the bombs dropped landed within 1,000 feet of the aim point.



GBU-38 Joint Direct Attack Munition

The GBU-38 JDAM is a Mk 82 500-pound bomb converted into a precision strike weapon by utilizing a GPS-aided Inertial Navigation System in a bolt-on tail that controls three steerable fins. A nose kit with small strakes add stability and glide performance. The weapon detonates on impact or is triggered by a proximity fuse. The JDAM has a target error of less than 40 feet.

to meet COCOM needs for small munitions (in lieu of half-filled bombs as temporary solutions to collateral damage concerns, such as in Operation Inherent Resolve), this approach does not address the air combat effects shortage as it relates to more high-end scenarios, such as a conflict with a near-peer adversary such as Russia or China.

BALANCING PRESENT NEEDS, FOSTERING FUTURE CAPABILITIES

The demands of current operations in the Middle East and Afghanistan have understandably driven mandates to replenish existing munition stockpiles but, as a result, current Air Force resourcing for new munitions development is at a dangerously low level. Some key technologies that hold great promise for new and tailorable effects are now essentially on “life-support-level” funding. Yet, at the same time, potential

adversaries continue to make significant gains in developing and testing their own new weapons. Funding must enable the Air Force to refill today’s weapons stockpile, while also investing in new munition-effects design concepts that can offset key capability gaps. Absent a deeper level of investment, these capability gaps could worsen over the coming decades.

The need for new munition effects has been publicly highlighted as a pressing issue since at least 2011, when AFRL noted that munitions development was lagging behind advances in fifth generation aircraft and next generation systems, creating significant challenges and limitations to Air Force-wide capabilities. This problem can only be effectively corrected by direction from the top of the Air Force, where future plans and programs are crafted—namely the acquisition policy and force development guidance being developed under the auspices of AFWIC. Senior AFWIC and Air Staff officials must ensure aircraft and munition effects are fused programmatically and do not wind up as separate and sequential development efforts. The service must defend this principle vigorously as the budget process evolves, and the resultant pressure from modernization begins to increase in the years ahead—whether as a result of program changes, budget cuts, force-structure adjustment, or technological challenges. Transparency in planning and analysis must be put forward when force structure is adjusted (up or down) to make sure Air Force leaders can express the resulting impacts across the range of military operations to decision makers in DOD and in Congress.

All of this becomes even more pressing as the Air Force and US military embrace new warfighting paradigms such as the “combat cloud”—where information will be gathered and rapidly processed and disseminated to relevant aircraft, assets, and actors. An integrated intelligence, surveillance, and reconnaissance strike-and-maneuver complex will link all weapons systems on land, at sea, in air, space, and cyber-space. Such an environment will compress kill chains and require rapid action with little preplanning.

SSgt. Patrick Waters (l) and TSgt. Sherman Padgett install a JDAM GBU-54 tail-fin guidance kit on a 500-pound bomb in Southwest Asia. With the JDAM guidance kit, the bomb has a target error of less than 40 feet.



Photo: MSgt. Caycee Watson/ANG

By employing the combat cloud's operational design with older weapons, all future operations would be fundamentally limited. US forces using older weapons will be limited in their ability to pair compatible weapons from scheduled loadouts with vastly increased strike opportunities, as a result of the combat cloud's rapidly expedited kill chain. New munitions for this type of warfare must be more flexible, in terms of shaping effects for a wider range of targets and potential operating environments. Hence, advanced munition effects must be co-developed at the same time as these operational concepts; they cannot become an afterthought or secondary priority.

Advancing the evolution of munitions effects must also be accompanied by a rethinking of how to calculate the costs of weapons. AFWIC, ACC, and AFRL should examine the metric of "cost per effect" in order to guide future munition program choices and development efforts. A new regime of munition effects will generate benefit beyond just pairing a more effective weapon with a desired impact point. Greater systems efficiencies, the flexibility of the kill chain, aircraft weapons loadouts, and the potential logistical benefits of these new munitions are all relevant to a full-value budgetary assessment, no matter the resulting acquisition strategy.

New munition effect designs, and the operational flexibility they afford, will reduce costs in both dollars and strategic impact across DOD's portfolios. It is essential that Air Force leaders and spokespeople promote the operational advantages of developing new munition designs to Congress and the general public.

PRESERVING AIRPOWER AS A DECISIVE FORCE

In order for this effort to succeed, both Air Force and DOD officials need to follow through on their oft-cited desire to better engage the aerospace industry to explain modern warfighting requirements and solicit ideas to address capability gaps.

Some efforts are underway to better match up ideas with requirements at organizations such as ACC and US Special

Operations Command, but often these efforts only succeed to the extent that the right personnel support them—especially those with requisite operational expertise and a realistic understanding of how new technology can enhance current operational concepts and lead to new ones. Industry needs more direction on where to focus limited independent research and development funds. The Air Force should establish an ongoing working group to fine tune the rules and structures that govern the cross-flow of information between the government and the defense industry, and recommend modifications where needed to eliminate barriers to effective communication from federal acquisition regulations and Air Force instructions. Ultimately, building a safe and secure means to exchange ideas between the defense industry, academia, the US Air Force, and DOD will do more to foster a revolution in munition effects than will funding of any single initiative.

Over the past century, America's Air Force has become indispensable for all successful military operations, and it continues a strong tradition of affording unique policy options to commanders and decision makers that cannot be replicated through force projection in other domains. However, continuous deployment since the start of Operation Desert Storm in 1991, coupled with the costs of combat operations since 2001, has led to an Air Force increasingly defined by the gaps between its available capabilities and real-world demands.

The US will not be able to restore its Air Force overnight. It is critical that a lack of resources do not starve a potential revolution in munitions effects, which will greatly aid these efforts. New munition capabilities will increase airpower efficiency and expand the flexibility that combat aircraft can offer. If prioritized, a powerful era of precision munitions is feasible in the near- to medium-term. Failure to capitalize on this potential will result in a mismatch between present-day munitions and increasingly capable aircraft. As the United States now faces rapidly modernizing peer-level military threats, the time to act is now. ✦

