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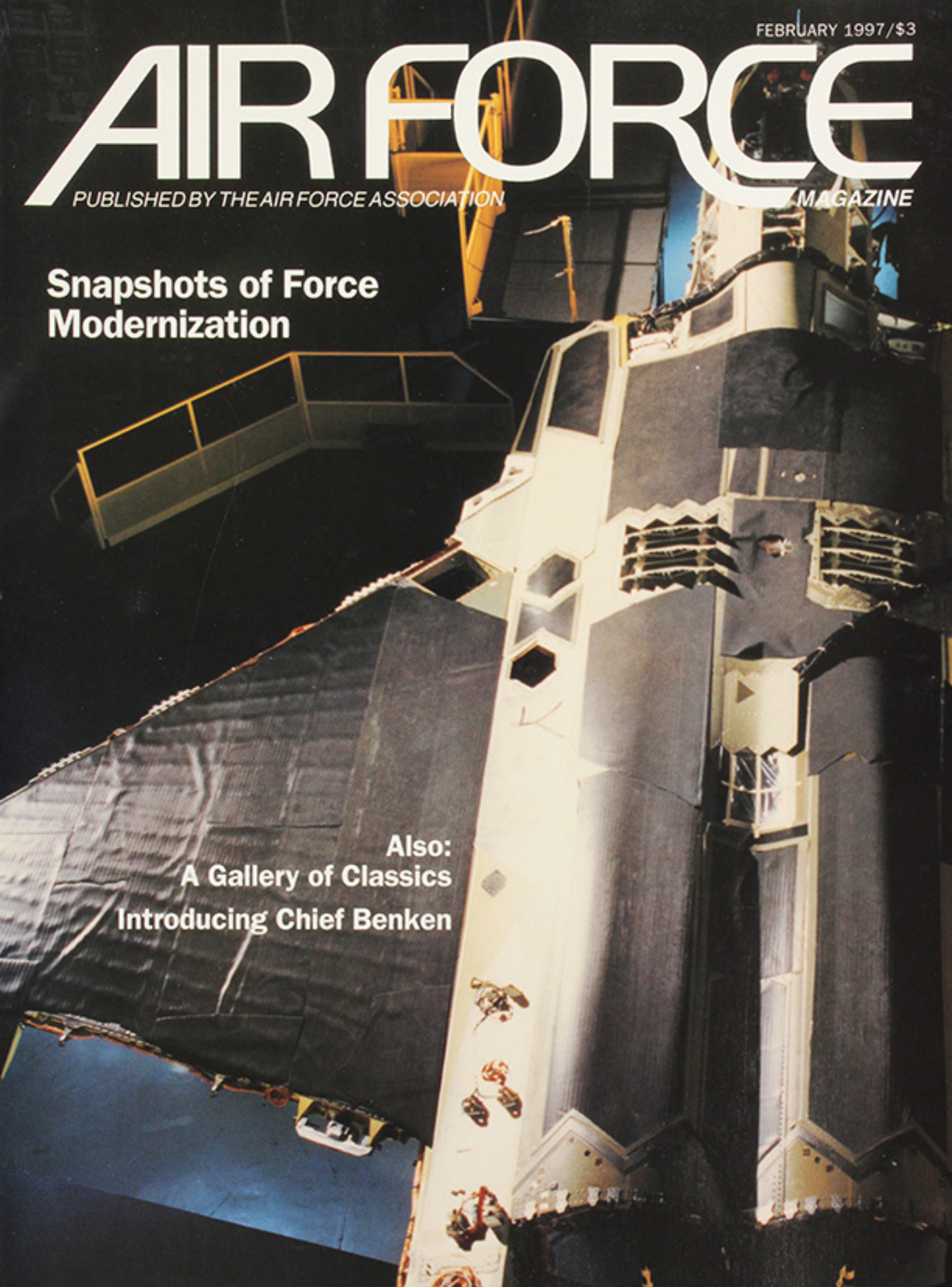
AIR FORCE

PUBLISHED BY THE AIR FORCE ASSOCIATION

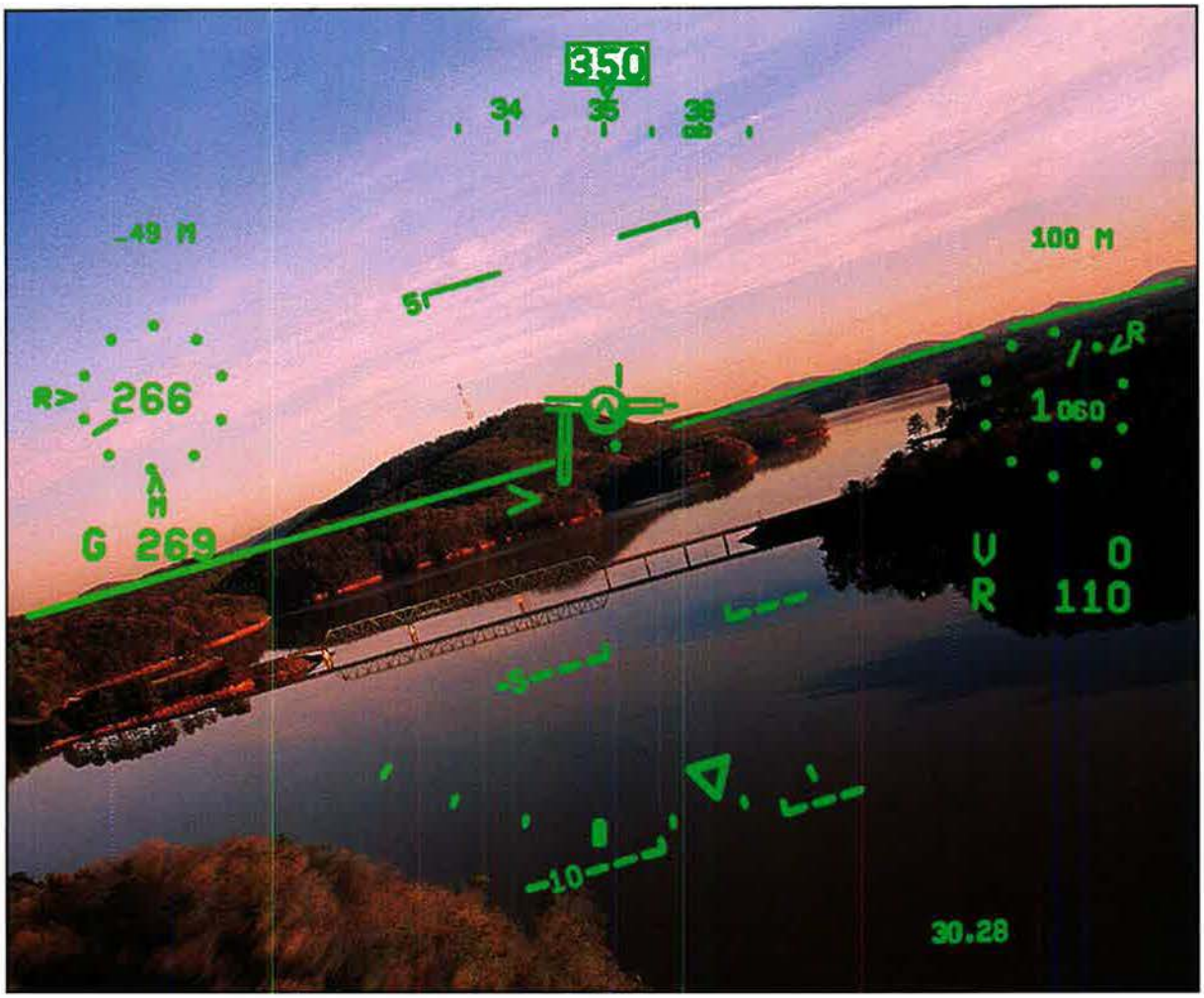
MAGAZINE

Snapshots of Force Modernization



Also:
A Gallery of Classics
Introducing Chief Benken

Pilots aboard the new C-130J can utilize a special low-altitude technique. We call it "looking out the window."



If you're wondering why we put a Head Up Display on the new C-130J, ask the pilots who must routinely pull out of approaches just 10 feet off the ground in order to drop their cargo. They'll tell you that the aircraft's twin HUDs are a great safety feature, particularly during those critical low-altitude drops and when executing instrument approaches at minimums. They also help maximize terrain masking enroute.

Of course, this is just one of the "J's" many technological improvements. We've also replaced 600 pounds of hard wiring with MIL-STD 1553 databus architecture, redesigned the props, and installed fuel-efficient twin-spool engines. In addition, mission plans are now put on a 2-by-3 inch card and inserted into the aircraft's mission computer.

We've done all this to help you accomplish your mission. It's been our *modus operandi* since the Hercules debuted in 1955. And with this all-new, cost-efficient aircraft, it will continue to be for years to come.

http://www.lmco.com/

LOCKHEED MARTIN

Mission Success

February 1997, Vol. 80, No. 2

AIR FORCE MAGAZINE

PUBLISHED BY THE AIR FORCE ASSOCIATION

About the cover: The first production F-22, one of USAF's major aircraft systems, is undergoing final assembly. First flight is expected in May. See "Snapshots of Force Modernization," p. 20. F-22 Team photo by John Rossino.

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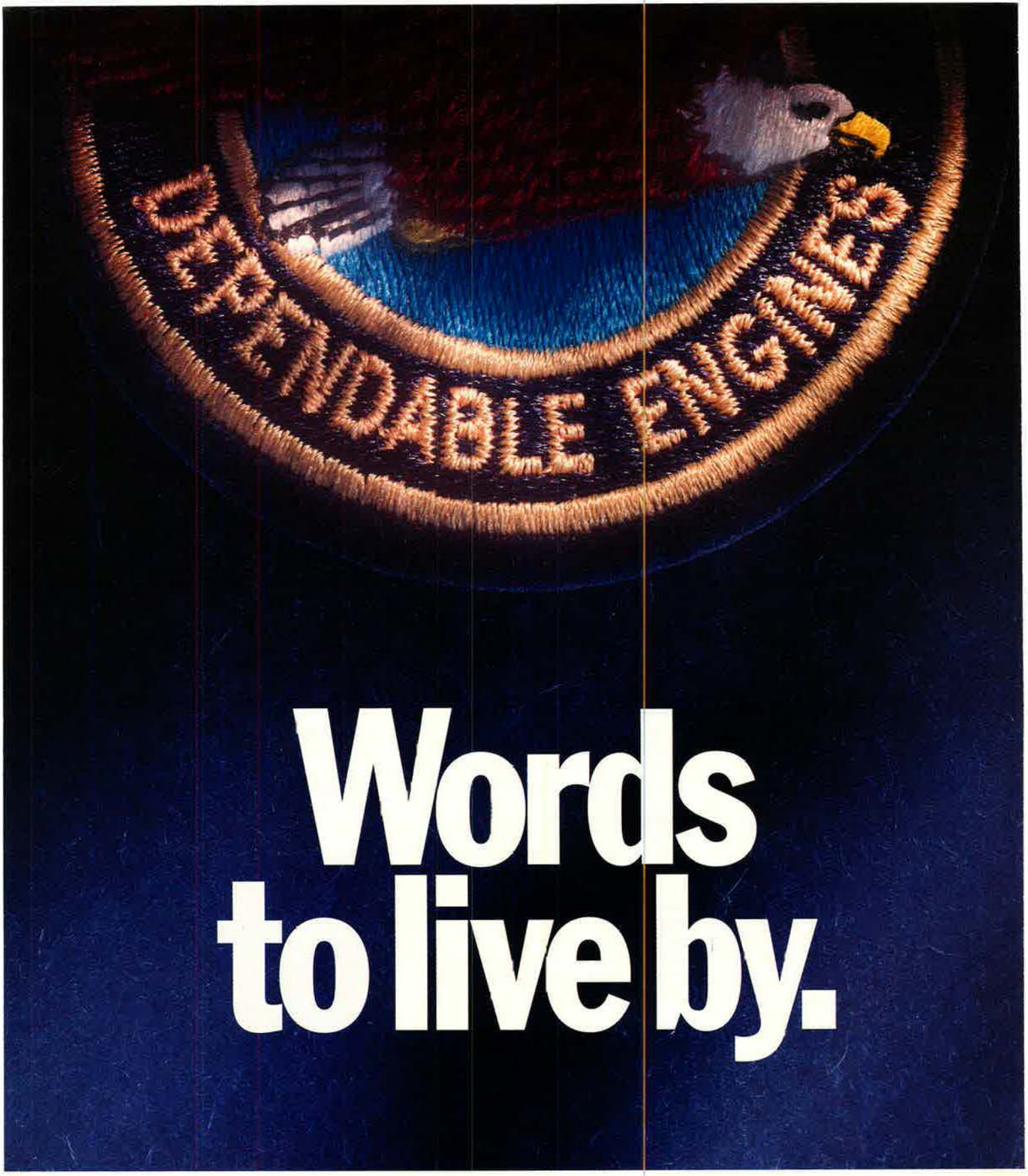

Words to live by.

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UNITED TECHNOLOGIES
PRATT&WHITNEY

Editorial

By John T. Correll, Editor in Chief

Health-Care Realities

In November, three days before he retired, Lt. Gen. (Dr.) Edgar R. Anderson, Jr., the USAF surgeon general, told Air Force News Service that the Air Force could no longer deliver on the promise of lifetime, no-cost health care at military medical facilities.

More than a third of the military hospitals that existed in the US in 1987 will be closed by 1997. Meanwhile, the retired military population has grown by leaps and bounds. The system can't handle the patient load.

Years ago in simpler times, generations of military members were promised health-care benefits for the rest of their lives to offset the lower pay and other exigencies of career service. That promise became even more important as the cost of medical care rose to unprecedented levels. Today, it is regarded as the number one noncash benefit.

From the 1960s on, direct care in military medical facilities was supplemented by the Civilian Health and Medical Program of the Uniformed Services (CHAMPUS). Planners did not foresee the inversion and overload on military hospital facilities that lay ahead in the 1980s and 1990s when force cuts set up a decline in medical infrastructure just as the large Cold War force was reaching retirement age. More than half a million retired beneficiaries lost access to military hospitals and clinics because of base closures.

Older retirees are hit especially hard. Military health programs close abruptly for them when they move over to Medicare at age 65. Up to now, military hospitals have been treating Medicare eligibles on a space-available basis, but that is wearing thin.

A provision called "subvention" would allow Medicare to reimburse the Defense Department for care provided to these older retirees, but Congress adjourned last fall without approving such subvention. A new bill will be introduced this year. It would particularly help the 55 percent of the over-65, Medicare-eligible military retirees who live within 40 miles of one of the military hospitals that remain.

As the Military Coalition said in testimony to Congress last year, the perception that military retirees have better-than-average health-care benefits is a myth. According to a 1994 survey by Hay Associates, the majority of corporate employers provide at least some coverage in addition to Medicare for their retirees. Military retirees must buy their own Medigap policies. It is further telling that about two million of the 8.4 million persons eligible for military medical care have obtained private health insurance instead.

The perception that military retirees have better-than-average health-care benefits is a myth.

Two years ago, budgeteers floated the preposterous notion that medical care for retirees was a "contingent benefit" rather than an entitlement. They have since retreated from that position under a barrage of evidence to the contrary. Government officials no longer deny that the promise of lifetime health care was made, although they continue to hedge about whether it was "contractual" or only a "moral commitment."

Either way, what the government says it will ultimately deliver for most retirees is some sort of civilian health-care program with enrollment fees and copayments. The centerpiece of the plan is Tricare, a series of managed-care options for active-duty and retired military families. Implementation is under way, and surveys say that those who have tried Tricare like it. Former Surgeon General Anderson said that one of the first things he was going to do after retirement was sign up for Tricare.

Under the option called Tricare Prime, patients are treated in military facilities when care is available there and by contract physicians when it isn't. Enrollment is free for the active-duty force, $460 a year for retired military families. Retirees who do not live in a Tricare Prime service area near a military hospital get Tricare Standard—previously known as CHAMPUS—which involves burdensome paperwork and has costly deductibles and copayments.

Many retirees, especially those without access to Tricare Prime, would like to join the Federal Employees Health Benefits Program, which covers 4.1 million federal beneficiaries. It offers a wide choice of doctors and excellent medical coverage. (It also avoids some of the problems of Tricare, such as vague and uncertain reciprocity agreements among the 12 geographic regions.) FEHBP is the health-care plan that members of Congress chose for themselves. A variation is "FEHBP-65," which would allow Medicare eligibles to enroll. The $1,377 premium for a family buys better coverage at less cost than Medicare supplements provide.

When the possibilities are arrayed, it is clear that one size does not fit all. The Air Force Association and the Military Coalition have taken the position that at least three options, supported and funded as necessary by the federal government, are required.

- Continued access, via subvention funding, to military hospitals for retirees after age 65.
- Tricare, for retirees who can take good advantage of it, for active-duty families who cannot afford enrollment fees in other programs, and because military doctors need patients other than healthy young people to maintain military readiness and medical proficiency.
- FEHBP, for those, especially older retirees, whose needs are not well met by the other options.

This isn't the way that either military members or the government thought 40 years ago that things would work out, but under the circumstances, it is the least—the very least—the government can do to redeem its obligation and to meet the health-care needs of those who served. ■

Letters

Lessons Unlearned

Congratulations to *Air Force* Magazine for finally cracking the wall of silence surrounding one of our most important issues: the primacy of strategic airpower to the Air Force mission. With your publication of Gen. Charles A. Horner's critically important article *["What We Should Have Learned in Desert Storm, But Didn't," December 1996, p. 52]*, perhaps now the debate can be fully joined on an issue that affects not just this year's budgetary priorities but no ess than the future of our Air Force as a separate service.

For too long, USAF's "mouthpiece" publications, *Air Force* Magazine included, have apparently tacitly accepted our current senior leadership's pronouncements about the blurring of strategic and tactical missions, about the doctrinal primacy of air superiority, and about the abilities of precision guided munitions (PGMs) to replace massive strategic strikes as the Air Force's primary instrument of power projection.

Now comes no less a personage than our "air boss" of the last war to blow all these pronouncements out of the water. Finally, someone with a primarily tactical background who understands strategic airpower application.

It should come as no surprise that events have transpired as they have. In the background of virtually every one of our senior uniformed Air Force leaders, one common element is clear: They are almost all fighter pilots. While they all possess impeccable tactical credentials, those very credentials have most assuredly been the primary influence on their collective outlook regarding which Air Force missions deserve the highest doctrinal and budgetary priority. They have crafted USAF's future to be centered on systems that, ultimately, merely support the accomplishment of other services' core functions.

Nowhere in our long-term blueprint is there a substantial (in terms of resource allocation) combat arms mission that the Air Force alone can do. In building our force structure to support such missions as the operation in Bosnia-Hercegovina or two nearly simultaneous regional conflicts, we may be sacrificing our ability to do those missions that will be necessary in the next "real" war—a war requiring a lot more than just surgical strikes and generating more than Nintendo-style, prime-time news footage.

War has always been a messy business, requiring *mass* application of force to achieve victory. This maxim has been proven repeatedly, most recently in the Persian Gulf War, and no amount of high technology can dent its immutability. As a nation, we turn our backs at our peril on building the capability (*i.e.*, meaningful numbers of the B-2) to deliver a massive blow against an adversary. As a service, we sacrifice such a capability in favor of other, peripheral capabilities at the risk of becoming irrelevant as a separate entity.

As a former bomber pilot, I applaud General Horner's courageous stand. I can only hope that his forthright and candid exposition on this critical national security issue will be the beginning of the long-overdue debate on the merits of long-range strategic airpower and its primacy to both USAF's mission and its long-term survival as a separate service.

Lt. Col. Peter M. McCarthy,
USAF (Ret.)
San Antonio, Tex.

General Horner's "What We Should Have Learned in Desert Storm, But Didn't" is the first intelligent discussion I've read on the use of the B-2 for the projection of US airpower into the twenty-first century. It should be required reading for all senators and representatives on Capitol Hill.

Perhaps the General didn't quite go far enough. What we need are four wings of B-2s at 36 aircraft per wing, plus six spares, for a total of 150 B-2s. One wing for training, one wing on alert, and two wings on standby, a minimum if you plan to move into the twentieth century with strategic airpower that's going to grab anybody's attention.

Long-range planning and the history of airpower tell us we're going to need this bird—and soon. The jigs and the tooling are in place, and 60 percent of the sunk costs have already been spent, so let's get cracking.

Maj. Maynard H. Kolb,
USAF (Ret.)
Seguin, Tex.

I agree with General Horner's view that bomber modernization is vital to our defense.

I see only one lesson of Operation Desert Storm: The US, its military, and its allies need to reduce their dependence on foreign oil. It is a simple truth—if not for Kuwait's oil, Iraq would never have invaded. It's time we learned this lesson.

Robert J. Ferrara
Phoenix, Ariz.

A Breath of Fresh Air

It's a breath of fresh air to learn that combat-tested Vice Adm. Donald D. Engen, USN (Ret.), is now leading the Smithsonian Institution's National Air and Space Museum *["It's a New Day at Air and Space," December 1996, p. 34]*. It is also good news that Lt. Col. Donald S. Lopez, USAF (Ret.), World War II ace, is his deputy director. . . .

Lt. Col. Tony Weissgarber,
USAF (Ret.)
San Antonio, Tex.

I was delighted to read "It's a New Day at Air and Space." Finally, some common sense at the greatest mu-

Do you have a comment about a current issue? Write to "Letters," *Air Force* Magazine, 1501 Lee Highway, Arlington, VA 22209-1198. Letters should be concise, timely, and preferably typed. We cannot acknowledge receipt of letters. We reserve the right to condense letters as necessary. Unsigned letters are not acceptable. Photographs cannot be used or returned.—THE EDITORS

seum in the world, and you certainly have my thanks for your efforts toward that end.

As for "The Revelations of Martin Harwit" *[p. 38],* Dr. Harwit can rest assured that I will spend my $27.50 on something other than his book.

Robert M. Bascom
San Jose, Calif.

The Pound-Wise F-16

I'm afraid I cannot sit idly by while Rudolph E. Nartker *["The Making of a Joint Fighter," December 1996 "Letters," p. 6]* not only besmirches the reputation of the F-16 but makes a flimsy, unsubstantiated argument against single-engine fighters in general.

Mr. Nartker, where are the facts and figures to support your wild claims regarding the F-16's reliability? You are aware of some crashes and some reported engine problems, but you cannot conclude anything from newspaper headlines and 15-second sound bites regarding the causality of these mishaps—certainly not that they could have been avoided if only the F-16 were a twin-engine aircraft. Also, what does an inadvertent jettisoning of stores have to do with the number of engines on an aircraft?

The versatile F-16 is by far the most prevalent aircraft in the Air Force inventory, not to mention one of the most predominant and combat-proven fighters in the world. Couple this with the multitude of high-risk missions it is assigned (*e.g.,* low-level attack, night interdiction, Suppression of Enemy Air Defenses) and brisk operations and training tempos and, inevitably, we are going to lose a few F-16s every year. These losses are attributable to a wide variety of causes, one of the more common being controlled flight into terrain. Anyone would be hard-pressed to build a statistically solid case against the single-engine aspect of the F-16.

Survivability is a function of much more than just an aircraft's ability to take a hit and keep flying. Other variables in the equation include stealth, maneuverability, and countermeasures capability. A smaller, single-engine fighter is inherently more agile and more stealthy than a larger, twin-engine aircraft. Therefore, it is less likely to be detected, tracked, fired on, or hit. Considering the lethality of modern weaponry, it makes more sense to emphasize threat avoidance rather than the ability to survive taking hits.

Realistically, once it is hit, a twin-engine fighter is probably not much more survivable than a single-engine fighter—it is very difficult to isolate catastrophic battle damage to one engine bay once the engine comes apart. The number of engines is irrelevant in cases of damage to flight-control systems. I would be interested to see any statistics or evidence to counter this argument.

Finally, we cannot use Vietnam-era fighters, such as the venerable twin-engine F-4 and legendary single-engine F-105, to argue this case. Modern propulsion technology and resultant engine reliability, as demonstrated by F-15s and F-16s of the 1970s and 1980s, are a quantum leap better. The engines that power tomorrow's F-22 and Joint Strike Fighter will be even more efficient, reliable, and trustworthy.

As Mr. Nartker acknowledged in his letter, a single-engine fighter makes sense economically. I argue that it also makes sense from a survivability standpoint—penny-wise and pound-wise.

Capt. Allan J. Smith,
USAF
Burtonsville, Md.

Airpower Flexibility

I read with great interest "The Rediscovery of Strategic Airpower" *[November 1996, p. 26].* The opinions of both author John T. Correll and one of his quoted sources, Maj. Gen. Charles D. Link, represented an unashamed and unrepentant advocacy of airpower that I found revitalizing. Nonetheless, it concerned me that the article contended that airpower has become the dominant factor in warfare, without reservation.

Airpower, particularly the strategic use of airpower, certainly proved itself as the decisive force in the Persian Gulf War. The article is correct: Operation Desert Storm represents a point in military history at which technology—such as precision guided munitions and stealth aircraft—has caught up with the classic airpower doctrine espoused by the founders of the US Air Force. There is no disputing that essential point.

I would argue, however, that classic airpower doctrine cannot be applied equally across the realm of human conflict. While such doctrine proved its effectiveness when married with the appropriate technology, as in Desert Storm, it does not necessarily follow that airpower will enjoy the same relative effectiveness during a campaign similar to that in Vietnam prior to the Tet Offensive.

General Link may be correct when he states, "By 1965, thinking of airpower as an auxiliary force . . . had

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Letters

pretty much become a habit" with regard to tactical air assets. However, I do not agree that "Vietnam could have given us an opportunity to rethink this idea, but we didn't take that opportunity."

First, the guerrilla nature of the war in Vietnam before Tet was such that it emasculated and frustrated the effective use of airpower. There were no supply lines to interdict, no massed forces to attack, and the Viet Cong could have carried on whether or not USAF removed Hanoi from the map.

After the Tet Offensive, the war took on a much more conventional character, and USAF capitalized on that shift, at least to the degree that political and diplomatic concerns (such as averting World War III) would allow. . . .

While I agree that Desert Storm vindicated the classical airpower theorists, I feel that the Air Force must recognize that classical airpower theory cannot be applied in every conflict with the same degree of success. *Flexibility* is the key to airpower. The challenge is to make our doctrine flexible enough that we will not hesitate to use strategic air attack when appropriate but that we will not foolishly expend lives and resources in such an attack when it is futile.

1st Lt. Alexus G. Grynkewich, USAF
Eielson AFB, Alaska

Remember the Navigators

I enjoyed "The Fast Pace of Special Ops" *[September 1996, p. 50]*. I was a bit surprised that the opening statement, "The Air Force's special operations forces—a relative handful of pilots, combat controllers, pararescuemen, and support groups," left out the special operators who wear navigator wings and the enlisted crew members. Those of us with navigator wings outnumber pilots on the fixed-wing side of the house, and the enlisted crew members outnumber the rated officers across the board.

The current commander of the 4th Special Operations Squadron wears navigator wings (fire-control officer), and the next commander proudly wears navigator wings (electronic warfare officer) as well. This is certainly not a swipe at our pilots—they are the best around—just a reminder that our missions are accomplished by rated officers and enlisted crew members working together as a team. I long ago accepted that the mainstream media will only mention pilots in their stories. However, I expected more from *Air Force* Magazine.

Maj. Brian Johnson, USAF
4th SOS
Hurlburt Field, Fla.

Bismarck Sea Bomb Groups

"Victory in the Bismarck Sea" *[August 1996, p. 88]* is misleading. It would have been better labeled "Lt. Gen. George C. Kenney Remembers Old Friends in the Bismarck Sea Battle." At the time of the Bismarck Sea Battle, two B-25 bomb groups were in New Guinea: the 3d BG, which the article discusses, and the 38th BG, which was not mentioned.

Both groups had about the same number of aircraft engaged in the battle, and both had about the same number of ships destroyed to their credit from the same low-level tactics. However, the 3d BG flew aircraft converted to the strafing configuration, *i.e.*, eight .50-caliber machine guns in the nose of the aircraft. These B-25s had four guns in what had been the bombardier's compartment and two gun pods of two guns each, one on each side of the fuselage. The 38th BG aircraft did not receive the added guns until a week or two later. Therefore, Australian Beaufighters were used to provide to the 38th BG the strafing power that the 3d BG possessed. . . .

The 38th BG was also at Rabaul. The 38th destroyed the Japanese base at Wewak during the last week of August 1943 with the final destruction on September 2, 1943, a day and events I will always remember. The 3d BG did not participate in that action. That is not meant to demean the 3d BG, nor could I, because that group was a very effective force, but so was the 38th. The story of the low-level B-25C-1 strafers in the Pacific is a valuable story that has hardly been remembered. . . .

Roy Lee Grover
Santa Maria, Calif.

Erratum

In "Aviation Hall of Fame" *[January 1997, p. 42]*, an editing error rendered the entry for Hans P. von Ohain incorrect. Dr. von Ohain's biographical data should have read, "Chief scientist of USAF's Aerospace Research Laboratories from 1963 to 1975 and chief scientist, Aero Propulsion Laboratory, from 1975 to 1979." We regret the error.—THE EDITORS

Capitol Hill

By Brian Green, Congressional Editor

Senator Levin Steps Up

Sam Nunn's replacement as senior Democrat on the Armed Services Committee is a sharper critic of the Pentagon.

IN NATIONAL security affairs, the 105th Congress won't feature many significant transitions. One truly notable shift of power, however, concerns the rise of Sen. Carl Levin (D-Mich.) as senior Democrat on the Senate Armed Services Committee in the wake of Sen. Sam Nunn's retirement.

With Senator Nunn's departure, the Senate loses a moderate-to-conservative defense intellectual with a deep understanding of national security issues and a reputation for bipartisanship. Senator Nunn, though he had an independent streak that caused him to clash on occasion with the Defense Department, had a record of consistent support for DoD programs.

Now, Senator Levin's ascendancy puts him in a position of considerable influence. Compared to Senator Nunn, he is a sharper critic of the Defense Department and the military services. His voting record demonstrates greater opposition, in general, to Pentagon programs and priorities and a stronger emphasis on arms-control issues and acquisition and management problems.

This record frequently has put Senator Levin in conflict with the Republican majority, much more than was the case with Senator Nunn.

Senator Levin brings to his new leadership post a reputation for being a highly intelligent, shrewd, and tenacious negotiator. Senator Nunn recently said, "I used Carl Levin as one of my secret weapons when we went into conference with the House on the annual defense authorization bill. . . . I only had to threaten to turn an issue over to Carl Levin to break a conference deadlock."

Senator Levin, however, professes a sincere belief in bipartisanship when considering key foreign policy and national security issues. "Particularly in the defense area, most major issues . . . can only be resolved on a bipartisan basis," he said in a recent session with journalists.

The Senator counts as a success a ballistic missile defense (BMD) compromise in the Senate's Fiscal Year 1996 defense authorization bill. In this, he worked with Senator Nunn and two senior Republicans—Sen. John W. Warner of Virginia and Sen. William S. Cohen of Maine, Secretary of Defense–designate. Ultimately, President Clinton vetoed the measure anyway, largely because of disagreements over the BMD provisions.

Missile Defense—Again

Senator Levin believes that BMD again will be a key issue in the 105th Congress. He continues to favor technology development to support a decision after the turn of the century on whether or not to deploy defenses.

"During this period of [technology] development," he argued, the US should "attempt to negotiate changes in the ABM treaty bilaterally with Russia, so we don't take unilateral steps, . . . which could undermine our arms-control progress."

That sentiment reflects Senator Levin's long commitment to arms control and distrust of military solutions to the dangers posed by weapons of mass destruction. Throughout his career, he has consistently voted to curtail nuclear modernization programs and lower funding levels for ballistic missile defenses.

He also has been a key supporter of the Chemical Weapons Convention to ban the production, possession, and use of chemical weapons. The Administration intends to push hard for approval early in this Congressional session, and Senator Levin will help lead that fight.

While arguing that nuclear weapons are "expensive and useless," he has been more amenable to the need for strong conventional forces. Even here, however, he frequently clashes with the Pentagon. He has held true to the notion that national interests are best served by maintaining smaller, more capable conventional forces at a high state of readiness.

Last year, for example, he led an unsuccessful fight to reduce the buy of attrition reserve F-16 fighters. But he has in the past supported the acquisition of additional stocks of precision munitions to improve the capabilities of existing conventional forces.

In 1988, he published a study that maintained that NATO technology and readiness advantages largely offset Soviet numerical superiority in Europe. Today, he believes that the Quadrennial Defense Review (QDR) of forces, budgets, and strategy under way in the Pentagon should take a careful look at "what capabilities we can build on that might permit us to have a smaller force structure" while still meeting such threats as proliferation and terrorism.

The Michigan Democrat intends to focus on DoD efficiency, as he has in the past. He is a strong advocate of joint initiatives and acquisition reform and is not shy about going after programs he thinks are poorly run.

Watching the F-22

In this coming session, for example, he intends to keep a careful eye on the F-22 fighter program. "It is clear that we ought to avoid excessive concurrency. We are not facing a situation where we ought to be taking big risks," he said. In the past, he supported the B-2 stealth bomber "until the management of the program by the Air Force raised serious concerns the taxpayers would not be getting the plane that they paid for."

He argues against additional acquisitions of the B-2 as "an inexcusable waste of money." The Senator indicated that DoD financial and inventory management, areas in which it has had problems in the past, will continue to receive his attention in 1997.

Overall, however, the Senator believes that 1997 will be a year of review and reflection rather than dramatic change. A combination of the continuing QDR, the National Defense Panel commentary on the QDR results, a new Secretary of Defense, and a strong emphasis on bipartisanship, he says, will prevent "any major shift taking place either in budget or policy in defense" this year. ■

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Aerospace World

By Suzann Chapman, Associate Editor

Air Staff Gets New Look

The Air Force has changed its Air Staff organization "to more effectively employ its warfighting capabilities," according to a December statement. The changes mark the first top-level reorganization since 1991.

The reorganization took effect last month and made several changes to the deputy chief of staff, assistant DCS, and directorate structure. The DCS for Plans and Operations split into the DCS for Operations and the DCS for Plans and Programs. USAF eliminated the ACS for Intelligence and made intelligence part of the DCS for Operations. The DCS for Plans and Programs absorbed the directorate for Programs and Evaluations.

The DCS for Logistics became the DCS for Installations and Logistics and absorbed the directorates of Civil Engineer and Services. The DCS for Communications and Information became a directorate. And, finally, the Air Force created a new directorate, called Security Forces, with responsibility for force protection.

Air Force officials stated that the merger of intelligence with operations would "lead to creation of an information-operations culture." The DCS for Operations now controls functions in intelligence, surveillance and reconnaissance, weather, command and control, and operations.

The service also wanted to centralize programming and planning processes. The new DCS for Plans and Programs now hosts all long-range planning efforts and ties "the revitalized long-range planning process" into programming plans to meet national objectives.

The new Security Forces directorate also will oversee a new direct reporting unit, slated to be located at Lackland AFB, Tex. Air Force officials said the new DRU would focus on quick and effective responses to protect airmen around the world.

The Air Force Doctrine Center will move from Langley AFB, Va., to Maxwell AFB, Ala., where it will become a DRU. Another new DRU, the Air Force Communications Center, will set up in the Washington, D. C., area. The service expects to establish all three DRUs in April.

On December 5 at the Pentagon, US Postal Service and Air Force officials unveiled this 1997 commemorative stamp featuring the USAF Thunderbirds. The stamp honors the Air Force's fiftieth anniversary and goes on sale September 18.

EELV Enters New Phase

The Air Force announced on December 20 the selection of Lockheed Martin and McDonnell Douglas for the next phase in its Evolved Expendable Launch Vehicle program.

The EELV is to be based on a single, modular family of launch vehicles designed to replace the current medium- and heavy-lift expendable launchers—Delta, Atlas, and Titan.

Each company will receive $60 million for the 17-month pre–engineering and manufacturing development (pre-EMD) phase. The two companies competed against Alliant Techsystems and Boeing in a 15-month, low-cost concept validation phase.

Once the pre-EMD phase is concluded, USAF will select a single contractor to develop the standardized EELV family of boosters. The estimated contract value is $1.6 billion.

Service officials expect the EELV program to cost at least 25 percent less than existing launch vehicles. They estimate savings of $5 billion to $10 billion between 2002 and 2020. The first test launch of the EELV medium-lift version is set for Fiscal 2001 and the first government operational payloads for the following year.

Teams Develop New Core Boosters

Both Lockheed Martin and McDonnell Douglas have developed common core booster designs based on long-running, proven launch vehicles. Each also selected new first-stage main engines.

Lockheed Martin bases its EELV concept on an updated version of its Atlas booster, the Atlas IIAR, powered by the new RD-180 engine, developed by Pratt & Whitney and its Russian partner, NPO Energomash. The company plans to launch the first Atlas IIAR in December 1998. It expects to use the RD-180 as the baseline engine for its EELV entrant, as well as the Agena 2000, developed by Atlantic Research Corp. and Aerojet, for its storable propellant upper stage and the Pratt & Whitney RL-10E for the Centaur upper stage.

Boeing, McDonnell Douglas to Merge

Boeing and McDonnell Douglas in December announced their decision to merge, the first step in a $13.3 billion transaction that will create "the world's largest aerospace company."

Only weeks earlier, Boeing successfully acquired Rockwell aerospace and defense units—now grouped under the title Boeing North American, Inc.—for approximately $3.2 billion. Acquisition of McDonnell Douglas means that the new megacompany will have about 200,000 employees and operate in 27 states.

Boeing estimates its 1997 revenues will top $48 billion.

Based on those numbers, Boeing would step ahead of Lockheed Martin in the lineup of defense aerospace giants, which may soon have even fewer major players. Various reports predict that 1997 will feature more defense business gamesmanship—most likely, major buyouts of Hughes Electronics and Texas Instruments' military interests.

Consolidations within the defense industry have been considered a necessary response to the Pentagon's overall scaling back of its forces. However, some defense analysts wonder now whether the trend may have gone too far. Other analysts and some senior Pentagon officials believe the Boeing–McDonnell Douglas combination will create an entity capable of competing successfully with Lockheed Martin.

Two industrial teams, one led by Boeing and another by Lockheed Martin, were selected in November to compete for the Joint Strike Fighter, the only major combat aircraft program in the foreseeable future. *[See "JSF Competition Narrows," January 1997 "Aerospace World," p. 9.]*

The following month, the Air Force selected McDonnell Douglas and Lockheed Martin for the final stage of its Evolved Expendable Launch Vehicle program. *[See p. 9.]*

Moreover, Boeing's merger with McDonnell Douglas leaves the Washington-based aerospace giant on center stage as the nation's only manufacturer of large commercial jets.

The two companies agreed to retain the Boeing company name, but officials stated that they "do not intend to let fade the proud heritage of the McDonnell Douglas name." Officials said their target for approval by the two companies' shareholders and government regulators is mid-1997.

Plans call for company headquarters to remain in Seattle. Principal manufacturing entities will operate in three locations: the Puget Sound area of Washington state; Saint Louis, Mo.; and southern California.

Boeing's current president and chief executive officer, Philip M. Condit, will be chairman and CEO of the new industrial giant, while McDonnell Douglas's president and CEO, Harry C. Stonecipher, will be president and chief operating officer.

Boeing and McDonnell Douglas Programs by Market Segment

(The companies are sole or primary subcontractors on the following systems.)

Boeing	McDonnell Douglas
Defense Systems	
Airborne Warning and Control System	AH-64 Apache
Attack Laser aircraft**	Airborne surveillance
Aircraft modifications	AV-8B Harrier
Bombers	C^4I systems
CH-47 Chinook	C-17 Globemaster III
Defense electronics	F-15 Eagle
F-22 fighter	F/A-18 Hornet
Government Contractor Logistics Support	Harpoon missile
Intercontinental ballistic missile systems	Information warfare
Information systems	Joint Direct Attack Munition
Joint Strike Fighter**	KC-10 tanker
Maritime patrol aircraft	Mast-mounted sight for OH-58D Kiowa scout helicopter
RAH-66 Comanche	Standoff Land-Attack Missile/Joint Air-to-Surface Standoff Missile
Tactical missiles	T-45 trainer
Tankers/transports	Thermal imaging
V-22 Osprey	Training systems
Space Systems	
Commercial space systems	Delta II and III Expendable Launch Vehicle
Global Positioning System satellites	Titan IV payload fairing
Launch vehicle propulsion	
Sea launch	
Space launch processing	
Space shuttle programs	
Delta ELV and propulsion*	Delta ELV & propulsion*
Evolved ELV*	EELV*/**
Space station prime and module construction*	Space station prime and module construction*
Commercial Aircraft	
737-series	MD-11
747-400	MD-80/90
757-200/300	MD-95
767-series	MD-500 helicopter
777-200/300	MD-600 helicopter
BB-609 light civil tiltrotor	MD-Explorer helicopter

*Boeing and McDonnell Douglas are teamed on these projects.

**One of two companies participating in program competition.

McDonnell Douglas plans to use a variation of its Delta boosters coupled with Boeing's new Rocketdyne RS-68 for its EELV concept. The Delta IV will use common hardware and software employed on existing Delta II and III boosters. It plans to use an Aerojet engine for its Delta IV small booster and a Pratt & Whitney engine for the second stages of its Delta IV medium and heavy boosters.

USAF Wraps Up Khobar Probe

The Air Force has wrapped up its review of the June 25 bombing of the Khobar Towers housing complex in Dhahran, Saudi Arabia, which left 19 airmen dead. The service review exonerates senior officers, in contrast to the DoD report issued September 16, according to news accounts.

The service had not officially released its conclusions by year's end. However, widespread news reports indicated that the Air Force had decided not to take any action against commanders responsible for protection of the housing complex.

The Pentagon's own review, headed by retired Army Gen. Wayne A. Downing, had faulted the entire command structure and specifically cited Brig. Gen. Terryl J. Schwalier, the senior USAF commander in Dhahran, for failing to take appropriate action against possible attacks.

The news reports prompted several lawmakers to label the Air Force decision a whitewash. Some Congressmen called for immediate hearings on the issue, while others who were still critical of USAF's supposed findings, wanted to wait for the official release.

The Air Force had intended to release its review in December, but officials stated it was still under legal review. According to a DoD spokesman on December 17, the Air Force had not briefed Defense Secretary William J. Perry on the report.

USAF Keeps "Footprint" in Balkans

As the original Clinton Administration deadline for removing US troops from peacekeeping duties in Bosnia-Hercegovina changed from December 1996 to spring 1997, then possibly to 1998, one thing did not change: Air Force support.