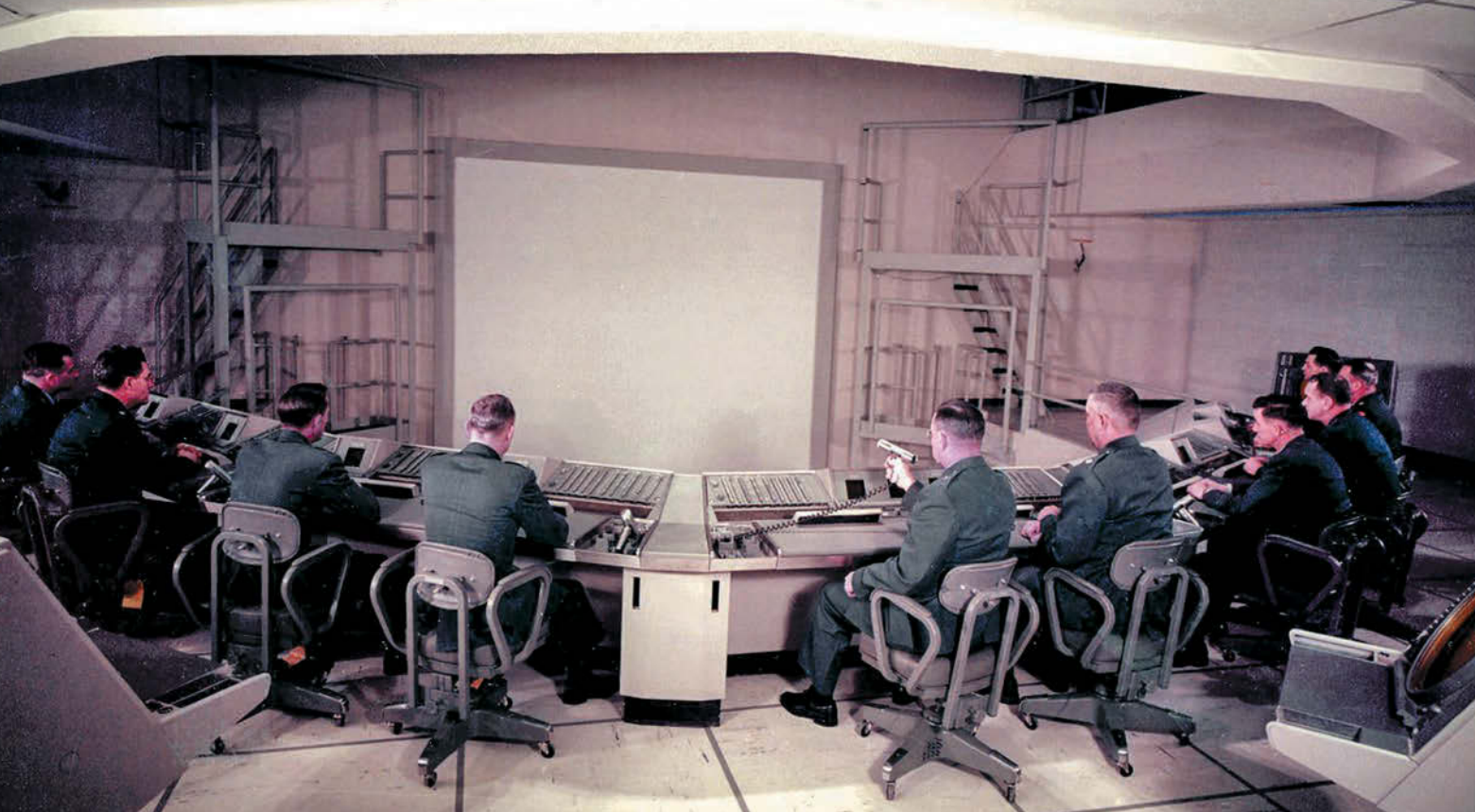


Photo: USAF/Mitre Corp.

Command post staff use computers at a SAGE Combat Center at Hancock Field, N.Y., to communicate with other SAGE sectors, monitor an air battle, and direct weapons in 1959.

From Cybernetics to Cyberspace

The roots of digital warfare are found in the birth of the US Air Force.

By Jason Healey

Cyberspace may seem new and exciting, but the Air Force has been advancing cyber concepts, technologies, and operations for more than 70 years—since 1947, in fact, the same year the Air Force was established as a separate service.

“Cyber” today has become shorthand for all things digital, but the term was actually coined just after World War II as “cybernetics,” the study of feedback, communication, and control. The term was derived from the Greek word for “steersman,” which refers “to the fact that the steering engines of a ship are indeed one of the earliest and best developed forms of feed-back mechanism,” according to Norbert Wiener, author of *Cybernetics*. Despite the nautical reference, modern cybernetics began with a wartime

air-defense problem: How to better aim anti-aircraft guns at fast-moving targets flown by pilots keen to avoid getting hit.

Before World War II, the US Army had basic air-defense radars and fire-control directors that required up to nine operators. It was clear during the Battle of Britain that targeting fast-moving bombers required faster, automated solutions. The Tizard Mission to share research and development secrets between the United States and United Kingdom led to a crucial breakthrough—a “gun-laying” radar to guide servo-driven, anti-aircraft guns firing shells with proximity fuses. This automation both improved accuracy and reduced the number of soldiers needed.

But even radar-guided guns could only aim at spots where planes were likely to be based on their previous path and altitude. Could a system predict enemy pilots’ evasive tactics and point the guns accordingly? Wiener, an



Photo : USAF/J.M. Eddins Jr.

Cyber warfare specialists with the 175th Cyberspace Operations Group train at Warfield ANGB, Middle River, Md., in 2017.

MIT scientist, spent his war years working on this problem, mostly unsuccessfully. While his research did little to help Army gunners, the processes of feedback, communication, and control that he developed led him to create the new science of cybernetics.

THE AUTOMATED AIR FORCE

The progression from World War to Cold War accelerated the development of cybernetic concepts. The newly created Air Force was at the center of it all, especially for the critical problem of automating air defense. Since the Battle of Britain, the areas to be monitored had grown, the aircraft were far faster, and the bombs more devastating. Any solution would have to be scaled up to intercept Soviet bombers before they reached the homeland, making automation through cybernetics the only plausible response. Thus was born the Semi-Automatic Ground Environment (SAGE) system, the world's first computer network.

In 1950, the Air Defense Systems Committee drew on Wiener's ideas of feedback, communication, and control to design and build a series of networked radar stations feeding powerful computers. By 1954, SAGE was complete, with a continental network of radar stations, nearly two dozen supercomputers the size of buildings and hundreds of field sites, all connected by telephone lines. SAGE's software programmers at Lincoln Laboratories (located at then-Hanscom Field, Mass.,) had to learn to write binary code through trial and error, and invented concepts such as assembler programs, that have since become central to programming. In 1960, J.C.R. Licklider, a member of SAGE working on human factors, wrote an Air Force-funded essay about this emerging "Man-Computer Symbiosis" with insights still relevant today. Humans "will set the goals, formulate the hypotheses, determine the criteria, and perform the evaluations. Computing machines will

do the routine work that must be done to prepare the way for insights and decisions," he said. In the early 1960s, SAGE became the Ballistic Missile Early Warning System (BMEWS), tracking missiles as efficiently as SAGE had identified bombers.

It was natural for the Air Force to take the lead in these early computer networks. The next cybernetic developments—sensory feedback and virtual reality—may not seem as close a fit for airmen. In 1955, the Air Force was experimenting with prototype nuclear-powered jet engines for a new generation of bombers that could stay aloft for weeks at a time. The maintainers needed to handle the radioactive fuel while shielded, a task requiring superhuman strength and delicacy. This led to the development of the "Handyman," an exoskeleton suit with powerful mechanical arms that provided sensory feedback. The underlying technology is now used in everything from power steering and fly-by-wire systems to video-game controllers. Few know that Air Force labs pioneered it.

In the 1970s, such revolutionary human-to-machine and machine-to-human interaction, combined with the declining costs of computing power, drove Air Force cybernetic research into virtual reality (VR). After the Vietnam War, the Air Force's aging fleet was due for a refresh, and the service's leadership saw the potential for major gains from a cockpit that could display far more information—about the aircraft, environment, friendlies, and hostiles—without overloading the pilot. Rather than focusing on just a physical redesign, the Air Force "virtualized" this information into the Visually Coupled Airborne Systems Simulator (VCASS) helmet. While cutting edge, these helmets were unwieldy, even at normal Gs. Fortunately, the technology had other applications, such as increasingly realistic flight simulators and heads-up displays. Today, helmet-mounted displays for fifth generation fighters allow the pilot to "look

Airmen compete in a cyber weapons competition in San Antonio. In the 1990s, USAF created the first unit anywhere to combine offensive and defensive cyber operations in direct support of a combat commander.

Photo: TSgt. R.J. Biermann



through” the airframe, and VR technology is finally coming of age to deliver aerial supremacy.

By the mid-1980s, the possibilities of this virtual world had captured the public’s imagination, and this Air Force-driven view of the modern era—along with the new science fiction of writers like Vernor Vinge and William Gibson—led to the modern concept of “cyberspace” as a computer-generated dimension distinct, yet, interconnected with the physical world.

Hindsight reveals the divergence of two distinct “cyber” tracks in the Air Force. The first was closely tied to Wiener’s 1947 original cybernetic concepts around guided anti-aircraft fire. The Air Force would come to call this track “information in war,” encompassing information operations, command and control, electronic warfare, and new classes of precision weaponry. Retired Air Force fighter pilot Col. John R. Boyd combined these ideas from the 1970s to the 1990s with his OODA Loop: to Observe, Orient, Decide, and Act to “unravel the competition.”

The second track was rooted more firmly in the new “cyberspace” of increasingly ubiquitous computers and the global networks linking them into a unified, borderless whole. That track would lead to “information warfare,” a truly novel kind of warfare in which information would be both weapon and target.

THE AIR FORCE IN CYBERSPACE

Lt. Col. Roger R. Schell drew on his experiences with BMEWS and SAGE to “red team” computer networks in the 1970s. “Computers are at the heart of” new Air Force capabilities like dynamically retargeting ballistic missiles, he wrote in 1979, so if those computers “were penetrated, an enemy could retarget the missiles to impact on low-value or even friendly targets as part of a surprise attack!” It wasn’t long before the first cyber conflict emerged.

In 1986, German hackers stole unclassified information about the Strategic Defense Initiative (President Ronald Reagan’s “Star Wars”) and sold them to the Soviet KGB, a case in which the Air Force Office of Special Investigations played a leading role. Just two years after that, an automated worm took down 10 percent of the early Internet, spurring the Air Force to create a cyber response capability years ahead of the other services. The Air Force Computer Emergency Response Team (AFCERT) at then-Kelly AFB,

Texas, reported to the Electronic Security Command (later the Air Intelligence Agency and now 25th Air Force).

While these incidents were important, they remained far from the service’s main warfighting concerns. During Operation Desert Shield, the buildup of US and coalition forces to eject Saddam Hussein’s Iraqi divisions from Kuwait, the Defense Department suffered an early shock: Dutch anti-war hackers penetrated 34 DOD computer systems, which had “easily guessed passwords [and] well-known security holes in computer operating systems,” according to a lessons-learned report. The hackers accessed systems with information on logistics, weapon systems, and personnel, causing concern that they might have been able to disrupt the massive flow of forces to the theater.

In September 1993, the Air Force restructured its Electronic Warfare Center to create the Air Force Information Warfare Center (the AFIWC, now the 688th Cyberspace Wing of 24th Air Force), aiming to drive change in the service for both information in war and information warfare. The Government Accountability Office reported in the mid-1990s that “because the Air Force’s computer emergency response team resources are larger and more experienced” as a result of confronting these earlier events, “they have had better success in detecting and reacting to attacks than either the Navy or Army.”



In the 1990s, Secretary of the Air Force Sheila Widnall saw the importance of cyber to the emerging USAF mission.

Photo: DOD/National Archives

indeed a new domain of warfare:

Before the Wright brothers—air—while it obviously existed, was not a realm suitable for practical, widespread military operations. Similarly, information existed before the Information Age. But the Information Age changed the information realm’s characteristics so that widespread military operations within it became practical.



Advanced layered sensing, command and control, and cyber technologies will be important contributors to future Air Force capabilities.

Graphic: USAF

Soon after, in a second major effort, the Air Force created the 609th Information Warfare Squadron at Shaw AFB, S.C. The 609th, in support of Air Forces Central Command, was the first unit anywhere to combine offensive and defensive cyber operations in direct support of a combat commander. Its first commander, then-Lt Col. Walter E. Rhoads, a former F-117 pilot, built up a team of airmen to plow a fresh path in cyberspace but, as “nobody knew what a ‘cyber warrior’ was,” the unit was built from “a combination of past warfighters, J-3 types, a lot of communications people, and a smattering of intelligence and planning people.” The unit had early successes getting senior officers to even realize what information warfare was and that “it was actually a viable capability.” In one exercise, the 609th proved its mettle by seizing the blue force Air Tasking Order: “They gave us a two-hour window to play in, and we got it within two hours.”

The lessons from these operations were critical to an exercise that would shake policymakers at the Pentagon and White House in 1997, when “red team” hackers from the National Security Agency (NSA) participated in a Joint Staff exercise, Eligible Receiver. Attempting to access and disrupt American networks and infrastructure, the NSA red team had little difficulty. This key exercise exposed a generation of political, military, and intelligence leaders to the dynamics and potential impact of cyber operations.

In 1998, with these lessons still fresh, technicians at the AFCERT detected cyber intrusions into multiple bases. Some of the attacks seemed to trace to Iraq just as the US military was flowing forces into the Middle East to dissuade Hussein from evicting nuclear inspectors. Deputy Secretary of Defense John Hamre briefed President Bill Clinton that this attack, dubbed Solar Sunrise, relaying that it might be the beginning of a cyber war as presaged by Eligible Receiver, only a few months earlier. As it turned out, the intrusions were serious—but the connection to Iraq was a false alarm. The intruders turned out to be teenagers spurred by a mentor to poke into DOD systems for fun. In the aftermath, the *Washington Post* asked a question still echoed today, “Why hadn’t the military bothered to effectively patch known vulnerabilities?” Worse, the Pentagon worried, if children can scare us to the core, what could determined professionals do?

To better answer these questions and speed defensive re-

sponses, the Joint Task Force for Computer Network Defense (JTF-CND) was established in December 1998, and AFCERT was immediately attached to the unit as its Air Force component. Air Force Maj. Gen. John H. Campbell, a former F-16 and F-15 pilot, won the coveted role of running the world’s first joint cyber command.

Cyber seemed like such a natural fit for the Air Force that in 2007, Lani Kass, director of the Air Force’s Cyberspace Task Force, announced that “cyber delivers on the original promise of airpower.” It was fast-changing and very high tech, offense had the advantage over defense, and cyber attacks with their rapid and intercontinental reach could bypass an enemy’s fielded forces. Air Force doctrine from 2010 highlighted these similarities between aerospace and cyber power, emphasizing that airmen should be in charge.

Airmen normally think of the application of force from a functional, rather than geographical, perspective [and according to AF basic doctrine, AFDD-1] “airmen conduct a greater percentage of operations not just over the horizon but globally, expanding operations first through space and now also in cyberspace.” ... Thus, cyberspace operations should be tightly integrated with capabilities of the air and space domains into a cohesive whole, commanded by an airman who takes a broader view of war, and unconstrained by geographic boundaries.

Then-Lt. Col. Gregory J. Rattray wrote the first ever cyber warfare Ph.D. in a 1997 dissertation—later to be published as *Strategic Warfare in Cyberspace*—which made an extended comparison of the promises made by early airpower enthusiasts and the nearly identical ones made (then and now) by early cyber enthusiasts. In 2011, the service also produced arguably the world’s first true “cyber” general, Brig. Gen. (now Lt. Gen.) Bradford J. Shwedo, who had predominantly been in cyber (as opposed to communications or intelligence) jobs since he was a young captain. Lt. Gen. John D. Bansemer earned his cyber chops as a captain of an elite NSA hacking program starting in 1996 and became the first cyber three-star officer 17 years later. Both Rattray and Bansemer went on to oversee military cyber operations at the National Security Council in a position the Air Force had a lock on for most of the 2000s.

Unfortunately, Air Force efforts in cyber leadership subsequently stalled because of mission confusion within the Air

Force, rivalry within DOD, and the growing strength of the other services in the field.

STEPS BACKWARD AND FORWARD

Constant shifts in focus undermined the service's early momentum in cyber. Because nearly every aerospace mission depends on or could influence cyberspace, airmen from intelligence, electronic warfare, warfighting, space control, and computers and networks all saw cyber as a natural extension of their own areas of expertise. Each community pressed the case to "normalize" Air Force cyber with its specialty in charge.