The NATO-led implementation force changed to a stabilization force in December, but work for USAF operations in the theater, by such units as the 4100th Air Base Group (Provisional) at Tuzla, has not changed. Gen. Michael E. Ryan, commander of US Air Forces in Europe, told Air Force journalists on November 28, "I think that as the political decision is being made for the United States to participate in the follow-on force, that we will probably keep the footprint that we have here at Tuzla about the same as it is right now."

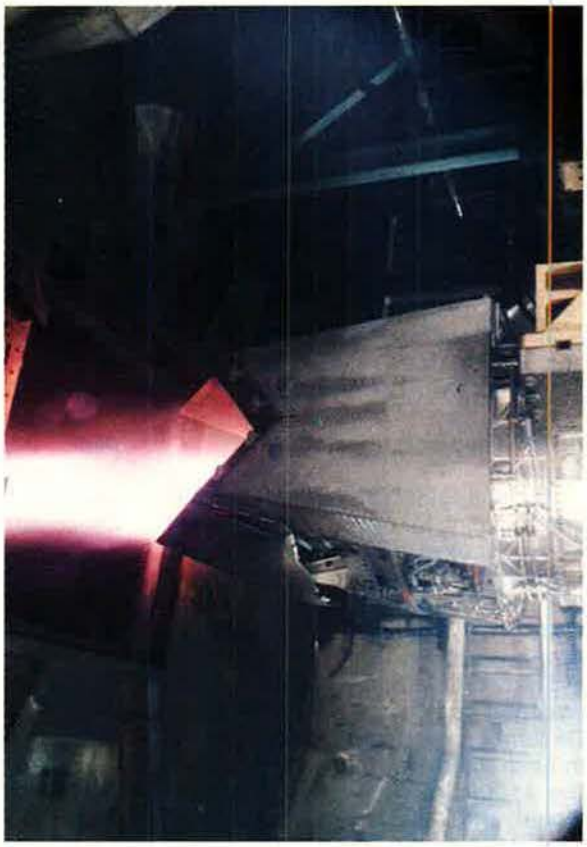
General Ryan did not see a change in USAF support for Operation Joint Endeavor at least through May 1997. He also dispelled rumors that deployments might go beyond the USAF-preferred limit of 120 days as the operation lengthens.

Fighter Cockpits Open

Faced with a shortage of fighter pilots, the Air Force has decided to open combat aircraft cockpits to some pilots of its other aircraft, including helicopters.

The first board to select candidates met last month and will be followed by five others as the service attempts to fill 150 fighter assignments over the next three years. Each board will select 25 pilots.

Air Force personnel officials said that they don't anticipate a problem filling the vacancies since about 600 pilots meet their criteria for selection. They noted that during the drawdown, fewer fighter assignments were avail-



The exhaust nozzle of Pratt & Whitney's F119 engine is undergoing tests at the Air Force's Arnold Engineering Development Center, Arnold AFB, Tenn. The F119 is the powerplant for the F-22, the service's new air-superiority fighter.

able as pilots completed undergraduate pilot training. The Air Force Personnel Center has already received many inquiries about the crossflow opportunity.

However, some major commands expressed reservations about the effect the transfer to fighters might have on their aircraft. To avoid potential problems, personnel officials stated that the selection boards will include members from the major commands involved.

Generals Seek Nuclear "Abolition"

Only three years ago, Gen. George Lee Butler, USAF (Ret.), headed the nation's nuclear forces as commander in chief of US Strategic Command. He also had served as the final commander in chief of the Air Force's Strategic Air Command. On December 4, at the National Press Club in Washington, D. C., General Butler called for elimination of the world's nuclear arsenals.

He is working with retired Army Gen. Andrew J. Goodpaster, the former Supreme Allied Commander Europe, and 57 retired flag officers around the world to press for more reductions and ultimately abolition of nuclear weapons.

In a joint statement, the two US generals said that, because the process could take decades, "the time for action is now, for the alternative of inaction could well carry a high price."

Responding to questions about General Butler's remarks, various Administration officials—including Secretary of Defense Perry—noted that complete elimination was unrealistic and maintained that nuclear weapons continued to provide an effective deterrent.

General Butler stated that, in recent years, he has made an "arduous intellectual journey from staunch advocate of nuclear deterrence to public proponent of nuclear abolition." However, he said that while he never imagined the end of the Cold War in his lifetime, he saw it as an opportunity to restore "a world free of the apocalyptic threat of nuclear weapons."

Another outspoken critic of nuclear weapons, retired USAF Gen. Charles A. Horner, said such weapons can be reduced, but he added, "We must always be prepared to live in a world where there are a limited number of nuclear weapons." General Horner, the Operation Desert Storm air component commander, gave his views on the Public Broadcasting System's "NewsHour With Jim Lehrer."

General Horner said he learned during the Persian Gulf War that nuclear weapons had diminishing utility and that the US must deter nations that have nuclear weapons by using "very strong conventional forces, such as B-2s and laser-guided bombs."

General Butler also stated that the Clinton Administration's 1993 Nuclear Posture Review was a "far from sufficient step" and "purposefully avoided the larger policy issues." He called for a "sweeping review" of US nuclear policies and strategies.

Everything on the Table?

DoD's Quadrennial Defense Review (QDR) started with the premise that "everything is on the table" as the Pentagon sought to shape itself for the twenty-first century. Deputy Defense Secretary John P. White told reporters on December 12 that nothing would be sacrosanct and the emphasis would be on innovation and jointness.

The deputy secretary also stated that he had delivered the same message privately to senior leaders for each service when he told them to "be realistic and be collegial in terms of making and adjusting to the changes that we have to make."

However, the Washington *Times* reported the next day that decisions essentially already had been made to put some Army and Air Force elements on the chopping block. The *Times* stated that defense leaders—encouraged by Clinton Administration officials—were considering the elimination of two active-component Army divisions and three of USAF's 20 remaining fighter wings. The Navy would keep its 350 ships but could lose one or two air wings.

According to Secretary White, the QDR will "reexamine our assumptions" about DoD's approach to determining military requirements. He added that it's time "to do a longer-term assessment" keeping within the President's budget guidance—about $250 billion over the next five years.

Since 1993, the Pentagon has operated under the hotly debated two-major-regional-conflict strategy introduced by then–Defense Secretary Les Aspin's Bottom-Up Review. One major criticism has been that the military budget simply cannot sustain the two-MRC as well as peacetime-contingency operations.

Civilian Review Panel Eyed

In addition to its own review, DoD faces two independent assessments—one by the Chairman of the Joint Chiefs of Staff (JCS) and one by a

McDonnell Douglas delivered the first operational test Standoff Land-Attack Missile–Expanded Response (SLAM ER) to the Navy on December 17. Low-rate initial production for the upgraded SLAM begins next month.

National Defense Panel, made up of nine private citizens knowledgeable about defense—mandated by Congress in the Fiscal 1997 defense budget conference report.

Pentagon officials expected to disclose the names of panel members following Congressional approval by the first of the year.

The NDP's initial report is due by the middle of next month. The Pentagon must complete the QDR and report to Congress by May 15. The review by JCS Chairman Army Gen. John M. Shalikashvili is also due to Congress on May 15.

Secretary White and USAF Gen. Joseph W. Ralston, JCS vice chairman, head the QDR steering group. The review structure also includes a strategy panel, force-structure panel, and human resources panel. An integration group will coordinate the information from the various panels.

As well as reviewing the Pentagon's efforts, the nine defense experts are also supposed to develop an alternative force structure. Congress wants that report by December 1, 1997.

Reserve Crash Claims 10

An Air Force Reserve HC-130P with 11 Reservists on board crashed November 22 into the Pacific Ocean about 60 miles off the coast of northern California.

The Coast Guard rescued TSgt. Robert T. Vogel, an airborne communications specialist from Albany, Ore., but the other nine crew members and one passenger, all members of the 304th Rescue Squadron at Portland IAP, Ore., were killed in the accident.

The crew reported to Oakland Center at about 7:30 p.m. that they had shut down one engine and had electrical problems. Air traffic controllers at Oakland, Calif., and Seattle, Wash., lost radar and radio contact soon after that report.

Those killed were Capt. Robert P. Schott, aircraft commander, West Linn, Ore.; Capt. Brant Ferrarini, aircraft commander, Tigard, Ore.; Lt. Col. John W. Keyes, chief of Standardization and Evaluation, Troutdale, Ore.; Capt. Kirk A. Wellnitz, navigator, Portland, Ore.; SMSgt. Robert J. Roberts, flight engineer superintendent, Milwaukie, Ore.; TSgt. David W. McAuley, loadmaster, Gresham, Ore.; SSgt. James R. Johnson, loadmaster trainee, Brush Prairie, Wash.; SSgt. Marvin H. Forrest, aircraft mechanic, Vancouver, Wash.; SSgt. Ronald E. Garner, Jr., aircraft mechanic, Silverton, Ore.; and SSgt. Jonathan Leonard, intelligence operations specialist, Tigard, Ore.

At about 9:00 p.m., a Coast Guard helicopter crew pulled Sergeant Vogel, who had been clinging to an aircraft seat cushion, from the frigid waters.

Crash Investigations Complete

The Air Force recently announced the results of three aircraft accident investigations into separate incidents involving a T-3A, C-130, and F-16.

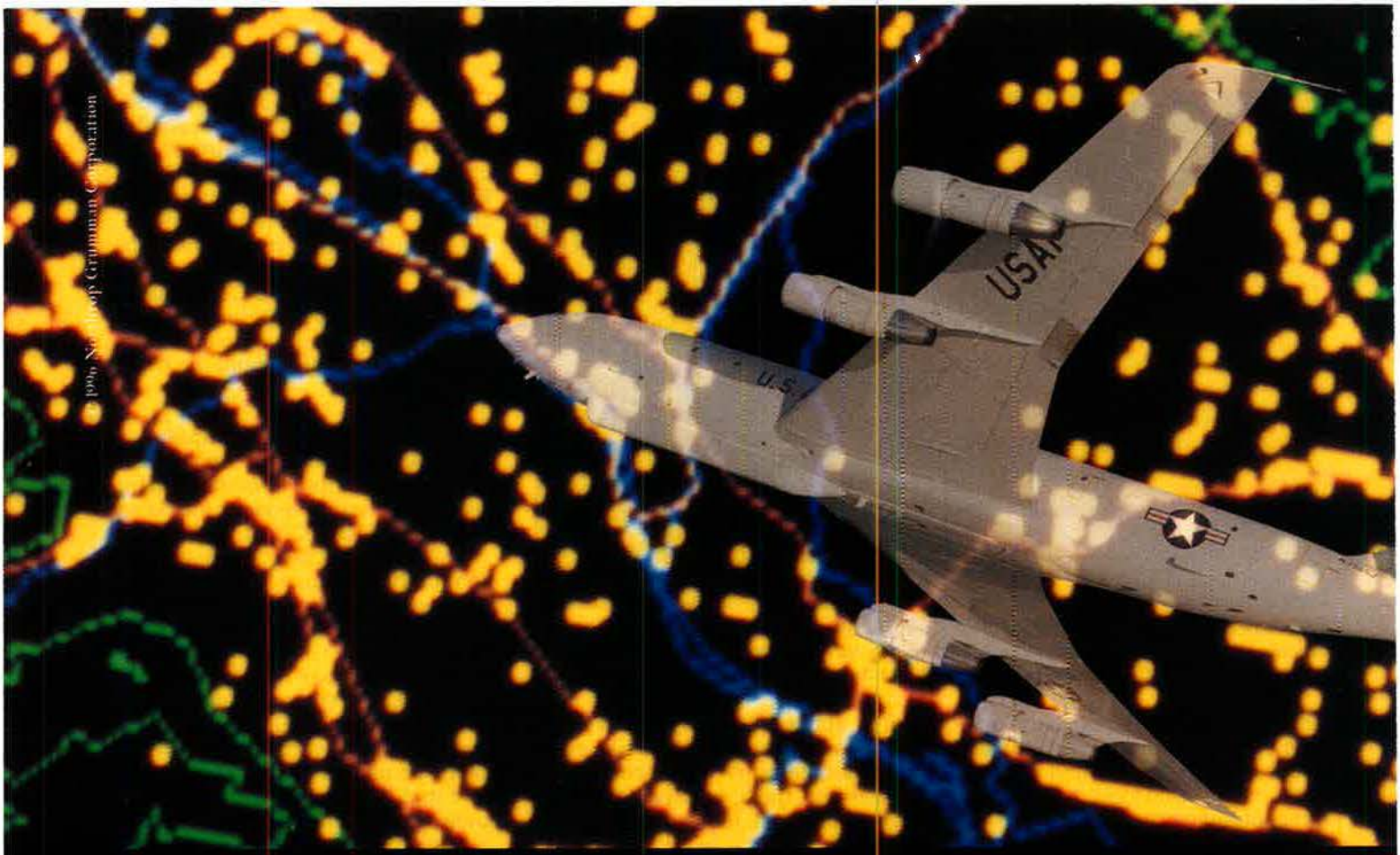
The T-3A crashed September 30 near Calhan, Colo., killing both a US Air Force Academy instructor pilot, Capt. Clay D. Smith, and a student, Cadet Dennis P. Rando *[see "News Notes," December 1996 "Aerospace World," p. 16]*. The report stated that the accident "was caused by a stalled condition from which the instructor pilot was unable to recover." It also said that "the engine quit for an unknown reason prior to the stall entry."

Inspections of the engine and maintenance records did not show why the engine stopped, according to a USAF release. The T-3A had been delivered to the 557th Flying Training Squadron, an Air Education and Training Command unit at the Academy in Colorado Springs, Colo., on March 27, 1996. Its last scheduled 50-hour maintenance inspection took place on September 18.

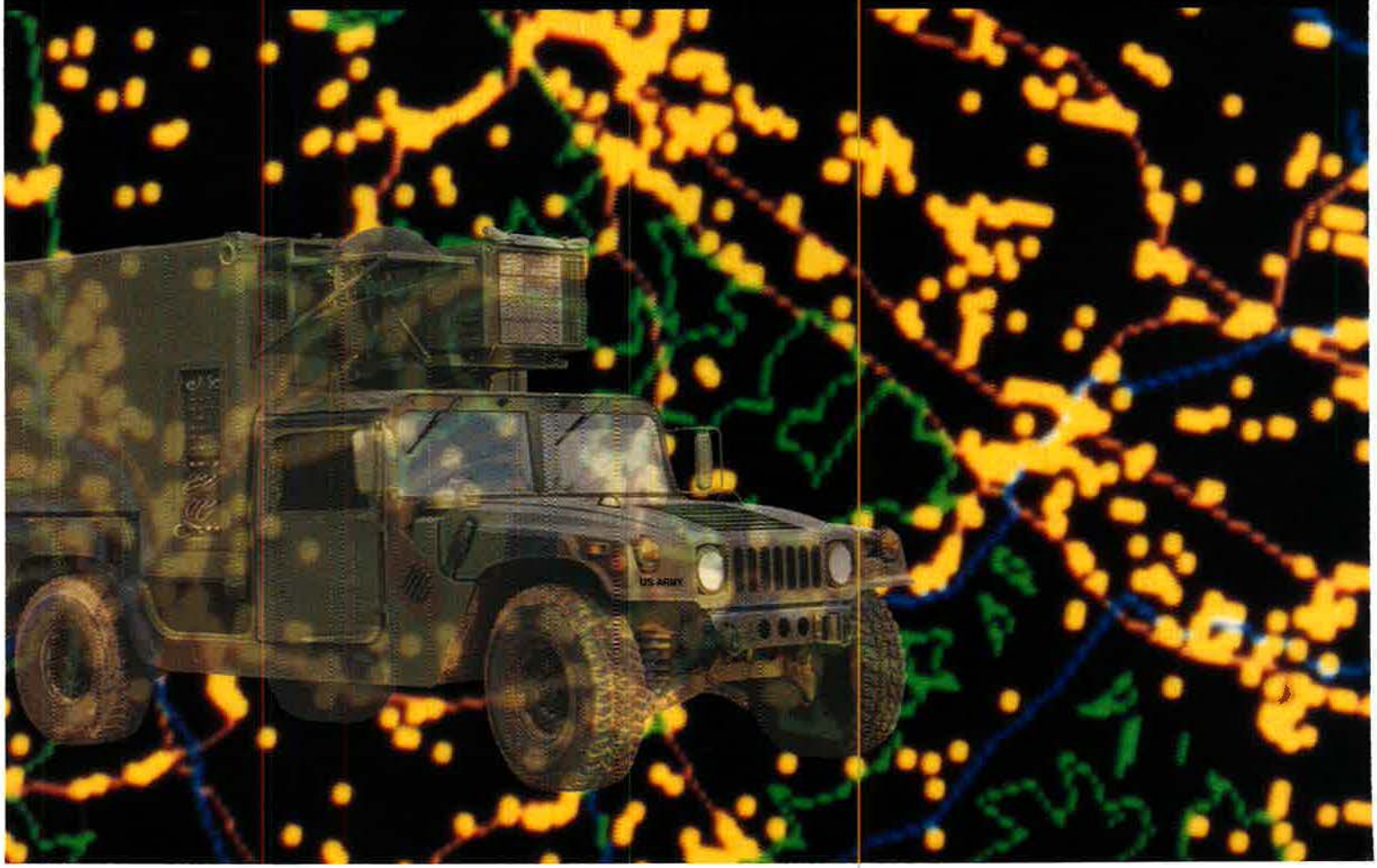
Investigation into the August 17

Lockheed Martin photo by John Rossino

Lockheed Martin completed assembly of the last H model C-130, ending a 32-year production run for this version of the Hercules. (For details on the C-130J, see "Snapshots of Force Modernization," p. 20.)



Providing and exploiting unprecedented situational awareness make it one of America's most effective



crash of a C-130 near Jackson Hole, Wyo. *[see "C-130 Crash Claims Nine," October 1996 "Aerospace World," p. 11.],* concluded that crew error caused the crash. According to the report, the crew failed to monitor the aircraft's position and flight path in relation to the high terrain surrounding Jackson Hole Airport.

According to the third report, a piece of concrete or very rough rock damaged an engine fan blade, causing the July 11 crash of an F-16 into a residential area near Pensacola, Fla. *[see "News Notes," September 1996 "Aerospace World," p. 23].* The pilot, Maj. Frederik G. Hartwig, ejected without serious injury, but the aircraft killed a four-year-old boy and injured his mother.

Although the foreign object caused "catastrophic failure" of a fan blade, followed by engine flameout, the report also cited insufficient actual straight-in simulated flameout approach training as a contributing factor. Noting that the pilot's simulated flameout knowledge "is excellent," the investigating officer stated that the mishap circumstances "didn't necessarily lend themselves to a textbook solution."

The pilot was flying the fighter from Shaw AFB, S. C., to Eglin AFB, Fla., to avoid Hurricane Bertha, when an engine failed and he tried to make an emergency landing at Pensacola Regional Airport, Fla. The report noted that the pilot could not see how densely populated the residential areas north of the airfield were until he was actually committed. He stayed with the aircraft, trying to aim for the most open area until the aircraft was at 209 feet and no longer responding to controls.

DoD Posts Safe Year

The Pentagon announced December 9 that Fiscal 1996 had been "its safest year ever." It cited a steady six-year decline in the major accident rate for aircraft, despite a rise in aviation-related fatalities—from 85 the previous year to 108.

Included in the 108 were 35 fatalities from the CT-43 crash that killed Commerce Secretary Ronald H. Brown and 34 others last April. Overall, the on-duty fatality rate for military members, federal civilian employees, and bystanders dropped from 206 to 171.

The number of aircraft totally destroyed hit "an all-time low of 67, down from 69 in the previous year," according to a DoD statement. The number of aircraft accidents per 100,000 flying hours dropped from 1.53 to 1.50.

Additionally, the department reported that the number of off-duty accidental deaths of military members dropped from 376 to 293, another all-time low.

USAF Posts Gains, Losses

Fiscal 1996 proved to be a record year for the Air Force in flying safety with four "best ever" marks and the second-lowest Class A mishap rate ever, according to Brig. Gen. Orin L. Godsey, USAF's chief of Safety. Class A mishaps are those involving either a fatality, more than $1 million in damage, or a destroyed aircraft.

He said that the bad news showed up in ground safety, where on-duty fatalities rose from six in Fiscal 1995 to 11 this past year. At the same time, off-duty fatalities dropped 25 percent from 92 to 69. Flight-related fatalities dropped from 53 to 51.

General Godsey said that the "best ever" results were based on a total of only 27 overall aircraft mishaps, only 20 aircraft destroyed, only 16 fighter/attack aircraft mishaps, and a fighter/attack Class A mishap rate per 100,000 flying hours of 2.20. He called the continued improvement in fighter/attack mishaps—down from 3.36 in 1995—particularly noteworthy.

The overall Class A mishap rate per 100,000 flying hours for Fiscal 1996 was 1.26, down from 1.44 in Fiscal 1995. The Air Force posted its best year in 1991 with a rate of 1.11.

USAF's top safety official also emphasized that the service had reduced Class A weapon mishaps by half, from six to three. The "weapon" category includes space, missile, and explosives safety.

Cheaper, Extended-Life C-5s?

According to a Lockheed Martin study commissioned by USAF's San Antonio Air Logistics Center, Kelly AFB, Tex., the Air Force could continue flying its fleet of C-5s through 2030 at greatly reduced operating costs and for much less than buying replacement aircraft.

The Air Force is considering various alternatives to help meet its strategic airlift requirements for the twenty-first century. The service has 126 C-5s, and many of the older versions have already reached the halfway point in projected service life.

Lockheed Martin said in December that it could reduce cost per ton-mile by 45 percent and extend the life of the giant airlifters for $35 million or less per aircraft. The one-time, com-

Photo by Robert F. Dorr

On December 19, USS* Enterprise *deck crews prepared for the last carrier launch of a US Navy A-6E Intruder, ending the attack aircraft's 31-year operational career, which included service in the Vietnam War and the Persian Gulf War.

prehensive modernization effort would involve installing four new commercial engines, state-of-the-art avionics, and other system improvements.

The new engines would increase thrust by 22 percent, stated company officials. They also predicted that the upgrades would improve the mission capable rate by 22 to 29 percent.

Lockheed Martin officials also plan to bid for the C-5 depot maintenance work that the San Antonio ALC expects to privatize with a contract award in June.

F-16s Mark Five Million Hours

The F-16 Fighting Falcon entered the history books December 4 when the aircraft officially logged its five millionth flying hour during an aerial demonstration at Hill AFB, Utah. Capt. Kurt Gallegos from Hill's 388th Fighter Wing was the pilot.

The flying-hour total includes time recorded since the first full-scale development F-16 began flying in 1976. It covers training sorties, continued developmental testing, and combat flying in the Middle East and the Balkans.

Hill AFB received the first production aircraft in January 1979 and continues to host one of the largest populations of F-16s. It is also home to the Ogden ALC, USAF's primary F-16 maintenance depot, and the first Air Force Reserve unit to receive F-16s, the 419th FW.

The 419th's Maj. Mike Brill received an award at the December 4 ceremony for having logged more F-16 hours than any other pilot in the world, according to a USAF press release. At that time, Major Brill had flown more than 3,700 hours in F-16s. The 1979 Air Force Academy graduate flew F-16s on active duty for 10 years before joining the Reserve, where he now flies about 200 hours per year.

News Notes

■ Capt. William R. Grace, an instructor pilot with Training Squadron Four at NAS Pensacola, Fla., and 2d Lt. Massimiliano Belvisi, an Italian Air Force student pilot, were killed when their US Navy T-34C crashed near Maxwell AFB, Ala., on December 2. They were practicing various landing approaches when they requested permission for an emergency landing but did not specify a reason.

■ A T-37 from the 47th Flying Training Wing, Laughlin AFB, Tex., crashed on landing at the base on December 12. Both people on board were taken to a local hospital.

■ An Air National Guard F-16 from the 178th Fighter Wing, Springfield-Beckley Municipal Airport, Ohio, crashed in a state forest near Piketon, Ohio, on November 27. Both crew members ejected safely.

■ Maj. Matthew Copp, a 53d Fighter Squadron pilot at Spangdahlem AB, Germany, recently became the fifth USAF pilot to reach 3,000 flying hours in the F-15C Eagle, the base reported in December.

■ The 429th Electronic Combat Squadron, Cannon AFB, N. M., recognized Capt. Michael Hake in November as the first electronic warfare officer to surpass 2,000 hours in the EF-111A Raven.

■ The Air Force Thunderbirds flew their 1,000th aerial demonstration in the F-16 on their last performance in 1996, November 10 at Pope AFB, N. C. A USAF release stated that more than 4.2 million spectators in 11 countries and 26 states saw a Thunderbird performance during 1996. The team's lifetime crowd count is more than 287 million.

■ Col. Jim Macon, 509th Bomb Wing vice commander, and Maj. Len

Senior Staff Changes

RETIREMENTS: M/G Hiram H. **Burr,** Jr., L/G John S. **Fairfield.**

PROMOTIONS: To be **Major General:** Maxwell C. **Bailey,** William J. **Dendinger,** Dennis G. **Haines,** Charles R. **Henderson,** Charles R. **Holland,** Silas R. **Johnson,** Jr., Thomas J. **Keck,** Rodney P. **Kelly,** Ronald E. **Keys,** David R. **Love,** Earl W. **Mabry** II, Richard C. **Marr,** William F. **Moore,** Thomas H. **Neary,** Susan L. **Pamerleau,** Andrew J. **Pelak,** Jr., Gerald F. **Perryman,** Jr., Roger R. **Radcliff,** Richard H. **Roellig,** Lansford E. **Trapp,** Jr., Thomas C. **Waskow,** Charles J. **Wax,** John L. **Woodward,** Jr., Michael K. **Wyrick.**

CHANGES: B/G Patrick O. Adams, from Dir. of Services, Hq. USAF, Washington, D. C., to Dir., Manpower and Personnel, J-1, Jt. Staff, Washington, D. C. . . . **Col. (B/G selectee) Charles E. Croom, Jr.,** from Dir., Mission Systems, DCS/Communications and Information, Hq. USAF, Washington, D. C., to Dir., C^3 Systems, Hq. USEUCOM, Stuttgart-Vaihingen, Germany, replacing retiring B/G Buford R. Witt.

SENIOR ENLISTED ADVISOR (SEA) RETIREMENT: CMSgt. Richard G. **Griffis.**

SEA CHANGE: CMSgt. Robert M. Clougherty, to SEA, Hq. AFSPC, Peterson AFB, Colo., replacing retired CMSgt. Richard G. Griffis. ■

Litton flew the 1,000th mission for the B-2 stealth bomber after less than three years of operation at Whiteman AFB, Mo., on November 21.

■ The National Guard celebrated its 360th anniversary on December 13 by presenting a new award, now its highest honor, to the person for whom it is named, Maj. Gen. G. V. "Sonny" Montgomery. The retired Mississippi National Guardsman served 30 years in the House of Representatives and, among many accomplishments, developed the modern-day Montgomery GI Bill.

■ Military and DoD civilian homeowners near Cannon AFB, N. M., who have been unable to sell their homes after the base's realignment, may be eligible for the Homeowners Assistance Program in which the government will pay 75 percent of the March 1995 (date of the announcement of base realignment action) fair market value or pay off the current mortgage balance. Those who sold their homes at a loss may be able to recover some money as well. The base plans to process applications through December 31, 1998.

■ USAF named the eleventh operational B-2 bomber *Spirit of Oklahoma* and the twelfth, *Spirit of Florida*. The thirteenth operational B-2 arrived at Whiteman AFB, Mo., in September and was dedicated as *Spirit of Kitty Hawk* in December. The unit will receive eight more B-2s by early 1998 to complete the 21-aircraft fleet.

■ Three Civil Air Patrol cadets—Amy Abrahms, Brooke Elliot, and Lauren Wagner—are three of the first four young women recently accepted by the formerly all-male Virginia Military Institute.

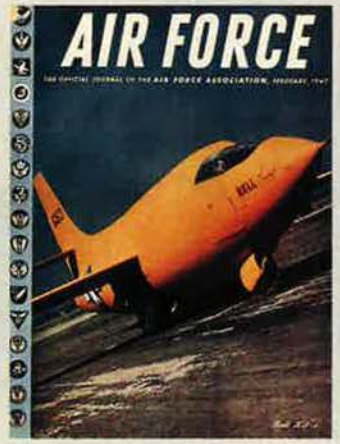
■ SSgt. Jennifer D. Noble, of the 305th Medical Group at McGuire AFB, N. J., received the Lakewood City (Calif.) Mayor's Award of Valor on November 14 for her heroism while assigned to March AFB, Calif., when she helped save several people injured in a two-car crash in December 1995.

■ The Air Education and Training Command team from Vance AFB, Okla., won the 1996 USAF Top Dollar competition held at Camp Bullis, Tex., November 18–22. The 11th Wing, from Bolling AFB, D. C., placed second.

■ The 1996 Chief of Staff Team Excellence Awards were won by the Fuel Systems Repair Section Process Action Team, 22d Maintenance Squadron, McConnell AFB, Kan.; the Oxygen Shop Lean Logistics Team, Oklahoma City Air Logistics Center, Tinker AFB, Okla.; the Isochronal/Refurbishment Quality Improvement Process Workgroup, 4th Air Force, McClellan AFB, Calif.; the F-15 Egress Natural Working Group, 18th MS, Kadena AB, Japan; and the Weapons Storage Area Security Enhancement Team, 321st Security Police Squadron, Grand Forks AFB, N. D.

■ The New York Air National Guard's 109th Airlift Wing began flights to Antarctica with a new LC-130H, chris-

50 Years Ago in *Air Force* Magazine



February 1947

On the cover: The Bell XS-1 rocket plane. Launched from the undercarriage of a B-29, it had achieved the speed of 550 mph in shakedown testing.

■ In "Flight Plan: 1947," Gen. Carl A. Spaatz, commanding general of the Army Air Forces, says the new Air Reserve Training Program will train 120,000 enlisted members and 50,000 officers in 1947 and that the combination of the Reserve, the Air National Guard, and the regular AAF will provide a force of 1.5 million.

■ According to an ad, the price for a Beechcraft Bonanza was $7,345, but "production for early 1947 is already sold."

■ The Veterans Administration announces that it will cover up to $500 of the tuition and costs for the airline transport pilot course when taken under the GI Bill.

■ AAF organization chart for December 1946, reprinted in the centerfold, shows headquarters and the eight major air commands as follows: Air Defense Command, Mitchel Field, N. Y.; Strategic Air Command, Bolling Field, D. C.; Tactical Air Command, Langley Field, Va.; Air Transport Command, Washington, D. C.; Air Training Command, Barksdale Field, La.; Air Proving Ground Command, Orlando, Fla.; Air Materiel Command, Wright Field, Ohio; and Air University, Maxwell Field, Fla.

■ **AFA news:** The Baltimore (Md.) Squadron (as chapters were called then), largest in the Association, draws a turnout of 300 to meet Brig. Gen. H. G. Thatcher, chief of staff of 11th Air Force.

Special thanks to Robert M. Hosan of Wilmington, Del., who lent his mint-condition copies of the February and June 1947 Air Force *Magazine for reproduction of the covers in this series.*

USAF Celebrates 50

Valiant Air Command, Titusville, Fla., will dedicate its annual airshow on March 14–16, featuring vintage aircraft, to the Air Force.

The Community College of the Air Force, Maxwell AFB, Ala., will celebrate its twenty-fifth anniversary and USAF's fiftieth with a reenactment of airmail delivery to Montgomery, Ala., when a de Havilland DH-4 symbolically delivers letters from the Secretary of the Air Force and the Chief of Staff on April 15.

Louisville, Ky., will salute the Air Force on April 19–20, during its Thunder Over Louisville airshow.

USAF will host the Global Air Chiefs Conference on April 22–24 at Las Vegas, Nev., during the Air Force Association's fiftieth-anniversary symposium.

Nellis AFB, Nev., will host the Golden Air Tattoo airshow, featuring foreign air force demonstration teams, the USAF Thunderbirds, and vintage aircraft on April 25–26.

The US Postal Service will release a commemorative 32-cent postage stamp on September 18, 1997, to recognize the Air Force's fiftieth anniversary. The stamp features an image of the USAF Thunderbirds flying F-16 Fighting Falcons.

Special World Wide Web sites established to honor the golden anniversary include the Pacific Air Forces site (http://www.cidss.af.mil/50th/index.html), selected by *Windows* Magazine as runner-up for the best organizational web site on the Internet.

The Armament Museum at Eglin AFB, Fla., opened a permanent exhibit in October featuring the history of the air commandos from World War II to present-day operations of Air Force Special Operations Command.

The first Swiss-assembled F/A-18 Hornet successfully completed its first flight on October 3. Switzerland will handle final assembly for 31 additional fighters out of the 34 it purchased from McDonnell Douglas.

tened *City of Christchurch,* in December as it replaces the US Navy in providing logistic support to the National Science Foundation's US Antarctic Program. Christchurch, New Zealand, serves as a gateway city in the program.

■ The Advanced Control Technology for Integrated Vehicles (ACTIVE) program F-15 flew four milestone flights at the Dryden Flight Research Center, Edwards AFB, Calif., on October 31 and November 1, in which the highly modified F-15B achieved vectoring, or deflecting, of its engine thrust at a speed of more than Mach 1.95. NASA's Dryden facility, the Air Force Flight Dynamics Laboratory at Wright-Patterson AFB, Ohio, Pratt & Whitney, and McDonnell Douglas are jointly pursuing the ACTIVE program to develop both commercial and military aircraft performance and maneuvering improvements.

■ USAF Maj. Mike Bloomfield will pilot space shuttle *Atlantis* on mission STS-86, set for launch in September, on the seventh of nine planned flights to dock the space shuttle with Russia's Mir space station. It will be his first spaceflight following more than a year of astronaut training.

■ The Air Force has changed its approach to its base inspector general system and began filling newly created, full-time IG positions at each wing last year. Formerly, a wing's vice commander filled the IG role. Now, rather than trying to separate the IG role from one of command, each wing has either a colonel or lieutenant colonel, depending on the wing's size, whose sole job is to act as an ombudsman.

■ World War II veteran Thomas J. Berry received a Silver Star November 26 at Scott AFB, Ill., more than 50 years after he successfully landed his glider behind enemy lines in Holland on September 22, 1944, as a first lieutenant supporting the US Army's 82d Airborne Division during Operation Market Garden. While returning to his unit, he helped an antitank gun crew destroy a German tank, but the crew did not learn his name until Mr. Berry met them again at a World War II reunion.

■ Retired Maj. Gen. Charles D. Metcalf, whose last assignment was commander of the Air Force Accounting and Finance Center in 1991, became the new director of the US Air Force Museum, located at Wright-Patterson AFB, Ohio, on December 2.

Obituaries

One of the most decorated Army Air Forces pilots in World War II, **Col. Frank Kurtz,** USAF (Ret.), died at his home in California October 31, following complications from a fall. He was 85. As an Army Air Forces pilot, he flew B-17s in the Pacific and, using parts from other aircraft, helped resurrect B-17 #40-3097, which was christened *Swoose,* and put it back to work in the Pacific theater. He then went to the European theater to head the "Swoose Group." After the war, Colonel Kurtz worked with the National Air and Space Museum to make the B-17 *Swoose* part of its permanent inventory.

The designer of the first partial pressure suit used by military pilots, **Dr. James P. Henry,** died of cancer on November 20. He was 82. As an assistant professor in Aviation Medicine at the University of Southern California in the 1940s, he designed and patented the pressure suit. During 15 years with the Air Force, including three years on active duty, he worked on cardiovascular problems caused by altitude and acceleration and directed the Physiology of Rocket Flight research project.

Astronomer **Carl Sagan,** who coined the term "nuclear winter," died from pneumonia on December 20 after a two-year battle with bone-marrow disease. The author, who won the Pulitzer Prize in 1978, helped popularize space with his Public Broadcasting System series, "Cosmos." He was 62. ■

Index to Advertisers

Verbatim

Airlift Power

"There aren't a lot of movies made about airlifters. There's no '12 O'Clock High' or 'Top Gun' about those heavy aircraft, but, despite their lack of glamour, they are arguably the most potent tool this nation has for shaping the international arena."

Secretary of the Air Force Sheila E. Widnall, in a December 3, 1996, address at American University in Washington, D. C.

Right and Wrong

"I think I was wrong on that."

Sen. Sam Nunn (D-Ga.), now retired, referring to his 1991 vote against authorizing the Persian Gulf War. He was quoted in a December 26, 1996, Associated Press interview.

The QDR Explained

"The [Quadrennial Defense Review] is about our military capabilities that this nation will need to further and to protect our interests in the years ahead. But I'd like to stress that the QDR is not about protecting today's force. It is, rather, about shaping tomorrow's force."

Gen. John M. Shalikashvili, Chairman of the Joint Chiefs of Staff, during a December 12, 1996, Pentagon press briefing on the Department of Defense's new all-encompassing review of defense requirements.

Over the Horizon

"Some argue that the forward presence these [naval] forces represent is no longer necessary. They argue that forces reacting from the United States are enough to maintain international stability. They further maintain that 'brush fires,' or outbreaks of regional instability, are insignificant or incidental at best, and they argue that America can no longer afford the forward presence of these forces on what amounts to a near-continuous basis.

"We would argue just the opposite. Forward-deployed US forces, primarily naval expeditionary forces, . . . are vital to regional stability and to keeping these crises from escalating into full-scale wars. To those who argue that the United States can't afford to have this degree of vigilance anymore, we say: The United States can't afford not to. These brush fires, whether the result of long-standing ethnic tensions or resurgent nationalism in the wake of the Cold War, will only continue. . . . The United States and the world cannot afford to allow any crisis to escalate into threats to the United States' and the world's vital interests. . . . The concepts of choice must be selective and committed engagement, unencumbered global operations, and prompt crisis resolution. There is no better way to maintain and enforce these concepts than with the forward presence of the US Navy–Marine Corps team."

December 1996 statement of Adm. Jay L. Johnson, Chief of Naval Operations, and Gen. Charles C. Krulak, Marine Corps Commandant.

Fading Memories

"The [Persian] Gulf War is remarkable not just for its swiftness but for the swiftness with which it disappeared from American consciousness. After a bare six years, it is hard now even to remember it. How often does it ever come up in discussion or in the popular media—except in the context of Gulf War syndrome? Indeed, the Gulf War lives in American consciousness almost exclusively in the form of Gulf War syndrome.

"When our Gulf War soldiers came home after their astonishing, heroic victory, we gave them parades and 15 minutes of honor. The only way they touch our hearts today, however, is when they troop before Congressional committees displaying their very real suffering. Once again we've shown that if you want care and sympathy—and media attention—in America, come not as a hero. Come as a victim."

***Charles Krauthammer, syndicated columnist, in the December 20, 1996, Washington* Post.**

Bring a Full Load

"Our theater strategy recognizes that generating the combat power needed to contend with the myriad of regional threats requires more than 'over-the-horizon' forces. We must harness the complementary capabilities of all of our armed services, some on land, some on sea, some in the air, to deter conflict and win decisively if deterrence fails."

Army Gen. J. H. Binford Peay III, commander in chief of US Central Command, MacDill AFB, Fla., in a November 12, 1996, address to the Association of Military Surgeons of the United States in San Antonio, Tex.

On Second Thought

"Everybody says [CIA director] is a job I've been pushed out of, but I would recall it's a job I was pushed into. . . . I fired a lot of people. I certainly could have fired more. [But] after a while, you have to ask, what are you accomplishing by doing it?"

Former CIA Director John M. Deutch, as quoted in a December 26, 1996, Washington* Post *interview.

No Gratitude

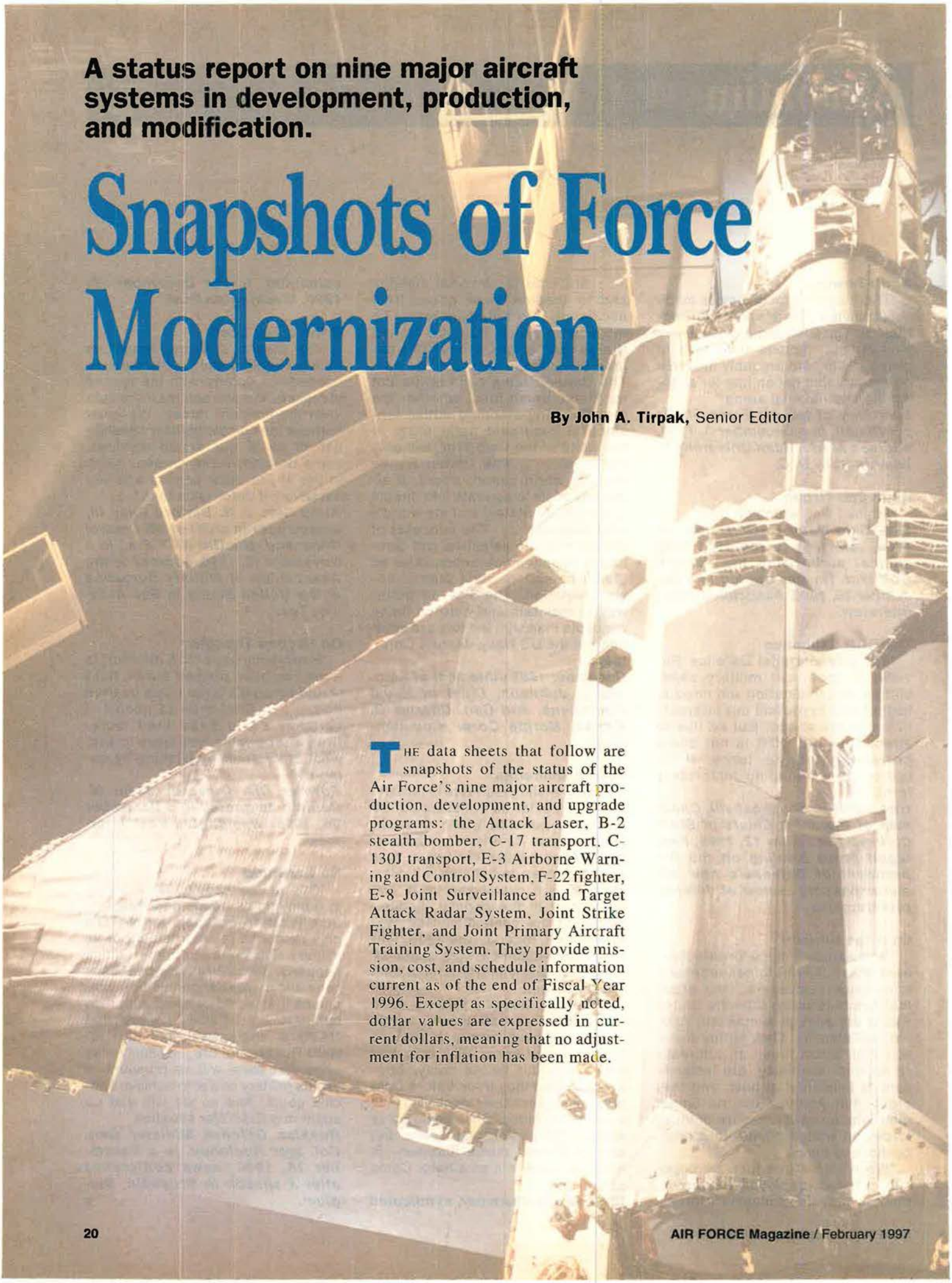
"Russia has made huge sacrifices in removing its troops and weapons from [eastern Europe], yet NATO's only response is enlargement of its military alliance to our border. If this happens, it would remove our buffer zone and create dangerous new conditions that would demand action on our part. . . . I don't believe that NATO is aggressive right now toward Russia, but the possibility may arise that there will be pressure to use its military power to achieve specific goals. And so we will end up again in a Cold War situation."