In the 1990s, the Air Force viewed cyber as a subset of information warfare, with the emphasis on warfare. Many of the first cyber missions resided with the intelligence specialists at the Air Intelligence Agency (AIA) who "defended the information highway" with unique skills and tools, "participating in, rather than just supporting, combat operations." To normalize the mission, the AIA was put under Air Combat Command in 2001 to recognize "the growing role of information operations as a warfighting weapon" and more seamlessly integrate cyber with targeting, electronic warfare, and traditional warfighting processes and missions. In parallel, at the Air Staff, the Intelligence directorate (now A2) folded under Operations (A3) to better organize all aspects of information operations.

ACC remained the Air Force's cyber lead for eight years until 2009, when the mission was transferred to Air Force Space Command under the logic that cyberspace—it was felt—depends on space-based satellites, and both "space and cyberspace forces are inherently global ... unfettered by time and distance." Then, in 2018, that decision was reversed, with the cyber and intelligence missions (the 24th and 25th Air Forces) reassigned back to ACC. "Normal" again meant integrating the cyber mission with electronic warfare and other traditional Air Force combat tasks. One senior Air Force general boasted that "cyber operations and intelligence in cyber capabilities under one command is a significant step toward enhancing our warfighting capabilities," perhaps not realizing the "significant step" was merely a return to a prior command relationship.

Meanwhile, the other services (as well as the National Security Agency) began to worry the Air Force was seizing the cyber missions for itself. To some degree, this was true. Much of the early defensive, investigative, and offensive capability was blue-suited, and the early "cyber power enthusiasts" were the Air Force generals who ran the NSA from 1996 to 2005, Lt. Gen. Kenneth A. Minihan and then-Lt. Gen. Michael V. Hayden.

The perception in the rest of DOD that the Air Force intended to grab the entire cyber mission tipped toward outrage after the service updated its mission statement in December 2005: "... to fly and fight in the Air, Space, and Cyberspace," and then, soon after, announced a provisional Air Force Cyber Command, built on the 8th Air Force. This command projected the somewhat grandiose goal of being "the provider of [cyber] forces that the president, combatant commanders, and the American people can rely on," prompting the rest of the defense establishment to block what they saw as a unilateral Air Force power grab. In response, Chief of Staff Gen. Norton A. Schwartz shelved the plans for the new command, instead organizing cyber airmen as the 24th Air Force. But the damage was done. It is probably not a coincidence that no Air Force officer has run the NSA (or US Cyber Command) since 2005, the longest drought for any service since the NSA's creation in 1952.

Another reason the Air Force lead faltered was simply that the other services caught up, especially after the creation of US Cyber Command in 2010. This resulted in stronger and more centralized leadership from DOD while the other services steadily built their own cyber capabilities (run by three-star flag officers, while Air Force efforts are still run by a two-star). These factors reduced the scope for a particularly blue-suit cyber identity. Few cyber missions, other than defeating integrated air defenses, seem specifically related to the service's doctrinal missions. Strategic attack, for example, was the justification for a separate Air Force in the first place. But if sailors and soldiers can cause similar strategic effects using similar cyber capabilities to those of an airman, it was natural to ask, "what sets airmen apart in cyber operations?"

CYBER-MINDEDNESS

Of course, it turns out that *decades* of history set the Air Force apart. It has been two decades since airmen first started learning the lessons of cyber conflict at the 609th Information Warfare Squadron, six decades since the automated air defenses of SAGE, and seven decades since Norbert Weiner first coined the concept of cybernetics from his work on the anti-aircraft problem. But little of this history is remembered.

The cyber challenges over the horizon in 2028 and 2038 might be shattering if America's Air Force is not prepared. The response to the interactions between four trends, in particular, will determine success: the recombination of "cyber" and "information" warfare; overwhelming societal dependence on information technology; artificial intelligence; and the return of great power competition raising the risk of major war.

The Air Force should build on its early cybernetics history to play a lead role in the future of cyber. As America's adversaries seek to lock out US aircraft and ships by means of advanced area-denial defenses, the Air Force should leverage its inherent strengths to suppress these defenses, including cyber means and other capabilities to cause strategic effects without the need to penetrate conventional defenses. The nation created the Air Force in 1947 to have a force specialized in rapidly bypassing the enemies' fielded forces with new, technological capabilities. This new battlefield of cyberspace should be a natural fit for airmen.

The exact future is uncertain, but this much is clear: A mentality of "cyber-mindedness" will be just as crucial in the future as that of "air-mindedness" has been since the advent of flight—an understanding which can only be achieved by studying and building on the legacy of the Air Force's cyber history. This heritage must be taught in our professional military education, especially Squadron Officer School. Just as officers and cadets must learn about the service's heroes in air and space, they should also know of Air Force cyber pioneers: Rattray, Rhoads, Campbell, and Hayden.

The Air Force led cyber before it was cool, before even the invention of the computer or the Internet. Peek behind nearly every critical cyber technology and you'll find blue-suiters. Today's airmen should internalize this heritage and renew our dedication to driving the future of cyberspace. ✪

Jason Healey is a senior research scholar at Columbia University's School of International and Public Affairs and author of the first history of cyber conflict, *A Fierce Domain: Conflict in Cyberspace, 1986 to 2012*. He is a 1991 graduate of the US Air Force Academy. This is his first article for *Air Force Magazine*.

U-2 DOWN



"We have parts of the plane," Khrushchev said. "We also have the pilot."

By John T. Correll

The mysterious U-2 on the corner of the airfield at Peshawar, Pakistan, the morning of May 1, 1960, had no markings or insignia. It had been flown in the night before by a ferry pilot and would remain on the ground for only a few hours. Takeoff would be soon after daybreak to reduce the chance it would be seen by curious local observers.

In the cockpit was Francis Gary Powers, the most experienced of the Central Intelligence Agency's U-2 pilots, awaiting the specific order to launch. It came at 6:26 a.m. local time from the White House in Washington, D.C.

The CIA's U-2s had previously penetrated Soviet airspace 25 times, but this time was different. Each of the previous operations had been a partial overflight, going in for a limited distance, then returning by the same route.

The May Day mission was to be the first complete transit of the Soviet Union, a nine-hour flight of some 3,800 miles from Pakistan to Bodo on the northern coast of Norway.

Powers took off and headed northwest, across the Hindu Kush mountain range. Approaching the Soviet border, he reached penetration altitude of 66,000 feet. He used a single click of his radio switch to indicate

Overflights had been suspended and would not be resumed.

—Eisenhower, May 16.

no problem that would preclude flying the mission as planned. After that, he was on strict radio silence.

By late afternoon, he had not arrived in Norway. US officials had no clue as to what had happened, but realized that Powers must have gone down somewhere in the Soviet Union. Confirmation came May 5 when Soviet leader Nikita Khrushchev announced that the USSR had shot down a US spy plane.

The United States, mistakenly believing that neither the U-2 nor the pilot could survive the fall from the altitudes at which it was flying, responded with a clumsy cover story about a weather plane that had wandered off course.

The cover story was demolished on May 7: "We have parts of the plane," Khrushchev revealed. "We also have the pilot."

Spin merchants in Washington continued their efforts for several more days, making the situation worse with each new fabrication. President Dwight D. Eisenhower finally put an end to it May 11, acknowledging the intelligence-gathering overflight and taking responsibility for it. Pressed by Khrushchev, Eisenhower said on May 16 that the overflights had been suspended and would not be resumed.

After a show trial in Moscow, Powers was sentenced to three years in prison to be followed by seven years



When a U-2C crashed on a spy mission over the Soviet Union in 1960, the United States tried to cover up the incident. Pilot Francis Gary Powers was not at fault—but it took decades for some in the public to accept that.