Russian Defense Minister Gen. Col. Igor Rodionov, in a December 18, 1996, news conference after a speech in Brussels, Belgium. ■

A status report on nine major aircraft systems in development, production, and modification.

Snapshots of Force Modernization

By John A. Tirpak, Senior Editor



THE data sheets that follow are snapshots of the status of the Air Force's nine major aircraft production, development, and upgrade programs: the Attack Laser, B-2 stealth bomber, C-17 transport, C-130J transport, E-3 Airborne Warning and Control System, F-22 fighter, E-8 Joint Surveillance and Target Attack Radar System, Joint Strike Fighter, and Joint Primary Aircraft Training System. They provide mission, cost, and schedule information current as of the end of Fiscal Year 1996. Except as specifically noted, dollar values are expressed in current dollars, meaning that no adjustment for inflation has been made.

F-22 F-22

Program	F-22A
Mission	Air superiority, with a secondary ground-attack role.
Operator	Air Combat Command.
Contractors	Lockheed Martin is the prime contractor; Boeing is the principal subcontractor. Pratt & Whitney is the F119 engine contractor.
Status	Engineering and manufacturing development (EMD) 60 percent complete.
Next major milestone	Full-rate production decision in September 2000.
First flight	Rollout in April 1997; first flight in May 1997.
Planned production	432 production aircraft, to equip four wings; 12 test models.
Production schedule	Per year, beginning in FY 2001: four, 12, 24, 36, and 48 through FY 2011; 18 in FY 2012.
Initial operational capability (IOC)	November 2004.
Flyaway cost	$71 million in FY 1996 dollars.
Program acquisition cost	$70 billion (includes development and production).
Current funding	$2 billion in FY 1997.
Significant features	Stealth, supercruise, high agility, integrated avionics, data fusion, and thrust vectoring.
Performance	Range comparable to F-15E; agility comparable to F-16.
Armament	Internal: six AIM-120C Advanced Medium-Range Air-to-Air Missiles (AMRAAMs) or two AIM-120Cs and two 1,000-lb Joint Direct Attack Munitions (JDAMs) in center bay; two AIM-9X short-range dogfight missiles in side bays. External: Two wing hardpoints can carry additional fuel or munitions.
Deployment	Test aircraft will be deployed at Edwards AFB, Calif.; Nellis AFB, Nev.; Tyndall AFB, Fla.; and Eglin AFB, Fla. The first operational base has not yet been chosen.

The stealthy F-22 will succeed the F-15 as the primary provider of air superiority for US theater armed forces well into the twenty-first century. It will have the unprecedented capability to cruise at supersonic speeds without afterburner. This feature, when coupled with stealth and enhanced integrated sensors and avionics, will make the F-22 capable of defeating any projected combat aircraft or surface-to-air missile. The F-22 will be able to perform a secondary ground-attack mission after air superiority has been established.

The program still faces challenges in the areas of weight and cost, which at present is running at 105 percent of budget, though "management reserve" funds are built into the program to cover some of the overrun. Trade-offs among performance, cost, and weight continue to be made. A two-seat, B model variant has been eliminated from the project to save money.

JSF Joint Strike Fighter

The JSF will replace the F-16 and A-10 in the Air Force, the AV-8B and F/A-18 in the Marine Corps, and the A-6 in the Navy. The UK Royal Navy has committed to buying the JSF to replace its Sea Harrier aircraft, and other allied air arms are exploring participation in the program. Intended as the "low-end" complement to the "high-end" F-22 in USAF, the JSF must meet stringent cost limits and demonstrate a level of performance that gives it advantages over the F-16, particularly in stealth and range.

The Marine/UK version is to be capable of short takeoff and vertical landing (STOVL). All variants are to be 70 to 90 percent common by cost, to derive the price benefits of common manufacture and field support. The Pentagon plans a competition between the baseline Pratt & Whitney F119 engine and the General Electric F120.

Lockheed Martin JSF concept

Boeing JSF concept

Program	Joint Strike Fighter
Mission	Ground attack, with a secondary air-superiority role.
Operator	Air Combat Command in USAF.
Contractors	Boeing and Lockheed Martin were selected in November 1996 as the two design competitors.
Status	Concept exploration work under way.
Next major milestone	One contractor will be selected for EMD in 2000.
Planned production	Air Force: 2,216. Marine Corps: 600. Navy: 300. UK Royal Navy: 60.
First flight	Prototypes are scheduled to fly in 1998.
IOC	2008.
Flyaway cost	Air Force: $30 million. Marine Corps/UK: $40 million. Navy: $34 million to $36 million.
Program acquisition cost	$96 billion (includes development and production of 3,232 aircraft).
Current funding	$599 million in FY 1997, of which $263.8 million supports the USAF version.
Significant features	The STOVL version will be capable of supersonic speeds; all versions will make heavy use of off-board sensors to reduce weight; lowest-cost stealth combat aircraft yet.
Range	Classified, but more than 600 nautical miles combat radius.
Armament	Internal: two 1,000-lb JDAMs and two AIM-120C AMRAAMs. External: more than 12,000 pounds.
Deployment	Bases now operating the F-16 and A-10 will likely receive the JSF.

B-2A B-2A

Program	B-2A Spirit
Mission	Long-range area and precision strike.
Operator	Air Combat Command.
Contractors	Northrop Grumman is the prime contractor, with Boeing as a principal subcontractor.
Status	Eight in service, three in testing, two in production, and eight being converted to more advanced configurations.
Next major milestone	Delivery of first Block 30 aircraft in fall 1997.
Planned production	20, plus one converted test aircraft, for a total of 21.
Production schedule	Block 30 deliveries per year, beginning in FY 1997: four, five, eight, and four.
IOC	Limited operational capability (conventional) on January 1, 1997. Full IOC in spring 1997.
Flyaway cost	$997 million in FY 1996 dollars.
Program acquisition cost	$42 billion (includes development and production).
Current funding	$624 million in FY 1997.
Program completion	The last aircraft in Block 30 configuration is to be delivered in mid-2000.
New features	The Block 10 aircraft includes capability for B83 and B61 nuclear weapons. Block 20 adds the GAM. Block 30 adds virtually all standard bombs and cluster bombs, including JDAM and Joint Air-to-Surface Standoff Missile (JASSM).
Performance	Able to reach any point on the globe with one aerial refueling; certified for four-G turns.
Armament	All internal: Typical load is 16 GAMs or Mk. 83 bombs.
Deployment	All B-2As are to be based at Whiteman AFB, Mo.

The Air Force's B-2A Spirit is the first aircraft to combine stealth with large size and long range. It is USAF's only penetrating nuclear bomber, as the B-52 serves as a stand-off cruise missile platform and the B-1B has been removed from the nuclear role. The B-2A program has been capped at 20 production aircraft, and consideration of additional buys has been tabled for now, but Congress has funded conversion of the first test aircraft to operational standard, for a force of 21 airplanes. IOC for the B-2A with nuclear weapons was established last year, and IOC with conventional munitions is expected early this year.

Tests last fall with the Global Positioning System–Aided Targeting System/GPS-Aided Munition proved highly successful. The GATS/GAM provides the B-2A with an interim precision bombing capability until the arrival of the JDAM in 1998. Continued B-2 funding focuses on test, development, and adding more conventional weapon capability. All B-2s will eventually be fitted to the all-up Block 30 configuration. Improvements being considered beyond the Block 30 include a communications/navigation and weapons upgrade.

C-130J C-130J

The Air Force is acquiring C-130J aircraft to replace its aging C-130E and H intratheater transports and special-mission aircraft. Lockheed Martin developed the C-130J with its own funds and is underwriting most of the test effort as well. The C-130J offers electric flight controls, new engines and propellers, and performance about one-third better than previous models. Congress has added funds to accelerate production for special-mission variants. USAF requested one for Fiscal 1997, but nine were funded for USAF and four for the Marine Corps.

As of mid-1996, there were 687 C-130s of various types in the active-duty USAF, Guard, and Reserve inventories, but they will not be replaced on a one-for-one basis. The Intratheater Lift Analysis completed last summer determined that the C-130 force can shrink, though a final figure has yet to be stated. The C-130J has also been ordered by the UK and Australia.

Program	C-130J Hercules
Mission	Intratheater lift, Airborne Battlefield Command and Control Center (ABCCC), gunship, electronic warfare, weather, and special operations.
Operator	Air Mobility Command.
Contractor	Lockheed Martin.
Status	Flight test, to be concluded in fall 1997.
Next major milestone	Delivery of first USAF aircraft in October 1997.
Planned production	No total has been established, though USAF estimates a need for at least 400 aircraft over the next 20 years.
Production schedule	If Congress continues adding funds at present rate, production should average about nine C-130Js for USAF per year.
IOC	USAF will accept its first C-130J in October.
Flyaway cost	For WC-130 version, $55 million. For EC-130 version, $70.5 million (all variants, conversion costs included). For cargo version, $50.2 million.
Program acquisition cost	No estimate; final production not yet determined. Because the C-130J is a "nondevelopmental item," USAF paid no development cost.
Current funding	$450 million for Guard/Reserve special-mission aircraft in FY 1997.
Program completion	Production potential through 2020.
New features	Better engines, "curved" six-blade propellers, fly-by-wire avionics, "glass cockpit" displays, and two-person flight crew (vs. three).
Performance	The C-130J's Allison AE 2100D3 engines, coupled with the Dowty six-blade propellers, generate 31 percent more thrust and 18 percent better fuel efficiency. Takeoff roll is one-third shorter than C-130H, time to climb to 20,000 feet is one-third faster than C-130H, cruise altitude is 29,000 feet vs. 24,000 feet for C-130H, and range is improved to 2,404 nautical miles vs. 1,745.
Deployment	Harrisburg IAP, Pa. (EC-130J), Keesler AFB, Miss. (WC-130J), Tinker AFB, Okla. (ANG C-130J).

C-17A Globemaster III C-17A

Program	C-17A Globemaster III
Mission	Strategic inter- and intratheater lift.
Operator	Air Mobility Command.
Contractor	McDonnell Douglas.
Status	In production. As of November 1996, 30 aircraft delivered.
Next major milestone	Completion of seven-year multiyear production contract in 2003.
Planned production	120 aircraft, though the Air Force's last strategic lift study called for 140 C-17-equivalents.
Production schedule	From FY 1997 through FY 2003: eight, nine, 13, 15, 15, 15, and five.
IOC	Established in 1995 with 12 aircraft at Charleston AFB, S. C.
Flyaway cost	$172.8 million per aircraft for remaining 80 airplanes.
Program acquisition cost	$42.5 billion, including development, test, procurement, and military construction.
Current funding	$2.33 billion in production for eight aircraft in FY 1997, plus $87 million for research, development, test, and evaluation (RDT&E).
Program completion	The last of 120 aircraft is to be delivered in 2003, though export potential exists for as many as 50 additional aircraft.
New features	The C-17 features glass cockpit with head-up display, three-person crew (including load-master), and ability to back up on the ground and operate from much smaller ramps and airfields than the C-5.
Deployment	Four squadrons of 12 aircraft each will be deployed at Charleston AFB, S. C., and McChord AFB, Wash. An additional six will be deployed with the Air National Guard at Jackson, Miss., and eight will be based at Altus AFB, Okla., which is the airlift "schoolhouse." Approximately 10 will be routinely in test, depot, or reserve.

The C-17 is Air Mobility Command's newest strategic airlifter, capable of carrying outsize and oversize cargo while landing and operating on smaller and more austere airfields than can be used by the larger C-5 Galaxy. After an exhaustive but successful operational test in 1995, the C-17 program, which had been on probation, was cleared for a further 80 airplanes, in addition to the 40 then in the pipeline. The Air Force has negotiated a seven-year agreement to buy C-17s; the deal saved slightly more than $1 billion.

While there has been discussion of procuring additional C-17s to replace the aging C-5, neither USAF nor AMC has any plans to do so for now. Congressional talk of "capping" production of the C-17 has evaporated in light of its performance in the field. McDonnell Douglas is seeking export orders from Japan and several NATO nations, and a commercial variant may be developed.

JPATS Joint Primary Aircraft Training System

The JPATS is the planned basic-trainer replacement for the Air Force T-37B and the Navy T-34C. Beech Aircraft Corp. was selected in June 1995 as the JPATS prime contractor, offering a single-turboprop, two-seat variant of the Swiss Pilatus PC-9. After legal protests from other competitors, the award was upheld in early 1996, and work began on the project, which is to yield 711 aircraft: 372 for the Air Force and 339 for the Navy. Beech is to select a subcontractor this spring for the groundbased training system (GBTS), which includes courseware and simulators. Air Force and Navy undergraduate pilot training have been merging into a joint operation over the last few years, and JPATS will supply a joint aircraft to further harmonize the system.

Program	Joint Primary Aircraft Training System (JPATS)
Mission	Primary undergraduate pilot training, as well as support of USAF navigator and naval flight officer training.
Operator	Air Education and Training Command.
Contractor	Beech Aircraft Corp.
Status	In development.
Next major milestone	Critical Design Review and design lock-in were slated to take place in December 1996. Selection of the GBTS contractor is due in April 1997.
Planned production	711 aircraft, of which 372 will be for USAF.
Production schedule	From an initial 12 in 1998, the services plan to ramp up to a peak production rate of 43 airplanes per year in 2002.
IOC	The first USAF unit will be operational in 2001, and all projected USAF units will be equipped with JPATS by 2011.
Flyaway cost	$3.4 million per airplane for 711 aircraft.
Program acquisition cost	About $7 billion, though the Pentagon expects this figure to be lower due to savings from streamlined acquisition methods. The Air Force's share for production is $1.75 billion.
Current funding	$67 million for procurement and $64.5 million for RDT&E in FY 1997.
Program completion	The Air Force is to receive its last JPATS in 2011; the Navy receives its last airplane in 2017.
New features	The JPATS offers better climb and turn agility than the T-37, as well as a modern glass cockpit with color multifunction displays and a zero-zero ejection seat.
Deployment	First operational aircraft arrive at Randolph AFB, Tex., in June 1999; at Laughlin AFB, Tex., in May 2001; at Vance AFB, Okla., in June 2004; at Columbus AFB, Miss., in September 2006; and at Sheppard AFB, Tex., in November 2008.

Attack Laser YAL-1A

Program	YAL-1A Attack Laser
Mission	Boost-phase ballistic missile defense.
Operator	Air Combat Command.
Contractor	A Boeing-led team including TRW and Lockheed Martin.
Status	Concept development.
Next major milestone	EMD is to begin in 2002.
Planned production	Seven aircraft.
Production schedule	One prototype aircraft will be built during the concept phase, one in the EMD phase, and five in production. The two developmental aircraft will then be retrofitted to production standard.
IOC	2006, with three deployable aircraft.
Flyaway cost	About $750 million per aircraft.
Program acquisition cost	About $5 billion.
Current funding	$57 million in RDT&E was approved by Congress for FY 1997, though the Air Force awarded a $1.1 billion contract to the Boeing team to get started.
Program completion	The seventh YAL-1A is to be deployable in 2008.
New features	The Attack Laser will offer the first operational directed-energy weapon and the only boost-phase missile defense system. It is also expected to be a pathfinder for future directed-energy weapons.
Deployment	No home base has been chosen, but the first several aircraft will undergo testing at Edwards AFB, Calif.

The Attack Laser aircraft (YAL-1A) is a new initiative by the Air Force to develop a rapidly deployable theater ballistic missile defense system. The system employs a high-energy laser mounted on the nose of a new-manufacture 747-400 freighter, and it will be able to detect, track, and shoot a ballistic missile in the boost phase at a range described only as "hundreds of kilometers," depending on the size of the missile. USAF foresees an intermediate role for the Attack Laser in theater ballistic missile defense—the second step in the sequence of direct attack, boost-phase intercept, midcourse intercept, and terminal-point defense. In a typical engagement, the YAL-1A crew would have 40 to 100 seconds to locate, track, and fire on a missile, keeping the laser trained on it for an average of five seconds to cause a booster explosion. It is also to have capability against low-flying cruise missiles.

USAF sees high deterrent value in the YAL-1A because it would cause the missile and its warhead to fall back on the launching nation. The Attack Laser will also provide an additional layer of protection to ensure that terminal defenses are not overwhelmed and will increase surveillance coverage by providing a 360° infrared sensor capability. A deployable aircraft will be built during the concept phase. With a crew of six and capability for 30 shots at $1,000 each, the Attack Laser is regarded as a highly cost-effective tool for protecting theater assets and personnel.

E-8C E-8C Joint Surveillance and Target Attack Radar System

The Joint STARS is the USAF-Army system for detecting enemy vehicle movements within a theater of operations. A synthetic aperture radar mounted in an underbody "canoe" aboard a Boeing 707 provides imagery of moving ground objects hundreds of kilometers away. This information is passed to a ground station where a commander can see, in near–real time, where the enemy is advancing, as well as to keep an eye on his own units as they move near the forward edge of the battle area.

Two developmental versions, designated E-8A, were used with great success in the Persian Gulf War of 1991. Development continued, and a more advanced aircraft, designated E-8C, is the current production standard. NATO Allies are considering purchase of Joint STARS aircraft under a program that may mirror partnership on the AWACS program. Though an open-ended production program has been suggested, USAF plans currently call for a total of 19 aircraft, one of which will be a designated test airplane.

All Joint STARS systems are mounted in used and refurbished Boeing 707 airframes, but the two used in the Gulf War have so many hours on them that the systems in the aircraft may be transferred to fresher airframes. In addition, worse-than-anticipated corrosion on all Joint STARS–intended 707s has pushed up program costs by more than 15 percent. Linkages to unmanned aerial vehicles and satellites are being added to all Joint STARS, as well as the ability to more directly designate targets for aircraft and ground fire.

Program	E-8C Joint Surveillance and Target Attack Radar System (Joint STARS)
Mission	Theater surveillance and target designation.
Operators	Air Combat Command and the US Army.
Contractors	Northrop Grumman is the prime contractor for the Joint STARS system; E-Systems maintains the airframe.
Status	In production.
Next major milestone	IOC in September 1997.
Planned production	19 aircraft.
Production schedule	Due to cost growth, USAF has reduced acquisition to one aircraft in 1998 and 1999, two each year until 2002, and one in 2003.
IOC	Three aircraft will be operational with the 93d Air Control Wing at Robins AFB, Ga., in September 1997.
Flyaway cost	$266.2 million.
Program acquisition cost	$9.6 billion.
Current funding	$816.4 million in FY 1997.
Program completion	The nineteenth and last operational Joint STARS is slated for delivery in 2005.
New features	Compared with the developmental E-8A, the E-8C has a more comprehensive and jam-resistant radio suite and additional consoles with more off-the-shelf computer equipment. USAF plans to put the Joint Tactical Information Distribution System on the aircraft, as well as an ultrahigh-frequency satellite terminal. An infrared countermeasures suite is also contemplated.
Deployment	Robins AFB, Ga., will host all 19 operational Joint STARS, but most are expected to be deployed almost constantly. Two will remain at Robins for training, and two will be in the depot at any given time, leaving the others free for operations.

E-3C Sentry Airborne Warning and Control System Radar System Improvement Program

E-3C

Program	E-3C Sentry AWACS Radar System Improvement Program (RSIP)
Mission	Theater aerial radar surveillance and control.
Operator	Air Combat Command.
Contractor	Boeing.
Status	Operational test and evaluation under way.
Next major milestone	Production decision expected in September 1997.
Planned production	33 aircraft.
Production schedule	USAF plans two per year in 1998 and 1999, four in 2000, five in 2001, six in 2002, seven in 2003, and six in the outyears. A test aircraft has already been modified.
IOC	As delivered.
Flyaway cost	$14.6 million per aircraft.
Program acquisition cost	$850 million for 32 aircraft, including US share of development and test costs.
Current funding	$36 million authorized in FY 1997.
Program completion	Expected in 2004 to 2005.
New features	More powerful radar, ability to discriminate among targets with smaller radar cross sections, modern line-replaceable units, and updated displays. Airframe life extension is funded separately in a program known as Extend Sentry.
Deployment	Unchanged.

The E-3C AWACS RSIP represents the second major overhaul of the AWACS fleet since its inception in the 1970s. This second refit will give AWACS the ability to see stealthier targets, such as cruise missiles, or see the same targets further away. Ranges are classified, but an AWACS of current vintage could, from a point above Connecticut, track all the air traffic over New York city and Boston.

The RSIP will increase the radar's range and power as well as replace many of the electronic systems aboard the aircraft with modern modular units for improved reliability and maintainability. The upgrade is being planned and developed jointly by USAF and NATO, and the UK is purchasing eight RSIP kits, plus spares.

Though consideration was given to replacing the E-3C airframe with a new-manufacture Boeing 767, this was deemed uneconomical. Costs given are for the RSIP effort only and do not include acquisition cost of AWACS aircraft or basic systems.

Representatives of all the military services got together at Maxwell AFB for a new type of war game.

Strategic Force

By Suzann Chapman, Associate Editor

THE Air Force last November launched a unique war game, one that was, for the first time, both global in scale and "joint" in execution. This week-long effort, held at Maxwell AFB, Ala., brought together senior Air Force, Army, Navy, and Marine officers from the staffs of every theater commander in chief. Their goal: to explore promising employment concepts for future weapons in a computer-assisted war of the future.

Strategic Force '96, the first of what is expected to be an annual war game, was set in 2010. It pitted three Blue teams—each consisting of the US and coalition partners—against three Red teams—each representing Iran. The Blue teams had a mix of theater CINC staff warfighters and planners. Maj. Gen. Thomas R. Case, USAF's director of Modeling, Simulation, and Analysis, said each was led by a retired four-star officer "with good warfighting credentials."

According to the director of the game, USAF Col. Parks Schaefer, "The war game proved the efficacy of an air campaign, executed at its fullest, as a means to bring an enemy to an attrition level that rendered him ineffective." The game, based on current and projected weapons and heavily reliant on a high-intensity air campaign, "demonstrated that we could bring the enemy to the table."

General Case emphasized the significance of USAF's use of a joint-force concept for the game in order to test its warfighting assumptions. The game examined not only the role of air- and spacepower but also the contribution each could make, as emphasized in "Joint Vision 2010," written by the Chairman of the Joint Chiefs of Staff, Gen. John M. Shalikashvili. Joint Vision 2010 is a "conceptual template," concentrating on expectations about warfare of the future.

Full Leverage

General Case explained, "The objective is to fight a war of the future. You create a Red force adversary that acts as an adversary might, then present the warfighters with a challenging situation. Then the exercise becomes one of innovative thinking about how . . . you best extract the full leverage of the value of the forces you will have in this 2010 time frame."

All three "Blue CINCs" endorsed the selection of players and the emphasis on integrating service capabilities.

Gen. John A. Shaud, USAF (Ret.), Executive Director of the Air Force Association, said the theater CINCs "sent us the right people" for the game. "You don't need to do Persian Gulf 101 with these people, and it's for that reason alone that we are able to march to 2010 quickly," General Shaud said. He added that the CINCs' assignment of good people was an "obvious endorsement of the Air Force that the CINCs felt this joint war game would be something of value—it is the most sincere way of saying that I respect what you're doing."

Another team leader, retired Army Gen. John W. Foss, said the game did not "give you the traditional way that each service would like to spend its forces." There were no big air-to-air battles, no big land battles or big naval battles taking place, he noted. "Everybody's got a problem, and they have to use their resources and try to resolve the problem the way it exists, not the way they'd like it to be." Retired Navy Adm. William N. Small echoed that sentiment, stating, "It was certainly not an Air Force–driven war game. It's one in which everybody gets an equal say."

The game planners pitted the Blue teams against capable adversaries, led by Graham Fuller, longtime RAND Corp. analyst and author of numerous books about Iran and Islamic fundamentalism. Although Mr. Fuller admitted he had never played a war game before, he maintained that he is "a true Red-team type, in the sense that I have spent my whole life living in the Middle East, learning foreign cultures, languages—thinking about how these countries operate."

With his three Red teams, each of which contained service personnel as well as intelligence analysts, Mr. Fuller crafted a set of "rational and

coherent political goals" that seemed realistically attainable and made sense for "Iranian" national interests. He said he then let his military commanders implement the agenda. "For a game that is by definition artifice, it is pretty realistic," he added. "I think we are working with real problems, real states, real peoples, real passions, real psychological mindsets."

Political Dimension

The reality of the game also extended to "a formally constituted Green cell that acted as the coalition partners," stated Colonel Schaefer. He said that, although the game assumed US control of coalition forces, the Green cell, led by two former ambassadors with considerable political experience, kept the military players conscious of the political dimension.

For instance, he said that coalition forces, which even in 2010 might still be using older-generation aircraft, had to be given a viable role to maintain political unity.

The game also featured on-site access to logistics expertise, which Admiral Small said was a great improvement over other games he had played. Essentially, the logistics cell, which had experts from DoD, ran requests for transportation of weapon systems, munitions, and support equipment through a "logistics 'doability' filter so that we really account for the logistics factor," said General Case. The logistics cell also forecasted what the 2010 weapon systems might need for logistics support.

Lt. Col. Steven L. "Fuzz" Fuzzell, the Air Force's logistics cell leader, said that, if his team did not have the data to answer a request, it would call on the system experts with the Army, Navy, or Air Force to develop a realistic response.

The game design included three assessment teams that used a suite of analytical computer models to evaluate moves by both the Blue and Red teams. The assessment team then returned an "adjudicated" move to the teams, essentially providing outcomes that the assessors believed would have been generated by each move.

A central contention for several years for the Air Force has been that the Joint Staff has relied on a computer model, "Tacwar," that does not accurately represent the contributions of airpower. *[See "The Rediscovery of Strategic Airpower," November 1996, p. 26.]* While Strategic Force '96 employed a different model, "TAC Thunder," to represent air and space forces as well as ground forces, General Case emphasized the war game was "not an exercise in dueling models." He said that each model has its strengths and weaknesses.

Colonel Schaefer said that Tacwar is a force-on-force model and answers very well the questions it was designed to answer. "However, we are no longer asking that aggregated [force-on-force] type of question." The questions have gotten much more complex and detailed. While Thunder more accurately represents air and space contributions, he stressed that the Air Force is still exploring these issues, and "we know that Thunder is not the ultimate model. . . . There is no ultimate model. If you ask better questions, you need better tools."

In general, the same initial Red action occurred across all three teams. The scenario was based on a coordinated incursion of Kuwait by Iranian ground forces crossing Iraq, coupled with a simultaneous theater ballistic missile and cruise missile launch at Bahrain and the ports and the oil fields across the Persian Gulf. It also included an attempt to close the Strait of Hormuz, using mines and missile- and ground-force deployments.

"The initial [Red] move was essentially a coordinated three-pronged attack over, around, and through the Gulf," said Colonel Schaefer.

Each Blue team could call immediately on a number of forces within the theater: two land-combat brigades, an aircraft carrier battle group, a Marine Expeditionary Force, and a bit more than five USAF tactical fighter squadron equivalents. However, Colonel Schaefer stated that by the time "Iran" had actually established a hostile intent, the Blue teams had already begun to bring in additional forces from outside the theater.

The initial Blue response included the activation of defenses against ballistic and cruise missile attack, posturing of ground forces to counter the Red ground-force incursion, and the marshaling of warships to proceed to the Strait of Hormuz.

The Air Campaign

Each Blue team immediately employed an intensive aerial campaign—a central focus of the 1996 game. "For this year's game, we wanted to look at the impact of a high-intensity air campaign early in the beginning of a conflict," stated Colonel Schaefer. He said that he specifically created a scenario within which the enemy was not facing an equivalent ground force or a superior naval force in immediate contact, ensuring a "high-intensity air campaign was a necessary choice."

"So we played with a much more realistic expectation of [immediate] force availability," he added.

For purposes of the 2010 "war," each Blue team had a wide assortment of tactical fighters—Air Force F-22s, F-15Es, F-16s, and A-10s, along with Navy F/A-18E/Fs and F-14s. Additionally, each Blue team employed B-2, B-1B, and B-52 bombers, some of which were deployed to the theater for continuous operations and some of which were employed from outside the theater. One team also brought in AH-64D Longbow Apache helicopters from Europe, which was "an offensive weapon of significant contribution for the air and space campaign," noted Colonel Schaefer.

He added that the play realistically included all of the available "multigenerational platforms."

In 2010, he said, the US still will have B-52s capable of conventional weapons delivery, and there will still be C-130s and A-10s in the inventory, as well as older Army and Navy systems. "So everybody will be dealing with sort of a multigenerational problem," said Colonel Schaefer, "and one of the things that we needed to be very careful about was not creating an environment that postulated [that] some one system would be the silver bullet."

Some ground forces were involved for each Blue team, but there was no need for a decisive land campaign, since the air campaign reduced the fighting strength of the enemy to the point where Iranian forces could no longer advance, and thus were no longer a threat, he added. However, Colonel Schaefer emphasized that because the game did not include an examination of an end state, the Air Force did not know the ultimate requirement for ground forces.

He further explained that the Blue teams played at the strategic rather than the tactical level. They did not assign specific weapon systems to specific targets but instead plotted strategy and developed operational priorities. Then, a group of computer modelers handled the tactical moves, making weapon selections and assigning the targets to each weapon system.

The CINCs developed the overall strategy. The component commanders developed the operational priorities to best pursue the strategy. The modelers executed the tactical strategy at the operational level. However, the games were different at the operational level since each Blue team and the modelers had to respond to a different Red team. After the first move, the games were no longer identical.

Big Blast

For instance, the Colonel noted, one of the Red teams managed to close the Gulf for a long time by expending half of its missile inventory in the opening salvo. The corresponding Blue team found itself engaged in a longer air campaign—running about 96 hours behind the other two. The Colonel stated that, despite the divergence in time, each Blue team's air campaign "clearly showed that the halting phase was accomplished by joint combined air forces."

The game also demonstrated a credible Theater Missile Defense (TMD). "The major insight that came from all three games is the efficacy of the layered, integrated theater missile defense," stressed Colonel Schaefer. Each team employed Patriot missiles, Theater High-Altitude Area Defense (THAAD), and the Attack Laser aircraft. The Patriot served as the initial layer, a point defense weapon. THAAD provided the next layer of upper-tier coverage. The Attack Laser was used for area coverage to knock out ballistic missiles in their boost phase. They also used the AEGIS cruiser and the arsenal ship, the Navy's 2010 cruise missile platform.

"You've got an area weapon to cover you in the early stage, then an upper-tier weapon that will take care of the leakers through that area layer, then a point-defense weapon to take care of the few remaining leakers," explained Colonel Schaefer. "So what you're doing is not saturating at any given time any level of defense and you're placing the theater ballistic missile defenses into the arena where they do the most good."

He said that working TMD as a multiservice problem provided the most effective defense. However, although there were no gaps in coverage, he said that different deployment decisions were made by Blue commanders based on their perception of their Red adversary. He called it a "risk management problem."

Each team had only a limited number of assets and a set of potential targets that had to be defended, and the teams slightly varied the deployment of their TMD forces. "This allows us to look at the span of approaches that might be real and the span of responses or initiatives against those defensive approaches and how those things work against each other," stated Colonel Schaefer.

"If you only have one airfield to defend, you can do a very good job with a point-defense weapon and an area weapon, but if you have a whole city, five airfields, and two ports and you still have only one point-defense system, where do you put it, how do you deal with that, what kinds of risks are you willing to take, what kinds of questions do you have to ask to work that out? Those are the questions that commanders will have to face."

Concentrating the Mind

Blue commanders had to constantly rethink options in light of the fact that "Red" had a full complement of nuclear, biological, and chemical weapons. Theoretically, in fact, the Red teams could have launched a nuclear weapon into central Europe.

Red team leader Mr. Fuller said that the "nuclear option" depended not on game constraints but rather on an assessment of "real-world implications" for the one using such weapons. He explained, "After all, we know that there is going to be an end to the war. We may not succeed in winning, . . . so we have to live with the consequences of these actions in the real world."

As it turns out, the only weapons of mass destruction actually used by the Red teams were chemical weapons. One Blue ploy in response to the chemical weapons was to use a "reverse CNN effect," stated Colonel Schaefer. General Shaud said that his team widely publicized the results of the attack to gain worldwide support. He added, however, that "to have a robust TMD really made a difference."

Colonel Schaefer pointed out that the game had very aggressive, highly capable Red teams, and part of their job was "to make sure that it didn't become some sort of ludicrous military scenario where some crazed general caps off a nuke to solve his problems."

Adding to the realism across the board were the space elements. According to Colonel Schaefer, US Space Command was one of the top supporting commands in the entire game. They not only supplied enough personnel for two players on each Blue team but also had space experts for the Red teams and assessment teams.

"If we had only one player on each Blue team, none in the assessment cells, and none in the Red cells, we would have been able to claim that we 'played' space, but we wouldn't have been able to claim that we learned anything," he added. He also stressed that the space players came from each service, making the war game "top-notch."

However, one drawback noted by General Shaud in the information warfare element was that it was still classified to such an extent that it was difficult to play. He said that it was vital to play IW openly as part of the normal thought process.

The Air Force has already started work on its next Strategic Force war game. The Army and Navy are also working on creating or revising their war games to focus on joint operations in a future scenario. "There have been other war games out in the future," said General Foss, "but this is one that has laid a challenge in that you don't have symmetrical approaches—that is, land-on-land, air-on-air, sea-on-sea—but use a joint force of varying capabilities to try to solve the problem."

General Case emphasized that as each service works to "figure how best to contribute to the Joint Vision 2010 construct for future warfare, it will take a significant amount of wargaming and other types of concept-developing activities over time to refine that vision." ■

Valor

By John L. Frisbee, Contributing Editor

Honest John

Superace Bud Mahurin faced a greater challenge in Korea than in the skies of Europe and the Pacific during World War II.

A FRIEND of Walker M. "Bud" Mahurin observed that this handsome, ebullient young man could have made it in Hollywood, but that was not to be his destiny. In September 1941, he was in the uniform of the Army Air Forces. After completing training as a fighter pilot, he was assigned to the 56th Fighter Group, the "Wolf Pack," led by Col. Hubert A. "Hub" Zemke.

The group arrived in the UK in January 1943 with no combat experience and soon to go into battle against some of the best and most experienced fighter pilots in the history of air warfare. A fast learner, by March 1944 Bud Mahurin had become the leading AAF ace in Europe.

On March 27, Mahurin shot down a Dornier Do 217 bomber. His P-47 was hit and set afire. Mahurin bailed out and spent several adventurous months with the French underground before being flown back to England in an antique plane operated by the underground. Because of his knowledge of the underground, he was not allowed to continue flying combat over Europe and was sent home.

By pulling all the strings he could reach, Mahurin got an assignment as commander of the 3d Fighter Squadron, 3d Air Commando Group, which was about to deploy to the Pacific. By early 1945, there were few enemy fighters left in the Philippines. Mahurin did down one of them, ending the war with 20.75 confirmed victories even though his time in the hunting grounds of Europe had been cut short a year before that war ended.

When the Korean War broke out, Bud Mahurin was serving in the office of the Air Force Secretary—no place, in his mind, for a fighter pilot when a war was going on. Some deft maneuvering got him an assignment in 1951 as commander of the 1st Fighter-Interceptor Group, an F-86 unit at George AFB, Calif., a step toward returning to combat. The next move was to convince his superiors that he could do a better job training fighter pilots if he were allowed to spend 90 days on temporary duty in Korea. Again a winner, he arrived at Suwon AB, South Korea, early in December 1951 and became special assistant to the 51st Fighter-Interceptor Wing's commanding officer, his old friend Col. Francis S. "Gabby" Gabreski.

While helping Gabreski develop tactics and solve logistics problems, Bud Mahurin shot down two MiG-15s and later was credited with 1.5 more, bringing his total to 24.25 and becoming the only Air Force pilot with victories in the World War II European theater of operations, Pacific theater, and Korea. Before his 90-day TDY was up, he was given command of the 4th Fighter-Interceptor Wing at Kimpo AB, South Korea. His call sign was "Honest John."

Mahurin conceived and developed the idea of using the F-86 for dive-bombing as well as air-to-air combat and strafing. Low-level operations proved to be his ticket to a catastrophe that would test his heroism beyond anything he had experienced in hundreds of combat engagements.

On May 13, 1952, while strafing in North Korea, he was hit, crash-landed (breaking an arm), and was captured by the North Koreans. For more than a year, he was kept in solitary confinement in a tiny cell, fed only enough to keep him alive, inadequately clothed in subzero weather, deprived of sleep, and interrogated for hours at a time, often all night, while forced to stand at attention, threatened with execution if he did not answer his captors' questions.

What the enemy wanted most was a "confession" that Mahurin and others had waged germ warfare, never mind that both sides knew it was not true. After weeks of interrogation, propaganda, and psychological torture, Mahurin feared that he was losing control and might give in. He attempted suicide but was discovered in the act and thwarted, though he had lost so much blood that he barely survived.

The interrogators finally gave up, to be replaced by a well-educated Chinese officer who spoke fluent English, brought Mahurin books, arranged for better food, and generally improved his conditions. Eventually the Chinese officer's real purpose emerged—to get a confession of germ warfare by persuasion rather than threats. He reminded Mahurin that the allies did not know he was a POW, so he could be held until his death, never to see his wife and children again. Bud Mahurin at last agreed to write a "confession" so full of inaccuracies and implausible information that any Western reader would know it was fiction. Unknown to him, the war had already ended.

After his release and return to the States, Bud Mahurin and other former POWs were shocked to learn that some Americans, including Sen. Richard B. Russell (D-Ga.), thought that those who signed confessions should be discharged under conditions other than honorable. The Defense Department thought otherwise. All but four who had signed confessions were cleared of wrongdoing by a board of senior Air Force officials.

Colonel Mahurin was assigned as vice commander of the 27th Air Division. Because of his position on the promotion list, it seemed unlikely that he would be promoted to regular colonel and be considered for a star and a higher command in his remaining years of service. He therefore resigned his commission to accept a senior position with the aircraft industry.

Bud Mahurin served this country with distinction as a fighter pilot in two wars and as a prisoner of war in Korea. He will always hold a special place in the Air Force galaxy of heroes. ■

Through his drawings, a fighter pilot–artist captured the life of a flyer during World War II.

The Art of a Fighter Pilot

Like thousands of young men during World War II, George W. Rarey was drafted into the Army. The cartoonist and commercial artist left his Greenwich Village studio apartment and reported for duty in January 1942, from that moment on drawing scenes about his new military life.

In volumes of sketchbooks and in letters and postcards home—even on envelopes—he chronicled the next two years of his life, creating a daily, visual record with his art.

Rarey, who disliked his given name and always went by his last name, picked up the nickname "Dad" because his peers considered him an old man at age 27. He was quickly assigned to preflight training at Maxwell Field, Ala., having shown the intelligence, aptitude, and physical skills necessary for flying. Between learning military routines and classroom training, he continued painting and sketching events in his life as a pilot trainee, often sending them to his fiancée, Betty Lou Hodge. Because she carefully saved the artwork he turned out so prolifically, these scenes of a World War II fighter pilot's experiences—showing both comical and serious viewpoints—survive.

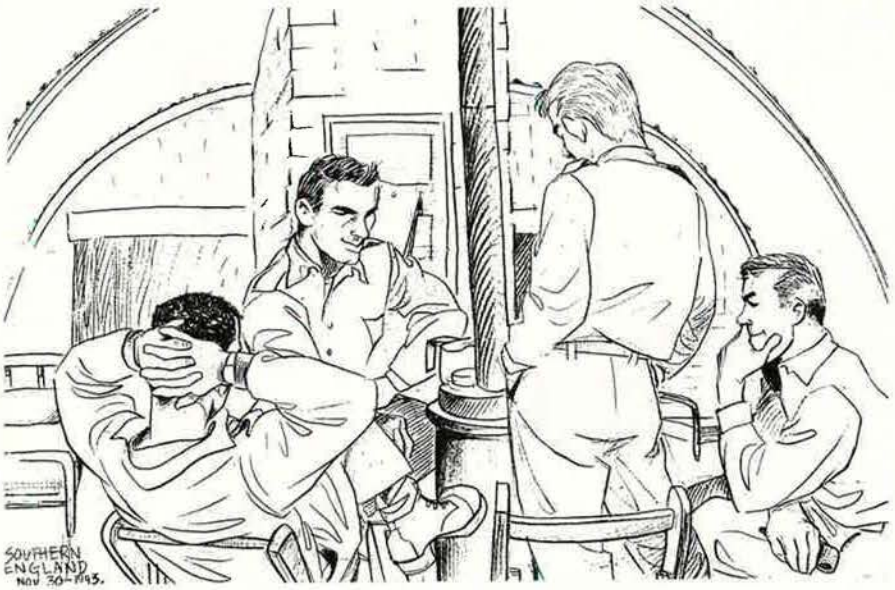
Photos by Paul Kennedy

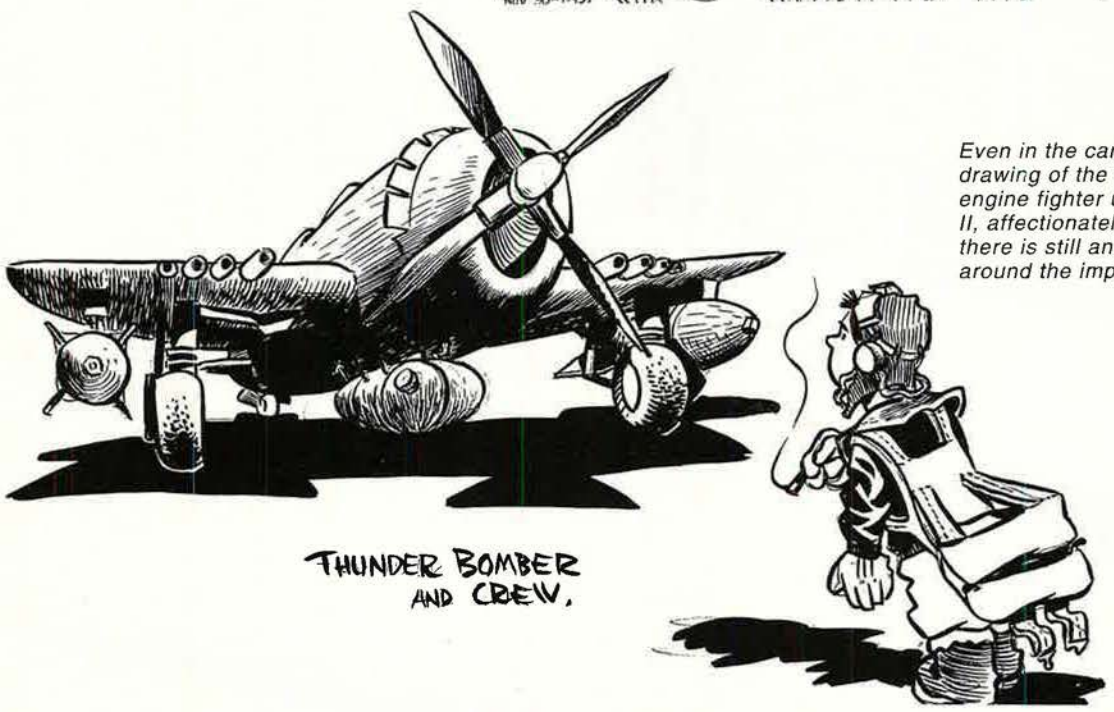

JOURNAL OF THE
379TH FIGHTER SQUAD
WINSOR
SPIRAL SKETCH BOO
FOR
Water Colour, Crayon
30 Sheets
VOL - III

Photos by Paul Kennedy

Rarey went on to join Class 42-J at Primary Flight School in Ocala, Fla. The class was among the first to allow aviation cadets to get married during training, and Rarey and Betty Lou did so in June 1942. Basic Flying School at Greenville, Miss., and Advanced Flying School at Selma, Ala., came next, followed by graduation and an assignment to Westover Field, Mass., where Lieutenant Rarey trained in P-47s as part of the 379th Fighter Squadron.

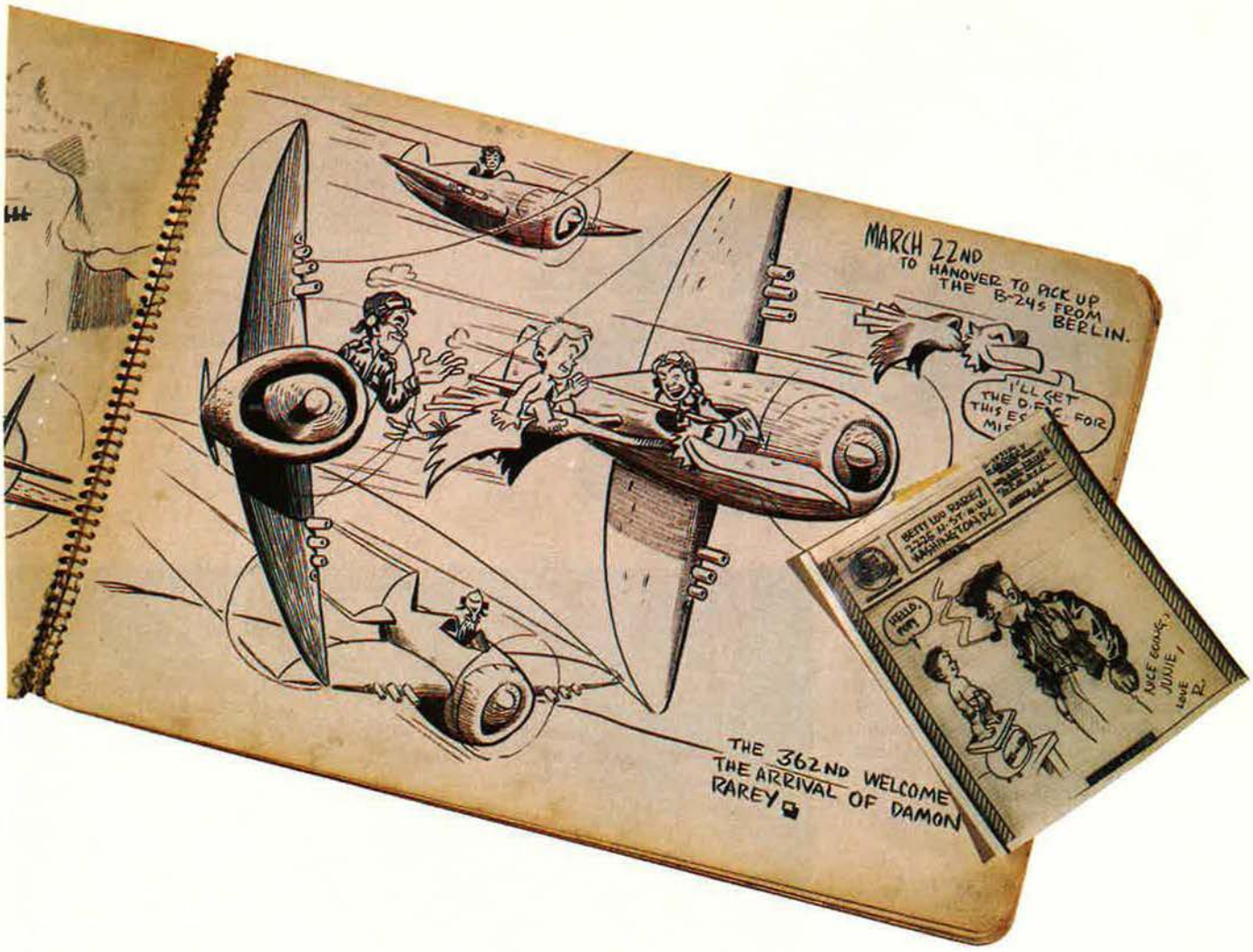
In November 1943, Rarey was sent to Wormingford, UK, with Ninth Air Force's 362d Fighter Group. His sketchbooks then began filling up with images of life during the winter in England, like the drawing at right, depicting his squadron mates at a bull session around a coal stove in one of the many Nissen huts that had sprung up to house the increasing number of Americans in the country.



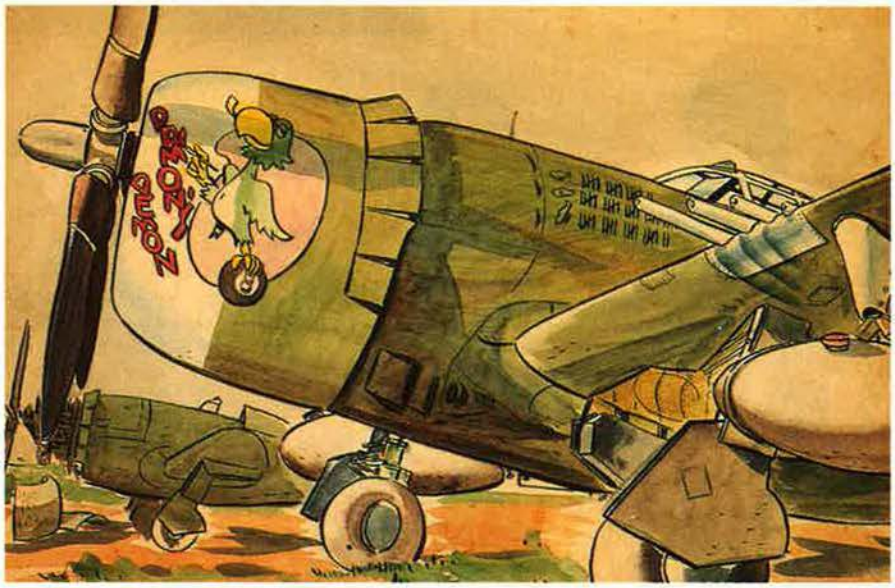


Even in the cartoon quality of this drawing of the largest single-engine fighter used in World War II, affectionately called "the Jug," there is still an air of intimidation around the imposing P-47.

Photos by Paul Kennedy



Rarey's squadron waited for almost a month before their unit's first P-47s finally caught up with them at the end of December 1943. Then the London nightlife and two years of training gave way to real combat missions—sometimes two a day—over the English channel and into France, Belgium, and Germany. In March 1944, Rarey returned from a B-24 escort mission to Hannover and learned that he had become a father. The arrival of his son, Damon, fills pages in Rarey's sketchbook, and soon Damon's Demon *appeared on the engine cowling of the fighter pilot's P-47. At right is a watercolor of the newly painted aircraft.*



Death, disruption, and destruction happened around the clock when the Germans began launching V-1 guided missiles—"vengeance" weapons—against London in June 1944. At the very least, they could keep you awake at night. Rarey, now stationed in Headcorn, UK, captured one of these nights of interrupted sleep caused by a V-1 flying bomb (at left). Pilotless, the missiles were dubbed "nonunion aircraft" by one squadron member.

During World War II, anyone with artistic talent inevitably ended up with a cowling as a canvas. Rarey soon had his artwork on the aircraft of nearly everyone in his squadron. Along with his final design for a plane, he also painted a picture of the pilot. Some of these watercolors are shown at right.

SUNDAY
-RELEASED FOR THE DAY
-PAINTED COWLINGS.

Rarey never aborted a mission but found time to paint cowlings on days off. He drew himself at work during one of these moments. In a letter to Betty Lou, he once remarked on how colorful the squadron looked because of his art. "It sort of gives personality to an otherwise pretty cold collection of machinery," he wrote.

Photos by Paul Kennedy

In late spring 1944, Lieutenant Rarey and his friends bought tickets for a ballet in London. The date for the event, June 6, 1944, turned out to be the same date of another, bigger show—D-Day. The unused ticket became part of the sketchbook, above.

A few weeks later, on a search-and-destroy mission over central France, the aircraft of the newly promoted Capt. George Rarey took a direct hit of 20-mm flak and exploded. Like so many, Betty Lou Rarey received official notification in a telegram, shown at right. While overseas, Rarey, shown in the photo at far right taken after graduation from flight school, drew from memory this portrait of his wife. Rarey's son, Damon, of Santa Rosa, Calif., graciously let Air Force *Magazine photograph the contents of original sketchbooks from this important collection. George Rarey's legacy to his family and to those who served with him is in these several hundred pieces of art that document his life as a fighter pilot.* ■

The Russians and Their Nukes

For post–Cold War Russia, the importance of nuclear weapons has increased rather than declined.

By David R. Markov

THE severe political turmoil and fiscal uncertainty in today's Russia have provoked considerable skepticism in the West about the effectiveness and reliability of Russia's Strategic Missile Forces (RVSN).

An examination of the public record of recent RVSN operations suggests the following conclusion: Russia's intercontinental ballistic missile (ICBM) force is still managing to perform its mission, though it faces serious short- and long-term problems. Asked about the RVSN, former Russian national security advisor Alexander I. Lebed described the RVSN as being "rusty but still effective." Indeed, all evidence is that Russia is still capable of waging a general nuclear war.

The importance of strategic nuclear weapons to Russia's overall military strategy has grown, rather than declined, since the collapse of the Soviet Union five years ago. In part, the increased importance stems from the dramatic shrinkage of Russian military forces from more than four million troops under arms at the height of the Cold War to fewer than two million today.

Unable to rely on massive conventional forces, as it has in the past, the Russian military today plans to develop a much smaller, highly mobile force. In practice, this means that Russia's conventional capabilities are stretched thinly over a vast geographic area.

New Russian military doctrine, adopted in 1993, reflected that reality. It resembled US doctrine in the late 1950s and early 1960s, when the Pentagon placed heavy emphasis on nuclear weapons to deter conven-

tional conflict. Because conventional force capabilities have declined, "nuclear weapons of Russia begin to play a more important role," said Gen. Yevgeni Volkov, a retired senior officer who advised Soviet and Russian Strategic Arms Reduction Talks negotiators and is now a member of the Russian Academy of Cosmonautics and the International Academy of Information.

The new role envisioned by Russian military doctrine seems to be a kind of "nuclear umbrella" that protects Russian ground forces abroad as well as allies and members of the Commonwealth of Independent States. The new doctrine asserts that "deterrence of [conventional attacks on Russia] may also be nuclear."

The Answer to PGMs?

Many Russian military theorists believe nuclear weapons provide the best answer to the challenge posed by conventionally armed precision guided munitions, which have become such an important part of Western military strategies. Russian generals fear that, in a general war, Western nations could employ such "smart munitions" to degrade Russian strategic nuclear forces, without ever having to "go nuclear" themselves.

Consequently, said General Volkov, Russia "should enjoy the right to consider the first [enemy] use of precision weapons as the beginning of an unrestricted nuclear war against it."

Senior Russian officials make clear that the US and the other NATO nations still constitute their main security concern. Recent RVSN training exercises, for example, emphasize responding to a short-warning nuclear attack from the US. Russian suspicions of NATO are heightened by its proposed expansion eastward into the former Warsaw Pact states. Oleg Grinevski, Russia's envoy to Sweden, recently warned, "If NATO expands in Europe, the nuclear threat will increase substantially."

Gen. Igor Rodionov, the Russian Defense Minister, expanded Grinevski's remarks by warning that "matters may go so far that we might retarget missiles, directing them at some European countries that will join NATO."

Defense Minister Rodionov's words are a reminder that, although Russian strategic missiles are not targeted against any country in their day-to-day peacetime mode, they can be retargeted on fairly short notice. Gen. Col. Igor D. Sergeiev, the commander of the RVSN, stated in a recent television interview from his command post that Russia's ICBMs could be "retargeted and launched from this war room in a matter of minutes."

Russia's philosophy for targeting US aimpoints seems little changed from the Cold War. The overall target set is smaller—the result of arms control agreements that have caused the US to remove weapon systems—but Russian nuclear forces still seem to emphasize preemptive strikes against US strategic nuclear forces if war appears imminent.

Several valid methods exist for counting the weapons of the old Soviet Union. An official US-Russian memorandum, using START I "counting rules," provided a snapshot of the forces of Russia, Ukraine, Kazakhstan, and Belarus, as of July 1, 1996. It reported that the total was 966 ICBM launchers (down from 1,398 in 1990) and 5,169 ICBM warheads (down from 6,612 in 1990). These figures included all systems in the inventory, even those that are not operational but have not yet been destroyed.

Another method is to count only those weapons on Russian soil and to count only operational weapons ready for actual launch against an adversary. This accounting technique yields lower numbers. It is the method used in the text and the tables on p. 43.

Today, the RVSN provides about 50 percent of Russia's strategic nuclear delivery vehicles, 54 percent of its warheads, and 75 percent of its megatonnage. They would be assigned to carry out between 50 and 90 percent of Russia's strategic nuclear missions in a general war.

Russia maintains a landbased force of roughly 760 ICBMs with 3,629 nuclear warheads. At present, some 47 percent of the inventory is based in fixed silos. Based in this fashion are all of the SS-18s and SS-19s and a few of the SS-24s. The remaining 53 percent is mobile, comprising all of the SS-25 launchers and SS-24s based aboard railway cars. The Russian ICBM inventory is presented in the table above, current as of November.

Emphasis on Silos

Today, 80 percent of the RVSN's nuclear warheads are to be found on launchers based in fixed silos, with the remainder based on mobile systems. Such a silo-based MIRVed warhead force allows precise targeting of an opponent's silo-based nuclear forces. Mobile forces, like the road-

Where They Are

Missile Field Location	ICBM Type	Number at Site	RVs at Site
Aleysk	SS-18	30	300
Dombarovskiy		52	520
Kartaly		46	460
Uzhur		52	520
Kozel'sk	SS-19	60	360
Tatishchevo		107	642
Bershet	SS-24	12	120
Kostroma		12	120
Krasnoyarsk		12	120
Tatishchevo		10	100
Barnaul	SS-25	36	36
Drovyanaya		18	18
Irkutsk		36	36
Kansk		45	45
Nizhniy Tagil		45	45
Novosibirsk		45	45
Teykovo		36	36
Vypolzovo		9	9
Yoshkar-Ola		36	36
Yur'ya		45	45
Unassigned		16	16

mobile SS-25 and rail-mobile SS-24 ICBMs, however, are neither as effective in rapidly responding to nuclear attacks nor able to do so with the same accuracy as fixed-site ICBMs. These mobile ICBMs are more survivable and provide a hedge against surprise attack.

For Russia, the mobile ICBMs have other disadvantages, including their heavy personnel requirements (roughly five to six times that of a silo-based ICBM) and their higher maintenance costs (roughly two to four times that of a silo-based ICBM). Any move to shift more of the Russian deterrent onto mobile systems would exact a high cost in rubles and personnel.

The RVSN also bears a heavy burden of dependence on Ukraine for critical spare parts for their inventories of SS-18s, SS-19s, and SS-24s. Many of these missiles are rapidly reaching the end of their service lives and will require maintenance, midlife extensions, or replacement. At present, 50 percent of the Russian ICBMs have exceeded their planned service lives.

Russia has already obtained, in a barter arrangement, 127 SS-19s from Ukraine and should be able to maintain a START I force of 105 systems. In addition, Russia has embarked on a midlife improvement program for the SS-19 to extend its service life by at least 10 years.

Russia's supply dependencies will likely shape the kind of ICBMs that Moscow deploys during the next decade. Currently, the only ICBM produced in Russia is the SS-25, built at the Votkinsk Plant Production Association. This facility has seen its production, which topped out at 62 SS-25s per year, drop to only nine ICBMs in 1994. Current Western media estimates place SS-25 production at 10 to 11 per year in the past two years.

An improved version of the SS-25, called SS-X-27 by NATO, has been in development since 1993. After its third flight in July 1996, General Sergeiev, the RVSN commander, announced the start of series production. However, this program is roughly one and a half to two years behind schedule and will be deployed on far fewer test launches than previous Russian ICBM designs.

The SS-X-27 will be based in three configurations: in converted SS-18 silos, in new silos, or on new road-mobile transporter-erector-launchers. The first 10 SS-X-27 ICBM complexes will be put on alert in 1997 and will become the backbone of the ICBM force.

However, several influential Russian commentators are dissatisfied with the SS-X-27 and have called for the development of an 80- to 120-ton liquid-fuel missile fitted with 10 medium-size nuclear warheads. Proponents of this option have claimed that such a system could be developed in three to five years and at a reasonable cost.

Thoroughly Professional

The RVSN currently comprises 192,000 troops, representing about 96 percent of authorized end strength. Nearly all of these troops are thoroughly professional officers who hold advanced degrees and who were screened for reliability prior to acceptance into the RVSN.

Chronic budgetary shortfalls, assignments to remote locations, and declining purchasing power of low wages have all affected RVSN personnel. Living conditions are difficult. The Russians have reported that 48 percent of all RVSN fatalities in 1996 were suicides. Many RVSN personnel live in substandard housing and receive their wages only sporadically. Overall, the Russian government owes the RVSN a total of nearly 500 million rubles in back wages and rations. Indeed, some RVSN servicemen and -women go without pay for months. All of these problems have raised considerable concern in the West (and among some Russian observers) about the reliability of RVSN personnel.

Recent press reports in the US and in Russia suggest that Russia's control of its nuclear forces may be eroding or in need of serious strengthening. The Washington *Times* in October noted a US government warning that Russia's nuclear command-and-control system "is being subjected to stresses it was not designed to withstand as a result of wrenching social change, economic hardship, and malaise within the armed forces." Still further, the report stated that the RVSN recently implemented procedures to report accidental or unauthorized missile launches. Such a possibility exists, given the technical capability of the RVSN's command posts to launch their missiles without prior approval from Russia's political leadership or General Staff.

Despite such dire predictions, US Defense Secretary William J. Perry stated in a press conference after his visit to Moscow in October that "All evidence through the years has been the Russians put their best and the most highly qualified troops to that assignment, and I have every reason to believe that is still the case and that they are still under good control."

Russian military leaders are less concerned about the possibility of an unsanctioned launch than they are with another danger—a swift, sudden decapitation strike against Russia.

This concern led to the deployment of a "doomsday" command-and-control complex called "Perimeter." This system was designed to permit the RVSN to launch its forces in time of war even if all command-and-control systems were disabled or destroyed.

A Samsonite Briefcase

The main wartime automated nuclear command-and-control coding system is called "Kazbek." This system is designed to authorize the launching of a nuclear strike and is initialized by the Russian leadership's "nuclear briefcase" (called "Cheget" by the Russians). The black, Samsonite briefcase, fitted with three combination locks, can communicate to the Russian General Staff the requisite codes granting permission to launch an attack.

Russia maintains three such nuclear suitcases (called the "football" in the US). The Russian President, the Minister of Defense, and the Chief of the General Staff each have one handy at all times. The General Staff receives the signal and initiates the strike through the passing of authorization codes to missile silo launch complexes or by remotely launching individual ICBMs.

This process was put to the test on January 25, 1995. A Norwegian sounding rocket was detected by Russian early warning systems, and Russian President Boris N. Yeltsin used his "nuclear briefcase" to activate the Kazbek system. Authorization for the launch of a nuclear strike was given to the General Staff, but the attack was not initiated; the rocket was traveling away from Russia, not

toward it. An investigation found that a prelaunch notification message issued by the Norwegians was not properly delivered to Russia's early warning forces.

This incident generated one of the few media reports on the operation of Russia's nuclear command-and-control system since the 1991 coup and was the only reported post–Cold War activation of the Kazbek system.

According to a November 1996 report of the RVSN Military Council, 76 percent of the missile divisions were assessed to be "good" and the remainder were judged "satisfactory." The report assessed missile division performance during numerous RVSN exercises and operational missile training launches held in 1996. In addition, efforts are under way to replace some 40 percent of the operational training exercises with specially equipped classroom simulators designed to perform tactical drills.

Despite the RVSN's major financial difficulties, it has conducted 30 ICBM combat-training launches since 1992. Six combat-training launches and one new missile test launch were made in 1996. The first combat-training launch of 1996 took place on April 17. The SS-25 was launched from Plesetsk Missile Range in the Arkhangel'sk region, close to the Arctic Circle, and struck a target on the Kamchatka peninsula.

The second combat-training launch took place on June 6. The RVSN launched a 20-year-old SS-19 ICBM that had been on continuous combat alert before launch. According to the commander of the RVSN, the ICBM's six warheads hit targets on Kamchatka. This test was designed to confirm whether the SS-19 could be safely stored and its operational service life extended.

New Missile Tested

On July 25, the RVSN test-launched the new SS-X-27 from the Plesetsk Missile Range. This was the third launch of the improved SS-25.

The third combat-training launch of 1996 took place on October 3. It was conducted as part of a two-day strategic command-and-staff war game called "Redoubt '96." Prime Minister Victor Chernomyrdin, General Rodionov, and General Sergeiev participated. The war game involved all three legs of the Russian strategic nuclear triad and included the combat-training launch of an SS-25, the firing of a submarine-launched ballistic missile (SLBM) from a strategic submarine, and the launch of a cruise missile from a Tu-95 "Bear-H" bomber.

On November 2 and 3, Mr. Chernomyrdin participated in several combat-training tests. He launched an SS-25 from Plesetsk Missile Range and an SLBM from a submarine in the Barents Sea.

The fifth combat-training launch of 1996 was held on November 9. The final event—the sixth—came on November 30, when Russian officials launched an SS-24 from a railcar; its 10 warheads hit their targets in Kamchatka. Until then, the Russians had not test-launched a mobile SS-24 for six years, a spokesman disclosed.

The way ahead for the RVSN is anything but clear, and the course for Russia's missile force will turn on several variables. Gen. Col. Victor I. Yesin, chief of Strategic Missile Troops Main Staff, said that developments during the next 10 to 15 years will be determined by Russia's economic condition, government arrangements with industry, and limits imposed by the START I and START II treaties.

Russia delayed START II ratification throughout 1996. The provisions of this treaty would greatly affect Russia's strategic force mix and allocation of weapons among the legs of its triad of ICBMs, SLBMs, and bombers. The results of this realignment would impede the RVSN's ability to execute its current targeting plan and would force a change. Restructuring would require investment of $40 billion to $50 billion to purchase new systems, according to START II critics in Russia.

This level of investment would greatly strain the present defense budget. The RVSN received only 56 percent of its approved 1996 defense budget. Current estimates place the 1997 defense budget at only one-third of the requested amount. If this is the final budget result, many of Russia's problems outlined above will worsen. ■

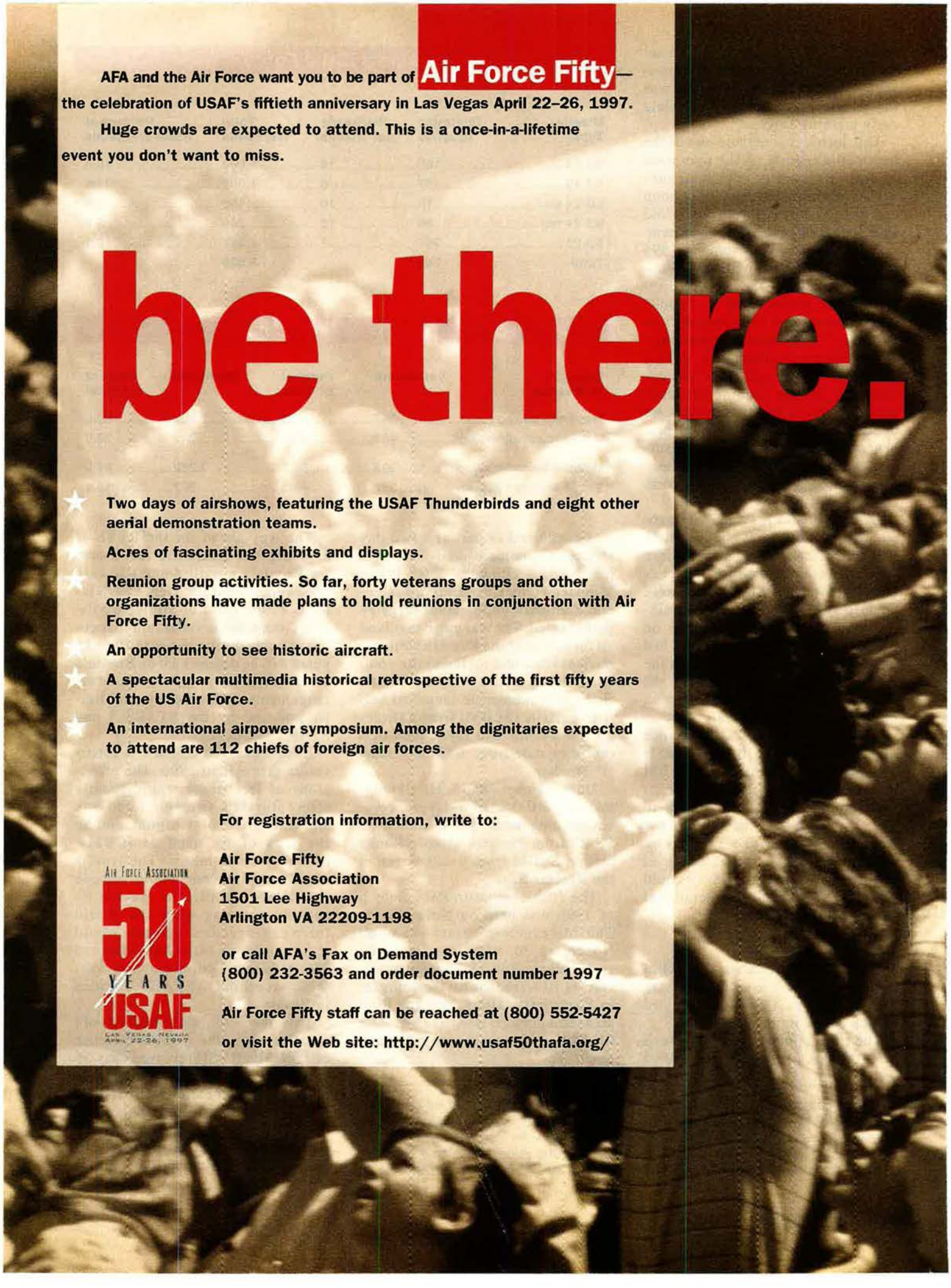
Russia's ICBM Force

Missile Type	Deployed Missiles	Warheads per Missile	Total Warheads	Percent of ICBM Warheads
SS-18	180	10	1,800	49.6
SS-19	167	6	1,002	27.6
SS-24 silo	10	10	100	2.8
SS-24 rail	36	10	360	9.9
SS-25	367	1	367	10.1
Total	**760**		**3,629**	

The Mix of Weapons

Category of Weapon	Launchers	Percent of Total	Warheads	Percent of Total
Fixed silo basing	357	47.0	2,902	80.0
Mobile road/rail basing	403	53.0	727	20.0
Multiple-warhead system	393	51.7	3,262	89.9
Single-warhead system	367	48.3	367	10.1

David R. Markov, an analyst in the Strategy, Forces, and Resources division of the Institute for Defense Analyses in Alexandria, Va., tracks international aerospace developments. His most recent article for Air Force *Magazine, "The Aviation Market Goes Global," appeared in the June 1995 issue. Views expressed herein are solely those of the author, not IDA or the US Defense Department.*



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Gallery of Classics

Compiled By Jeffrey P. Rhodes

Bombers

MB-2/NBS-1

A derivative of the first US-designed bomber, the Martin MB-1, the MB-2 featured a number of improvements. Twenty MB-2s were ordered in June 1920, and the type was rushed into production so that Brig. Gen. William L. "Billy" Mitchell could use the aircraft in the planned strategic bombing tests off the Virginia Capes. From July 13–21, 1921, General Mitchell's 1st Provisional Air Brigade, based at Langley Field, Va., sank three ships, including the captured German battleship *Ostfriesland*, and demonstrated the vulnerability of naval vessels to aerial attack. The Air Service then ordered another 110 aircraft, which were designated NBS-1 for "Night Bombing, Short-Range." Curtiss underbid Martin (which had included development costs in its bid of $23,485 per aircraft) and received a contract for 50 aircraft (although Curtiss lost money on the program), while L. W. F. Engineering and Aeromarine received contracts for 35 and 25 aircraft, respectively. Martin then provided its competitors with drawings, parts lists, templates, and even jigs, so all the aircraft were essentially identical. The type was retired in 1928. *(Specifications for MB-2.)*

Contractors: 1. Glenn L. Martin Co. 2. L. W. F. Engineering Co. 3. Curtiss Aeroplane and Motor Co. 4. Aeromarine Plane and Motor Co. **Locations built:** 1. Cleveland, Ohio. 2. College Point, N. Y. 3. Garden City, N. Y. 4. Keyport, N. J. **Number built (USAF):** 130 (130).
FF: 1921. **FFM:** MB-2. **FFL:** Cleveland, Ohio. **FFP:** Unconfirmed. **Models/variants:** MB-2, NBS-1.
Powerplant: Two Packard Liberty 12A liquid-cooled V-12s of 420 hp each.
Wingspan: 74 ft 2 in. **Length:** 42 ft 8 in. **Height:** 15 ft 6¾ in. **Weight:** 13,695 lb gross.
Armament: Five .30-cal. Lewis machine guns in nose and amidships; 1,800 lb of bombs internally and up to 2,000 lb of bombs externally.
Accommodation: Four (pilot, copilot/navigator, bombardier/gunner, and rear gunner). **Cost:** $17,490 (Curtiss).
Max. speed: 101 mph. **Range:** 560 mi. **Ceiling:** 8,500 ft.

B-10

The B-10 was the first all-metal monoplane bomber to be produced in quantity. It also introduced such innovations as a monocoque fuselage, variable-pitch propellers, retractable landing gear, enclosed cockpits, and a rotating gun turret. A company-developed design, the prototype was found to have some deficiencies when testing began at Wright Field, Ohio, in the spring of 1932. It was modified to meet the Army's recommendations, and the XB-907A returned to Wright Field where it reached a speed of 207 mph with a full bomb load, which was considerably faster than any biplane bomber and as fast as most of the pursuit ships of the day. The Air Corps then bought the prototype (and redesignated it XB-10) along with 14 YB-10 service test aircraft. A total of 103 B-10B aircraft were built, and the type served in every AAC bomb group in the 1930s. Lt. Col. Henry H. "Hap" Arnold led a mass flight of B-10 crews from Washington, D. C., to Alaska for a six-week mapping mission that covered 18,000 miles. In 1935, B-10s were used to test the Norden bombsight. Thirty-two YB-12/B-12A were built, which were essentially the same as the B-10, except for different engines, extra fuel, and flotation chambers for overwater flying as part of the AAC's coastal defense mission. Export versions (192 Martin Model 139s) were sold to the Soviet Union, the Netherlands, China, Siam, Argentina, and Turkey. Most of the B-10s were still in service in 1940, although relegated to target-towing duties. Only one B-10 exists today, a Model 139 on display at the US Air Force Museum at Wright-Patterson AFB, Ohio. *(Specifications for B-10B.)*

Contractor: Glenn L. Martin Co. **Location built:** Baltimore, Md. **Number built (USAF):** 155 (155).
FF: February or March 1932. **FFM:** Company Model XB-907. **FFL:** Baltimore, Md. **FFP:** Likely William K. "Ken" Ebel. **Models/variants:** B-10B.
Powerplant: Two Wright R-1820-33 Cyclone nine-cylinder radials of 775 hp each.
Wingspan: 70 ft 6 in. **Length:** 44 ft 9 in. **Height:** 15 ft 5 in. **Weight:** 14,700 lb gross.
Armament: Three .30-cal. machine guns (one each in nose turret, aft cockpit, and ventral tunnel) and 2,260 lb of bombs internally.
Accommodation: Four (pilot and copilot/radio operator in separate cockpits, bombardier/gunner, and gunner). **Cost:** $50,840.
Max. speed: 215 mph. **Range:** 1,240 mi. **Ceiling:** 24,200 ft.

B-17 Flying Fortress

The B-17 was the first truly modern heavy bomber and one of the most recognized airplanes ever built. It was the first four-engine bomber put into production for the Army Air Corps but gained its greatest fame for daylight strategic bombings over Europe. On August 20, 1935, the prototype was flown to Wright Field for its official tests, flying 2,100 miles nonstop in nine hours, but the prototype crashed on October 30, when a gust lock was inadvertently left on the elevators and the airplane went out of control on takeoff. The first airplanes were delivered to the 2d Bomb Group at Langley Field, Va., in 1937. In December 1941, Maj. Truman H. Landon led a flight of unarmed B-17s to reinforce Hawaii. The planes were nearly out of gas as they landed at Wheeler Field in the middle of the Japanese attack on Pearl Harbor. Subsequently, B-17 production ramped up quickly, and the aircraft was used in great numbers in every theater of the war. On January 27, 1943, Eighth Air Force B-17 crews made the first American air raid on Germany. The B-17G, the most produced version, featured additional guns in an attempt to prevent some of the heavy losses that had been inflicted on the earlier models. One of the more unusual modifications was the conversion of at least 25 war-weary B-17s into BQ-7 Aphrodite radio-controlled missiles, which were loaded with 12,000 lbs of high explosives and used against the German U-boat pens. B-17s were used by the Navy and the Army Air Forces for sea-air rescue. While the B-17 was essential to winning the war, the type was obsolete by 1945 and disappeared almost overnight, although a few remained in service for several years. *(Specifications for B-17G.)*

Contractors: 1. Boeing Aircraft Co. 2. Douglas Aircraft Co. 3. Vega Aircraft Corp. **Locations built:** 1. Seattle, Wash. 2. Long Beach, Calif. 3. Burbank, Calif. **Number built (USAF):** 12,731 (12,487).
FF: July 28, 1935. **FFM:** Company Model 299. **FFL:** Seattle, Wash. **FF Crew:** Leslie Tower and crew. **Models/variants:** Y1B-17, B-17B, C, D, E, F, G, H, TB-17H (later redesignated SB-17G), QB-17L, N, DB-17G, P, YB-40, BQ-7, F-9A, B, C.
Powerplant: Four Wright R-1820-97 Cyclone nine-cylinder radials of 1,200 hp each with exhaust-driven supercharger.
Wingspan: 103 ft 9 in. **Length:** 74 ft 4 in. **Height:** 19 ft 1 in. **Weight:** 65,500 lb gross.
Armament: 13 .50-cal. machine guns (two each in chin, dorsal, ball, and tail turrets, two in nose, two waist positions, and one in radio operator's position) and 6,000 lb of bombs internally.
Accommodation: Crew of 10 (pilot, copilot, bombardier, navigator, radio operator, and five gunners). **Cost:** $238,329.
Max. speed: 287 mph. **Range:** 2,000 mi. **Ceiling:** 35,600 ft.

B-24 Liberator

More B-24 heavy bombers were built than any other American airplane in history. The B-24 was used in every theater in World War II, and it had greater range and could carry a much larger bomb load than the B-17, but it never had the notoriety of the Flying Fortress. Probably the most famous B-24 was named *Lady Be Good*. On April 4, 1943, returning from a bombing mission, it overshot its base at Soluch, Libya, and was not heard from again. In 1959, the wreckage was found by an oil exploration party 440 miles into the Libyan desert. On August 1, 1943, staging from Benghazi, Libya, 177 Ninth Air Force B-24 crews dropped 311 tons of bombs from low level on the oil refineries at Ploesti, Romania, during Operation Tidal Wave. This was the first large-scale, minimum-altitude attack by Army Air Forces heavy bombers on a strongly defended target. Five officers (Lt. Col. Addison E.

KEY

FF	first flight
FFL	first flight location
FFM	first flight model
FFP	first flight pilot
USAF	Air Force and all predecessors
Models/variants	quantity production models and major variants

bombers

Photo via Robert F. Dorr

B-24 Liberator

bombers

Baker, Col. Leon W. Johnson, Col. John R. Kane, Maj. John L. Jerstad, and 2d Lt. Lloyd H. Hughes) were awarded the Medal of Honor for this mission. More Air Force Medals of Honor were awarded for this mission than any other in the service's history. The B-24 was also used extensively by Britain. Almost 1,000 were used by the US Navy as PB4Ys. A total of 6,678 B-24Js were built, starting in August 1943. One C-87, the widely used cargo version of the Liberator, named *Guess Where II*, was intended to be the first Presidential aircraft, although there is no evidence that Franklin D. Roosevelt ever flew in it. B-24 operations were concentrated in the Pacific, and the first Liberators went into action on November 16, 1943, at Bougainville in the Solomon Islands. There were 6,000 operational B-24s in use by the end of 1944, equipping 45 groups. A year later, the type was declared surplus and hundreds were scrapped virtually overnight. The lone XB-24N was a single-tail test version. Approximately a dozen Liberators remain today. *(Specifications for B-24J.)*

Contractors: 1. Consolidated Aircraft Co. 2. Douglas Aircraft Co. 3. Ford Motor Co. 4. North American Aviation, Inc. **Locations built:** 1. San Diego, Calif., and Fort Worth, Tex. 2. Tulsa, Okla. 3. Willow Run, Mich. 4. Dallas, Tex. **Number built (USAF):** 18,481 (approx 16,300).

FF: December 29, 1939. **FFM:** XB-24. **FFL:** San Diego, Calif. **FFP:** Bill Wheatley. **Models/variants:** B-24A, C, D, E, G, H, J, L, M. C-87, C-87A. C-109. F-7, F-7A, B. AT-22 (later redesignated TB-24D).

Powerplant: Four Pratt & Whitney R-1830-43 or -65 Twin Wasp 14-cylinder, twin-row radials of 1,200 hp each.

Wingspan: 110 ft 0 in. **Length:** 67 ft 2 in. **Height:** 18 ft 0 in. **Weight:** 65,000 lb gross.

Armament: 10 .50-cal. machine guns—eight in four manned electric turrets (nose, dorsal, ball, and tail) and two single guns in the waist, plus 8,800 lb of bombs.

Accommodation: Crew of 10 normally (pilot, copilot, navigator, bombardier, radio operator/top gunner, plus five other gunners). **Cost:** $366,000 (B-24D).

Max. speed: 290 mph. **Range:** 2,100 mi. **Ceiling:** 28,000 ft.

Photo by Fred E. Bamberger

B-25 Mitchell

B-25 Mitchell

On January 25, 1939, the Army Air Corps announced a competition for a medium bomber design, but instead of waiting for the prototypes, the Army awarded production contracts to North American for the B-25 and Martin for the B-26. Named in honor of US airpower proponent Brig. Gen. William "Billy" Mitchell, the B-25 served in every theater of World War II and was made in larger quantities than any other American twin-engine combat airplane. The 17th Bomb Group at McChord Field, Wash., was the first unit to receive B-25s in 1941. On April 18, 1942, Lt. Col. James H. "Jimmy" Doolittle led the Doolittle Raid, in which 16 B-25B crews took off from the aircraft carrier USS *Hornet* (CV-8) and bombed Tokyo and other targets, the first time US aircraft had bombed Japan. The 75-mm cannon in the B-25G/H was used with mixed results, primarily against ships. Recoil from the cannon was 21 inches and momentarily stopped the plane in flight. The Marine Corps received 706 B-25Bs, Cs, and Ds, which were redesignated PBJ-1, and used for antisubmarine patrol duties. Mitchells were later relegated to support duties and did not see service in Korea. The last B-25s were used to train pilots assigned to fly bombers and tankers. Large numbers of B-25s were flown by the Soviet Union and Britain. It was also flown by the Netherlands, Taiwan, and Brazil. A number of surplus B-25s were used by civilian operators as aerial camera ships for Hollywood movies. On May 21, 1960, the last serving aircraft, a VB-25J staff transport, was retired from service at Eglin AFB, Fla. *(Specifications for B-25J.)*

Contractor: North American Aviation, Inc. **Locations built:** 1. Inglewood, Calif. 2. Kansas City, Mo. **Number built (USAF):** 11,433 (9,816).

FF: January 1939. **FFM:** NA-40. **FFL:** Inglewood, Calif. **FFP:** Paul Balfour. **Models/variants:** B-25, B-25A, B, C, D, G, H, J. AT-24A, B, C, D (later redesignated TB-25D, G, C, J). F-10.

Powerplant: Two Wright R-2600-29 Cyclone 14-cylinder radials of 1,700 hp each.

Wingspan: 67 ft 7 in. **Length:** 52 ft 11 in. **Height:** 16 ft 4 in. **Weight:** 35,000 lb gross.

Armament: 12 .50-cal. machine guns and 4,000 lb of bombs (Some H/J models were modified with a solid nose and an additional four to eight .50-cal. machine guns or two or four .50-cal. machine guns and a 75-mm M4 cannon).

Accommodation: Crew of six normally (pilot, copilot, bombardier, radio operator/top turret gunner, waist gunners, and tailgunner; some models required fewer people). **Cost:** $96,000 (B-25B).

Max. speed: 272 mph. **Range:** 1,350 mi. **Ceiling:** 24,000 ft.