Photo: USAF

at hard labor. However, in February 1962, he was exchanged in Berlin for Soviet spy Rudolf Abel, who had been held by the United States.

Inquiries by the CIA and Congress not only cleared Powers of any blame for his actions during the flight or in captivity but also commended him. However, the CIA—keeping the veil of secrecy in place—gave him little public support and was displeased when he published his own account in 1970.

The official CIA history was not declassified and released until 1998. Large sections were blacked out, but the document confirmed much of what Powers had said. Even so, some aspects and details of the overflight mission are still undisclosed or in dispute almost 60 years later.

THE SPECIAL AIRPLANE

Reconnaissance flights by US aircraft along the Soviet border—and sometimes just over it—dated back to the early days of the Cold War. The need was urgent for information about Russian force deployments, the emerging atomic weapons program, and the development of long-range aircraft and missiles.

The shallow penetrations on the periphery provided some data, mostly tactical. US intelligence on matters deep in the Russian heartland consisted of what could be gleaned from World War II German maps and other insubstantial sources.

In an attempt to reduce tensions and uncertainty, Eisenhower's "Open Skies" proposal in July 1955 suggested that both sides give each other maps of their military installations and provide facilities from which they could conduct aerial surveillance to the extent they desired.

The Russians refused, and shortly thereafter, Eisenhower approved reconnaissance missions in Soviet airspace by the still-secret U-2, which had made its first flight in August 1955.

The U-2 was a radical departure in aeronautical design, developed by Kelly Johnson and the Lockheed "Skunk Works" in Burbank, Calif. It was "basically a powered glider, a jet engine inside a glider frame," Powers said. The

wingspan was 80 feet, almost twice the length of the aircraft, which was not quite 50 feet. It flew at 72,500 feet, more than 13 miles high.

The U-2's high altitude flight and long range were made possible by major reduction in weight, achieved mainly through a tradeoff of structural strength. The tail assembly was attached with only three bolts. The main wing spar, which in conventional design passes through the fuselage, had two separate panels, fixed to the side with tension bolts.

"Each piece of structure was a little thinner than a pilot would have liked," Powers said.

"While there was usually extra support, such as joints and junctures, in the U-2 there was none. It was not a plane for heavy or drastic maneuvers."

Almost half of the U-2's fuel supply was in tanks inside the "wet wings," which were narrow and thin. At the end of each wing was a "pogo," an outrigger with a wheel on it, to keep the wingtip from dragging. Each would be jettisoned on takeoff.

"At maximum altitude, the fastest the plane would go was very close to the slowest it would go," Powers said. Only six knots separated a low-speed stall from high-speed buffeting, which could cause the loss of wings or tail.

The U-2 mostly avoided public notice, although *Model Airplane News* had a short article and some drawings in March 1958, and the 1959 edition of Jane's *All the World's Aircraft* had an entry describing the U-2 as a weather research platform.

The CIA was placed in control by Eisenhower, who said, "I want this whole thing to be a civilian operation. If uniformed personnel of the armed services of the United States fly over Russia, it is an act of war—legally—and I don't want any part of it." Despite that, the Air Force had a significant presence in supporting roles.

SHEEP-DIPPED

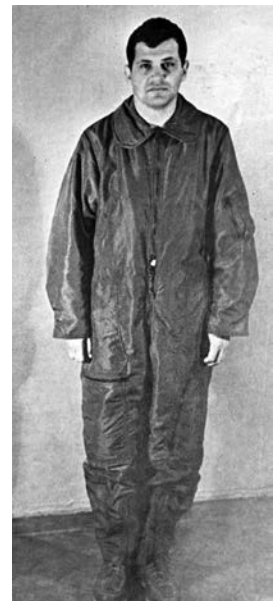
The pilots were former Air Force officers who entered the U-2 program by a process known as "sheep-dipping." They resigned from Active Duty to become contract employees of the CIA, but with a secret guarantee that they could return to the Air Force later with no loss in grade or longevity.

Among the first to be recruited was 1st Lt. Francis Gary Powers, an F-84F jet fighter pilot at Turner AFB, Ga., who



Powers (left, in a CIA photo, and right, in a Russian prison propaganda shot) was held by the Soviets until February 1962, when he was exchanged for Russian spy Rudolph Abel on the "Bridge of Spies" in Berlin.

Photos: CIA; Ria Novosti



joined the CIA in May 1956. He and a dozen others underwent training in the U-2 at a remote base in the Nevada desert.

They went overseas in two groups, one to Wiesbaden in West Germany and the other to Incirlik Air Base at Adana in southern Turkey. The first five flights into Soviet territory were out of Wiesbaden in July 1956. The sixth was in November from Adana, with Powers as the pilot.

Gradually, Adana became the mainstay of the program. The CIA called the organization there Detachment 2. To the Air Force, it was Detachment 10-10. The Air Force provided logistics, and the CIA conducted planning and operations. "There was a commanding officer [USAF] and an executive officer [agency] who together ran the outfit," Powers said.

The Adana U-2s occasionally flew their missions out of Pakistan, which was closer to the Soviet Union. In such instances, the pilots and ground crew were transported to Peshawar a day ahead of time, and the aircraft was ferried in under the cover of darkness. Should takeoff be delayed, the U-2 would return to Adana before dawn for security reasons.

By 1958, half of the CIA's hard intelligence on Russia was coming from the U-2.

THE OPERATORS GROW CARELESS

The fundamental assumption was that the high-flying U-2s were beyond the range of Soviet air defenses. There was little guidance to the pilots about what to do if they went down in enemy territory. An intelligence officer told Powers, "You may as well tell them everything, because they're going to get it out of you anyway."

A further assumption was not shared with the pilots. "I had been assured that if a plane were to go down it would be destroyed either in the air or on impact, so that proof of espionage would be lacking," Eisenhower said. "Self-destructing mechanisms were built in." The CIA told Eisenhower that no pilot would survive to be captured.

In later years, great controversy would arise about the destruction devices Powers supposedly could have used to destroy his airplane and the means he had to kill himself rather than falling into Soviet hands.

According to Powers, the destruct mechanism was a two-and-a-half-pound charge to destroy the camera and other equipment in the bays behind the wings. It was not sufficient to blow up the airplane, nor was it intended to do

so. This was confirmed by the CIA's statement after Powers' interrogation in 1962.

Suicide measures were offered to the pilots, to be used at their discretion if faced with imminent torture. "There were no instructions that he should commit suicide and no expectation that he would do so," Powers said.

The first such device was a cyanide pill. Powers never carried it, nor did most of the other pilots. It was replaced with what appeared to be a regular silver dollar with a key chain loop at the end. Inside the loop was a thin needle coated with a deadly poison, curare. Offered the silver dollar before the May Day flight, Powers decided to take it. The intelligence officer pointed out that it could also be used as a weapon.

In retrospect, the CIA's official history concluded, "after almost four years of successful U-2" missions, CIA leaders "had become overconfident and were not prepared for the 'worst-case' scenario that actually occurred in May 1960."