B-26 Marauder

The B-26 was ordered off the drawing board (no prototypes were built) at the same time as the B-25. With a troubled development history, it was called (among other things) the "Flying Prostitute"—with its high wing loading (51 lbs per square ft) and small wings, it was said to have had no visible means of support. Although most problems were caused by pilot unfamiliarity, there were some development problems. Eventually, the type's deficiencies were corrected and the B-26 went on to a stellar career. B-26 crews began flying combat missions in the South Pacific in the spring of 1942, but most of the aircraft were sent to England and the Mediterranean. The Marauder had the lowest loss rate of any Allied bomber, less than one-half of one percent. One B-26B, nicknamed *Flak Bait*, flew more missions in Europe (202) than any other Allied airplane in World War II. A small number were used by the Navy as JM-1/-2 for target tug, reconnaissance, and utility duties. Most of the B-26s were retired by 1948. It was one of several American warplanes given its official nickname by the British. Production aircraft were ordered to Australia the day after Pearl Harbor was attacked to provide additional defense. The B-26 was the only Army bomber to drop torpedoes. Because of its reputation as a "widow-maker" early in its career, Lt. Col. Jimmy Doolittle was ordered to go to training airfields to personally demonstrate that the B-26 could stay aloft on one engine. Late in the war, Marauders were used to attack German rocket sites, airfields, and communications centers in France and the Low Countries. One airplane was modified in order to test the tandem landing gear arrangement for the Boeing B-47 after the war. *(Specifications for B-26B.)*

Contractor: Glenn L. Martin Co. **Locations built:** Middle River, Md., and Omaha, Neb. **Number built (USAF):** 5,266 (4,440).

FF: November 25, 1940. **FFM:** B-26. **FFL:** Middle River, Md. **FFP:** William K. "Ken" Ebel. **Models/variants:** B-26, B-26A, B, C, F, G. AT-23A, B. TB-26B, C.

Powerplant: Two Pratt & Whitney R-2800-41 or -43 Double Wasp 18-cylinder, twin-row radials of 2,000 hp each.

Wingspan: 71 ft 0 in. **Length:** 58 ft 3 in. **Height:** 19 ft 10 in. **Weight:** 38,200 lb gross.

Armament: 12 .50-cal. machine guns (two each in nose, dorsal turret, ventral, and tail positions; four package guns on fuselage sides) and 4,000 lb of bombs.

Accommodation: Crew of seven (pilot, copilot, bombardier, navigator, and turret, ventral, and tailgunners). **Cost:** $227,000.

Max. speed: 317 mph. **Range:** 1,150 mi. **Ceiling:** 23,500 ft.

B-29 Superfortress

Designed as a replacement for the B-17 and B-24, the B-29 was considered the ultimate bomber of World War II. An extremely complex airplane, it introduced such concepts as pressurization and remotely controlled gun turrets, and its severe development troubles led to a delay in service introduction. In December 1943, the Air Force decided not to use the B-29 in Europe but to put its great range to use in the Pacific. The first B-29 unit, the 58th Bomb Wing (VH), was established in Marietta, Ga., on June 15, 1943. The first B-29 raid against Japan came on June 15, 1944. B-29s from the 509th Composite Group dropped the only nuclear weapons ever used in wartime. On August 6, 1945, the *Enola Gay*, piloted by Col. Paul W. Tibbets, dropped the "Little Boy" (uranium) bomb on Hiroshima. Three days later, *Bockscar*, commanded by Maj. Charles W. Sweeney, dropped the "Fat Man" (plutonium) bomb on Nagasaki. After the war, B-29s were modified as the first aerial tankers in quantity. The remaining B-29s were sent into combat during the Korean War. After World War II, B-29s were used as "mother ships" for several of the Air Force's and Navy's high-speed experimental aircraft, such as the X-1, X-2, and D-558. In the late 1940s, a significantly modified version of the B-29 was developed and was designated B-50. One of the B-50s, nicknamed *Lucky Lady II*, completed the first nonstop flight around the world. Eventually, 370 B-50s were built and served as late as 1964. *(Specifications for B-29.)*

Contractors: 1. Boeing Aircraft Co. 2. Bell Aircraft Co. 3. Glenn L. Martin Co. **Locations built:** 1. Wichita, Kan., and Renton, Wash. 2. Marietta, Ga. 3. Omaha, Neb. **Number built (USAF):** 3,967 (3,967).

FF: September 21, 1942. **FFM:** XB-29. **FFL:** Seattle, Wash. **FF Crew:** Edmund T. "Eddie" Allen and crew. **Models/variants:** YB-29, B-29, B-29A, B, F. KB-29M, P. F-13.

Powerplant: Four Wright R-3350-23 Cyclone 18-cylinder twin-row radials of 2,200 hp each.

Wingspan: 141 ft 3 in. **Length:** 99 ft 0 in. **Height:** 29 ft 7 in. **Weight:** 124,000 lb gross.

Armament: Usually eight (some with 10) .50-cal. machine guns in four remotely controlled turrets and two .50-cal. machine guns and one 20-mm cannon or two, three, or four .50-cal. machine guns in tail and up to 20,000 lb of bombs.

Accommodation: Crew of 10 (pilot, copilot, bombardier, navigator, flight engineer, radio operator, and four gunners). **Cost:** $639,000.

Max. speed: 358 mph. **Range:** 3,250 mi. **Ceiling:** 31,850 ft.

B-36 Peacemaker

Designed in 1941 to bomb targets in Europe from North America when it seemed Britain might fall to Germany. Development was slowed by shortages of critical materials and the need to devote effort to wartime production. The XB-36, the largest aircraft in the world, did not fly until almost five years after the development contract was let. The prototypes used a large single-wheel main landing gear, but the wheel broke up concrete runways. The B-36, with its intercontinental range and ability to carry nuclear weapons (primarily the Mk. 17 hydrogen bomb), served as the US's airborne nuclear deterrent through the 1950s. The type entered service in 1948, was politically controversial, and was partially responsible for the "Revolt of the Admirals" in 1949. Three separate projects were tried to provide the B-36s with long-range fighter escort in the early 1950s. The XF-85 parasite fighter was designed to fit in the bomb bay (which was never actually accomplished), while the YRF-84 FICON (Fighter-Conveyor) used a nose-mounted hook to latch on to a trapeze. Project Tom-Tom used wingtip-mounted hookups to carry two RF-84Fs.

Aerial refueling of fighters proved much more practical. The NB-36 was a specially modified test-bed that carried an operating nuclear reactor in an effort to develop an atomic-powered aircraft. The lone XC-99 was the transport version of the B-36, and the XB-60 was the sweptwing, jet-powered experimental version. The last B-36 was retired on February 12, 1959, leaving the Air Force with an all-jet bomber force. The last flight came on April 30, 1959, when a B-36J was flown to the US Air Force Museum at Wright-Patterson AFB, Ohio, where it is now on display. *(Specifications for B-36H.)*

Contractor: Consolidated-Vultee Aircraft Corp. (Convair). **Location built:** Fort Worth, Tex. **Number built (USAF):** 385 (385).

FF: August 8, 1946. **FFM:** XB-36. **FFL:** Fort Worth, Tex. **FF Crew:** Beryl A. Erickson and G. S. "Gus" Green. **Models/variants:** B-36A, B, C, D, F, H, J. RB-36D, E, F, H.

Powerplant: Six Pratt & Whitney R-4360-53 Wasp Major four-row radials of 3,800 hp each in a pusher arrangement and four General Electric J47-GE-19 turbojets of 5,010 lb static thrust each.

Wingspan: 230 ft 0 in. **Length:** 162 ft 1 in. **Height:** 46 ft 8 in. **Weight:** 410,000 lb gross.

Armament: 16 M24A1 20-mm cannon in eight remotely controlled nose, tail, and retractable fuselage turrets and 72,000 lb of nuclear and/or conventional bombs.

Accommodation: 16 (pilot, copilot, radar bombardier, navigator, two flight engineers, two radio operators, and three gunners in the forward pressurized compartment and five gunners in the aft pressurized compartment). **Cost:** $1.4 billion for the entire program (R&D, prototypes, and production); approx $3.6 million per aircraft.

Max. speed: 411 mph. **Range:** 8,800 mi. **Ceiling:** 33,000 ft.

B-45 Tornado

The B-45 was the first American four-engine jet bomber to fly and the first Air Force jet bomber to go into production. However, the B-45's career was only moderately successful. The type entered service in 1948 with the 47th Bomb Group at Barksdale AFB, La. Three RB-45Cs were sent to Korea for an operational evaluation and were pressed into service with the 91st Strategic Reconnaissance Squadron, but the type's wartime experience was short. Originally designed as conventional bombers, 40 B-45s were extensively modified to carry nuclear weapons under the Backbreaker program, starting in 1950. Nuclear-capable aircraft reached the United Kingdom by May 1, 1952. On July 29, 1952, an RB-45C crew made the first nonstop transpacific flight by a multiengine jet bomber with the help of a KB-29 tanker. In flying the 3,640 miles from Alaska to Japan in nine hours, 50 minutes, the crew of Maj. Louis H. Carrington, Jr., Maj. Frederick W. Shook, and Capt. Wallace D. Yancey won the Mackay Trophy. In the 1950s, two aircraft were used in the development of jet engines (the JB-45A was used by Westinghouse, and the JB-45C was used by both General Electric and Pratt & Whitney). Other aircraft were used as target tugs, conversion trainers, and drone director aircraft. The B-45 was phased out of service by 1959. *(Specifications for B-45C.)*

Contractor: North American Aviation, Inc. **Location built:** Long Beach, Calif. (in a former Douglas Aircraft Co. factory). **Number built (USAF):** 142 (142).

FF: March 17, 1947. **FFM:** XB-45. **FFL:** Muroc AAF, Calif. **FFP:** George Krebs. **Models/variants:** B-45A, C. RB-45C.

Powerplant: Two General Electric J47-GE-13 and two General Electric J47-GE-15 turbojets of 5,200 lb static thrust each.

Wingspan: 89 ft 0 in (96 ft 0 in over wingtip tanks). **Length:** 75 ft 4 in. **Height:** 25 ft 2 in. **Weight:** 112,952 lb gross.

Armament: Two Browning M7 .50-cal. machine guns in tail turret and 22,000 lb of conventional or nuclear bombs.

Accommodation: four (pilot and copilot in tandem, bombardier, and tailgunner). **Cost:** $1.08 million.

Max. speed: 573 mph. **Range:** 1,910 mi. **Ceiling:** 43,250 ft.

B-47 Stratojet

The B-47 was the world's first sweptwing bomber and the first to use a bicycle arrangement for the landing gear, which was necessary because of the thin wing. At the time, the design was so advanced that some writers called it "futuristic." The advanced design was also a curse in that it led to a number of developmental troubles. The B-47A entered service at MacDill AFB, Fla., in 1951. The B-47B was the first model to enter wide-scale service, and by 1957, 28 bomb wings were flying 1,260 B-47s; another 600 reconnaissance or training versions were in use. Several versions of the B-47 were high-altitude photoreconnaissance aircraft, and a number of them were used for electronic reconnaissance. Spurred by the Suez Crisis of 1956, Strategic Air Command demonstrated its ability to launch a large strike force on short notice. Within a two-week period, more than 1,000 B-47 crews flew nonstop simulated combat missions, averaging 8,000 miles each, over North America and the Arctic. The last Air Force Stratojet, an RB-47H, was retired on December 29, 1969. The Navy had a specialized test version that was used until 1976. *(Specifications for B-47E.)*

Contractors: 1. Boeing Aircraft Co. 2. Douglas Aircraft Co. 3. Lockheed-Georgia Co. **Locations built:** 1. Seattle, Wash., and Wichita, Kan. 2. Tulsa, Okla. 3. Marietta, Ga. **Number built (USAF):** 2,041 (2,041).

FF: December 17, 1947. **FFM:** XB-47. **FFL:** Seattle, Wash. **FF Crew:** Bob Robbins (pilot) and Scott Osler (copilot). **Models/variants:** B-47A, B, E. RB-47B, E, H. TB-47B. RB-47B. WB-47B, E. EB-47E, L. QB-47E.

Powerplant: Six General Electric J47-GE-25 or -25A turbojets of 7,200 lb thrust each with water injection.

Wingspan: 116 ft 0 in. **Length:** 109 ft 10 in. **Height:** 27 ft 11 in. **Weight:** 206,700 lb gross.

Armament: Two M24A1 20-mm cannon in remotely controlled tail turret and up to 25,000 lb of bombs internally.

Accommodation: Crew of three (pilot, copilot, and navigator). **Cost:** $1.9 million.

Max. speed: 606 mph. **Range:** 4,000 mi. **Ceiling:** 40,500 ft.

B-57 Canberra

The B-57 was the only airplane of non-US design adopted for operational service since World War II and was the first selected for US production since World War I. The B-57 was a version of the Royal Air Force's English Electric Canberra. The shortcomings of the obsolete Douglas B-26 (A-26) accounted for the urgent procurement of a light tactical bomber, and the Canberra was the only aircraft available. The B-57 entered service with the US Air Force in 1955. Development problems (resulting in several fatal crashes and groundings) early in the B-57's career were eventually overcome. In 1955, a major redesign was undertaken and produced the high-altitude RB-57D for electronic and photographic reconnaissance. The B-57E was the first aircraft built new for the Air Force for target towing. The Canberra (or "Cranberry," as it was sometimes called) was sent to Vietnam in early 1965 to be used for daylight bombing, night interdiction, and reconnaissance missions. The need for aircraft was so great that a number of early models were recalled from storage at Davis-Monthan AFB, Ariz., and refurbished. The General Dynamics–built RB-57F had even larger wings than the D model and required two additional engines. It was used for intelligence collection. The RB-57Fs were retired in 1974, and an Air National Guard unit flew the last EB-57s until 1982. *(Specifications for B-57B.)*

Contractors: 1. Glenn L. Martin Co. 2. Fort Worth Division of General Dynamics Corp. **Locations built:** 1. Middle River, Md. 2. Fort Worth, Tex. **Number built (USAF):** 403 (403).

FF: July 20, 1953 (US-built aircraft). **FFM:** B-57A. **FFL:** Middle River, Md. **FFP:** Unconfirmed. **Models/variants:** B-57A, B, C, E. RB-57A, C, D, E. EB-57A, B, E. TB-57E. RB-57F. WB-57F.

Powerplant: Two Wright J65-W-5F turbojets of 7,220 lb of thrust each.

Wingspan: 64 ft 0 in (122 ft 5 in on RB-57F). **Length:** 65 ft 6 in (68 ft 10 in on RB-57F). **Height:** 15 ft 7 in (20 ft 6 in on RB-57F). **Weight:** 56,956 lb gross (63,000 lb gross on RB-57F).

Armament: Eight .50-cal. machine guns or four 20-mm cannon in outer wings and up to 5,000 lb of bombs in internal rotary bay and two underwing hardpoints for up to 1,000 lb of ordnance.

Accommodation: Crew of two (pilot and navigator in tandem); (pilot and systems operator on RB/EB-57). **Cost:** $1.26 million (EB-57B).

Max. speed: 582 mph. **Range:** 2,300 mi. **Ceiling:** 48,000 ft.

B-58 Hustler

The B-58 was the first supersonic bomber put into production and the first bomber to reach Mach 2. The Hustler had no internal weapons stowage and made use of stainless-steel honeycomb construction for lower weight and greater strength. Crew members had individual escape capsules rather than individual ejection seats. The B-58 used sophisticated inertial and star-tracking navigation methods. On October 15, 1959, one of the first B-58s built was flown 1,680 miles in 80 minutes with one refueling, maintaining a speed of more than Mach 2 for more than an hour. The 43d Bomb Wing at Carswell AFB, Tex., was the first B-58 unit, and the only other unit was the 305th Bomb Wing at Bunker Hill AFB, Ind. Aircraft were withdrawn from service in January 1970 primarily because of the high cost of operation. B-58s were used to set more world records than any other type of combat airplane. On March 5, 1962, Maj. Robert G. Sowers and Capts. Robert McDonald and John T. Walton were the only entry in the twenty-first and last Bendix Trophy transcontinental race. Called Operation Heatrise, the crew completed the Los Angeles to New York course with an average speed of 1,214.71 mph and total elapsed time of two hours, 56 seconds. The crew was also awarded the 1962 Mackay Trophy. On October 16, 1963, in Operation Greased Lightning, a B-58 crew led by Maj. Sidney J. Kubesch took off from Okinawa, flew to Alaska, over Canada to London to set a world speed record by flying 8,028 miles in eight hours, 35 minutes, 20.4 seconds, averaging 938 mph. Out of 116 aircraft built, 26 crashed, although most of the accidents occurred early in the plane's career. Eight B-58s survive today in various states of repair.

Photo by Ken Smith via Warren Thompson

B-58 Hustler

Contractor: Convair Division of General Dynamics Corp. **Location built:** Fort Worth, Tex. **Number built (USAF):** 116 (116).

FF: November 11, 1956. **FFM:** XB-58. **FFL:** Fort Worth, Tex. **FF Crew:** Beryl A. Erickson, pilot; J. D. McEachern, flight-test observer; and Charles Harrison, flight-test engineer. **Models/variants:** YB-58, B-58A. RB-58A, TB-58A.

Powerplant: Four General Electric J79-GE-5A, -5B, or -5C turbojets of 15,600 lb of thrust each in afterburner.

Wingspan: 56 ft 10 in. **Length:** 96 ft 9 in. **Height:** 31 ft 5 in. **Weight:** 163,000 lb gross.

Armament: One General Electric T171 (later designated M61) Vulcan 20-mm cannon in tail, plus one MA-1C, MB-1C, or Two-Component Pod

(TCP) ventral pod containing fuel and a variety of nuclear weapons; aircraft later modified to carry up to four Mk. 43 free-fall nuclear weapons with a yield of approx one megaton each.
Accommodation: Crew of three (pilot, navigator/bombardier, and defensive systems operator) in tandem. **Cost:** $12.44 million.
Max. speed: 1,385 mph. **Range:** 1,750 mi (combat) on internal fuel only; approx 4,000 mi (ferry) on internal fuel only. **Ceiling:** 64,800 ft.

B-66 Destroyer

Utilitarian aircraft developed from the Navy's A3D Skywarrior to provide the Air Force with a tactical light bomber and reconnaissance aircraft. The Destroyer was almost canceled due to early developmental problems, but it overcame them. Deliveries began in 1956. In the fall of 1957, only 17 hours after being put on alert in the US, several B-66B crews, after crossing the Pacific as elements of a Composite Air Strike Force, were flying simulated bombing missions over the Philippines. The RB-66C was designed for electronic reconnaissance and had a pressurized compartment for electronic warfare officers, rather than a bomb bay. The B-66B was the only pure bomber version, and even those were subsequently modified. The WB-66D, the final production version, was designed for weather data collection in combat areas. The EB-66Cs were used to locate North Vietnamese radar sites, determine their function, and identify their frequency to develop an enemy electronic order of battle. The type was retired in the mid-1970s, primarily because they had been used so extensively that fatigue was a problem. B-66s also had excessive maintenance requirements. The EB-66 models were eventually replaced by the EF-111. The X-21A was an extensively modified WB-66D and was a test-bed for wing laminar flow control system. *(Specifications for RB-66B, except as noted.)*
Contractor: Douglas Aircraft Co. **Locations built:** Long Beach, Calif., and Tulsa, Okla. **Number built (USAF):** 294 (294).
FF: June 28, 1954. **FFM:** RB-66A. **FFL:** Long Beach, Calif. **FFP:** George Jansen. **Models/variants:** RB-66A, B, C. B-66B. WB-66D; EB-66C, E. NB-66B, X-21A.
Powerplant: Two Allison J71-A-11 or -13s nonafterburning turbojets of 10,200 lb of thrust each.
Wingspan: 72 ft 6 in. **Length:** 75 ft 2 in. **Height:** 23 ft 7 in. **Weight:** 83,000 lb gross.
Armament: Two 20-mm cannon in a remotely controlled tail turret (15,000 lb of bombs internally on B-66B only).
Accommodation: Crew of three (pilot, navigator, and gunner/camera operator); crew of seven (pilot, navigator, and five electronic warfare officers) on RB/EB-66C. **Cost:** $2.55 million.
Max. speed: Approx 600 mph. **Range:** Approx 1,800 mi. **Ceiling:** 43,000 ft.

F-4E Phantom II

Fighters

Nieuport 28C.1

The Nieuport 28 was the first airplane flown in combat by pilots of the American Expeditionary Force in World War I. Pilots from the 94th Aero Squadron (the "Hat-in-the-Ring" Squadron) made the first US operational flights across the front lines in France on March 19, 1918. On April 14, 1918, Lts. Alan Winslow and Douglas Campbell downed two German Albatros fighters in a 10-minute battle. Lieutenant Winslow was the first American pilot in the American sector of the front to down an airplane; Lieutenant Campbell was the first US-trained pilot to score a victory. The AEF obtained all of their Nieuport 28s directly from the factory. Although more maneuverable than the Spad XIII that replaced it, the Nieuport 28 had a reputation for being somewhat fragile, and it had a tendency to shed its upper wing fabric when the pilot put the aircraft into a dive. Both of the aircraft's machine guns were located on the left side of the fuselage. Capt. Edward V. "Eddie" Rickenbacker, the leading American ace of the war and the commander of the 94th AS, began his combat career flying the Nieuport 28, and he recorded his first solo victory on May 7, 1918. The Nieuport 28 was also flown by the 27th, 95th, and 103d Aero Squadrons. The Lafayette Escadrille, the group of American volunteer pilots flying for France, began operations in 1916 flying the Nieuport 11. When the AEF arrived in France, the US obtained more than 850 examples of the Nieuport 17, 21, 23, 24, and 27 as training aircraft, which was fortunate, as all of these were underpowered and would not have fared well in combat. The Nieuport 28 was also flown by Switzerland and Greece.
Contractor: Société Anonyme des Etablissements Nieuport. **Location built:** Issy-les-Moulineaux, France. **Number built (USAF):** Unconfirmed (298).
FF: June 14, 1917. **FFM:** Nieuport 28C.1. **FFL:** Unconfirmed but most likely Paris. **FFP:** Unconfirmed. **Models/variants:** Nieuport 28C.1.
Powerplant: One Gnome 9-N seven-cylinder rotary of 160 hp.
Wingspan: 26 ft 3 in. **Length:** 21 ft 3¼ in. **Height:** 8 ft 0 in. **Weight:** 1,625 lb gross.
Armament: Two Vickers .303-cal. machine guns.
Accommodation: Pilot only. **Cost:** Unconfirmed.
Max. speed: 122 mph. **Range:** 248 mi. **Ceiling:** 19,685 ft.

S.P.A.D. XIIIC.1

The Spad was the ultimate model of the top-of-the-line French fighter in World War I and the most prevalent fighter type flown by the American Expeditionary Force. Fifteen of the 16 AEF pursuit squadrons flew Spad XIIIs by the Armistice on November 11, 1918. Deliveries to the Americans began in March 1918, almost nine months after French units started receiving their aircraft. By the time the Americans began flying this Spad, the German Fokker D.VII had been introduced, and once more, as had happened throughout the war, the balance of power in the air tipped to the Central Powers. The Spad XIII offered a number of evolutionary improvements over the Spad VII (such as a more powerful engine and stronger structure), but its major improvement over the earlier version was the fact it carried two machine guns. The AEF obtained 189 of these earlier aircraft, and the Lafayette Escadrille, the group of volunteer American pilots flying for France, was flying this type when the unit was absorbed by the AEF in early 1918 and became the 103d Aero Squadron. Capt. Eddie Rickenbacker, the commander of the 94th Aero Squadron and America's "Ace of Aces," recorded most of his victories in the Spad XIII, and 2d Lt. Frank Luke, Jr. (27th Aero Squadron), scored all of his "kills" (13 of which came in one week) in this biplane fighter. The last solo American aerial victory in World War I came on November 10, 1918, when Maj. Maxwell Kirby recorded his first and only "kill." The Bolling Commission chose the Spad XIII as one of the foreign-designed aircraft for production in the US, but orders for 2,000 aircraft to be built by Curtiss were canceled. Almost half of the Spad XIIIs for the US were delivered after the Armistice, and the Army Air Service used them into the mid-1920s. In addition to the Spad VII and XIII, the AEF also obtained 35 Spad XIs and six examples of the two-seat Spad XVI, one of which was used by Brig. Gen. Billy Mitchell, commander of the American air forces on the Western Front.
Contractor: Société Anonyme pour l'Aviation et ses Dérivés (SPAD). **Location built:** Surenes, France. **Number built (USAF):** Approx 8,400 (893).
FF: On or about March 22, 1917. **FFM:** Spad XIIIC.1. **FFL:** Unconfirmed but most likely Villacoubly, France. **FFP:** Lieutenant Salze. **Models/variants:** Spad XIIIC.1.
Powerplant: One Hispano-Suiza 8 Be liquid-cooled V-8 of 220 hp.
Wingspan: 26 ft 6 in. **Length:** 20 ft 4¼ in. **Height:** 7 ft 8½ in. **Weight:** 1,862 lb gross.
Armament: Two Vickers or Marlin .303-cal. machine guns.
Accommodation: Pilot only. **Cost:** Approx $10,000.
Max. speed: 139 mph. **Range:** Approx 200 mi. **Ceiling:** 22,300 ft.

F-4 Phantom II

The F-4 was the dominant Air Force fighter of the 1960s and early 1970s and was also the tactical workhorse in Vietnam. It was another Air Force aircraft that began its life as a Navy fighter. The Air Force made the decision to adopt the F-4 in March 1962—at the time an unprecedented action. The Phantom II was originally designated F-110 under the 1948 designation system. The first Air Force Phantom flew on May 27, 1963, and the type became operational in early 1964 with the 12th Tactical Fighter Wing. On July 10, 1965, Capts. Thomas S. Roberts and Ronald C. Anderson, along with Capts. Kenneth Holcombe and Arthur C. Clarke, in F-4Cs, shot down two MiG-17s, the first Air Force air-to-air victories of the Vietnam War. On January 2, 1967, Col. Robin Olds shot down a MiG-21, becoming the first and only Air Force ace with victories in World War II and Vietnam. The RF-4C photoreconnaissance variant was designed to replace the RF-101. The RF-4C was deployed to Vietnam at the end of 1965. The F-4D was the Air Force's first true ground-attack version and could carry twice the normal bomb load of a World War II–era B-17. The F-4E addressed a serious pilot concern with the addition of an M61A1 20-mm cannon. All of the Air Force aces (Capts. Charles B. DeBellevue, Jeffrey S. Feinstein, and Richard "Steve" Ritchie) and Navy aces of the Vietnam War flew F-4s. The F-4G was modified for the "Wild Weasel" radar site–suppression role, first flew in December 1975, and saw action in Operation Desert Storm. In March 1996, the "Wild Weasels" were the last Air Force F-4s to be retired. The RF-4Cs also saw action in Desert Storm and were retired from the Air National Guard in 1995. The F-4 family picked up the nicknames "Rhino" and the "Double Ugly." *(Specifications for F-4E.)*
Contractor: McDonnell Aircraft Corp. (later McDonnell Aircraft Division of McDonnell Douglas Corp.). **Location built:** St. Louis, Mo. **Number built (USAF):** 5,201, incl license-built aircraft (2,742).
FF: May 27, 1958. **FFM:** XF4H-1. **FFL:** St. Louis, Mo. **FFP:** Robert Little. **Models/variants:** F-110A, F-4C, D, E, G. RF-4C. QF-4.
Powerplant: Two General Electric J79-GE-17 turbojets of 17,900 lb of thrust in afterburner.
Wingspan: 38 ft 5 in. **Length:** 63 ft 0 in. **Height:** 16 ft 6 in. **Weight:** 61,651 lb gross.
Armament: One General Electric M61A1 Vulcan 20-mm cannon and up to four AIM-7 Sparrow radar-guided missiles and up to four AIM-9 Sidewinder heat-seeking missiles or up to 16,000 lb of assorted external stores.
Accommodation: Crew of two (pilot and weapon system officer in tandem). **Cost:** $2.48 million.
Max. speed: 1,500 mph. **Range:** 1,050 mi. **Ceiling:** 57,200 ft.

P-12

The P-12 was one of the most successful American fighters produced between the world wars. More P-12s were ordered than any other type until 1940. This type was used by both the Army and the Navy (as the F4B). This was the last biplane fighter flown by the Air Corps. The P-12 program began as a Boeing-funded venture. The first two aircraft, both company demonstrators, were eventually purchased by the Navy. The first P-12 was flown on April 11, 1929. The P-12 was one of the very first Air Corps pursuit ships (and the first purchased in quantity) powered by an air-

cooled engine. The P-12 and P-12B, C, and D aircraft had a bolted aluminum frame with fabric covering. The fuselages of the P-12E and F were all metal, semimonocoque construction. The aircraft made an auspicious debut, on February 26, 1929, when Capt. Ira C. Eaker flew the first P-12 accepted by the Air Corps from Boeing Field, Wash., to the Panama Canal and back. The trip took several weeks. The P-12 entered service with the 95th Pursuit Squadron at Rockwell Field, Calif., in April 1929. P-12s were in operational service from 1929 to 1936. A number of P-12s were pressed into service delivering mail during the air mail crisis of 1934. Navy F4Bs served until 1938. In 1940, the last 23 P-12s were transferred to the Navy and converted for use as radio-controlled targets. These aircraft were designated F4B-4As. *(Specifications for P-12E.)*

Contractor: Boeing Airplane Co. **Location built:** Seattle, Wash. **Number built (USAF):** 586 (366).
FF: June 25, 1928. **FFM:** Company Model 83. **FFL:** King County Airport (Boeing Field), Wash. **FFP:** Unknown. **Models/variants:** P-12, P-12B, C, D, E, F.
Powerplant: One Pratt & Whitney R-1340-17 Wasp nine-cylinder radial of 500 hp.
Wingspan: 30 ft 0 in. **Length:** 20 ft 3 in. **Height:** 9 ft 0 in. **Weight:** 2,690 lb gross.
Armament: Two .30-cal. or one .30-cal. and one .50-cal. machine guns; 244 lb of bombs on external racks.
Accommodation: Pilot only. **Cost:** $15,000.
Max. speed: 189 mph. **Range:** 570 mi. **Ceiling:** 26,300 ft.

P-26 "Peashooter"

This was the first monoplane fighter produced for the Army Air Corps, the first all-metal production fighter, and the last front-line AAC fighter with an open cockpit. It was also the last Boeing-designed fighter and the last fighter program the company was involved with until the current F-22. The P-26 was a joint development between Boeing and the Air Corps. The company financed building the first three prototypes, which after testing, were purchased by the service. The aircraft had a relatively high landing speed (82 mph), and pilots referred to it as "landing a high-speed rock." Deliveries began in 1933, and the P-26 equipped three units (20th Pursuit Group at Barksdale Field, La., 1st PG at Selfridge Field, Mich., and 17th PG at March Field, Calif.). By 1937, the aircraft were relegated to the Philippines, the Panama Canal Zone, and Hawaii. At least 13 aircraft were at Wheeler Field, Hawaii, at the time of the Japanese attack on December 7, 1941. In the Philippines, Capt. Jesus Villamor was credited with destruction of a Japanese bomber while flying a P-26 on December 12, 1941. Many aircraft in the Philippines were burned to prevent capture. A number of aircraft stationed in the Canal Zone were sold to Panama and Guatemala, and, in fact, two P-26s were in use as trainers in Guatemala as late as 1957. *(Specifications for P-26A.)*

Contractor: Boeing Airplane Co. **Location built:** Seattle, Wash. **Number built (USAF):** 151 (136).
FF: March 20, 1932. **FFM:** Company Model XP-936 (later redesignated XP-26). **FFL:** King County Airport (Boeing Field), Wash. **FFP:** Les Tower. **Models/variants:** P-26A, B, C.
Powerplant: One Pratt & Whitney R-1340-27 Wasp nine-cylinder radial of 550 hp.
Wingspan: 27 ft 11 1/2 in. **Length:** 23 ft 7 1/4 in. **Height:** 10 ft 0 1/2 in. **Weight:** 2,955 lb gross.
Armament: Two .30-cal. or one .30-cal. and one .50-cal. or two .50-cal. machine guns; 200 lb of bombs on external racks.
Accommodation: Pilot only. **Cost:** $9,999, less engine and GFE.
Max. speed: 234 mph. **Range:** 360 mi. **Ceiling:** 27,400 ft.

P-38 Lightning

Originally designed as a high-altitude interceptor, the P-38 proved very versatile and went on to become one of the most famous aircraft of all time. The Air Corps was so impressed with the XP-38 in its early trials that on February 11, 1939, even though the prototype had less than five hours of flight time, 1st Lt. Benjamin S. Kelsey tried to break the transcontinental speed record, but he crashed on approach to Mitchel Field, N. Y. Despite this setback, ground speeds of 420 mph and an elapsed time of only seven hours convinced the Air Corps to order the type into production. Britain ordered 667 P-38s, which it nicknamed "Lightning," but only three P-38s were delivered. The rest (and the nickname) were absorbed by the US. After some developmental troubles, the P-38 entered US service in 1941 and served in every theater of the war. 2d Lt. Elza Shahan, flying a P-38F, recorded the first American victory in the European theater of operations when he and a P-40 pilot downed a Focke-Wulf FW-200 near Iceland on August 14, 1942. The P-38 saw extensive service in North Africa, where the Germans called the aircraft the "Fork-Tailed Devil." On April 18, 1943, P-38 pilots from the 339th Fighter Squadron, using external tanks, flew from Guadalcanal to Bougainville and shot down Japanese Adm. Isoroku Yamamoto. The top two American aces of all time, Maj. Richard I. Bong (40 confirmed victories) and Maj. Thomas B. McGuire, Jr. (38), both flew P-38s in the southwest Pacific. P-38s also were used for photoreconnaissance (these dedicated aircraft were designated F-4 and F-5), bomber, and night fighter. Consolidated-Vultee built 113 P-38Ls in Nashville, Tenn., to meet wartime needs. The last P-38 was delivered in September 1945, and the type was phased out of service in 1949. *(Specifications for P-38L.)*

Contractors: 1. Lockheed Aircraft Co. 2. Consolidated-Vultee Aircraft Corp. **Locations built:** 1. Burbank, Calif. 2. Nashville, Tenn. **Number built (USAF):** 10,038 (10,035).
FF: January 27, 1939. **FFM:** XP-38. **FFL:** March Field, Calif. **FFP:** 1st Lt. Benjamin S. Kelsey. **Models/variants:** P-38, P-38D, E, F, G, H, J, L, M, F-4, F-4A, F-5A, B, C, E, F, G.
Powerplant: One Allison V-1710-111 and one Allison V-1710-113 (the different engine submodels turned the P-38's propellers in opposite directions) liquid-cooled V-12s of 1,600 hp each.
Wingspan: 52 ft 0 in. **Length:** 37 ft 10 in. **Height:** 9 ft 10 in (wheels to tip of fin); 12 ft 10 in (wheels to tip of propeller). **Weight:** 21,600 lb gross.
Armament: Four .50-cal. machine guns and one 20-mm cannon, plus two 2,000-lb bombs or 10 5-in. High-Velocity Aerial Rockets (HVARs) on underwing hardpoints.
Accommodation: Pilot only on most models (crew of pilot and bombardier on some P-38J/Ls; pilot and radar operator on P-38M). **Cost:** $95,150.
Max. speed: 414 mph. **Range:** 500 mi (up to 2,000 mi with external tanks). **Ceiling:** 44,000 ft.

P-39 Airacobra

One of the first "modern" Air Corps fighter designs and the first fighter designed by Bell, Airacobras were used primarily for ground attack. The XP-39 prototypes featured an engine supercharger, but the Army's decision to eliminate it on production aircraft greatly limited the type's effectiveness, and, in fact, the aircraft performed best below 17,000 ft. The P-39 had a unique automobile-type cockpit door, tricycle landing gear (another first for an AAC fighter), and a center-fuselage-mounted engine. The Airacobra entered Air Corps service in 1941. At the time of the Japanese attack on Pearl Harbor, 179 British Airacobras were still in the US waiting to be delivered, and these aircraft were commandeered by the AAC, redesignated P-400, and sent to the southwest Pacific. US P-39s were used extensively in operations in North Africa (most particularly Operation Torch), Italy, and the Pacific. The type achieved the lowest loss rate per sortie of any Army Air Forces fighter used in the European theater of operations, although it was mostly used in areas where Bf-109s and FW-190s were scarce. Numerous P-39s remained in the US during the war, where they were used for training units. Almost half of the production run was sent to the Soviet Union, where its tank-killing capability was used to great advantage. Most of these aircraft were ferried to Russia via Alaska. P-39s were also flown in numbers by the RAF and the Free French. Production ended in August 1944. Several aircraft were used by NACA as research aircraft at the Ames Flight Research Center in California, and a number were flown as racers after the war, but only a handful of P-39s are still in existence. The larger, better-performing P-63 Kingcobra was a direct descendent of the P-39. *(Specifications for P-39Q.)*

Contractor: Bell Aircraft Corp. **Location built:** Buffalo, N. Y. **Number built (USAF):** 9,558 (approx 3,675).
FF: April 6, 1938. **FFM:** XP-39. **FFL:** Dayton, Ohio. **FFP:** James Taylor. **Models/variants:** P-39C, D, F, J, K, L, M, N, Q.

P-38 Lightning

Photos via Jeffrey L. Ethell

Powerplant: One Allison V-1710-85 liquid-cooled V-12 of 1,200 hp.
Wingspan: 34 ft 0 in. **Length:** 30 ft 2 in. **Height:** 12 ft 5 in. **Weight:** 7,651 lb gross.
Armament: One 37-mm T9 cannon firing through the propeller hub; four (two nose- and two underwing-mounted) .50-cal. machine guns; 500 lb of bombs.
Accommodation: Pilot only. **Cost:** $46,000.
Max. speed: 382 mph. **Range:** 650 mi. **Ceiling:** 34,790 ft.

P-40 Warhawk

One of the most rugged fighters ever built, the P-40 was the Army Air Forces' front-line fighter at the start of World War II. The P-40 is among the top five aircraft in US history in terms of number of aircraft produced and was eventually flown by 28 countries. The lone XP-40 was a modified P-36 airframe with the V-1710 engine installed. Not an ad-

P-40 Warhawk

fighters

vanced design (nonsealing fuel tanks, no cockpit armor), the P-40 was actually obsolescent when production began, but its straightforward design allowed for a rapid ramp up to quantity production. Pilots with the 46th and 47th Pursuit Squadrons (both units flying P-40s) scored the first American victories of World War II when they downed 10 Japanese aircraft over Hawaii during the Pearl Harbor attack on December 7, 1941. Lt. Boyd "Buzz" Wagner, based in the Philippines and also flying a P-40, became the first American ace of the war when he downed his fifth Japanese aircraft on December 16. The P-40's greatest notoriety, though, came with the American Volunteer Group in China. Organized under the command of Claire Chennault, the AVG, better known as the Flying Tigers, entered combat on December 21, 1941. In existence only until July 6, 1942 (when it was absorbed in the Army Air Forces and became the 23d Fighter Group), the AVG shot down approximately 300 Japanese aircraft. The P-40 was also used extensively in North Africa and was flown off escort carriers during the initial stages of the invasion. As late as April 1944, nearly 2,500 P-40s were in AAF service. P-40 production ran until November 1944. After the war, the decision to keep the P-40 in production for so long, even after more modern aircraft became available, was severely criticized in the Truman Report. A majority of P-40 production went to Britain, where the RAF called them Tomahawks and Kittyhawks. Large numbers of aircraft were also used by Russia, Australia, New Zealand, and Canada. The Brazilian Air Force flew P-40s into the mid-1950s. *(Specifications for P-40N.)*

Contractor: Curtiss-Wright Corp. **Location built:** Buffalo, N. Y. **Number built (USAF):** 13,738 (5,380).
FF: October 14, 1938. **FFM:** XP-40. **FFL:** Buffalo, N. Y. **FFP:** Edward Elliott. **Models/variants:** P-40, P-40B, C, D, E, F, G, K, L, M, N.
Powerplant: One Allison V-1710-81, -99 or -115 liquid-cooled V-12 of 1,360 hp.
Wingspan: 37 ft 4 in. **Length:** 33 ft 4 in. **Height:** 12 ft 4 in. **Weight:** 8,850 lb.
Armament: six .50-cal. machine guns and up to 1,500 lb of bombs (one 500-lb bomb on each wing and centerline).
Accommodation: Pilot only. **Cost:** $52,869.
Max. speed: 350 mph. **Range:** 360 mi. **Ceiling:** 31,000 ft.

P-47 Thunderbolt

Originally conceived as a lightweight fighter, the P-47 ended up as the heaviest single-engine fighter flown by the Army Air Forces. The P-47 was used as both a high-altitude escort fighter and a low-level fighter-bomber. More P-47s were produced than any other US fighter before or since. More P-47Ds were produced—12,603—than the total production run of P-38s and nearly as many as the entire run of P-40s. Production began in 1942, and on September 20, 1944, the 10,000th P-47 rolled off the line to much fanfare, including aviatrix Jackie Cochran, the head of the Women's Airforce Service Pilots, dubbing the aircraft "10 Grand." Just 10 months later, the 15,000th P-47 came off the line. The P-47 entered service with the 56th and 78th Fighter Groups in late 1942 and saw its first combat on April 8, 1943, escorting B-17s over Europe. The P-47 picked up the nickname "Jug," because it was something of a juggernaut—heavy, extremely sturdy, and well armed. The early models (and the first blocks of P-47Ds) featured a humpback fuselage that blended into the tail via a "razorback" spine. Later blocks of P-47Ds and all subsequent models (including the 354 Curtiss-built aircraft) had a "bubble" canopy that offered the pilot near 360° visibility. The only theater of operations where the P-47 was not used in quantity was the Aleutians. By the end of 1944, 31 AAF fighter groups flew P-47s. The third- and fourth-ranked AAF aces of World War II, Lt. Col. Francis S. "Gabby" Gabreski (28 victories) and Capt. Robert S. Johnson (27), both flew P-47s in Europe. P-47s were also flown by Britain (830 aircraft), the Soviet Union, and Brazil during the war, and a number of countries flew the P-47 after the war. The P-47D and N models served until the formation of the US Air Force, and the F-47 (as it was later redesignated) served with the Air National Guard until 1955. *(Specifications for P-47D.)*

Contractors: 1. Republic Aviation Corp. 2. Curtiss-Wright Corp. **Locations built:** 1. Farmingdale, N. Y., and Evansville, Ind. 2. Buffalo, N. Y. **Number built (USAF):** 15,683 (14,562).
FF: May 6, 1941. **FFM:** XP-47B. **FFL:** Farmingdale, N. Y. **FFP:** Lowery Brabham. **Models/variants:** P-47B, C, D, G, M, N.
Powerplant: One Pratt & Whitney R-2800-59 Double Wasp 18-cylinder, two-row radial of 2,300 hp.
Wingspan: 40 ft 9 in. **Length:** 36 ft 1 in. **Height:** 14 ft 8 in. **Weight:** 19,400 lb gross.
Armament: Eight .50-cal. machine guns and up to 2,500 lb of bombs on two underwing and one centerline rack or 10 5-in High-Velocity Aerial Rockets (HVARs).
Accommodation: Pilot only. **Cost:** Approx $54,600.
Max. speed: 428 mph. **Range:** 800 mi (more than 1,200 mi with external tanks). **Ceiling:** 42,000 ft.

P-51 Mustang

The P-51 was designed (as the NA-73) in 1940 at Britain's request. An in-line engine, the British preference, was specified as well as the British standard of eight machine guns. The prototype was constructed within a 120-day limit. It was one of the few aircraft types that were conceived after the start of World War II yet saw large-scale service in the war. In permitting North American to design a fighter for a foreign buyer, the US Army Air Corps stipulated that two examples of the production model should be supplied free of charge for evaluation. It was the Royal Air Force that bestowed the nickname "Mustang" on the type. The first version for the US was the A-36 Apache dive bomber that first flew in 1942. About 500 of these "near-Mustangs" were built and saw action in the Italian campaign and in India. In December 1943, P-51Bs first entered combat over Europe, powered by Packard-built Rolls-Royce Merlin engines. They provided high-altitude escort to B-17s and B-24s, and by war's end, P-51 pilots had destroyed 4,950 enemy aircraft in the air (nearly half of the US total destroyed) and an additional 4,131 on the ground, more than any other US fighter in Europe. Despite this showing, none of the top four Army Air Forces aces flew Mustangs. P-51s saw service in nearly every combat zone in the war; in the Pacific, they escorted B-29s to Japan from Iwo Jima. At war's end, 5,541 Mustangs were on hand. Surplus machines were sold or given to Australia, Canada, China, Cuba, Denmark, the Dominican Republic, France, Indonesia, Israel, Sweden, Korea, Switzerland, and Italy. During the Korean War, F-51Ds (as they were redesignated in 1948) were used primarily for close support of ground forces until the type was withdrawn from combat in 1953. Mustangs have been popular for many years on the unlimited racing circuit. In 1984, the Piper Enforcer, a turboprop design based on the P-51, was marketed to smaller air forces as a light attack aircraft although none was bought. *(Specifications for P-51D.)*

Contractor: North American Aviation, Inc. **Locations built:** 1. Inglewood, Calif. 2. Dallas, Tex. **Number built (USAF):** 15,621, incl 500 A-36As (13,722).
FF: October 26, 1940. **FFM:** NA-73 (also referred to as NA-73X). **FFL:** Inglewood, Calif. **FFP:** Vance Breese. **Models/variants:** P-51, P-51A, B, C, D, H, K, F-6A, B, C, D, K, A-36A Apache.
Powerplant: One Packard V-1650-7 (license-built Rolls-Royce Merlin) liquid-cooled V-12 of 1,490 hp.
Wingspan: 37 ft 0 in. **Length:** 32 ft 3 in. **Height:** 13 ft 8 in. **Weight:** 11,600 lb gross.
Armament: Six .50-cal. machine guns and up to 2,000 lb of bombs or 10 5-in. High-Velocity Aerial Rockets (HVARs).
Accommodation: Pilot only. **Cost:** $50,985.
Max. speed: 437 mph. **Range:** 950 mi. **Ceiling:** 41,900 ft.

P-59 Airacomet

The P-59 was the first US jet aircraft. Developed in secrecy, its genesis came at the personal direction of Gen. "Hap" Arnold. Bell Aircraft was chosen for the project in part because of its location near the General Electric engine plants in New York and Massachusetts. Aircraft flew almost exactly a year after development began. To ensure secrecy, the XP-59 was fitted with a dummy propeller whenever it was towed on the ground. Col. Laurence C. "Bill" Craigie became the first USAAF pilot to fly a jet when he made the type's "official" first flight on October 2, 1942. First jet flight made by a USN aviator came on April 21, 1943, when Capt. Frederick M. Trapnell flew the XP-59 at Muroc AAF, Calif. The 412th Fighter Group became the first USAAF jet fighter unit when it was formed in 1943 and stationed at Bakersfield, Calif., and then later at March Field, Calif. This unit primarily served as a jet pilot training unit. The P-59 was never a great performer and was quickly overtaken by development of other jet aircraft, mainly the P-80. Only in operational service for about a year, the type was phased out of service by 1949. *(Specifications for P-59A, except as noted.)*

Contractor: Bell Aircraft Corp. **Location built:** Buffalo, N. Y. **Number built (USAF):** 66 (66).
FF: October 1, 1942. **FFM:** XP-59A. **FFL:** Rogers Dry Lake, Calif. **FFP:** Robert Stanley. **Models/variants:** P-59A, B.
Powerplant: Two General Electric I-16 turbojets of 1,600 lb thrust each. (P-59B: two General Electric J31-GE-5 turbojets of 2,000 lb thrust each).
Wingspan: 45 ft 6 in. **Length:** 38 ft 10 in. **Height:** 12 ft 0 in. **Weight:** 13,700 lb.
Armament: One 37-mm cannon and three .50-cal machine guns.
Accommodation: Pilot only. **Cost:** Unconfirmed.
Max. speed: 413 mph. **Range:** Approx 400 mi. **Ceiling:** 46,200 ft.

P-61 Black Widow

The P-61 was the first US aircraft specifically designed as a night fighter. As large as a medium bomber, it was actually very maneuverable. The P-61 was first fielded in Europe but found greater use in the Pacific. The Black Widow replaced the interim Douglas P-70 and eventually equipped all 14 USAAF night-fighter units. The key to the P-61's success was the Western Electric SCR-720 airborne intercept radar. The first recorded "kill" came on July 6, 1944, when 1st Lt. Francis Eaton (pilot), 2d Lt. James E. Ketchum (radar operator), and SSgt. Gary Anderson (gunner) intercepted and shot down a Japanese "Betty" bomber. P-61 crews accounted for 127 confirmed victories, including 18 V-1 "buzz bombs" in Europe. Four Black Widow crews became aces. The last aerial battle of World War II came on August 14, 1945, when Lt. Robert W. Clyde (pilot) and Lt. Bruce K. Ledford (radar operator), flying the P-61 *Lady in the Dark* got behind a Nakajima "Oscar," and in an attempt to escape from its pursuer, the Japanese fighter crashed into the Pacific without a shot being fired. In 1946, 36 aircraft of a slightly modified design were built as the F-15 Reporter photoreconnaissance aircraft. P-61s were also used for ejection-seat tests and for a research program that studied the effects of thunderstorms on aircraft structures after the war. In 1946, a dozen P-61Cs were transferred to the Marines as

P-51 Mustang

Photo by Ed Mason via Warren Thompson

trainers and were designated F2Ts. The P-61 was phased out of USAF service in 1952, and the last F-15 was retired in 1955. Only three P-61s are thought to exist today. *(Specifications for P-61B.)*

Contractor: Northrop Aircraft Corp. **Location built:** Hawthorne, Calif. **Number built (USAF):** 742 (742).

FF: May 26, 1942. **FFM:** XP-61. **FFL:** Northrop Field, Calif. **FFP:** Vance Breese. **Models/variants:** P-61A, B, C. F-15 Reporter.

Powerplant: Two Pratt & Whitney R-2800-65 Double Wasp 18-cylinder, twin-row radials of 2,000 hp each.

Wingspan: 66 ft 0 in. **Length:** 49 ft 7 in. **Height:** 14 ft 8 in. **Weight:** 38,000 lb gross.

Armament: Four .50-cal. machine guns in a remote-control ventral turret, four M2 20-mm cannon in the fuselage belly; 6,400 lb of bombs on underwing racks.

Accommodation: Three (pilot and gunner in forward cockpit; radar operator in rear cockpit). **Cost:** $170,000.

Max. speed: 366 mph. **Range:** 1,200 mi. **Ceiling:** 33,100 ft.

P-80 (F-80) Shooting Star

The Shooting Star recorded a number of firsts: It was the first Air Force aircraft to exceed 500 mph in level flight, the first American jet airplane to be manufactured in large quantities, and the first Air Force jet to be used in combat. In June 1943, Lockheed was invited to design an aircraft around the de Havilland H-1 turbojet newly developed in Britain. Lockheed's design team led by Clarence L. "Kelly" Johnson completed the project details in a week, and the first prototype was flown 143 days later. On that first flight, pilot Milo Burcham was so pleased with the performance of the aircraft that he presented a display of low-level aerobatics prior to landing. Several early P-80s were sent to Europe for a demonstration tour, but World War II ended before the aircraft could be employed in combat. The aircraft was redesignated in 1948 when "P" for pursuit was changed to "F" for fighter. Although it was originally conceived as a high-altitude interceptor, the F-80C was used extensively as a fighter-bomber in the Korean War, primarily for low-level rocket, bomb, and napalm attacks against ground targets. F-80C pilots flew more than 15,000 sorties in the first four months of the war. On November 8, 1950, 1st Lt. Russell J. Brown, flying a 16th Fighter-Interceptor Squadron F-80C, shot down a Soviet-built MiG-15 in the world's first all-jet air battle. The early success was short lived, however, and soon F-80 pilots required help from F-86 pilots in the form of top cover. Only 14 F-80s were shot down by enemy aircraft in Korea, but 113 were downed by ground fire. Many Shooting Stars were converted into FP-80 (later RF-80) reconnaissance and QF-80 drone versions. The T-33, for many years the world's most widely used jet trainer, and the radar-equipped F-94C all-weather interceptor were both developed from the F-80. *(Specifications for F-80C.)*

Contractor: Lockheed Aircraft Co. **Location built:** Burbank, Calif. **Number built (USAF):** 1,731 (1,678).

FF: January 8, 1944. **FFM:** XP-80. **FFL:** Muroc AAF, Calif. **FFP:** Milo Burcham. **Models/variants:** YP-80. P-80A, B, C (later redesignated F-80A, B, C). FP-80A, C (later redesignated RF-80A, C). F-14A. QF-80A, C.

Powerplant: One Allison J33 of 5,400 lb thrust (with water/alcohol injection).

Wingspan: 38 ft 10½ in. **Length:** 34 ft 6 in. **Height:** 11 ft 4 in. **Weight:** 16,856 lb.

Armament: Six .50-cal. machine guns and eight 5-in rockets or 2,000 lb of bombs.

Accommodation: Pilot only. **Cost:** $93,456.

Max. speed: 580 mph. **Range:** 1,380 mi. **Ceiling:** 48,000 ft.

F-82 Twin Mustang

The F-82 was the last propeller-driven fighter acquired in quantity by the Air Force and, with the exception of the A-1 Skyraider attack aircraft, was the last tail-dragger. Development began in 1944 to provide a twin-engine, long-range bomber escort with accommodations for a relief pilot who could aid in navigation. The F-82 appears to be two Mustang fuselages on one wing, but in reality it was a totally new design. Delivery from production did not begin until early 1946. After World War II, radar-equipped F-82s were used extensively by Air Defense Command as replacements for the P-61 night fighter. Nine F-82Fs and five F-82Gs were converted as F-82H winterized interceptors for Alaska. During the Korean War, Japan-based F-82s were among the first Air Force aircraft to operate over Korea. Lts. William G. Hudson and Charles B. Moran recorded the first "kill" in Korea on June 27, 1950, when they shot down a North Korean Yak-11. Two other F-82 crews recorded air-to-air victories, and a total of 16 aircraft were destroyed on the ground by Twin Mustang crews. The type flew 1,868 sorties in the Korean War before being withdrawn in February 1952. The Tennessee ANG flew F-82s for a brief time. The type was retired by June 1953. *(Specifications for F-82E.)*

Contractor: North American Aviation, Inc. **Location built:** Inglewood, Calif. **Number built (USAF):** 272 (272).

FF: July 6, 1945. **FFM:** XP-82. **FFL:** Unconfirmed but likely Inglewood, Calif. **FFP:** Unconfirmed but possibly Vance Breese. **Models/variants:** F-82B, E, F, G, H.

Powerplant: One Allison V-1710-143 and one Allison V-1710-145 (the different engine submodels turned the F-82's propellers in opposite directions) liquid-cooled V-12s of 1,600 hp each.

Wingspan: 51 ft 3 in. **Length:** 31 ft 1 in. **Height:** 13 ft 10 in. **Weight:** 24,864 lb gross.

Armament: Six .50-cal. machine guns and 4,000 lb of bombs or 25 5-in rockets.

Accommodation: Crew of two (pilot and copilot; pilot and radar operator on F-82G only). **Cost:** $215,154.

Max. speed: 465 mph. **Range:** 2,500 mi. **Ceiling:** 38,900 ft.

F-84 Thunderjet

The F-84, USAF's first post–World War II fighter, began rolling off the production lines in June 1947. It was the first Air Force jet fighter capable of carrying a tactical nuclear weapon and the last subsonic straight-wing fighter-bomber. The F-84 pioneered the use of aerial refueling for fighters. The Thunderjets entered service in Korea in December 1950, were assigned to escort B-29s, and later were increasingly used for ground operations. F-84s were used on two significant raids on dams, on May 13 and 16, 1953, causing the loss of all electrical power to North Korea. In Korea, F-84 pilots flew 86,408 missions, dropped 50,427 tons of bombs, and managed to shoot down or damage 105 MiG-15s. On August 20, 1953, 17 F-84Gs, refueling from KC-97s, were flown nonstop 4,485 miles from Turner AFB, Ga., to RAF Lakenheath, UK, in the longest nonstop mass movement of fighter-bombers in history to that point and the greatest distance ever flown nonstop by single-engine jet fighters. The first sweptwing model, the F-84F, originally designated YF-96A, was first flown on June 3, 1950. Four Air National Guard F-84F units were recalled to active duty during the Berlin crisis of 1961–62. The straight-wing F-84G was the first airplane used by the Air Force's aerial demonstration team, the Thunderbirds. F-84s were used in two different programs to provide protection for B-36 Peacemakers. One aircraft, the YRF-84F, was designed with a nose-mounted hook to attach to a trapeze suspended from the bomb bay of a B-36; another version featured a wingtip-to-wingtip attachment. Both of these programs were discontinued when aerial refueling was found to be much more practical. In addition to being used by the US Air Force, many were supplied to Allied nations participating in the Mutual Defense Assistance Program. The last straight-wing F-84s were retired from the Air National Guard in 1957. The last Guard F-84Fs were retired in 1971. *(Specifications for F-84F.)*

Contractors: 1. Republic Aviation Corp. 2. General Motors Fisher Body Division. **Locations built:** 1. Farmingdale, N. Y. 2. Kansas City, Mo. **Number built (USAF):** 7,524 (4,009).

FF: February 28, 1946. **FFM:** XP-84. **FFL:** Muroc AAF, Calif. **FFP:** Maj. Bill Lien. **Models/variants:** F-84B, C, D, E, G. F-84F Thunderstreak. RF-84F Thunderflash.

Powerplant: One Wright J65-W-3 nonafterburning turbojet of 7,220 lb thrust.

Wingspan: 33 ft 7 in. **Length:** 43 ft 5 in. **Height:** 15 ft 0 in. **Weight:** 28,000 lb gross.

Armament: Six .50-cal. machine guns and up to 6,000 lb of bombs (incl nuclear) or rockets underwing.

Accommodation: Pilot only. **Cost:** $667,608.

Max. speed: 685 mph. **Range:** 1,650 mi. **Ceiling:** 44,300 ft.

Photo, Kent Collection via Warren Thompson

F-86 Sabre

F-86 Sabre

The Air Force's first sweptwing jet fighter, the F-86 was flown by 20 other countries. In spring 1948, the prototype become the first US fighter to go faster than the speed of sound when it exceeded Mach 1 in a shallow dive. On September 15, 1948, Maj. Richard L. Johnson recaptured the world speed record for the US, flying an F-86 over a three-km course at Muroc AFB, Calif., at 670.981 mph. In the Korean War, Sabre pilots shot down 792 Soviet-built MiG-15s at a loss of only 76 F-86s, a victory ratio of 10 to one. On December 17, 1950, Lt. Col. Bruce Hinton won the first combat between sweptwing fighters when he shot down a MiG-15. On July 27, 1953, Capt. Ralph S. Parr, while flying an F-86, recorded the last aerial victory in the Korean War when he shot down an Il-2. Air Force requirements for Korea precipitated the need for a second Sabre line, which was opened in Columbus, Ohio. The F-86D was designed as an all-weather interceptor and featured a redesigned nose to carry the radar. Pilots referred to this version as a "Sabre Dog." The F-86D was also the first Air Force fighter to have an all-rocket armament and the first all-weather interceptor to have only one person operating the radar fire-control system and flying the aircraft. It was one of the first airplanes to succeed itself in setting new world speed records, with pilots reaching 698.505 mph on November 19, 1952, and 715.697 mph on July 16, 1953. Lt. Col. William Barnes, the pilot on the latter flight, was also the first person to pass the 700 mph barrier. The F-86 was the mount for all 36 allied jet aces during the Korean War. F-86s were built under license in Canada, Japan, Australia, and Italy. More F-86Ds were produced than any other model: 2,504. The last F-86L (a modified D) left Air Defense Command service in June 1960, and the type served with the Air National Guard until mid-1965. Some aircraft (mostly foreign-built) were modified into remotely controlled full-scale targets and were used primarily by the Navy into the 1980s. *(Specifications for F-86H.)*

Contractor: North American Aviation, Inc. **Locations built:** Inglewood, Calif., and Columbus, Ohio. **Number built (USAF):** 6,353 (5,893).

FF: October 1, 1947. **FFM:** XP-86. **FFL:** Muroc AFB, Calif. **FFP:** George S. "Wheaties" Welch. **Models/variants:** F-86A, D, E, F, H, L. RF-86A, F.

Powerplant: One General Electric J47-GE-27 turbojet of 5,970 lb thrust.

fighters

Wingspan: 37 ft 1 in. **Length:** 37 ft 6 in. **Height:** 14 ft 8 in. **Weight:** 17,000 lb gross.
Armament: Six .50-cal. machine guns and 2,000 lb of bombs or 16 5-in. rockets.
Accommodation: Pilot only. **Cost:** $211,111.
Max. speed: 690 mph. **Range:** Approx 1,200 mi with external tanks. **Ceiling:** 50,000 ft.

F-89 Scorpion

The F-89 was an all-weather fighter-interceptor designed to replace the P-61 and the interim F-82. Fairly conventional in design, the F-89's less than stellar career can be attributed primarily to the fact that it was underpowered. The Scorpion did have an unusual (for the time) design feature called decelerons, a control surface that could operate in one piece as an aileron or could be split open to serve as a speed break to allow crews to get into firing position behind a target. The first unit to be equipped with F-89s was the 84th Fighter-Interceptor Squadron at Hamilton AFB, Calif. The F-89 picked up the unofficial nickname "Stanley Steamer" because of the oversize main landing gear wheels that appeared to have come off of a locomotive. Unique wingtip tanks on the F-89D carried folding-fin aerial rockets in the front half and fuel in the rear half. Because the engines sat so low to the ground, F-89C and later models featured a retractable inlet screen designed to prevent foreign-object ingestion. A total of 350 F-89Ds were converted to F-89Js under Project Ding Dong. These modifications were done to enable the Scorpion to carry the AIR-2A Genie, which allowed the F-89 to become Air Defense Command's first interceptor to carry nuclear weapons. On July 19, 1957, a Genie was launched from an F-89J, marking the first and only time in history that an air-to-air rocket with a nuclear warhead was launched and detonated.

Photo via Robert F. Dorr

F-94 Starfire

Called Operation Plumb Bob, this test took place at 20,000 ft over Yucca Flats, Nev. The rocket was fired at a point approximately 14,000 ft from the F-89, and the Genie coverec this distance in 4.5 seconds. The warhead was detonated by ground command. The F-89 was removed from active-duty Air Force service in 1959. The last of the Air National Guard F-89s were retired in July 1969. *(Specifications for F-89D.)*
Contractor: Northrop Aircraft, Inc. **Location built:** Hawthorne, Calif. **Number built (USAF):** 1,052 (1,052).
FF: August 16, 1948. **FFM:** XF-89. **FFL:** Muroc AFB, Calif. **FFP:** Fred Bretcher. **Models/variants:** F-89A, B, C, D, H, J.
Powerplant: Two Allison J35-A-35 (or -33A, -41, or -47) turbojets of 7,200 lb of thrust in afterburner.
Wingspan: 59 ft 8 in (over tiptanks). **Length:** 53 ft 10 in. **Height:** 17 ft 6 in. **Weight:** 42,241 lb gross.
Armament: 52 Mighty Mouse 2.75-in folding-fin aerial rockets (FFARs) in each wingtip pod.
Accommodation: Two (pilot and radar operator in tandem). **Cost:** $801,602.
Max. speed: 632 mph. **Range:** 1,370 mi. **Ceiling:** Approx 49,200 ft.

F-101 Voodoo

F-94 Starfire

The F-94 was an interim a l-weather interceptor developed from the T-33 trainer, which had been developed from the F-80. Initial tests showed that the engine was not powerful enough to support the increased weight of the electronic equipment and the Hughes E-1 fire-control radar. In addition to a higher-performing engine, several changes to the aircraft's lines were required. First accepted in December 1949, F-94As began replacing North American F-82s in Air Defense Command. When the Korean War broke out, Starfires were prohibited from flying over North Korea for fear of compromising their sophisticated electronic equipment. However, mounting B-29 losses led to the lifting of this restriction. On January 30, 1953, Capt. B. L. Fithian (pilot) and Lt. S. R. Lyons (radar operator) shot down an unseen LA-9 piston-engine fighter. The F-94C was phased out of Air Force service in 1959, and the last Air National Guard F-94s were retired in early 1960. *(Specifications for F-94C.)*
Contractor: Lockheed Aircraft Co. **Location built:** Burbank, Calif. **Number built (USAF):** 856 (856).
FF: April 16, 1949. **FFM:** YF-94. **FFL:** Van Nuys, Calif. **FF Crew:** Tony LeVier (pilot) and Glenn Fulkerson (observer). **Models/variants:** F-94A, B, C.
Powerplant: One Pratt & Whitney J48-P-5 or -5A turbojet of 8,750 lb of thrust.
Wingspan: 42 ft 5 in (over tiptanks). **Length:** 44 ft 6 in. **Height:** 14 ft 11 in. **Weight:** 24,200 lb gross.
Armament: 24 2.75-in Mighty Mouse FFARs in nose and 24 2.75-in FFARs in two wing pods (12 rockets in each).
Accommodation: Crew of two (pilot and radar intercept officer). **Cost:** $534,000.
Max. speed: 640 mph. **Range:** 1,200 mi. **Ceiling:** 51,000 ft.

F-100 Super Sabre

The F-100 was USAF's first operational airplane to be flown faster than the speed of sound (760 mph) at sea level in level flight. Originally designed as a dogfighter, the F-100 found greater utility as a fighter-bomber. On October 29, 1953, flying the YF-100A, Frank K. "Pete" Everest, Jr., established a new world speed record of more than 750 mph while flying a little more than 100 ft above the course set up at Salton Sea, Calif. On February 26, 1955, North American test pilot George Smith became the first person to survive ejection from an aircraft flying at supersonic speed. His F-100 was traveling 777 mph when the controls jammed and he was forced to punch out. The 479th Fighter Wing at George AFB, Calif., was the first unit to receive the "Hun," as the type became widely known. Shortly after initial delivery started, the airplanes were grounded and had to be modified, primarily because little was known about the sustained high-speed flight regimen. F-100s were sent to South Vietnam in February 1965. Several two-place F-100Fs became the first aircraft modified for the "Wild Weasel" radar-suppression mission. The first "Wild Weasels" arrived in Southeast Asia in November 1965; the first combat mission was flown on December 3. These Ironhand antiradar missions were usually undertaken by one F-100F accompanied by four F-105s. F-100s were used as armed forward air controllers, and these pilots were called Misty FACs. F-100s were used in Vietnam until the late 1960s. The Thunderbirds, the Air Force's aerial demonstration squadron, flew F-100Cs and Ds for most of 13 years and 1,080 shows. F-100s also flew with France, Denmark, Turkey, and Taiwan. F-100As were released to Air National Guard units in April 1958, and the type served until 1979. *(Specifications for F-100D.)*
Contractor: North American Aviation, Inc. **Locations built:** Inglewood, Calif., and Columbus, Ohio. **Number built (USAF):** 2,294 (2,249).
FF: May 25, 1953. **FFM:** YF-100. **FFL:** Edwards AFB, Calif. **FFP:** George S. "Wheaties" Welch. **Models/variants:** F-100A, C, D, F, RF-100A.
Powerplant: One Pratt & Whitney J57-P-21A turbojet of 16,000 lb of thrust in afterburner.
Wingspan: 38 ft 9 in. **Length:** 47 ft 5 in (54 ft 2 in with pitot boom). **Height:** 16 ft 2 in. **Weight:** 38,048 lb gross.
Armament: Four M39E 20-mm cannon and six underwing hardpoints for up to 7,040 lb of payload, consisting of external tanks and/or ordnance incl bombs (incl nuclear), missiles (AIM-9 Sidewinder or AGM-12 Bullpup), or 38 2.75-in folding-fin aerial rockets (FFARs) in LAU-3/A launchers.
Accommodation: Pilot only (crew of two in tandem on F-100F). **Cost:** $697,029.
Max. speed: 864 mph. **Range:** 1,200 mi. **Ceiling:** 47,700 ft.

F-101 Voodoo

Developed from the XF-88 interceptor, the F-101 was originally conceived as a long-range escort fighter for Strategic Air Command B-36s but went on to a lengthy career as an interceptor and the Air Force's first supersonic reconnaissance aircraft. After entering service in 1957, the F-101 was used in a number of speed and point-to-point record runs. On November 27, 1957, four RF-101A pilots took off from March AFB, Calif., as part of Operation Sun-Run. Refueled in flight, two of the crews landed at McGuire AFB, N. J., and two turned around and landed back at March. Lt. Gustav Klatt set an eastbound coast-to-coast record of three hours, seven minutes, 43 seconds, while Capt. Robert Sweet set a westbound coast-to-coast record (3:36:33) and a Los Angeles–New York–Los Angeles record (6:46:36). On December 12, 1957, Maj. Adrian Drew, flying an F-101A at Edwards AFB, Calif., set a new absolute speed record of 1,207.34 mph. The last record-breaking flight of this rush of records came on April 15, 1959, when Capt. George A. Edwards set a 500-km closed-course record of 816.28 mph, also at Edwards. The Voodoo picked up the nickname "One-Oh-Wonder." The F/RF-101 series achieved a record for the lowest first-year accident rate of any Air Force fighter in history to that point. F/RF-101 production ran until 1961. RF-101 crews flew their first missions in Vietnam in 1961 as part of Operation Pipe Stem and the later Operation Able Mable. Pilots from the 363d Tactical Reconnaissance Wing at Shaw AFB, S. C., flew the RF-101's first operational low-level missions on October 23, 1962, during the Cuban Missile Crisis. RF-101 crews provided a majority of tactical reconnaissance in Southeast Asia until 1965, then shared duties with RF-4 crews. Most of the RF-101s ended up with the Air National Guard, and a number of F-101 interceptors were later converted to RF-101G/Hs. Roughly 70 surplus Voodoos were transferred to the Royal Canadian and Nationalist Chinese Air Forces.

The last Air Force F-101 and the last Guard RF-101 were both retired in 1982. *(Specifications for F-101B.)*

Contractor: McDonnell Aircraft Co. **Location built:** St. Louis, Mo. **Number built (USAF):** 807 (807).

FF: September 29, 1954. **FFM:** F-101A. **FFL:** Edwards AFB, Calif. **FFP:** Robert Little. **Models/variants:** F-101A, B, C, F. RF-101A, B, C, G, H. TF-101B, F.

Powerplant: Two Pratt & Whitney J57-P-53 or -55 turbojets of 16,900 lb of thrust each in afterburner.

Wingspan: 39 ft 8 in. **Length:** 71 ft 1 in (incl pitot boom). **Height:** 18 ft 0 in. **Weight:** 52,400 lb gross.

Armament: Two AIR-2A Genie rockets in an internal bay and two AIM-4 Falcon missiles under the fuselage.

Accommodation: Two (pilot and radar intercept officer in tandem). **Cost:** $1.82 million.

Max. speed: 1,134 mph. **Range:** 1,550 mi. **Ceiling:** 52,100 ft.

F-102 Delta Dagger

The F-102 was the world's first supersonic all-weather jet interceptor and the Air Force's first operational delta-wing aircraft. It was developed from the XF-92A, and it was the first Air Force aircraft program to have an integrated weapons system, as the fire-control radar and the missile were both made by Hughes. At peak deployment, there were more than 25 squadrons of F-102s. After the prototype flew, it was readily apparent that the original design was seriously flawed and the aircraft would not routinely reach supersonic speeds. Convair embarked on a major redesign program and, using the "area rule" principle developed by noted aerodynamicist Richard T. Whitcomb, produced the revised prototype after only 117 days. With its pinched or "Coke bottle" waist, the revised design corrected the problems. The F-102 was the first Air Force fighter whose primary armament was guided missiles. F-102s were sent to South Vietnam, initially for air defense, but later flew escort for B-52s, and one was shot down by a MiG-21 on February 3, 1968. F-102s were also stationed in Greenland and Europe, in addition to the continental US and Alaska. Some of the Air Force planes were transferred to the Greek and Turkish air forces. The TF-102As were the operational trainers and had side-by-side seating. After being withdrawn from service, the F-102s were converted into target drones by Sperry Flight Systems under a program called Pave Deuce. The last F-102 was phased out of Air National Guard service in 1976. *(Specifications for F-102A, except as noted.)*

Contractor: Consolidated-Vultee Aircraft Corp. (later Convair Division of General Dynamics Corp.). **Location built:** San Diego, Calif. **Number built (USAF):** 1,000 (1,000).

FF: October 24, 1953. **FFM:** YF-102A. **FFL:** Edwards AFB, Calif. **FFP:** Richard L. "Dick" Johnson. **Models/variants:** YF-102A. F-102A, TF-102A. QF-102A, PQM-102A.

Powerplant: One Pratt & Whitney J57-P-23 turbojet of 16,000 lb of thrust in afterburner.

Wingspan: 38 ft 1 in. **Length:** 68 ft 3 in (incl pitot boom). **Height:** 21 ft 2 in. **Weight:** 31,500 lb gross.

Armament: Two AIM-26 (nuclear warhead–tipped Falcon missile derivative; one W-54 nuclear warhead in the low kiloton range yield) or one AIM-26 and two AIM-4 Falcon missiles or six AIM-4 Falcon missiles and 24 2.75-in Mighty Mouse folding fin aerial rockets (FFARs) in an internal bay.

Accommodation: Pilot only (pilot and student, side by side in TF-102). **Cost:** $1.2 million.

Max. speed: 825 mph. **Range:** Approx 1,000 mi. **Ceiling:** 54,000 ft.

F-104 Starfighter

The F-104 was frequently described as "the missile with a man in it." The type found greater use with foreign operators than with the US Air Force. The F-104, while an extremely high-performance airplane, was extremely "hot" and an unforgiving aircraft to fly. It was the first operational fighter capable of sustained speeds above Mach 2 and the first aircraft ever to hold the world speed and altitude records simultaneously. Because of development problems, the type entered service two years later than expected. Deliveries to the Air Force began in January 1958. On May 7, 1958, Maj. Howard C. Johnson reached an altitude of 91,243 ft, and on May 16, Capt. Walter W. Irwin reached a speed of 1,404.19 mph. On December 14, 1959, an F-104C pilot boosted the world's altitude record to 103,389 ft, thus becoming the first aircraft to take off under its own power and exceed the 100,000-ft plateau. In 1964, Jacqueline Cochran flew a TF-104 to three women's speed records over a closed course. One F-104 was modified with the addition of a rocket engine and reaction-control jets, was designated NF-104, and was used for astronaut training. F-104s were deployed to NAS Key West, Fla., in response to the Cuban Missile Crisis. F-104s were sent to Vietnam but were not effective. The Air Force used only about one-third of the F-104s built, with most going to or being built in West Germany, Italy, Japan, Belgium, Denmark, Greece, Norway, Spain, Taiwan, Jordan, Pakistan, and Turkey. A number of aircraft were converted into full-scale drones. The last Air National Guard Starfighters were retired in 1975. *(Specifications for F-104A.)*

Contractor: Lockheed Aircraft Co. **Location built:** Burbank, Calif. **Number built (USAF):** 2,536 (296).

FF: March 4, 1954. **FFM:** XF-104. **FFL:** Edwards AFB, Calif. **FFP:** Tony LeVier. **Models/variants:** F-104A, B, C, D.

Powerplant: One General Electric J79-GE-3 turbojet 14,800 lb thrust in afterburner. **Wingspan:** 21 ft 11 in. **Length:** 54 ft 9 in. **Height:** 13 ft 6 in. **Weight:** 24,804 lb gross.

Armament: One General Electric M61 Vulcan 20-mm cannon and two GAR-8 (later redesignated AIM-9) Sidewinder air-to-air missiles.

Accommodation: Pilot only (student and pilot in tandem in F-104B, D). **Cost:** $1.7 million.

Max. speed: 1,324 mph. **Range:** 730 mi. **Ceiling:** Approx 57,700 ft.

F-105 Thunderchief

The F-105 was developed to meet Air Force requirements for a supersonic, single-seat fighter-bomber able to deliver heavy loads of conventional bombs and rockets and nuclear weapons at high speeds over long ranges. The F-105, popularly known as the "Thud," "Lead Sled," and "Squash Bomber" (if all else failed, the pilot could shut down his engine and squash the target with the aircraft), ended up as the heaviest US single-engine, single-seat fighter ever. The first airplane was delivered to the Air Force on May 27, 1958. The F-105Ds bore the brunt of the Rolling Thunder campaign to bomb targets in North Vietnam. The F-105F replaced the F-100F in the "Wild Weasel" radar-suppression mission. Some later G models were also converted for that role. The F-105 "Wild Weasels" carried both the AGM-78 Standard ARM and the AGM-45 Shrike antiradiation missiles. Despite the huge size of the airplane, Thunderchief crews downed 25.5 enemy aircraft of all types in Vietnam. Thunderchief crews flew 101,000 strike missions and dropped 202,596 tons of bombs. All told, 382 F-105s were shot down over Vietnam. However, on August 2, 1967, F-105 pilots successfully destroyed the Paul Doumer Bridge north of Hanoi, which was one of the most heavily defended targets of the war. Fourteen SA-2 SAMs were launched at the F-105s, but not one aircraft was shot down. Capt. Merlyn H. Dethlefsen and Maj. Leo K. Thorsness were both awarded the Medal of Honor for their actions while flying F-105s during 1967. The F-105B was briefly flown by the Air Force's aerial demonstration team, the Thunderbirds, for six performances in 1964, but the aircraft was found to be unsuitable for airshows. The last active-duty F-105 was retired in 1980 and the last from the Air Force Reserve in 1984. *(Specifications for F-105D.)*

Contractor: Republic Aviation Corp. **Location built:** Farmingdale, N. Y. **Number built (USAF):** 833 (833).

FF: October 22, 1955. **FFM:** YF-105A. **FFL:** Edward AFB, Calif. **FFP:** Russell M. "Rusty" Roth. **Models/variants:** F-105B, D, F, G.

Powerplant: One Pratt & Whitney J75-P-19W turbojet of 24,500 lb thrust in afterburner.

Wingspan: 34 ft 11 in. **Length:** 64 ft 5 in (67 ft 0 in with boom). **Height:** 19 ft 8 in. **Weight:** 52,546 lb gross.

Armament: One General Electric M61 Vulcan 20-mm cannon and up to 14,000 lb of bombs (incl nuclear) or missiles.

Accommodation: Pilot only (pilot and weapons system operator in tandem on F-105F/G). **Cost:** $2.14 million.

Max. speed: 1,390 mph. **Range:** 2,206 mi. **Ceiling:** 51,000 ft.

F-106 Delta Dart

The F-106 was originally developed from the F-102, but the changes were so extensive that the aircraft was redesignated. The Delta Dart was fitted with the MA-1 electronic guidance and fire-control system, which operated with the SAGE (Semiautomatic Ground Environment) defense system. The SAGE system allowed the F-106 to be flown automatically from wheels up on takeoff to flareout before touchdown. The F-106 was the aircraft that finally met the Air Force's original 1948 specifications for the "ultimate interceptor." The Delta Dart entered service in July 1959 with the 498th Fighter-Interceptor Squadron at Geiger Field, Wash. Fourteen squadrons eventually received the F-106, and deliveries were completed in 1961. Retired from the active-duty Air Force and Air National Guard interceptor squadrons in 1988, the remaining aircraft were converted into QF-106 target drones. The last dedicated air defense interceptor, the Delta Dart was universally referred to as "the Six." On February 2, 1970, an F-106 entered an uncontrollable flat spin, and the pilot ejected. After the pilot and seat departed, the aircraft recovered on its own (apparently due to the balance and configuration changes), circled, and miraculously made a gentle belly landing in a snow-covered field near Big Sandy, Mont. That aircraft was repaired, returned to service, and is now on display at the US Air Force Museum at Wright-Patterson AFB, Ohio. The F-106 was continually upgraded over its career, such as with a new ejection seat and updated avionics, under several programs named Wild Goose, Broad Jump, and Dart Board. The F-106 was primarily replaced by F-16s, although a few Air National Guard units converted to F-15s. *(Specifications for F-106A, except as noted.)*

F-106 Delta Dart

Contractor: Convair Division of General Dynamics Corp. **Location built:** San Diego, Calif. **Number built (USAF):** 340 (340).

FF: December 26, 1956. **FFM:** YF-106A (originally F-102B). **FFL:** Edwards AFB, Calif. **FFP:** Richard L. "Dick" Johnson. **Models/variants:** F-106A, B. NF-106B.

Powerplant: One Pratt & Whitney J75-P-17 turbojet of 24,500 lb of thrust in afterburner.

Wingspan: 38 ft 3½ in. **Length:** 70 ft 9 in. **Height:** 20 ft 3 in. **Weight:** 34,510 lb gross.

Armament: One AIR-2A Genie nuclear-tipped rocket (one W-25 warhead with a yield of approx 1.5 kilotons) and four AIM-4 Falcon missiles in an

attack/observation

internal bay; the AIR-2A was later replaced in some aircraft with a General Electric M61A1 Vulcan 20-mm cannon.
Accommodation: Pilot only (student and pilot in tandem on F-106B). **Cost:** $4.9 million.
Max. speed: 1,525 mph. **Range:** Approx 1,500 mi. **Ceiling:** 53,000 ft.

F-111 Aardvark
The F-111 was the first operational Air Force aircraft to have variable-geometry, or swingwings. This allowed for slower speeds for good takeoff and landing characteristics and better high-speed qualities with the wings swept back. The F-111 had a controversial history. Defense Secretary Robert S. McNamara mandated that the Air Force and Navy fly the same airplane. Seven Navy F-111Bs were built, but the type was deemed unsuitable for carrier operations. The Navy version was canceled, and the F-14 was built instead. Initially known as TFX, the F-111 was designed to replace the F-105. As an early operational test, six F-111s were sent to Vietnam, but three of the aircraft were lost to noncombat accidents and the type was withdrawn. The F-111 used a terrain-following radar system. The FB-111 was the nuclear-capable version. These aircraft were converted to F-111Gs in 1987. On April 15, 1986, F-111 crews stationed at RAF Lakenheath, UK, along with Navy A-6 crews, carried out a retaliatory raid (Operation Eldorado Canyon) against Libya in response to state-sponsored terrorism. During the Persian Gulf War, F-111s were used to great effect in a role for which they were never intended—"tank plinking," or hunting down and destroying individual vehicles. It was also the only airplane that could carry the GBU-28/U deep-penetrating bomb. The F-111 was retired in July 1996, although the EF-111A is still in service. The F-111 was nicknameless until the crews' unofficial name, Aardvark, was bestowed officially on the day it was retired. *(Specifications for F-111A.)*
Contractors: 1. Fort Worth Division of General Dynamics. 2. Grumman Aerospace. **Locations built:** 1. Fort Worth, Tex. 2. Bethpage, N. Y. **Number built (USAF):** 562 (531).
FF: December 21, 1964. **FFM:** F-111A. **FFL:** Fort Worth, Tex. **FF Crew:** Dick Johnson and Val Prahl. **Models/variants:** F-111A, D, E, F, G. FB-111A. EF-111A Raven.
Powerplant: Two Pratt & Whitney TF30-P-103 turbofans of 18,500 lb thrust each with afterburner. (Two Pratt & Whitney TF30-P-7 turbofans of 20,350 lb thrust each with afterburner on FB-111A.)
Wingspan: Wings extended: 63 ft 0 in (70 ft 0 in on FB-111A). Wings swept: 31 ft 11 in (33 ft 11 in on FB-111A). **Length:** 73 ft 6 in (75 ft 6 in with pitot boom). **Height:** 17 ft 1½ in. **Weight:** 92,657 lb gross.
Armament: One General Electric M61A1 Vulcan 20-mm cannon and one B61 free-fall nuclear bomb with a selectable yield between 100 and 500 kilotons or two B61s internally and up to 31,000 lb of bombs, missiles, or fuel tanks on four underwing hardpoints. (Two AGM-69 Short-Range Attack Missiles, each with a W-69 nuclear warhead with a yield of 170 kilotons internally, and up to four AGM-69 on underwing hardpoints or provisions for up to 31,500 lb of conventional bombs on FB-111.)
Accommodation: Two (pilot and weapon system officer, side by side, in an escape module). **Cost:** $8.2 million.
Max. speed: 1,452 mph. **Range:** Approx 3,800 mi. **Ceiling:** 51,000 ft.

Attack / Observation

A-1 Skyraider
This rugged, dump truck of an attack aircraft originally developed for the Navy was used to attack targets on the ground in Viet Cong strongholds in South Vietnam as well as in Cambodia and Laos. It was nicknamed "Spad," as pilots considered it a throwback airplane in the jet-age Air Force. The Skyraider was also used to cover rescue operations, where the type picked up a second nickname, "Sandy," its radio call sign. On March 10, 1966, Maj. Bernard F. Fisher, a 1st Air Commando Squadron A-1E pilot, landed on the A Shau airstrip after it had been overrun by North Vietnamese regulars and rescued Maj. D. Wayne "Jump" Myers. Major Fisher was awarded the Medal of Honor, and his A-1E was flown by Major Myers to the US Air Force Museum at Wright-Patterson AFB, Ohio, where it is now on display. On September 1, 1968, Col. William A. Jones III, while leading a rescue mission, was hit and his A-1H was heavily damaged, but he returned to base and reported the position of the downed flyer, who was rescued that day. Shortly thereafter, Colonel Jones perished in a civilian aircraft accident, and he was posthumously awarded the Medal of Honor. The Air Force flew Skyraiders in Vietnam until late 1972, when the aircraft were turned over to the South Vietnamese Air Force. *(Specifications for A-1E.)*
Contractor: Douglas Aircraft Co. **Location built:** El Segundo, Calif. **Number built (USAF):** 3,180 (approx 100).
FF: March 18, 1945. **FFM:** XBT2D-1. **FFL:** El Segundo, Calif. **FFP:** LaVerne Brown. **Models/variants:** A-1E, G, H, J. EA-1E.
Powerplant: One Wright R-3350-26W89A Cyclone 18-cylinder radial of 2,700 hp.
Wingspan: 50 ft 0 in. **Length:** 40 ft 1 in. **Height:** 15 ft 10 in. **Weight:** 24,872 lb.
Armament: Four 20-mm cannon mounted in the wings and 15 underwing and centerline hardpoints for up to 8,000 lb of bombs, rockets, gun pods, or fuel tanks.
Accommodation: Pilot only. **Cost:** $414,000.
Max. speed: 321 mph. **Range:** Approx 1,400 mi. **Ceiling:** 26,200 ft.