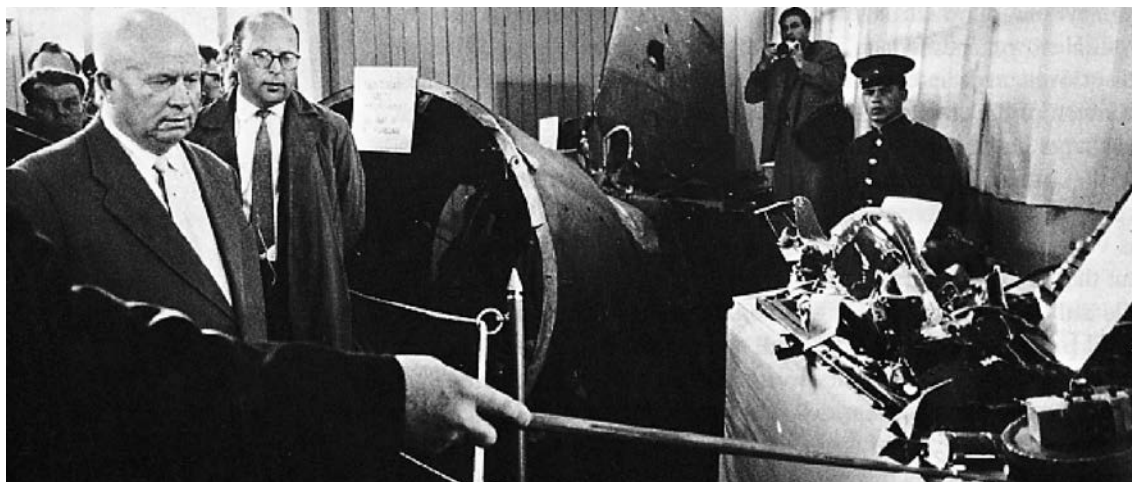
In March 1960, the USAF Air Technical Center warned the CIA that the Soviet S-75 Dvina surface-to-air missile had "a high probability of successful intercept at 70,000 feet." This was the same missile that—known by its NATO designation of SA-2 Guideline—took a heavy toll on US aircraft in Vietnam.

As Powers acknowledged in his memoir, he had become complacent, too. In packing for the May Day mission, he thought mainly of what he might need on the short layover in Norway. In addition to civilian clothes and his shaving kit, he took along a Defense Department ID card authorizing medical care and PX privileges, an instrument rating card, and US and international driving licenses.

GRAND SLAM

When the Adana contingent deployed to Peshawar, they expected the full overflight mission—none too subtly named Operation Grand Slam—to occur on April 28 with Powers flying their best U-2. Bad weather forced a postponement, and the airplane was ferried back to Adana, where it was pulled from service for periodic maintenance. It was replaced for the May 1 flight with the detachment's worst airplane, which Powers described as "never having flown exactly right."

Thus, Powers was not too surprised when, 1,300 miles inside Russia, the autopilot conked out. An hour earlier and



Soviet leader Nikita Khrushchev examines the wreckage of the downed U-2. The airplane remnants—and the captured pilot—were a huge propaganda coup for the Soviets.

Photo: CIA

he would have aborted the mission, but he decided to fly the temperamental aircraft manually for the rest of the way.

He passed the Tyuratam Cosmodrome, the big Russian missile test and space launch facility, and turned north up the backbone of the Urals toward Sverdlovsk—previously known as Ekaterinburg, where the tsar and the imperial family had been executed by the Bolsheviks in 1918.

He never made it past Sverdlovsk. Four-and-a-half hours into the mission and flying at 70,500 feet, the U-2 was rocked by the detonation of a Dvina SAM close by. Powers no longer had control of the airplane, which spiraled downward, tail first. Thrown forward by centrifugal force, he managed to release the canopy to escape, but dangling by his oxygen hose, could not reach the destruct switches.

He finally broke free and descended by parachute to a small village where he was taken prisoner. He was moved to a larger village and then on to Sverdlovsk, where custody was assumed by the KGB. He had destroyed his flight map during the descent, but the ground crew had stuck a duplicate into his pack. The route from Pakistan to Norway was clearly marked.

A story persisted for years, based on a weak report from the National Security Agency, that Powers had taken the U-2 down to 34,000 feet before the missile got him. The facts were eventually sorted out by Soviet sources. The Soviets fired a total of 13 SAMs and launched a number of interceptor aircraft, one of which was a MiG-19 that was inadvertently hit by a SAM. That was stretched into the idea that Powers had flown to a lower altitude.

The capture and trial of Powers, exploited for full propaganda effect by the Russians, effectively marked the end of the U-2 overflight program. In January 1961, President John F. Kennedy continued the Eisenhower order that the flights not be resumed. The Powers mission was the 26th and final penetration of Soviet airspace.

THE AMBIGUITY LINGERS

Although Powers was technically cleared by a CIA board of inquiry and a Congressional hearing, a cloud of ambiguity hung over his head. As the official CIA history put it, John A. McCone, director of Central Intelligence 1961-1965, “remained hostile to Powers” and demanded a closer look at his actions. Both the CIA and the Air Force kept Powers at arm’s length.

In 1963, all of the U-2 pilots except Powers were awarded the CIA Intelligence Star. Two days before McCone left office, the Intelligence Star was awarded to Powers as well, with the inscription awkwardly backdated to 1963.

The Air Force notified Powers that, unlike the other U-2 returnees, his time with the CIA would not be credited toward retirement or promotion and that he would not receive the Distinguished Flying Cross he had been awarded in 1957. The DFC was presented to his family in 1986, nine years after Powers had died.

Powers enjoyed considerable support from the general public, but more than a few newspapers were critical of his failure to destroy himself. “Why, knowing that neither he nor the U-2 should fall into unfriendly hands, didn’t he blow himself up, and the plane?” asked the *New York Herald Tribune*. “Why didn’t Powers use the poison needle he had on hand? Or the pistol he had with him?”

Powers joined Lockheed, where he was a U-2 test pilot until 1970, then flew light aircraft and helicopters for a television station. He died in a helicopter crash in August 1977.

The CIA and the U-2 Program, the comprehensive history released by the CIA in 1998, agreed in all important respects with the story as Powers had told it in his memoir and provided a measure of long-overdue vindication from the agency.

U-2 KEEPS FLYING

The strategic intelligence value lost with the end of the U-2 overflights was replaced in the 1960s by photoreconnaissance satellites, but the U-2 remained in service with both the CIA and the Air Force.

In the Cuban Missile Crisis of 1962, the U-2 famously discovered medium- and intermediate-range Soviet ballistic missiles in Cuba. A new version of the aircraft, the U-2R, was introduced in 1967 and was 40 percent larger and more capable than the original. In 1974, the CIA stopped its participation in manned reconnaissance, leaving the U-2 operation to the Air Force.

The demise of the U-2 has been regularly predicted over the years, but the aircraft outlasted its presumed successor, the SR-71, which was retired in 1998. Subsequently, the RQ-4 Global Hawk drone was supposed to replace the U-2, but plans changed when intelligence gathered by the U-2 over Afghanistan proved to be of particularly high quality.

In 2017, the Air Force announced plans to keep the U-2S, “well into the future.” Currently, USAF operates 27 U-2s and two trainers. ★

John T. Correll was editor-in-chief of *Air Force Magazine* for 18 years and is a frequent contributor. His most recent article, “The Fall of France,” appeared in the December 2018 issue.

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AFA's **San Diego Chapter** helped organize a special POW/MIA recognition ceremony for Col. Arthur S. Mearns in Coronado, Calif, in August. Chapter President Dick Jeffreys and the chapter worked with the AFA Legislative Affairs office to honor his memory and family.

On Nov. 11, 1966, USAF then-Major Mearns led a flight of F-105s on a strike mission over Hanoi, North Vietnam. His aircraft was shot down. Because the crash site was not found, he was initially listed as missing in action. When it was discovered in November 1977, it was determined that he likely died that day. His status was changed to KIA.

When Mearns was still listed as missing, DOD commissioned a portrait of his daughters, Frances and Missy, writing a letter asking for the return of their father from Hanoi. The original painting hangs in the National Museum of the US Air Force at Wright-Patterson AFB, Ohio. A copy had hung in the office of former Congressman F. Edward Hebert for 35 years. After his death, Hebert's daughter, Dawn, sent the picture to widow Pat Mearns and her daughters.