A-7 Corsair II
The Air Force A-7s were derived from the Corsair developed for the Navy and were ordered virtually off the shelf, the only significant differences being in the engine and the addition of a 20-mm cannon, which the Navy adopted for later models. The aircraft were universally known as SLUFs, an acronym for Short Little Ugly Feller (polite form). The first Air Force YA-7D prototype was flown for the first time at NAS Dallas, Tex., by John W. Konrad on April 5, 1968. The type achieved high accuracy with bomb drops by the aid of an automatic electronic navigation and weapons delivery system. The first operational wing was the 354th Tactical Fighter Wing at Myrtle Beach AFB, S. C. A-7s were sent to Vietnam in October 1972 and were used for a number of missions, most extensively as support aircraft for search-and-rescue missions. The A-7 replaced the A-1 on these "Sandy" missions. In 1973, the Air Force began assigning A-7Ds to Air National Guard units. On August 15, 1973, Maj. John J. Hoskins and Capt. Lonnie O. Ratley flew the last US bombing mission of the Vietnam War when they bombed targets near Phnom Penh, Cambodia. Air Force A-7s were also used to support the rescue of the SS *Mayaguez* on April 30, 1975, after it was seized by Cambodian forces. The YA-7F was the Corsair II fitted with an F100 engine in an attempt to breathe new life into the type, but it never went beyond test flight. The Navy used some of their Corsairs in Desert Storm. All A-7s were phased out of Air National Guard service by the end of 1993. *(Specifications for A-7D, except as noted.)*
Contractor: Ling-Temco-Vought, Inc. (LTV). **Location built:** Dallas, Tex. **Number built (USAF):** 1,551 (484).
FF: September 27, 1965. **FFM:** YA-7A. **FFL:** NAS Dallas, Tex. **FFP:** John W. Konrad. **Models/variants:** A-7D, K.
Powerplant: One Allison TF41-A-1 nonafterburning turbofan of 14,500 lb thrust.
Wingspan: 38 ft 9 in. **Length:** 46 ft 1½ in. **Height:** 16 ft 0¾ in. **Weight:** 42,000 lb gross.
Armament: One General Electric M61A1 Vulcan 20-mm cannon and up to 15,000 lb of bombs, missiles, mines, rockets, or gun pods on six underwing and two fuselage hardpoints.
Accommodation: Pilot only (student and pilot on A-7K). **Cost:** $2.86 million.
Max. speed: 698 mph. **Range:** 2,871 mi. **Ceiling:** 51,000 ft.

A-20 Havoc
The A-20 was designed to meet an Army Air Corps attack specification in 1938 but was in use by the French and British before delivery to US squadrons. Begun as a company-funded venture, the Havoc eventually became the most-produced Army Air Forces attack aircraft. It was also the one of the first US combat aircraft to have a nosewheel. On July 4, 1942, the first Army Air Forces bomber mission over Western Europe was flown by US crews of the 15th Bomb Squadron operating British Bostons IIIs (the Royal Air Force's name for most of their Havocs) against airfields in the Netherlands. The A-20 was used in every theater of the war and was also flown by Australia, Brazil, South Africa, and the Netherlands. The Soviets actually received more A-20s than the US did, but little is known about the type's operational career there. Some of the Dutch aircraft were captured by the Japanese and appropriated into service. The export version of the A-20C was the first aircraft to be ordered under a lend-lease contract. The P-70 was a modified A-20 fitted with an airborne intercept radar and four 20-mm cannon in a belly package as an interim night fighter until the P-61 was available. The F-3A was the photoreconnaissance version. *(Specifications for A-20B.)*
Contractors: 1. Douglas Aircraft Co. 2. Boeing Aircraft Co. **Locations built:** 1. Santa Monica, El Segundo, and Long Beach, Calif. 2. Seattle, Wash. **Number built (USAF):** 7,478 (approx 5,310).
FF: October 26, 1938. **FFM:** Company Model 7B. **FFL:** El Segundo, Calif. **FFP:** Johnny Cable. **Models/variants:** A-20, A-20A, B, C, G, H, J, K. P-70.
Powerplant: Two Wright R-2600-23 Cyclone 14-cylinder radials of 1,600 hp each.
Wingspan: 61 ft 4 in. **Length:** 48 ft 0 in. **Height:** 17 ft 7 in. **Weight:** 27,200 lb gross.
Armament: Eight .50-cal. machine guns (six in the nose, two in the dorsal electric turret), one .30-cal. machine gun in the ventral opening and 2,000 lb of bombs internally and up to 2,000 lb of bombs externally on underwing hardpoints.
Accommodation: Crew of three (pilot, navigator, and gunner). **Cost:** $74,000.
Max. speed: 339 mph. **Range:** 1,090 mi. **Ceiling:** 25,800 ft.

A-26 Invader
The A-26 was the follow-on design to the A-20 and entered combat in late 1944. The type had early developmental difficulties, and it took 28 months to go from first flight to combat operations. After being redesignated as B-26 in 1948, it was the only attack airplane available when war broke out in Korea. Crews flew their first mission against North Korea on June 29, 1950, when they bombed an airfield at Pyongyang. Air Force B-26s were credited with the destruction of 38,500 vehicles, 3,700 railway cars, 406 locomotives, and seven enemy aircraft on the ground in Korea.

Photo by Ken LaMoreux via Warren Thompson

A/B-26 Invader

On September 14, 1951, while flying a night intruder mission, Capt. John S. Walmsley, Jr., attacked a North Korean supply train, but after his guns jammed he used his search light to light the way for his wingmen to finish destroying the train. Captain Walmsley was shot down, died, and was posthumously awarded the Medal of Honor. On July 27, 1953, 24 minutes before the cease-fire was signed, a B-26 crew from the 3d Bomb Wing dropped the last bombs of the Korean War. Some holdover RB-26s were part of the initial cadre of aircraft sent to Vietnam as part of Operation Farm Gate. In the early 1960s, On-Mark Engineering converted approximately 40 aircraft into the B-26K Counter Invader for counterinsurgency missions in Vietnam. These aircraft were later redesignated A-26A because of an agreement with the Thai government that no bombers would be stationed there. This type was flown by more than a dozen other countries. A number of aircraft were converted into executive transports for the civilian market. The Navy version, designated JD-1, was used into the 1960s for target towing. Most Air National Guard planes were retired by 1957, but the last VB-26 was retired in 1972. *(Specifications for A-26B.)*

Contractors: 1. Douglas Aircraft Co. 2. On-Mark Engineering Co. **Locations built:** 1. El Segundo and Long Beach, Calif., and Tulsa, Okla. 2. Van Nuys, Calif. **Number built (USAF):** 2,452 (2,364).

FF: July 10, 1942. **FFM:** XA-26. **FFL:** El Segundo, Calif. **FFP:** Ben O. Howard. **Models/variants:** A-26B, C. B-26K (later redesignated A-26A). TB-26B, C. VB-26B. EB-26C.

Powerplant: Two Pratt & Whitney R-2800-27 Double Wasp 18-cylinder, twin-row radials of 2,000 hp each.

Wingspan: 70 ft 0 in. **Length:** 50 ft 8 in. **Height:** 18 ft 6 in. **Weight:** 35,000 lb gross.

Armament: 10–12 .50-cal. machine guns (four or six in the nose and two each in the dorsal and ventral turrets) and 4,000 lb of bombs internally and up to 2,000 lb of bombs on underwing hardpoints or four .50-cal. machine guns in gun packs underwing.

Accommodation: Crew of three (pilot, navigator, and gunner). **Cost:** $172,000.

Max. speed: 355 mph. **Range:** 1,400 mi. **Ceiling:** 22,100 ft.

1909 Military Flyer

The world's first military aircraft. It was built in response to Signal Corps Specification 486, issued December 1907. On July 27, 1909, Orville Wright, with Lt. Frank P. Lahm as passenger, flew the aircraft for one hour, 12 minutes, 40 seconds and covered 40 miles, which met the Army's endurance requirement as stated in Specification 486. On July 30, 1909, Orville Wright, with Lt. Benjamin D. Foulois as passenger, covered a 10-mile test course from Fort Myer, Va., to Shooter's Hill in Alexandria, Va., and back to Fort Myer at an average speed of 42 mph, earning the Wrights their performance bonus (10 percent of the aircraft's base price for each mile an hour over 40). The aircraft was accepted by the Signal Corps on August 2, 1909, and redesignated Signal Corps Aeroplane Number 1. This aircraft was essentially the same as the 1908 Flyer, which had crashed and had been destroyed at Fort Myer on September 17, 1908, when a propeller shattered. Lt. Thomas E. Selfridge was killed and Orville Wright suffered a broken hip in that mishap. The 1909 Flyer was used to teach Lieutenant Lahm (the first US pilot to earn the distinction of "Military Aviator") and Lt. Frederic E. Humphreys to fly. Lieutenant Foulois taught himself to fly in this aircraft in 1910. Lt. Henry H. "Hap" Arnold, who would lead the AAF in World War II and would lead the crusade for a separate Air Force, also flew Aeroplane Number 1 while it was based in College Park, Md. The aircraft was determined unfit to fly by 1911 and was retired. It is now on display at the National Air and Space Museum in Washington, D. C.

Contractor: Wilbur and Orville Wright. **Location built:** Dayton, Ohio. **Number built (USAF):** One (one).

FF: June 3, 1909. **FFM:** 1909 Military Flyer. **FFL:** Fort Myer, Va. (first Army demonstration flight). **FFP:** Orville Wright. **Models/variants:** 1909 Military Flyer.

Powerplant: One Wright liquid-cooled, four-cylinder of 30.6 hp.

Wingspan: 36 ft 6 in. **Length:** 28 ft 11 in. **Height:** 8 ft 1 in. **Weight:** 740 lb gross.

Armament: None.

Accommodation: two, side by side. **Cost:** $25,000, plus $5,000 bonus for exceeding the speed performance specification.

Max. speed: 47 mph. **Range:** Endurance: Approx one hr. **Ceiling:** Approx 175 ft.

Caquot Balloon

The traditional spherical balloon spins and bucks terribly when tethered to the ground, so shortly after the turn of the century, the German Army came up with a kite-shaped balloon that would keep the aircraft pointed into the wind. This design was refined by the addition of tailfins for stability. French Lt. Albert Caquot greatly refined the design with the inclusion of three inflatable tailfins at 120° intervals around in the aft section of the gas bag. These fins were kept inflated by an airscoop facing into the wind. The Caquot-type balloons, capable of lifting the mooring cable, basket, observers, and communications and charting equipment, were used extensively for artillery-spotting over land and limited over-the-horizon observation at sea. During their months of service at the front, US balloon observers were credited with directing artillery fire at 316 targets, noting 11,856 aircraft, and reporting numerous enemy activities. Most of the US balloons were manufactured from 1918 to 1919 and, after being redesignated C-3s, were used until the 1930s at Army artillery schools. The design was briefly reprised at the beginning of World War II and produced in limited numbers. World War II barrage balloons used the same basic design. *(Specifications for Caquot Type R.)*

Contractor: Goodyear Tire and Rubber Co., primarily. **Location built:** Akron, Ohio. **Number built (USAF):** Approx 1,000 (Most of the US production run went to the American Expeditionary Force in Europe, although some were supplied to other Allies. Also, until rate production was achieved in the US, the AEF used approx 20 French-supplied Caquots.).

FF: Unconfirmed. **FFL:** Akron, Ohio. **FFP:** Unconfirmed. **Models/variants:** Type M, R. C-3.

Powerplant: None. **Length:** 92 ft 0 in. **Diameter:** 32 ft 0 in. **Gas Capacity:** 3,220 cu ft of hydrogen.

Armament: None.

Accommodation: Two (both observers in a wicker basket suspended underneath). **Cost:** Unconfirmed.

Max. speed: N/A. **Range:** Maximum observation distance was up to 40 mi, depending on weather and terrain. **Ceiling:** Operating altitude ranged between 1,000 and 4,000 ft.

L-4 Grasshopper

The military version of the Piper Cub, the L-4 was produced in large numbers for the then-new role of airborne artillery spotting and liaison. The L-4 prototypes, which were designated YO-59 and O-59, were evaluated by the Army in its annual maneuvers at the end of 1941. The L-4Bs (980 airplanes), L-4Hs (1,801), and L-4Js (1,680) were the only models that were actually produced as such, but the need for this type of airplane was so great that the L-4Cs, Ds, Es, Fs, and Gs were all civilian airplanes impressed into service by the Army. The impressed airplanes were used mainly to train glider pilots. The L-4 performed its first combat mission for the Army on November 9, 1942, when three of these airplanes were flown off a carrier deck to spot for ground units going ashore in the invasion of North Africa. The airplanes were piloted by Lt. William Butler (with Capt. Brenton Deval sitting in the back seat), Lt. John R. Shell, and Capt. Ford Allcorn. The TG-8 was a training glider evolved from the L-4. Members of the Civil Air Patrol flew hundreds of the L-4s searching for enemy submarines in coastal waters. At the end of World War II, many of the L-4s were sold in place in Europe. *(Specifications for L-4B.)*

Contractor: Piper Aircraft Corp. **Location built:** Lock Haven, Pa. **Number built (USAF):** 14,125 (approx 5,160).

Photo via Robert F. Dorr

O-1 Bird Dog

FF: September 10, 1930. **FFM:** Taylor Aircraft Co. E-2. **FFL:** Bradford, Pa. **FFP:** Unconfirmed. **Models/variants:** O-59, O-59A (later redesignated L-4, L-4A). L-4B, C, D, E, F, G, H, J, K.

Powerplant: One Continental O-170-3 flat-4 of 65 hp.

Wingspan: 35 ft 3 in. **Length:** 22 ft 0 in. **Height:** 6 ft 8 in. **Weight:** 1,220 lb gross.

Armament: Usually one or two M1911 .45-cal. pistols carried by crew; aircraft had none.

Accommodation: Crew of two (pilot and observer). **Cost:** $2,600.

Max. speed: 85 mph. **Range:** 190 mi. **Ceiling:** 9,300 ft.

O-1 Bird Dog

The O-1 is a two-place observation and liaison aircraft that was widely used by the Air Force in Vietnam for forward air control duties. It was developed from the Cessna commercial Model 170 for a joint Army and Air Force competition in 1950, although the Air Force did not buy any planes at that time. Originally designated L-19, the Bird Dog was redesignated O-1 when the observation category was revived in 1962. All of the Air Force's O-1s were originally transferred from the Army. Before pilots deployed to Vietnam, they trained at Holly Field, Fla., and then underwent special in-country training at Hue, South Vietnam, at what was called FAC University or, irreverently, "FAC U." The first dedicated Air Force FAC unit to be assigned to Vietnam was the 19th Tactical Air Support Squadron, which was activated at Bien Hoa AB, South Vietnam, in July 1963; three other squadrons were added later. In the high-threat environment, the slow and unarmed O-1s were eventually replaced by the O-2 in the Air Force and the OV-10 in the Marine Corps; most of the O-1s were given to the South Vietnamese Air Force. On February 24, 1967, Air Force Capt. Hilliard A. Wilbanks, a FAC, resorted to firing an M16 out of the side window of his O-1 in order to cover the retreat of a South Vietnamese Ranger battalion caught in an ambush near Dalat. Severely wounded by gunfire, Captain Wilbanks crashed in the battle area but was rescued by the Rangers. He soon died of his injuries and was posthumously awarded the Medal of Honor. The FACs became quite knowledgeable about the area where they worked and could spot even subtle changes that could indicate the presence of Viet Cong. On April 30, 1975, Vietnamese Air Force Maj. Buong Ly avoided capture by flying himself and his family on an O-1 out to the South China Sea and successfully landing on the aircraft carrier USS *Midway*. This airplane is now on display at the National Museum of Naval Aviation at NAS Pensacola, Fla. *(Specifications for O-1F.)*

Contractor: Cessna Aircraft Co. **Location built:** Wichita, Kan. **Number built (USAF):** 3,431 (unconfirmed).

FF: On or about December 8, 1950. **FFM:** Company Model 305A. **FFL:** Wichita, Kan. **FFP:** Hank Waring. **Models/variants:** O-1D, F, G.

Powerplant: One Continental O-470-11 flat-six piston of 213 hp.

Wingspan: 36 ft 0 in. **Length:** 25 ft 10 in. **Height:** 7 ft 3½ in. **Weight:** 2,800 lb gross.

Armament: Four underwing hardpoints for white phosphorus smoke

special duty / gliders

rockets; one M1911 .45-cal. pistol carried by pilot and/or one M16 7.62-mm rifle carried in the cockpit.
Accommodation: Pilot only. **Cost:** $11,000.
Max. speed: 151 mph. **Range:** 530 mi. **Ceiling:** 18,500 ft.

OA-1

The OA-1 was the first amphibious aircraft purchased by the Army Air Service in significant quantity and was the first to incorporate an integral fuselage float design. Three of the prototypes were turned over to the Navy for the 1925 MacMillan Expedition, during which Cmdr. Richard E. Byrd and his men flew 6,000 miles across the Arctic in less than 12 days. Those same airplanes were subsequently sent to Cuba where they were used to complete a hydrographic survey for the Navy. On December 21, 1926, five Air Corps OA-1A crews left San Antonio, Tex., on the 22,000-mile Pan-American Goodwill Tour of 25 Central and South American countries, which lasted until May 2, 1927. One airplane, *San Francisco,* was flown by Capt. Ira C. Eaker and 1st Lt. Muir S. Fairchild, who would go on to be leaders of the World War II Army Air Forces. All of the flyers on the tour were awarded the Mackay Trophy for the most meritorious flight of the year, and each member was awarded the Distinguished Flying Cross. *(Specifications for OA-1A.)*
Contractor: Loening Aeronautical Engineering Corp. **Location built:** New York, N. Y. **Number built (USAF):** 34 (34).
FF: 1924. **FFM:** XCOA-1. **FFL:** Unconfirmed but likely New York, N. Y. **FFP:** Unconfirmed. **Models/variants:** OA-1A, B, C.
Powerplant: One Liberty V-1650-1 V-12 of 400 hp.
Wingspan: 45 ft 0 in. **Length:** 34 ft 7 in. **Height:** 12 ft 1 in. **Weight:** 5,010 lb gross.
Armament: Three .30-cal. machine guns (one fixed firing forward and two flexible-mount).
Accommodation: Crew of two (pilot and observer in separate cockpits). **Cost:** $21,000.
Max. speed: 122 mph. **Range:** 600 mi. **Ceiling:** 12,000 ft.

Special Duty / Gliders

T-2

The first airplane type to be flown across the US nonstop. Air Service Lts. Oakley G. Kelly and John A. Macready took off from Roosevelt Field, N. Y., on May 2, 1923, and landed 26 hours, 50 minutes, three seconds later at Rockwell Field, Calif., after covering a 2,520-mile route. Lieutenant Kelly was the pilot on takeoff and Lieutenant Macready landed the aircraft. The crew was later awarded the Mackay Trophy for the flight, and each pilot received the Distinguished Flying Cross. Two earlier west-to-east attempts to cross the country in this aircraft failed. The T-2 was modified for the flight by the addition of two (one 410- and one 185-gallon) fuel tanks prior to the flight. The T-2's sister ship was designated A-2 and was used as a four-litter and four-seat (for ambulatory patients or medical attendants) ambulance aircraft. The T-2 is now on display at the National Air and Space Museum in Washington, D. C.
Contractor: Fokker NV. **Location built:** Veere, the Netherlands. **Number built (USAF):** Two (two).
FF: Late 1921 or early 1922. **FFM:** F.IV. **FFL:** Veere, the Netherlands. **FFP:** Unconfirmed, although Lt. Oakley G. Kelly served as one of the engineering test pilots for the aircraft at McCook Field, Ohio, after it was delivered to the Army on June 30, 1922. **Models/variants:** T-2, A-2.
Powerplant: One Liberty 12-A liquid-cooled V-12 of 420 hp.
Wingspan: 79 ft 8 in. **Length:** 49 ft 1 in. **Height:** 12 ft 7 in. **Weight:** 10,800 lb gross.
Armament: None.
Accommodation: Two, in connected cockpits (one open, the other enclosed). **Cost:** Unconfirmed.
Max. speed: 95 mph. **Range:** Endurance: The aircraft was flown for a record 35 hr, 18 min, 30 seconds over a 2,518-mi measured course on October 5–6, 1922, starting and ending at Rockwell Field, Calif. **Ceiling:** Unconfirmed, although the aircraft did fly over the Rocky Mountains at least once in three attempts to cross the country.

World Cruiser

The Douglas World Cruisers were the first aircraft to be flown around the world. The World Cruiser was a variant of the Navy's DT-2 torpedo bomber that could be operated either with wheels or floats. The prototype was delivered 45 days after the contract was let in summer 1923. Tests were successful, and four more DWCs were ordered. Each of the round-the-world flight aircraft was named after a US city representing a compass point: Aircraft number one, *Seattle,* crewed by Maj. Frederick Martin (pilot and flight commander) and SSgt. Alva Harvey ("mechanician," as the flight mechanics on the trip were called); aircraft number two, *Chicago,* crewed by Lt. Lowell H. Smith (pilot) and 1st Lt. Leslie Arnold; aircraft number three, *Boston,* with 1st Lt. Leigh P. Wade (pilot) and SSgt. Henry H. Ogden aboard; and aircraft number four, *New Orleans,* with Lt. Erik Nelson (pilot) and Lt. Jack Harding in the cockpits. The crews left Seattle, Wash., on April 6, 1924, and headed west. On April 30, *Seattle* crashed in Alaska, and Major Martin and Sergeant Harvey hiked out of the wilderness. The remaining crews continued, flying on to Japan, Southeast Asia, India, the Middle East, Europe, England, and Ireland. On August 3, *Boston* was forced down in the North Atlantic, and it sank in rough seas while being towed. The prototype was dispatched to Nova Scotia, where Lieutenant Wade and Sergeant Ogden renamed the aircraft *Boston II* and rejoined the flight. The crews stopped in several US cities and returned to Seattle on September 28. The trip totals: 175 days, 27,553 miles, stops in 61 cities, and a total flying time of 371 hours, 11 minutes. The logistics effort was equally impressive, which included securing cooperation of numerous governments, the Royal Air Force, and the US Navy. For example, 30 spare engines were dispatched all over the world prior to the flight. The Air Service later ordered five near-duplicate DWCs, and these were designated O-5. *Chicago* is now on display at the National Air and Space Museum in Washington, D. C., while *New Orleans* is on display at the Museum of Flying in Santa Monica, Calif.
Contractor: The Douglas Co. **Location built:** Santa Monica, Calif. **Number built (USAF):** five (five).
FF: October 1923. **FFM:** DWC. **FFL:** Clover Field, Santa Monica, Calif. **FFP:** Eric Springer. **Models/variants:** DWC, O-5.
Powerplant: One Liberty liquid-cooled V-12 of 420 hp.
Wingspan: 50 ft 0 in. **Length:** 35 ft 6 in (39 ft 0 in with floats attached). **Height:** 13 ft 7 in (15 ft 1 in with floats attached). **Weight:** 7,380 lb gross (8,180 lb gross with floats attached).
Armament: None.
Accommodation: Two (pilot and observer/mechanic in separated, tandem cockpits). **Cost:** $23,721 for prototype; $192,684 for four production aircraft plus spares.
Max. speed: 103 mph (100 mph with floats attached). **Range:** 2,200 mi (1,650 mi with floats attached). **Ceiling:** 10,000 ft (7,000 ft with floats attached).

R3C

One of only a handful of dedicated Army racing aircraft and the only Army seaplane racer. With public interest in airplane racing at an all-time high, the Army Air Service and the Navy teamed up in an effort to sweep both the 1925 Pulitzer Trophy for landplanes and the Schneider Cup for seaplanes. The result was the R3C, the latest in a line of Curtiss unlimited racers. The aircraft had several unique design features, including low-drag radiators made of corrugated brass sheeting .004 inches thick that covered most of the surfaces of the upper and lower wings, and a drop-forged duralumin propeller. Army Lt. Jimmy Doolittle lost a coin toss to Navy Lt. Al Williams to be the first to fly the new aircraft. On October 12, with the aircraft fitted with fixed landing gear (and designated R3C-1), Army Lt. Cyrus Bettis won the Pulitzer Trophy race with an average speed of 248.99 mph at Mitchel Field, N. Y. Lieutenant Williams was second. Ten days later, off the coast near Baltimore, Md., in the same aircraft, but now fitted with streamlined single-step wooden floats (and designated R3C-2), Lieutenant Doolittle successfully defended the US's championship in the Schneider Cup race, winning with an average speed of 232.7 mph. The Navy entrants, Lts. George Cuddihy and Ralph A. Ofstie, flying the other two R3C-2s, both had mechanical trouble and had to withdraw but still finished third and fourth. On October 27, Lieutenant Doolittle set a world seaplane record of 245.713 mph over a three-km course in the Army aircraft. Fitted with a new 665-hp engine (and redesignated R3C-4), the Army aircraft was loaned to the Navy for the 1926 Schneider Cup race, and Marine Lt. Christian F. Schilt finished second. This was last US military Schneider Cup team. The Army R3C-2, the only surviving aircraft, is now on display at the National Air and Space Museum in Washington, D. C.
Contractor: Curtiss Aeroplane & Motor Co. **Location built:** Garden City, N. Y. **Number built (USAF):** Three (one).
FF: September 11, 1925. **FFM:** R3C-1. **FFL:** Garden City, N. Y. **FFP:** Lt. Al Williams, USN. **Models/variants:** R3C-1, -2.
Powerplant: One Curtiss V-1400 liquid-cooled V-12 of 610 hp.
Wingspan: 22 ft 0 in. **Length:** 19 ft 8½ in. **Height:** 6 ft 9½ in (R3C-1). 8 ft 1 in (R3C-2). **Weight:** 2,150 lb gross (R3C-1). 2,539 lb gross (R3C-2).
Armament: None.
Accommodation: Pilot only. **Cost:** Approx $70,000.
Max. speed: 263 mph. **Range:** 216 mi at full throttle; approx 48 min endurance (R3C-1). 290 mi at full throttle; approx 1.3 hr endurance (R3C-2). **Ceiling:** Unconfirmed, as it was mostly flown at low altitudes around race py ons.

CG-4 Hadrian

The only US-built glider to see combat action in World War II, the CG-4 was selected over three other designs. The type holds the US record for most different manufacturers, as eventually 16 companies produced at least one CG-4. Ironically, Waco, the company that designed the CG-4, built only 1,075 examples of the production aircraft, which trailed Ford (4,190), Northwestern (1,510), Commonwealth (1,470), General (1,112), and Gibson (1,078). The CG-4 first saw combat in the Sicily invasion in July 1943. On March 5, 1944, US crews flew British Brig. Gen. Orde Wingate's Chindit commandos to a clearing 150 miles behind Japanese lines in Burma at night. Several thousand CG-4s were towed behind C-46s and C-47s in Operation Overlord, the invasion of France on June 6, 1944. The CG-4s, which, like all gliders, were considered expendable, were also used in the landings in southern France, at Arnhem, and the Rhein River crossing. They were also used in large numbers by Britain, and a few were transferred to the US Navy. After the war, large numbers of CG-4s were sold, not for the aircraft but for the shipping boxes, which were converted to chicken coops and other civilian uses. The last of the CG-4s received a new Navy-developed tow bar in 1948 and were redesignated G-4Cs. The type was removed from service shortly after that.
Contractors: 1. The Waco Aircraft Co. 2. Babcock. 3. Cessna Aircraft Co. 4. Commonwealth Aircraft Co. 5. Ford Motor Co. 6. G and A Aircraft Co. 7. General Aircraft Corp. 8. Gibson Refrigerator. 9. Laister-Kauffman. 10. National Aircraft Division. 11. Northwestern Aeronautical Co. 12. Pratt, Read, & Co. 13. Ridgefield Manufacturing Co. 14. Robertson Aircraft Co. 15. Timm Aircraft Co. 16. Ward Furniture Co. **Locations built:** 1. Troy, Ohio. 2. Deland, Fla. 3. Wichita, Kan. 4. Kansas City, Mo. 5. Iron Mountain, Mich. 6. Willow Grove, Pa. 7. Astoria, N. Y. 8. Greenville, Mich. 9. St. Louis, Mo. 10. Unconfirmed. 11. St. Paul, Minn. 12. Deep River, Conn. 13. Ridgefield, N. J. 14. St. Louis, Mo. 15. Van Nuys, Calif. 16. Fort Smith, Ark. **Number built (USAF):** 13,908 (12,700).
FF: May or June 1942. **FFM:** XCG-4. **FFL:** Unconfirmed. **FFP:** Unconfirmed. **Models/variants:** CG-4A, G-4C.
Powerplant: None.
Wingspan: 83 ft 8 in. **Length:** 48 ft 4 in. **Height:** 12 ft 7 in. **Weight:** 7,500 lb gross.
Armament: None.
Accommodation: Crew of two (pilot and copilot, side by side) and 13 troops or 3,710 lb of cargo. **Cost:** $24,000.
Max. tow speed: 125 mph. **Range:** Limited to range of tow aircraft and loaded weight. **Ceiling:** Limited to tow aircraft.

X-1

Developed in secrecy, the XS-1 (later redesignated X-1) research aircraft was the first to explore flight beyond the speed of sound (761 mph at sea level). Design basis for the aircraft was a .50-cal. bullet. Air Force Capt. Chuck Yeager became the first pilot to exceed Mach 1 when on October 14, 1947, he reached a speed of Mach 1.06 (700 mph) at an altitude of 45,000 ft. News of the flight was not revealed until nearly two months later. The aircraft was carried aloft by a B-29 "mother ship," and the rocket motor was started after the aircraft was released. First glide flight was made on January 25, 1946, at Pinecastle AB, Fla., by company pilot Jack Woolams. (The noted first flight was the first powered flight.) Eight USAF, seven NACA, and three company pilots made 157 flights in the type through 1951. The number one aircraft is on display at the National Air and Space Museum in Washington, D. C. The second aircraft was later modified to X-1E configuration and is on display at NASA's Dryden Flight Research Center at Edwards AFB, Calif. The third aircraft was destroyed on the ground prior to its second flight. Three other aircraft (X-1A, B, and D) were later built to investigate speeds greater than Mach 2 at high altitudes. X-1A reached Mach 2.44 (1,650 mph) in 1953. X-1s were flown for a total of 105 flights. Totals for other aircraft include: X-1A (25), X-1B (27), X-1D (1), and X-1E (26). The last flights came in 1958. The X-1A and D were destroyed in accidents; the X-1B is on display at the US Air Force Museum at Wright-Patterson AFB, Ohio. *(Specifications for X-1.)*

Contractor: Bell Aircraft Corp. **Location built:** Buffalo, N. Y. **Number built (USAF):** Three (three).
FF: December 9, 1946. **FFM:** XS-1. **FFL:** Muroc AAF, Calif. **FFP:** Chalmers "Slick" Goodlin. **Models/variants:** X-1, X-1A, B, D, E.
Powerplant: One Reaction Motors XLR11-RM-3 liquid fuel, four-chamber rocket rated at 6,000 lb static thrust.
Wingspan: 30 ft 11 in. **Length:** 28 ft 0 in. **Height:** 10 ft 10 in. **Weight:** 12,250 lb gross.
Armament: None.
Accommodation: Pilot only. **Cost:** $4.28 million for total program (three aircraft and development).
Max. speed: 927 mph (Mach 1.43). **Range:** Endurance: 5 min powered flight. **Ceiling:** 70,000 ft.

X-5

The first aircraft to fly using a variable-geometry wing, which allows for relatively low landing and takeoff speeds, but allows for higher in-flight speeds. The design was based on the Messerschmitt P.1101 captured at the end of World War II. Brig. Gen. Albert Boyd, then commander of the Air Force Flight Test Center at Edwards AFB, Calif., was the first pilot to complete full conversion from 20° sweepback to 60° sweepback in flight on August 23, 1951. The aircraft was difficult to fly and had a tendency to spin. Capt. Raymond Popson was killed on October 14, 1953, and the second X-5 was destroyed when he wasn't able to recover from a spin. Despite its flaws, the X-5 achieved all of its design objectives and provided a wealth of data on variable-geometry design. A total of 11 USAF, NACA, and contractor pilots made a total of 149 flights in the X-5s through 1955. The surviving aircraft is now on display at the US Air Force Museum at Wright-Patterson AFB, Ohio.

Contractor: Bell Aircraft Corp. **Location built:** Buffalo, N. Y. **Number built (USAF):** Two (two).
FF: June 20, 1951. **FFM:** X-5. **FFL:** Edwards AFB, Calif. **FFP:** Jean "Skip" Ziegler. **Models/variants:** X-5.
Powerplant: One Allison J35-A-17 nonafterburning turbojet rated at 4,900 lb static thrust.
Wingspan: 32 ft 9 in (wings extended); 22 ft 8 in (wings swept). **Length:** 33 ft 4 in. **Height:** 12 ft 0 in. **Weight:** 9,875 lb gross.
Armament: None.
Accommodation: Pilot only. **Cost:** Unconfirmed.
Max. speed: 705 mph. **Range:** 750 mi. **Ceiling:** 42,000 ft.

X-13 Vertijet

The diminutive X-13 was designed to test the idea of a jet-powered vertical takeoff aircraft that could make the transition to horizontal flight and then return to vertical flight for landing. A secondary design goal was to eliminate the need for conventional landing gear. The X-13 was transported on a specially constructed trailer. Once in position, the trailer, with the aircraft attached, would be raised to a vertical position. The aircraft had a hook under the nose and hung from the trailer on a steel cable attached to two movable hydraulic arms. Once airborne in vertical mode, the hook came off the cable, then pilot would clear the trailer and make the transition to horizontal flight. To land, the pilot would pull up, convert to vertical flight, and "walk" the aircraft into position to hook on the wire—a difficult maneuver, to say the least. The test program proceeded in small steps: conventional flight, then vertical flight with a test rig attached, then hooking and unhooking, and finally, full conversion. On July 30, 1957, in Arlington, Va., the X-13 took off vertically from a street in front of the Pentagon, retraced the route Orville Wright and Lt. Benjamin Foulois made on the final acceptance flight of the 1909 Military Flyer, and returned for a vertical landing. By early 1958, USAF and NACA turned their attention to other programs (mainly the X-15) and both X-13s were retired. One is on display at the San Diego (Calif.) Aerospace Museum, and the other is on display at the US Air Force Museum at Wright-Patterson AFB, Ohio.

Contractor: Ryan Aeronautical Co. **Location built:** San Diego, Calif. **Number built (USAF):** Two (two).
FF: December 10, 1955 (conventional takeoff and landing). April 11, 1957 (first full-cycle flight). **FFM:** X-13. **FFL:** Edwards AFB, Calif. **FFP:** Pete Girard. **Models/variants:** X-13.
Powerplant: One Rolls-Royce RA.28-49 Avon nonafterburning axial flow turbojet of 10,000 lb max thrust.
Wingspan: 21 ft 0 in. **Length:** 24 ft 0 in. **Height:** 15 ft 0 in. **Weight:** 7,200 lb gross.
Armament: None.
Accommodation: Pilot only. **Cost:** Total cost was approx $9.4 million.
Max. speed: 483 mph. **Range:** 167 mi. **Ceiling:** 20,000 ft.

Photo via Robert F. Dorr

X-1B

X-15

One of the most significant aircraft in history, the X-15 was designed to explore the identifiable problems of atmospheric flight at very high speeds and altitudes. The aircraft was the first to use a throttleable rocket engine, the first to be flown to speeds of Mach 4, 5, and 6, and the first to be flown to the lower edge of space (considered by the Air Force and NASA to be an altitude of 50 miles). There were also a great number of technical achievements in materials, construction, and testing associated with the X-15. Four Air Force pilots (Maj. Robert White, Maj. Robert Rushworth, Capt. Joseph Engle, and Maj. William "Pete" Knight) and three NASA pilots (Joseph Walker, John McKay, and William Dana) earned astronaut wings for flights above 264,000 ft. On July 17, 1962, Major White set the FAI-recognized absolute altitude record for an aircraft launched from a carrier airplane when he flew the number three X-15 to 314,750 ft. However, on August 22, 1963, Joe Walker reached a height of 354,200 ft, but the record is unofficial, as the necessary FAI paperwork was not submitted. Likewise, on October 3, 1967, Major Knight reached a speed of 4,520 mph in the number two X-15 (2,327 mph faster than the recognized absolute speed record set in 1976), but the record is not recognized. After a landing mishap on November 9, 1962, the number two X-15 was extensively modified for higher performance and was redesignated X-15A-2. Air Force Maj. Michael Adams was killed on November 15, 1967, when he became disoriented after a mechanical malfunction and the number three aircraft disintegrated. The type's 199th and final flight came on October 24, 1968. The number one X-15 is on display at the National Air and Space Museum in Washington, D. C., and the number two aircraft is on display at the US Air Force Museum. *(Specifications for X-15A-2.)*

Contractor: North American Aviation, Inc. **Location built:** El Segundo, Calif. **Number built (USAF):** Three (three).
FF: June 8, 1959 (first glide flight). September 17, 1959 (first powered flight). **FFM:** X-15. **FFL:** Edwards AFB, Calif. **FFP:** A. Scott Crossfield. **Models/variants:** X-15. X-15A-2.
Powerplant: One Reaction Motors XLR99 Pioneer liquid fuel throttleable rocket of between 25,000 to 50,000 lb of thrust (until the XLR99 was delivered in November 1960, the aircraft flew with two Reaction Motors XLR11-RM-5 liquid fuel rockets of 8,000 lb of thrust each).
Wingspan: 22 ft 4 in. **Length:** 52 ft 5 in. **Height:** 12 ft 7 in. **Weight:** 56,130 lb gross.
Armament: None.
Accommodation: Pilot only. **Cost:** Approx $300 million for design, development, three aircraft, and flight testing.
Max. speed: Mach 6.70 (4,520 mph). **Range:** More than 250 mi (flight path distance); most flights lasted 11 to 12 min. **Ceiling:** 354,200 ft.

X-24

The X-24 was one of several aircraft designed to test advantages of the lifting-body configuration (wedge-shaped, wingless aircraft that get their lift from body contours alone) for low supersonic, transonic, and landing-approach-speed flight. This work eventually paved the way for the space shuttle. The X-24 was also the last of the rocket-powered experimental aircraft. The program began slowly, as the X-24A was rolled out in July 1967 and, after full-scale wind tunnel tests at NASA's Ames Flight Research Center, did not fly until spring 1969. Three Air Force and NASA pilots made a total of 28 flights in the X-24A, totaling two hours, 54 minutes of flight time. It did not reach supersonic speeds until its eighteenth flight. The last flight came on June 4, 1971. In early 1972, the aircraft was sent to Martin Marietta's facility in Denver, Colo., where it was modified into the X-24B, with a delta-shaped body and nearly twice the lifting surface area. The modifications took 10 months and cost only $550,000. NASA pilot John Manke made the first glide flight of the X-24B on August 1, 1973, and the first powered flight on November 15, 1973. Four NASA pilots and two Air Force pilots (including Capt. Dick Scobee, who would be killed in the 1986 space shuttle *Challenger* accident) made a total of 36 flights totaling three hours, 46 minutes in the revised X-24B. On August 5, 1975, pilot Manke made the first landing of a lifting-body aircraft on a conventional concrete runway, and the feat was repeated by Air Force Lt. Col. Mike Love on August 20. The last flight of the program came on November 26, 1975. A proposed X-24C, which would have picked up the very-high-speed test role from the X-15 (planned speeds of Mach 8) was canceled. The X-24B is now on display at the US Air Force Museum at Wright-Patterson AFB, Ohio. *(Specifications for X-24B, except as noted.)*

Contractor: Martin Marietta Corp. **Location built:** Middle River, Md. **Number built (USAF):** One (one).
FF: April 17, 1969 (first glide flight). March 19, 1970 (first powered flight). **FFM:** X-24A. **FFL:** Edwards AFB, Calif. **FFP:** Jerauld Gentry. **Models/variants:** X-24A, B.

experimental

Powerplant: One Thiokol XLR11-RM-13 liquid fuel, four-chamber rocket of 9,800 lb of thrust and two Bell hydrogen peroxide landing rockets of 400 lb thrust each that could be used at pilot's discretion on landing.
Wingspan: 19 ft 2 in. **Length:** 37 ft 6 in. **Height:** 10 ft 4 in. **Weight:** 13,800 lb gross.
Armament: None.
Accommodation: Pilot only. **Cost:** Unconfirmed.
Max. speed: 1,164 mph. **Endurance:** Approx three min of powered flight followed by a five-min glide flight. **Ceiling:** 74,130 ft.