The city of Coronado, Calif., held a ceremony to officially present the portrait in August. Gen. David L. Goldfein, Chief of Staff of the Air Force, designated the ceremony as an official POW/MIA recognition event and authorized a USAF flyover.



The **Spirit of St. Louis Chapter** helped sponsor the Missouri Athletic Club's yearly salute to veterans in November. Maj. Gen. Stephen E. Farnen, commander of the US Army's Military Surface Deployment and Distribution Command was the keynote speaker.

The USAF Band of Mid-America from Scott AFB, Ill., performed.

L-r: Brig. Gen. Tracie Beckett, USA (Ret.), CMSgt. Daniel Kenemore, SSgt. Christopher Jackson, SSgt. Rachel McClary, SrA. Ryan Missel, Maj. Gen. Stephen Farnen, Sgt. Jack Poitas, TSgt. Chantelle Friedman, and MSgt. Bob Schure, USAF (Ret.).

The Ramstein AB, Germany, Chapter partnered with the European Department of Defense School's JROTC at the June 2018 Cadet Leadership Course. The CLC is a one-week journey where cadets from 13 schools across Europe, along with 120-plus youth groups, train as warfighting airmen.

The cadet's experiences included cliff climbing, marksmanship training, obstacle courses, meals ready to eat (MRE), physical training, and close-quarters weapons training, among other activities. The Air Force Association sent nine volunteers

to lead, guide, mentor, and train the cadets as they advanced through the course. All 120-plus cadets graduated.

SMSgt. Dustin "Lucky" Lawrence, Special Assistant, Europe, was very pleased with all the Field Training Officers who volunteered for this Team AFA event. The volunteers were: TSgt. Deencel Tan, SSgt. Alfonso Clark, SSgt. Alexander Schlesinger, SSgt. David Robinson, SSgt. Aaron Robison, SrA. Maseray Swarray, A1C Jorge Moran, A1C Griffen Vincent, and A1C Sabrina Nieto.



Photo: American Air Museum in Britain

Crew 704 completed 30 missions. It was the third mission (and Gulick's first) that tested their wits.

His Story: 2nd Lt. Laurence Gulick Masters the B-24 Catwalk

By Caroline Jok, Silver Wings National Staff

Laurence "Ray" Gulick joined the Army Air Forces and graduated from bombardier training in August 1943. Assigned to B-24s, he was in Crew 704, 787th Bomb Squadron, 466th Bomb Group. In February 1944, they deployed with the Eighth Air Force to Attlebridge, England. At the time, there were 60 bases in England and approximately 40 bombers per base.

Gulick's first flying mission was on March 27, 1944.

THE MISSION

Crew 704 was assigned to fly over Biarritz, France, and the Bay of Biscay, where they were ordered to release their payload on an advanced pursuit field with the goal of hitting the barracks. The B-24 was capable of carrying 8,000 pounds of explosives, but there were only 20 shackles to suspend the bombs in the bomb bay. When loaded with 100-pound bombs, the aircraft was only carrying 2,000 pounds.

The Liberator could carry a lot more weight,



Photo: American Air Museum in Britain

2nd Lt. Laurence Gulick

so that day, the armorers decided to expand the number of munitions that would be carried on the mission. In the true spirit of American ingenuity, they jury-rigged extra bombs on top of the standard 20 shackles and used wire to attach additional bombs on the stations. This gave each aircraft 40 bombs—double the load they were meant to carry, but still well within the weight capacity of the aircraft.

Each bomb had a propeller. When the bomb was latched into the bomb bay, a wire kept the propeller from turning. Once the bomb dropped a certain distance—normally no more than six inches—the wire came out and air would turn the propeller. After a number of revolutions, the bomb was armed, and any contact with the nose fuse after that detonated the bomb.

Once all of the bombs had been loaded and flight checks were complete, 30 B-24s took off for France. Not a single man knew that they were flying into a nightmare.

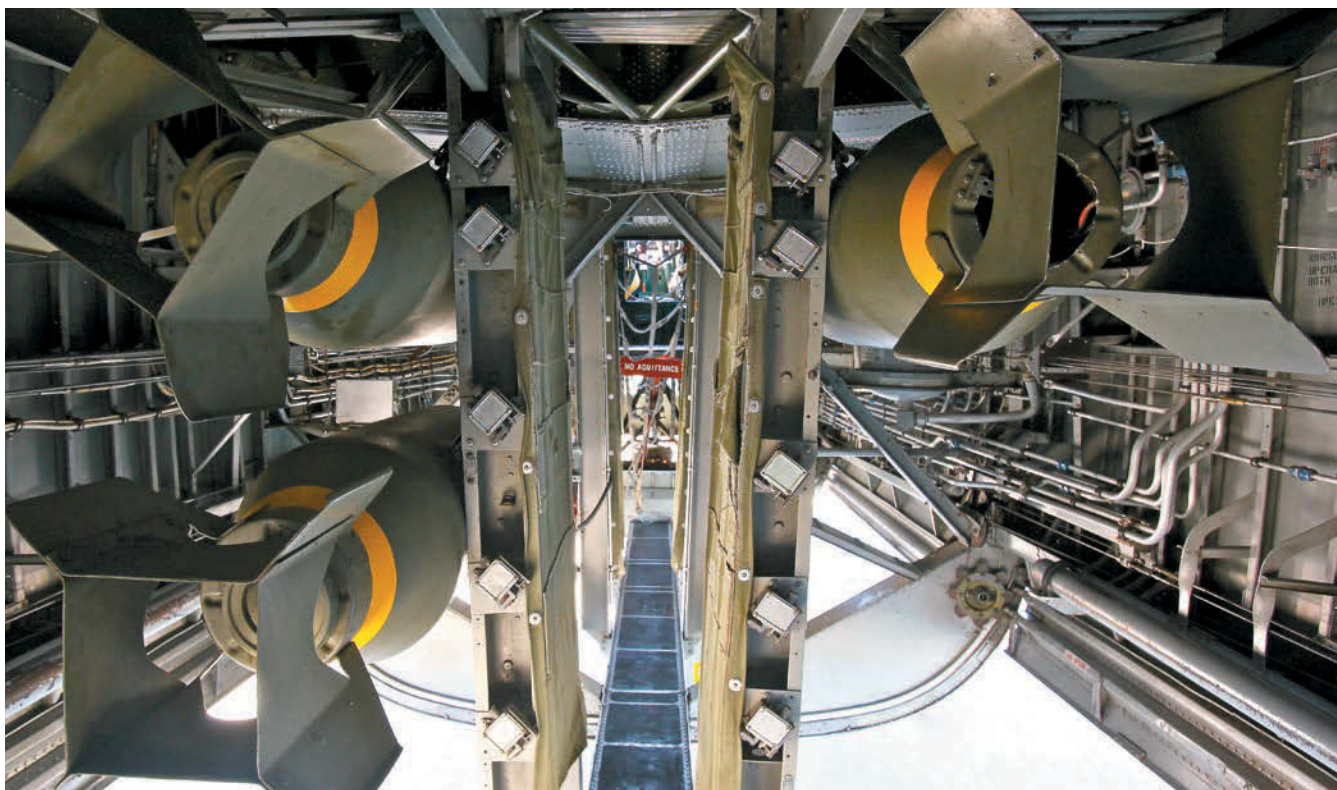
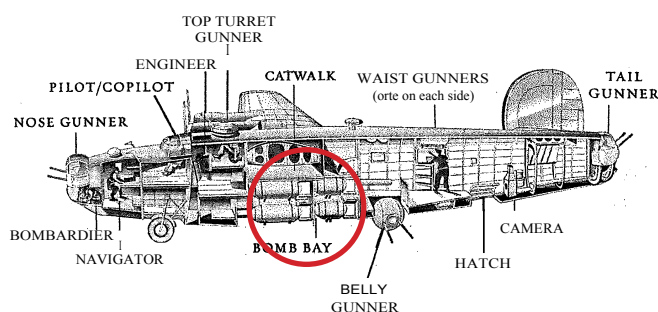


Photo: Steve Jurvetson

The catwalk on the B-24 was nine inches wide, leaving little margin for error when handling live bombs hung up in flight.

B-24 Liberator



IN-AIR NIGHTMARE

At 16,000 feet over the target, they began to release their weapons. However, Gulick noticed lights indicating that some bombs had not released. Gulick and the tail gunner, Sgt. Donald J. Waddle, went onto the catwalk to investigate. Three bombs were hung up. On top of them were four bombs that were lodged against the side of the aircraft. The wire had been pulled from the nose of the bombs, and the propellers had fallen off.

The bombs were hot.

Gulick went into survival mode. If he and Waddle did not act quickly, the bombs would detonate on board, and the crew and aircraft would be lost. They had to get rid of the bombs, and the only way to do it would be to jettison them by hand.

Only nine inches wide and without a side railing, he and Waddle had little room to maneuver 100-pound live bombs. To make matters worse, crew members needed to wear oxygen masks above 10,000 feet, but the catwalk was too narrow to accommodate the masks and hosing. They would have to continue without oxygen.

The pilot descended to 13,000 feet, and with the bomb bay doors open, surrounded by deathly cold air, Gulick and

Waddle carefully picked up the hot bombs one at a time. The propellers had already fallen off so if the nose of the bomb was touched, it would detonate. They had to lift each bomb with just the tips of their fingers, with Waddle at the back and Gulick at the front. Failure to coordinate the drop could force the other person off the catwalk. Any wrong move could set the bomb off.

TIME TO WAKE UP

Each bomb took about 15 minutes to remove. Every bomb jettisoned was a bomb that would not fall on target, but also a bomb that would not take the lives of the crew on board. Once the bombs had been safely evacuated from the aircraft, they triggered the release mechanism on the three bombs that were hung up, and they fell by themselves.

The entire mission took eight hours.

It was Gulick's first mission, and it had been horrifying. There were 29 more to go. During every mission that followed, this was the one that hung in the back of his mind. Thankfully, he never faced this situation again.

Many of the other Liberators flying over Biarritz, France, that day encountered other difficulties. The B-24s were never again manipulated to hold double the intended payload.

Had it not been for the quick thinking of Gulick and Waddle—and had they not been able to stay calm under pressure—the entire crew would have lost their lives.

Gulick went on to complete his 30 missions. During the last one, three of his crew members were wounded, and one was killed. In August 1944, he and the surviving crew returned to the states. He went on to train other young men to be bombardiers. In 1948, he transferred into the Air Force Reserve where he served for another 20 years, while in his civilian career, he served as a precision aerial photographer. He retired as a major in 1968 after serving 26 years, accruing 8,000 flying hours in over 40 types of aircraft.



1/ Tom McGuire Jr. 2/ C-17s on the runway at JB McGuire-Dix-Lakehurst. 3/ WWII's top aces Richard I. Bong (l) and McGuire, 1944.



Photos: USAF (1,3); Russell Meseroll/USAF (2)

McGUIRE

He Wrote the Book

Tom McGuire's chosen weapon was the P-38, and, in his hands, it became a terrible swift sword. He shot down 38 Japanese aircraft in 17 months.

USAF later named a base for McGuire, and not just in recognition of his gaudy kill record. He was also a superb tactician and inspirational leader. His 1944 book, "Combat Tactics in the Southwest Pacific Area," was a must-read for fighter pilots.

His dedication to air combat was total. It brought him a Medal of Honor. It also led to fiery death in a Lightning at age 24.

Thomas Buchanan McGuire Jr. was an only child, born in New Jersey. He studied aeronautical engineering at Georgia Tech, but he left college after his junior year, seeking adventure.

In July 1941, McGuire became a USAAF aviation cadet. What followed was flying training and a quiet Aleutian deployment in Alaska but not much else until February 1943, when he began flying the P-38.

It marked the start of a long haul through New Guinea, Biak Island, and the Philippines, where McGuire ran up his kill score.

In July 1943, McGuire joined the 431st Fighter Squadron, an all-P-38 outfit in New Guinea, and he soon began to make his presence felt. On Aug. 18-19, he shot down five Japanese fighters, becoming an "ace in two days."

Starved for combat, the slight, extroverted McGuire sought out every chance to hunt the enemy. His victory count grew apace.

His career nearly ended on Oct. 17, 1943, when, after downing three fighters, McGuire was himself attacked and forced to eject. With multiple injuries, he spent six weeks in a hospital but soon resumed combat.

In December, the young lion was promoted to captain and made squadron operations officer, but nothing kept him out of the cockpit. On Dec. 26, 1943, he led a



flight that destroyed 10 dive bombers and three fighters. He was awarded a Distinguished Service Cross.

With the enemy retreating, McGuire suffered a long dry spell, but the hunting picked up in May 1944. By October, he had become commander of the 431st and had 25 kills to his name.

On Dec. 25-26, 1944, McGuire led a squadron covering US bombers attacking a Japanese airdrome. In that engagement, he shot down seven enemy fighters, running his count to 38.

The streak ended there. On Jan. 7, 1945, McGuire died while coming to the aid of fellow US pilots in a dogfight. In a tight maneuver at low altitude, McGuire's P-38 stalled and crashed. He was killed on impact, but his actions helped the others escape.

For his heroism on that day and in the Dec. 25-26 engagement, McGuire was awarded the Medal of Honor. He ended up two victories short of Maj. Richard I. Bong, the kills leader at 40. McGuire stands among the most-decorated US fighter pilots of all time.

In June 1949, the existing Fort Dix Army Air Base, N.J., was renamed in his honor. McGuire Air Force Base for seven decades has stood out as a preeminent air mobility hub. In 2009, McGuire was folded into the tri-service JB McGuire-Dix-Lakehurst, N.J. Even so, everyone still refers to the Air Force portion of the facility as, simply, "McGuire."



THOMAS BUCHANAN McGUIRE JR.

Born: Aug. 1, 1920, Ridge-wood, N.J.

Died: Jan. 7, 1945 (KIA)

Visayas, Philippine Islands
College: Georgia Institute of Technology

Occupation: US military officer

Services: US Army Air Forces

Main Era: World War II

Years Active: 1941-45

Combat: Southwest Pacific Theater

Final Grade: Major

Honors: Medal of Honor (awarded posthumously); Distinguished Service Cross; Silver Star (3); Distinguished Flying Cross (6); Purple Heart (3); Air Medal (15); American Defense Service Medal; American Campaign Medal; Asiatic-Pacific Campaign Medal; World War II Victory Medal; Philippine Liberation Medal
Famous Friends: Richard I. Bong, Charles Lindbergh
Buried: Arlington National Cemetery

McGUIRE AIR FORCE BASE

State: New Jersey

Nearest City: Wrightstown

Area: 65 sq mi / 42,000 acres

Status: Open, operational
Opened as Rudd Field: 1937

Renamed Fort Dix

Airport: 1937

Renamed Fort Dix Army

Air Base: 1939

Inactivated: March 1, 1946

Reactivated: Aug. 29, 1948

Renamed McGuire AFB: June 1949

Current owner: Air Mobility Command

Former owners: First Air Force, Air Service Command, Air Transport Command, Strategic Air Command, Continental Air Command, Air Defense Command, Military Airlift Command



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