X-29

One of the most unusual-looking aircraft ever to fly, the X-29 was built primarily to explore the forward swept wing (FSW) concept, which gives an aircraft unprecedented agility. The X-29 also pioneered the use of advanced composite materials, movable close-coupled canards, and advanced flight controls. The FSW concept had first been explored by the Germans in World War II (and by the Army Air Forces with the XFG-1 fuel transport glider) but was not practical with conventional metal construction, as the wings could not be made rigid enough to keep them from bending. Funded by the Air Force, the Defense Advanced Research Projects Agency, and NASA, the X-29 was the first new pure research aircraft in more than a decade. In an effort to reduce costs, the two

Photo via Robert F. Dorr

X-24B

airplanes built were assembled by taking the forward fuselages from two F-5As and such off-the-shelf components as F-16 landing gear and flight-control actuators. Development of the triple redundant, fly-by-wire flight-control system and its software slowed the program. Also, as the program was a fairly low priority, the first X-29 was shipped from New York to California by military bulk freighter via the Panama Canal. Basic parameters, such as stability, loads, and flutter were examined in the first phase of flight test, which ran through 1986. The second phase of flight test concentrated on engine performance and air data collection. On June 8, 1988, the X-29 broke the record for most flights made by an X-series aircraft, when NASA pilot Rogers Smith flew the number one aircraft for the 200th time, breaking the X-15's record of 199. The first X-29 was flown 242 times before it was retired in 1988 and is now in the US Air Force Museum at Wright-Patterson AFB, Ohio. During testing, the X-29 picked up the unofficial nickname of "Polecat." The second X-29, identical to the first except for the addition of a spin test parachute and different instrumentation, was flown for the first time on May 23, 1989. The second aircraft was used to explore controlled flight at high angles of attack, including beyond 65°. It was retired in 1991.
Contractor: Grumman Aerospace. **Location built:** Bethpage, N. Y. **Number built (USAF):** Two (two).
FF: December 14, 1984. **FFM:** X-29A. **FFL:** Edwards AFB, Calif. **FFP:** Chuck Sewell. **Models/variants:** X-29A.
Powerplant: One General Electric F404-GE-400 turbofan of 16,000 lb thrust.
Wingspan: 27 ft 2 in. **Length:** 48 ft 1 in. **Height:** 14 ft 3 in. **Weight:** 17,303 lb gross.
Armament: None.
Accommodation: Pilot only. **Cost:** Approx $260 million (total program, incl two aircraft and flight test).
Max. speed: 1,200 mph. **Range:** Endurance of slightly more than one hr. **Ceiling:** 55,000 ft.

XB-70 Valkyrie

One of the most exotic aircraft ever built. Originally conceived as a high-altitude, Mach 3–capable bomber to replace the B-52, budget cuts reduced the number of aircraft to two and the program to a research effort aimed at studying aerodynamics, propulsion, and materials used on large supersonic aircraft. The original contract was let in 1955. The XB-70 was built largely of stainless-steel honeycomb sandwich panels and titanium and had heat-resistant paint. On one flight above Mach 3, the recorded skin temperature on the aircraft reached 620°. At Mach 3, it took the aircraft an arc of 287 miles and 13 minutes to make a 180° turn. The aircraft utilized the phenomenon of compression lift, where the aircraft actually rode its own shock wave. It was able to do this in part because of the wingtips that could droop in flight. The first Mach 3 flight came on October 14, 1965, with Al White and Col. Joe Cotton at the controls. That duo was also at the controls on the type's fastest flight, Mach 3.08 on April 12, 1966. On June 8, 1966, test pilot Joe Walker was killed when his F-104 made contact with the number two XB-70, got caught in vortices coming off the Valkyrie's wingtips, and rolled through the XB-70's tails. XB-70 copilot Maj. Carl Cross was also killed, and the XB-70 was destroyed. The two aircraft were flown 129 times for 252 hours, 28 minutes by seven contractor, Air Force, and NASA pilots. The two aircraft were flown at twice the speed of sound or better for nearly 52 hours. The surviving aircraft was flown to the US Air Force Museum at Wright-Patterson AFB, Ohio, on February 4, 1969, where it is now on display. Even on that flight, test data was collected.
Contractor: North American Aviation, Inc. **Location built:** Air Force Plant 42, Palmdale, Calif. **Number built (USAF):** Two (two).
FF: September 21, 1964. **FFM:** XB-70A. **FFL:** Air Force Plant 42, Palmdale, Calif. **FF Crew:** Alvin S. White (pilot). USAF Col. Joseph F. Cotton (copilot). **Models/variants:** XB-70A.
Powerplant: Six YJ93-GE-3 afterburning turbojets of 30,000 lb thrust each.
Wingspan: 105 ft 0 in. **Length:** 189 ft 0 in. **Height:** 30 ft 0 in. **Weight:** 534,700 lb gross.
Armament: None.
Accommodation: Two (pilot and copilot, side by side). **Cost:** Total program cost was approx $2 billion.
Max. speed: Mach 3.08 (more than 2,000 mph). **Range:** 6,000 mi. **Ceiling:** 74,000 ft.

Transports

C-46 Commando

The largest and heaviest twin-engine aircraft to see service with the Army Air Forces, this transport gained its greatest fame in airlifting supplies over "the Hump" (the Himalaya Mountains) in the China-Burma-India theater in World War II, although it saw action in every theater. The C-46 began its career as a pressurized, 36-passenger airliner with twin rudders, but the Army saw greater utility for the aircraft as a transport. The AAF bought the prototype in 1941, modified it to have a single fin, and designated it C-55. Demand for the C-46 grew rapidly, and manufacturing began at the new Curtiss plants in Louisville, Ky., and Saint Louis, Mo. The aircraft division of Higgins Industries (the New Orleans, La.–based boatbuilder that constructed most of the landing craft used in World War II) was given a contract for 500 aircraft, but only two C-46As were completed. A total of 1,490 C-46As were built, which included 160 R5Cs for the Marine Corps. The other major variant was the C-46D, with 1,410 aircraft built. The C-46 could carry more payload than its more famous stablemate, the C-47, and it offered better high-altitude performance, which was one of the reasons it was used so extensively in the CBI. C-46 crews began flying the hazardous air route over the Himalayas in 1943 after the Japanese closed the Burma Road. However, as a result of the CBI's harsh conditions, the type had a relatively high loss rate, and maintenance was a problem. In Europe, the C-46 was used to drop paratroopers during the Rhein River crossing in March 1945. The C-46 could tow two CG-4 gliders. The C-46A, D, and F models were used in Korea, and a few aircraft were used by Air Force Special Air Warfare Center in the early years of the Vietnam War. C-46s were in limited Air Force service as late as 1969. Many went into civilian hands after World War II, and a fair number are still in use today. *(Specifications for C-46A.)*
Contractors: 1. Curtiss-Wright Corp. 2. Higgins Aircraft Co. **Locations built:** 1. Buffalo, N. Y., Louisville, Ky., and St. Louis, Mo. 2. New Orleans, La. **Number built (USAF):** 3,182 (3,022).
FF: March 26, 1940. **FFM:** Civilian CW-20T. **FFL:** St. Louis, Mo. **FFP:** Edmund T. "Eddie" Allen (on loan from Boeing). **Models/variants:** C-46A, D, E, F.
Powerplant: Two Pratt & Whitney R-2800-51 Double Wasp 18-cylinder, twin-row radials of 2,000 hp each.
Wingspan: 108 ft 1 in. **Length:** 76 ft 4 in. **Height:** 21 ft 9 in. **Weight:** 56,000 lb gross.
Armament: None.
Accommodation: Crew of four (pilot, copilot, navigator, and flight engineer/loadmaster) and 50 troops or 33 litters with four attendants or 15,000 lb of cargo. **Cost:** $233,000.
Max. speed: 269 mph. **Range:** 1,200 mi. **Ceiling:** 27,600 ft.

C-47 Skytrain

The C-47 transport, commonly referred to as "Gooney Bird," was one of four weapons singled out by Gen. Dwight D. Eisenhower as the most instrumental in helping the US win World War II. (The others were the bazooka, the jeep, and the atomic bomb.) The C-47 was adapted from the DC-3 commercial airliner and was used to carry personnel and cargo, tow gliders (usually one Waco CG-4A), and drop paratroopers. Having great longevity, it was also used in Korea and in Vietnam, where it took on additional roles of attack as the AC-47 "Spooky" gunship and for psychological warfare missions. The need to take supplies over the Himalayas led to the C-47B version with higher horsepower engines. Among the unusual variants of the C-47 was one where the engines were removed and it was converted into a glider and another that was equipped with floats. The C-47 towed gliders and dropped 4,381 paratroopers in the invasion of Sicily on July 10, 1943; C-47 crews dropped 60,000 paratroopers and towed several thousand CG-4 gliders at Normandy on June 6, 1944. C-47s were used extensively in the Berlin airlift. In one notable action in Korea, C-47 crews flew 4,689 casualties out of the Chosin Reservoir area in five days. In Vietnam, the AC-47 gunships effectively suppressed enemy ground forces and picked up the secondary nickname of "Puff, the Magic Dragon." On February 24, 1969, while flying in a AC-47, A1C John L. Levitow, stunned and wounded by shrapnel, flung himself on an activated, smoking magnesium flare, dragged himself and the flare to the open cargo door, and tossed the flare out of the aircraft. For saving his fellow crew members and the gunship, he was awarded the Medal of Honor. AC-47s were replaced by AC-119s and AC-130s, and the last C-47 was retired from the Air Force in 1975. *(Specifications for C-47B.)*
Contractor: Douglas Aircraft Co. **Locations built:** Long Beach, Calif. (plus a few in Santa Monica, Calif.), and Oklahoma City, Okla. **Number built (USAF):** 10,654 incl civilian models, plus approx 2,500 aircraft license-built in Japan and the Soviet Union (8,882).
FF: December 17, 1935. **FFM:** Douglas Sleeper Transport (DST). **FFL:**

Santa Monica, Calif. **FF Crew:** Carl Cover (pilot), Fred Stineman (co-pilot), and Frank Collbohm (flight engineer). **Models/variants:** C-47, C-47A, B, D, E. TC-47B, D. EC-47B, D. VC-47B, D. SC-47D (later redesignated HC-47D). RC-47D. EC-47N. C-48, C-48A, B, C. C-49, C-49A, B, C, D, E, F, G, H, J, K. C-50, C-50A, B, C, D. C-52, C-52A, B, C, D. C-53, C-53B, C, D Skytrooper. C-117A, B, C, D. FC-47 (later redesignated AC-47) Spooky.
Powerplant: Two Pratt & Whitney R-1830-90C or -90D Twin Wasp 14-cylinder, twin-row radials of 1,250 hp each.
Wingspan: 95 ft 0 in. **Length:** 63 ft 9 in. **Height:** 16 ft 11 in. **Weight:** 25,200 lb gross.
Armament: None (three side-firing General Electric MXU-470/A 7.62-mm Minigun pods on AC-47).
Accommodation: Crew of three (pilot, copilot, and flight engineer/loadmaster) and 27 troops or 18–24 litters or 10,000 lb of cargo. **Cost:** $138,000.
Max. speed: 232 mph. **Range:** 1,513 mi. **Ceiling:** 24,450 ft.

C-54 Skymaster

This long-range heavy transport gained its greatest fame in World War II, the Berlin Airlift, and the Korean War. Originally developed for the airlines, the first batch of what would have been DC-4s was commandeered off the assembly line by the Army Air Forces in 1942 and redesignated C-54. Production orders followed, and to meet the demand, Douglas started a second assembly line in Chicago, Ill., which would eventually produce nearly 60 percent of all C-54s built. C-54s were first delivered on March 20, 1942, and saw service in every theater and became the primary airlifter across the Atlantic and Pacific. In the three years prior to V-J Day, C-54 crews made 79,642 crossings of the North Atlantic and only three aircraft were lost. The Navy received 201 C-54s, which were designated R5D. The first Presidential aircraft was the lone VC-54C, which was modified with a special hydraulic lift for Franklin D. Roosevelt's wheelchair. Nicknamed "Sacred Cow," it was used to take FDR to the Yalta Conference. President Harry S. Truman signed the National Security Act of 1947, creating an independent Air Force, on board this aircraft on July 12, 1947. It is now on display at the US Air Force Museum. Winston Churchill and Gen. Douglas MacArthur both used C-54s as their personal aircraft. On September 2, 1945, a C-54 crew made a record run of 31 hours, 25 minutes between Tokyo and Washington, D. C., to deliver films of the Japanese surrender ceremony on USS *Missouri*. At the height of the Berlin Airlift, 319 of the roughly 400 C-54s in service were hauling supplies to the city. On September 30, 1949, a C-54 crew made the last flight of the Berlin Airlift when it lifted off from Rhein-Main AB, West Germany. Less than six months later, on June 25, 1950, the first Air Force aircraft destroyed in the Korean War was a C-54 that was strafed on the ground at Kimpo AB, South Korea, by a pair of North Korean Yak fighters. C-54s were used for many other missions and saw limited Air Force service until 1972. *(Specifications for C-54D.)*
Contractor: Douglas Aircraft Co. **Locations built:** Santa Monica, Calif., and Chicago, Ill. **Number built (USAF):** 1,163 (955).
FF: March 26, 1942. **FFM:** C-54. **FFL:** Clover Field, Calif. **FF Crew:** John F. Martin and crew. **Models/variants:** C-54, C-54A, B, D, E, G, M.
Powerplant: Four Pratt & Whitney R-2000-11 Twin Wasp 14-cylinder radials of 1,350 hp each.
Wingspan: 117 ft 8 in. **Length:** 93 ft 10 in. **Height:** 27 ft 6 in. **Weight:** 73,000 lb gross.
Armament: None.
Accommodation: Four (pilot, copilot, navigator, and flight engineer/loadmaster) and 50 troops or 32,500 lb of cargo. **Cost:** Unconfirmed.
Max. speed: 275 mph. **Range:** 3,900 mi. **Ceiling:** 22,300 ft.

C-69/C-121 Constellation

Howard Hughes was one of the driving forces behind the design of the Lockheed Constellation. A number of aircraft intended for Hughes's Transcontinental and Western Airlines (and for Pan American) became the C-69 transport. It was the heaviest and the fastest transport built to date for the Army Air Forces. Twenty-two of these were built before V-J Day. The last aircraft piloted by Orville Wright was a C-69. The later model 1049G became the C-121 series. The C/EC-121s were ordered for use as cargo and passenger carriers, executive transports, and airborne early warning aircraft. The lone VC-121E was named *Columbine III* and was used throughout the Eisenhower Administration as Air Force One. Fifty-five percent of the Super Constellations built by Lockheed were delivered to the US Navy and Air Force, and the US military Constellations were flown from 1952 to 1977, when the last Air National Guard EC-121S was retired. A majority of the aircraft were used for electronic reconnaissance and airborne early warning. In the mid-1960s, the Air Force sent the first Warning Stars to Vietnam to maintain radar surveillance over North Vietnam and then later to warn of MiG attacks and alert American pilots who were straying over Chinese territory. Some versions were converted to airborne radio and TV transmitters for the Armed Forces Network in Vietnam. On October 24, 1967, an EC-121D crew guided a US fighter into position to destroy a MiG-21. This marked the first time a weapons controller aboard an airborne radar aircraft had ever directed a successful interception. *(Specifications for EC-121D, except as noted.)*
Contractor: Lockheed Aircraft Co. **Location built:** Burbank, Calif. **Number built (USAF):** 856 incl commercial production (205 incl C-69s).
FF: January 9, 1943. **FFM:** C-69. **FFL:** Burbank, Calif. **FF Crew:** Edmund T. "Eddie" Allen (pilot, on loan from Boeing) and Milo Burcham (copilot). **Models/variants:** C-69. C-121A, C. VC-121A, B, C, E, G. RC-121C, D (later redesignated EC-121C, D). EC-121G, H, P, R.
Powerplant: Four Wright R-3350-34 or -91 Cyclone 18-cylinder radials of 3,250 hp each.
Wingspan: 126 ft 2 in (over wing tanks). **Length:** 116 ft 2 in. **Height:** 27 ft 0 in. **Weight:** 143,600 lb.
Armament: None.
Accommodation: Crew of 27 (pilot, copilot, navigator, flight engineer, and 23 electronic warfare officers). Crew of four (pilot, copilot, navigator, and flight engineer) and up to 88 passengers or 72 troops on C-121A, C. **Cost:** $2.03 million.
Max. speed: 321 mph. **Range:** 4,600 mi. **Ceiling:** 20,600 ft.

C-97 Stratofreighter

The C/KC-97 series was a transport and definitive early tanker aircraft that had its design origin in the B-29. Boeing engineers essentially stacked one fuselage on top of another in a "double bubble" arrangement and used the same wings, engines, and tails as the Superfortress. Shortly after it made its first flight, a C-97 was flown nonstop from Seattle, Wash., to Washington, D. C., in six hours, four minutes at an average speed of 383 mph, while carrying a payload of 10 tons. Only 74 cargo variants were built, while 816 were KC-97 tankers. In its cargo version, early models were used extensively to bring Korean War casualties back to the US west coast from Japan. The later C-97s used an overhead rail cargo delivery system. Several aircraft were modified to a straight passenger configuration and were designated VC-97. Many other aircraft were modified for specialized roles, such as electronic reconnaissance. A small number of KC-97s were sold to Israel. Starting in 1956, Air Force KC-97s were gradually replaced by KC-135 jet tankers. Later in their career, KC-97s had two jet engines added so that the type could match speeds with the jet fighters and bombers they were refueling. Even so, most of the time the tankers had to enter a shallow dive to keep up. Eighteen Air National Guard squadrons were eventually equipped with KC-97s, and the last were retired in 1977. *(Specifications for KC-97G, except as noted.)*
Contractor: Boeing Aircraft Co. **Location built:** Renton, Wash. **Number built (USAF):** 945, incl commercial models (890).
FF: November 9, 1944. **FFM:** XC-97. **FFL:** Seattle, Wash. **FF Crew:** Unconfirmed but likely Elliott Merrill (pilot) and John Fornasero. **Models/variants:** YC-97, C-97A, C, D, G, K. KC-97E, F, G, L. HC-97G.
Powerplant: Four Pratt & Whitney R-4360-59B Wasp Major 28-cylinder, four-row radials of 3,500 hp each (Two additional General Electric J47 turbojets of 5,970 lb thrust each on KC-97L).
Wingspan: 141 ft 3 in. **Length:** 117 ft 5 in. **Height:** 38 ft 3 in. **Weight:** 175,000 lb gross.
Armament: None.
Accommodation: Crew of five (pilot, copilot, flight engineer, navigator/radio operator, and boom operator). As a transport: no boom operator and 134 troops or 69 litters or 25,500 lb of cargo. **Cost:** $2.21 million.
Max. speed: 375 mph. **Range:** 4,300 mi. **Ceiling:** 30,000 ft.

C-119 Flying Boxcar

The C-119 was a major redesign of the C-82 Packet. The C-119 had the same major design feature as the C-82—a rear-loading, all-through cargo hold—but featured more-powerful engines and a relocation of the flight deck. In an effort to speed production during the Korean War, Kaiser was chosen to establish a second assembly line (151 C-119F/Gs built; 41 C-119Cs assembled). The type saw extensive action in the Korean War, flying from bases in Japan. C-119s were also used to ferry supplies to the Arctic for construction of the Distant Early Warning (DEW) line radar sites. Production ended in 1955. A total of 68 C-119F/Gs were modified with an upward-hinged beaver-tail design cargo door and were redesignated C-119J. A few C-119Js were specially modified for midair retrieval of capsules containing Corona program satellite imagery reentering the atmosphere. The first successful effort came on August 18, 1960, when a C-119 crew flying over the Pacific snagged the parachute lowering the Discoverer XIV imagery capsule. The type was also used by US Navy and Marine Corps (as R4Qs), Italy, India, and Belgium. In the late 1960s, the Air Force selected the C-119 to replace the AC-47 Spooky. Fairchild Hiller (as the company had become in 1966) was chosen to modify 52 aircraft under the Gunship III program (26 AC-119G and 26 AC-119Ks). Entering service on March 11, 1969, with the 17th Special Operations Squadron, AC-119Gs mainly flew fire support and air base defense missions. The 18th SOS (AC-119K) was employed almost exclusively to destroy targets along the Ho Chi Minh Trail during the Vietnam War. The last C-119 was retired in September 1975. *(Specifications for C-119G, except as noted.)*
Contractors: 1. Fairchild Engine and Airplane Corp., Aircraft Division. 2. Kaiser Manufacturing Co. **Locations built:** 1. Hagerstown, Md. 2. Willow Run, Mich. **Number built (USAF):** 1,150 (963).
FF: November 1947. **FFM:** XC-119A (Modified C-82 Packet). **FFL:** Unconfirmed but likely Hagerstown, Md. **FFP:** Unconfirmed. **Models/variants:** C-119B, F, G, J, K, L. AC-119G Shadow, AC-119K Stinger.
Powerplant: Two Wright R-3350-89A Cyclone 18-cylinder radials of 3,500 hp each (C-119Ks also had two General Electric J85-GE-17 turbojets of 2,850 lb static thrust in underwing pods).
Wingspan: 109 ft 3 in. **Length:** 86 ft 6 in. **Height:** 26 ft 6 in. **Weight:** 72,700 lb gross.
Armament: None (C-119); four side-firing SUU-11A/A or SUU-11B/A gun

Photo by John L. Smith via Warren Thompson

C-123

pods (GAU-2B/A 7.62 miniguns) (AC-119G/K) and two General Electric M61A1 Vulcan 20-mm cannon (AC-119K only).
Accommodation: Six (pilot, copilot, navigator, radio operator, flight engineer, and loadmaster) and up to 62 troops (normally 45) or 35 stretchers plus four attendants or cargo. Eight (pilot, copilot, two navigators, flight engineer, two gunners, and loadmaster) on AC-119G/K. **Cost:** $590,000 for basic aircraft (AC-119G modifications cost approx $623,000 for each aircraft; AC-119K modifications cost approx $2.6 million for each aircraft).
Max. speed: 281 mph. **Range:** 1,630 mi. **Ceiling:** 24,000 ft.

C-123 Provider

The C-123 was a tactical transport originally designed as a glider, although the design was drawn up with the intention of its eventually being powered. There were many experimental and one-off variants of the Provider during its career, including one that was modified by Stroukoff and called a Pantobase, which allowed it to land on ice, snow, or water. A couple of aircraft were also modified as lightships (with high-intensity lighting on the cargo ramp to find targets on the ground), but the idea was not practical. Two C-123Ks were modified to the NC-123K configuration (also referred to as AC-123K) under the Black Spot project. This was designed to give the Air Force a self-contained night attack capability to seek out and destroy targets on the Ho Chi Minh Trail. C-123s contributed a substantial portion of in-country airlift and resupply in Vietnam and Cambodia. UC-123Bs and Ks were equipped for aerial spraying and were used extensively on defoliation missions. One of these Operation Ranch Hand units (as the defoliation mission was called) carried the motto, "Only we can prevent forests," as a play on Smokey Bear's famous slogan. On May 12, 1968, Lt. Col. Joe M. Jackson, flying a C-123, landed at a forward outpost at Kham Duc, South Vietnam, in a rescue attempt of a Combat Control Team. After a rocket-propelled grenade fired directly at his aircraft proved to be a dud, Colonel Jackson took off with the CCT on board and landed at Da Nang. He was later awarded the Medal of Honor. C-123s remained in Guard service until 1979. The type was also flown by five other countries and by Air America, the CIA's covert transport operation. *(Specifications for C-123B, except as noted.)*
Contractors: 1. Fairchild Engine and Airplane Corp., Aircraft Division. 2. Chase Aircraft Co. **Locations built:** 1. Hagerstown, Md. 2. West Trenton, N. J. **Number built (USAF):** 328 (304).
FF: October 14, 1949. **FFM:** Chase XC-123 Avitruc. **FFL:** West Trenton, N. J. **FFP:** Unconfirmed. **Models/variants:** C-123B, J, K. UC-123B. NC-123K. UC-123K.
Powerplant: Two Pratt & Whitney R-2800-99W Double Wasp 18-cylinder, twin-row radials of 2,500 hp (C-123K also had two General Electric J85-GE-17 turbojets of 2,850 lb thrust each on underwing pylons).
Wingspan: 110 ft 0 in. **Length:** 75 ft 9 in. **Height:** 34 ft 1 in. **Weight:** 60,000 lb gross.
Armament: None (NC/AC-123K aircraft had two dispensers for up to 6,372 one-lb bomblets).
Accommodation: Crew of three or four (pilot, copilot, flight engineer/loadmaster, and navigator usually) and 61 troops or 50 litters with six attendants or up to 15,000 lb of cargo. **Cost:** $601,719.
Max. speed: 245 mph. **Range:** 1,470 mi. **Ceiling:** 29,000 ft.

Photo via Robert F. Dorr

C-124 Globemaster II

C-124 Globemaster II

The Air Force's long-range airlifter that performed yeoman service through two wars and nearly 25 years, the C-124 was a major redesign of the C-74 that was developed at the end of World War II. The C-124 used the same wings, tail, and engines as the C-74 but had a deeper fuselage that featured clamshell doors in the nose that allowed for driving vehicles on and off under their own power. The C-124 retained the C-74's electrically operated elevator in the rear of the aircraft for loading of bulk cargo. The first operational aircraft were delivered in May 1950, and production ran through May 1955 (204 C-124As and 243 C-124Cs). The improved C-124C featured more-powerful engines, as well as wingtip-mounted combustion heaters that provided cabin heating and wing and tail surface deicing, and an APS-42 weather radar in a distinctive nose "thimble." These latter improvements were eventually retrofitted to the C-124As. Shortly after entering service with Military Air Transport Service and Troop Carrier Command, the C-124 suffered two isolated accidents (December 1950 and June 1951), each resulting in what was then the largest number of people killed in a single aircraft accident (86 and 129, respectively). The C-124 went on to provide a much-needed airlift capability in the Korean War, as it was the only aircraft that could carry many of the Army's vehicles. Nicknamed "Old Shaky," the C-124 saw service all over the world, from Antarctic resupply flights, to refugee evacuation in the Congo, to mercy flights in Chile and elsewhere. C-124s were used to deliver supplies to the French in Indochina in 1954–55 and then were regularly flown to Vietnam through the US buildup in the 1960s. While reliable, the C-124s were slow (97 hours from Travis AFB, Calif., to Tan Son Nhut AB, South Vietnam, and back), and they were all the Air Force had until the C-133, and later C-141 and C-5, came along. Most C-124s were transferred to the Air National Guard and Air Force Reserve by 1970. The type was phased out of service in mid-1974. *(Specifications for C-124C.)*
Contractor: Douglas Aircraft Co. **Location built:** Long Beach, Calif. **Number built (USAF):** 448 (448).
FF: November 27, 1949. **FFM:** YC-124. **FFL:** Long Beach, Calif. **FFP:** Unconfirmed. **Models/variants:** C-124A, C.
Powerplant: Four Pratt & Whitney R-4360-63A Wasp Major four-row, 28-cylinder radials of 3,800 hp each.
Wingspan: 174 ft 2 in. **Length:** 130 ft 0 in. **Height:** 48 ft 4 in. **Weight:** 194,500 lb gross.
Armament: None.
Accommodation: Crew of eight plus 68,500 lb of cargo or 200 passengers or 127 litters and 15 attendants. **Cost:** $1.65 million.
Max. speed: 304 mph. **Range:** 4,030 mi. **Ceiling:** 21,800 ft.

Trainers

JN-4 "Jenny"

The Jenny is probably the most famous US-built airplane to come out of World War I. This trainer and observation biplane picked up its nickname from its designation, JN. Roughly 95 percent of the US and Canadian pilots trained during World War I flew a Jenny at some point during their training. When the buildup of American airpower began after the US entered World War I, the JN-4 was the only proven domestic design ordered into immediate mass production. Wartime need required an expansion of production, and five other companies were chosen to build JN-4D. An earlier version, the JN-3, was used in 1916 during Maj. Gen. John J. Pershing's punitive expedition into Mexico, but the aircraft's performance was not satisfactory. After World War I, thousands of JN-4s were put on the civilian market, and the type was used by countless barnstormers all across the country. Some 200 airplanes were transferred to the US Navy from 1920 to 1923. The Army Air Service continued to use the better performing JN-4H and JN-6 models until September 1927. *(Specifications for JN-4D.)*
Contractors: 1. Curtiss Aeroplane and Motor Co. 2. Fowler Airplane Corp. 3. Liberty Iron Works. 4. Springfield Aircraft Co. 5. St. Louis Aircraft Co. 6. US Aircraft Co. 7. Howell & Lesser Co. **Locations built:** 1. Buffalo, N. Y. 2. San Francisco, Calif. 3. Sacramento, Calif. 4. Springfield, Ill. 5. St. Louis, Mo. 6. Redwood City, Calif. 7. San Francisco, Calif. **Number built (USAF):** 6,070 (approx 5,500).
FF: 1915. **FFM:** JN-2 (although it is sometimes referred to as just JN). **FFL:** Hammondsport, N. Y. **FFP:** Unconfirmed. **Models/variants:** JN-4, JN-4A, B, C, D, H. JN-4Can. JN-4HT, HB, HG. JN-5H. JN-6, JN-6HB, HG, HO, HP. JNS.
Powerplant: One Curtiss OX-5, liquid-cooled V-8 of 90 hp.
Wingspan: 43 ft 7 in. **Length:** 27 ft 4 in. **Height:** 9 ft 10 in. **Weight:** 1,920 lb gross.
Armament: Usually none.
Accommodation: Crew of two (student and pilot in separate tandem cockpits). **Cost:** $4,750 (airframe only; engines added approx $1,000 to the cost).
Max. speed: 75 mph. **Endurance:** two hr, 15 min. **Ceiling:** 6,500 ft.

AT-6 Texan

One of the most widely used aircraft in history. Nearly every Army Air Forces pilot, a majority of British, Canadian, Australian, and New Zealand pilots, and thousands of US Navy pilots in World War II trained in the AT-6 (called Harvard in Canada or SNJ by the Navy) prior to earning their wings. This aircraft exposed students to high-performance aircraft with retractable landing gear. One of two Army Air Forces aircraft types that were developed from the NA-16 company demonstrator. The AT-6C was unusual in that low-alloy steel and plywood were substituted for aluminum structure in an attempt to save strategic materials. While this saved more than 1,200 pounds of weight, fears of materials shortages were found to be exaggerated, and the standard materials were returned in the AT-6D. In service long after World War II ended, more than 2,000 remaining aircraft were redesignated T-6A, C, D, and F in 1948, when the A for "advanced," B for "basic," and P for "primary" trainer prefix nomenclature was dropped. These aircraft were remanufactured in 1948–49 and were all designated T-6G. The type was eventually used by several dozen nations. The T-6 was used in Korea for forward air control (or "mosquito missions," as they were known) and carried an observer in the second seat to spot enemy troops and gun emplacements for the pilot to mark with smoke rockets. On July 10, 1950, the first day of mosquito operations, Lt. James Bryant and Lt. Frank Mitchell called in a strike by F-80 pilots who destroyed a column of North Korean tanks. The 6147th Tactical Air Control Squadron was later "officially" formed for this mission and by the end of the war had flown 40,354 sorties and was responsible for the destruction of at least eight Communist divisions, 563 artillery pieces, 5,079 vehicles, 12 locomotives, thousands of railcars, and 84 bridges. The T-6 was phased out of Air Force and Navy service in 1958 *(Specifications for T-6G.)*
Contractor: North American Aviation, Inc. **Locations built:** Inglewood, Calif., Dallas, Tex., Fresno, Calif., and Columbus, Ohio. **Number built (USAF):** 15,109 (approx 7,088).
FF: April 1, 1935. **FFM:** NA-16. **FFL:** Dundalk, Md. **FFP:** Edmund T. "Eddie" Allen. **Models/variants:** AT-6, AT-6A, B, C, D, F. T-6G. LT-6G. BC-1, BC-1A.
Powerplant: One Pratt & Whitney R-1340-AN1 Wasp nine-cylinder radial of 550 hp.
Wingspan: 42 ft 0¼ in. **Length:** 29 ft 6 in. **Height:** 11 ft 9 in. **Weight:** 5,617 lb gross.

Armament: Usually none (although some AT-6B aircraft were used for gunnery training and carried two .30-cal. machine guns; T-6Gs in the Korean War carried smoke rockets for marking targets).
Accommodation: Crew of two (student and pilot in tandem). **Cost:** $27,000.
Max. speed: 210 mph. **Range:** 770 mi. **Ceiling:** 23,200 ft.

AT-7 Navigator/AT-11 Kansas/C-45 Expeditor/F-2

The military versions of the popular civilian Model 18. The AT-7 was the Army Air Forces' first dedicated navigation trainer and featured a rotatable astrodome behind the cockpit. The AT-11 featured a glass nose, Norden bombsight, and a bomb bay and was used to train 90 percent of World War II bombardiers. Both types were first purchased in 1941. The C-45 was used as a utility transport and for advanced training. The F-2, like the C-45, was first purchased in 1940 and was the AAF's first specialized mapping and photoreconnaissance aircraft and featured up to four fuselage-mounted cameras. These aircraft also had uprated engines and an oxygen system for the crew. This aircraft type also saw service with the US Navy as the JRB (C-45) and SNB (AT-7/AT-11). Approx 900 USAF aircraft (mostly C-45s) were remanufactured by Beech in Herington, Kan., after the war. The C-45G/Hs (the remanufactured aircraft) stayed in USAF use until 1963. *(Specifications for C-45H, except as noted.)*
Contractor: Beech Aircraft Co. **Location built:** Wichita, Kan. **Number built (USAF):** 7,796, incl civilian models (4,526 of all types).
FF: January 15, 1937. **FFM:** Company Model 18A. **FFL:** Wichita, Kan. **FFP:** James N. Peyton. **Models/variants:** C-45, C-45A, B, F, G, H. UC-45C, D, E, J. AT-7, AT-7A, B, C. AT-11. F-2.
Powerplant: Two Pratt & Whitney R-985-AN-14B nine-cylinder radials of 450 hp each.
Wingspan: 47 ft 8 in. **Length:** 34 ft 3 in. **Height:** 9 ft 2 in. **Weight:** 9,300 lb gross.
Armament: None on C-45, AT-7, F-2. Two .30-cal. machine guns and 10 100-lb bombs on AT-11.
Accommodation: Crew of two, side by side, and six passengers (C-45); crew of two, side by side, and three students (AT-7, AT-11). **Cost:** $57,838.
Max. speed: 219 mph. **Range:** 1,440 mi. **Ceiling:** (C-45) 18,200 ft. (F-2) 26,200 ft.

PT-1 Trusty/PT-3

The PT-1 was the first airplane produced in substantial quantity following World War I. It was used for training aviation cadets in California and Texas and established the basic design for primary trainers into World War II. The PT-1 had a welded fuselage framework of chrome-molybdenum steel tubing for structural strength. Nicknamed "Trusty" because it was so sturdy and easy to fly, it bred overconfidence in some of the student pilots—an undesirable trait for men who were soon to be flying faster airplanes with more difficult handling qualities. It had excellent spin-recovery characteristics. The PT-3 was essentially the same airplane, with a different engine and other minor differences. The PT-1 was selected as the winner of a competition in 1924 held at Brooks Field, Tex. In its first year of service at Brooks, 531 students were trained without a serious injury, significantly better than the JN-4 that it replaced. Four PT-1s were built for Siam. The Navy's NY-1/NY-2 trainer was developed from the PT-1. The O-17 Courier was a development of the PT-3. The Trusty was one of the first aircraft used by the Air National Guard. Only a few PT-1s survive today, and one is on display at the US Air Force Museum at Wright-Patterson AFB, Ohio. *(Specifications for PT-1, except as noted.)*
Contractor: Consolidated Aircraft Co. **Location built:** Buffalo, N. Y. **Number built (USAF):** PT-1: 224 (220). PT-3: 157 (150).
FF: 1923. **FFM:** TW-3. **FFL:** Unconfirmed but most likely East Greenwich, R. I. **FFP:** Unconfirmed. **Models/variants:** PT-1/PT-3.
Powerplant: One Wright E liquid-cooled V-8 of 180 hp (One Wright R-790, also called J-5, Whirlwind of 220 hp on PT-3).
Wingspan: 34 ft 9 in. **Length:** 27 ft 8 in. **Height:** 9 ft 6 in. **Weight:** 2,577 lb gross.
Armament: None.
Accommodation: Crew of two (student and pilot in tandem). **Cost:** $9,800.
Max. speed: 95 mph. **Range:** 325 mi. **Ceiling:** 13,450 ft.

PT-13/PT-17/PT-18 Kaydet

The PT-13/-17/-18 series began as a company-funded venture in 1934, and nearly every pilot in the Army Air Corps/Army Air Forces, the US Navy, and a number of foreign countries flew the Kaydet as the first step toward earning their wings. The PT-13 replaced the PT-1 as the Army's primary trainer. The prototype was designed and built in only 60 days, and the Kaydet's airframe was stressed to a much higher load factor than it was ever expected to encounter in training operations. The aircraft was commonly called a "Stearman," even after Boeing bought the company. The PT-17 and PT-18 were essentially the same as the PT-13 with different engines and some different minor details. The PT-17 featured a blind-flying hood that fit over the rear cockpit to allow the students to become familiar with instrument flight. The Navy also flew hundreds of these airplanes as the N2S. Military flying schools in the 1930s provided the last market for the biplane as the type had ceased to be a factor even in civil aviation by then. Several thousand of these trainers were on the civil market after World War II, and a surplus Kaydet could be purchased for a few hundred dollars. The PT-27 was essentially a PT-17 with a full canopy to keep out the elements for pilots training in Canada. The last production Kaydet came off the line in 1945 after the type had been in production for 10 years. The Kaydet was the last biplane bought by the Air Force's predecessor organizations. *(Specifications for PT-17, except as noted.)*
Contractor: Stearman Aircraft Division of Boeing Aircraft Co. **Location built:** Wichita, Kan. **Number built (USAF):** 8,585 (4,328).
FF: Early 1934. **FFM:** Company Model 70. **FFL:** Unconfirmed but most likely Wichita, Kan. **FFP:** Unconfirmed. **Models/variants:** PT-13, PT-13A, B, C, D. PT-17, PT-17A, B. PT-18, PT-18A.
Powerplant: One Continental R-670-5 nine-cylinder radial of 220 hp.
Wingspan: 32 ft 2 in. **Length:** 24 ft 10 in. **Height:** 9 ft 8 in. **Weight:** 2,635 lb gross.
Armament: None.
Accommodation: Crew of two (student and pilot in separate tandem cockpits). **Cost:** $9,120.
Max. speed: 135 mph. **Range:** Approx 450 mi (PT-13D). **Ceiling:** 13,200.

PT-19/PT-23 Cornell

The PT-19 was developed as a company-funded effort to satisfy a military requirement for a rugged, monoplane trainer. Massive orders in 1941 led to the doubling of Fairchild's production facilities, but the demand exceeded capacity at Hagerstown, Md., and additional sources were provided by Aeronca and St. Louis Aircraft Corp. All three companies built the PT-19 version. The PT-19B had a hood that fit over the cockpit for blind-flying instrument instruction. The PT-19 and PT-23 were the same airplane except the PT-23 had a radial engine. The PT-26 had a canopy, a new engine, and other slight differences and was used by the Canadian government for the Commonwealth Air Training Plan. Cornells were also flown by the Norwegian forces in exile, Brazil, Ecuador, and Chile. Some PT-19s were in Air Force use as late as 1948. *(Specifications for PT-19A.)*
Contractors: 1. Fairchild Engine & Airplane Corp. 2. Aeronca Aircraft Corp. 3. St. Louis Aircraft Corp. 4. Howard Aircraft Corp. **Locations built:** 1. Hagerstown, Md. 2. Middletown, Ohio. 3. St. Louis, Mo. 4. St. Charles, Ill. **Number built (USAF):** 6,016 of both models (5,942 of both models).
FF: 1939. **FFM:** Company Model 62. **FFL:** Unconfirmed but most likely Hagerstown, Md. **FFP:** Unconfirmed. **Models/variants:** PT-19, PT-19A, B. PT-23, PT-23A.
Powerplant: One Ranger L-440-1 six-cylinder in-line of 175 hp.
Wingspan: 36 ft 0 in. **Length:** 27 ft 11 in. **Height:** 10 ft 6 in. **Weight:** 2,450 lb gross.
Armament: None.
Accommodation: Crew of two (student and pilot in separate tandem cockpits). **Cost:** $9,896.
Max. speed: 132 mph. **Range:** 400 mi. **Ceiling:** 15,300 ft.

T-28 Trojan

The winner of the competition to build the first new Air Force trainer after World War II, the T-28A fell short of expectations, and the Air Force eventually added the T-34 to the syllabus to provide *ab initio* training. Following a Department of Defense decision to standardize training, the Navy also purchased the T-28B and C versions, which had some significant differences from the Air Force version, including an arresting hook for carrier-landing training. The US used a number of T-28s in the early stages of Operation Farm Gate to train the South Vietnamese in commando-type operations. In 1962, the US Air Force began to modify nearly 300 T-28s as fighter-bombers for counterinsurgency warfare, and these were redesignated T-28D Nomads. Many of these airplanes were turned over to the South Vietnamese Air Force. T-28 pilots normally flew in two-plane formations for day strikes. One of the most successful uses for the T-28 was on night hunter-killer missions. A forward air control pilot in an O-1F used a Starlight scope to locate enemy vehicles, which the T-28 pilots then bombed. Several Air National Guard squadrons used T-28s briefly in the late 1950s while awaiting conversion to jets. Air Force

trainers

AT-6 Texan

Photo by Frank Swartz via Warren Thompson

Photo via Warren Thompson

PT-19 Cornell

training in T-28s ended in the late 1950s to the early 1960s, when the T-37 entered service. Armed T-28s were also used by France in Algeria.
Contractor: North American Aviation, Inc. **Location built:** Inglewood, Calif. **Number built (USAF):** 1,989 (1,175).
FF: September 24, 1949. **FFM:** XT-28. **FFL:** Unconfirmed but most likely Inglewood, Calif. **FFP:** Unconfirmed. **Models/variants:** T-28A, D. AT-28D.
Powerplant: One Wright R-1300-1 Cyclone nine-cylinder radial of 800 hp.
Wingspan: 40 ft 7 in. **Length:** 32 ft 0 in. **Height:** 12 ft 8 in. **Weight:** 6,365 lb gross.
Armament: None (T-28A); two .50-cal. machine guns in detachable pods and underwing pods for up to 1,800 lb of rockets or bombs (T-28D).
Accommodation: Crew of two (student and instructor in tandem). **Cost:** $123,000.
Max. speed: 283 mph. **Range:** 1,000 mi. **Ceiling:** 25,000 ft.

T-29 Flying Classroom/C-131 Samaritan

The T-29/C-131 series was a development of the civilian models 240/340/440 Convair-Liner. The T-29 was designed to replace TB-25J. A number of both types were modified with civilian interiors for executive transport. The first T-29 was delivered in 1950, but the first C-131 was not delivered until 1964. The C-131 was primarily used for casualty evacuation. Some were modified for special duties, including missile tracking, photographic survey, and airways checking. Air forces of Australia, West Germany, Italy, Bolivia, Spain, Paraguay, and Sri Lanka obtained small numbers of ex-civilian models. The US Navy flew a number of R4Y aircraft, and later some C-131s transferred from the Air Force. The current T-43 replaced the T-29 for training navigators. The last C-131s were retired from the Air National Guard in the mid-1980s. One C-131 was extensively modified, complete with a second cockpit attached to the front of the aircraft, to allow for simulation of large aircraft handling characteristics. The aircraft, designated NC-131H, is known as the Total In-Flight Simulator (TIFS) and is still in use. *(Specifications for T-29C.)*
Contractor: Consolidated-Vultee Aircraft Corp. (Convair). **Location built:** San Diego, Calif. **Number built (USAF):** 1,076 incl civilian models (472).
FF: March 16, 1947. **FFM:** Company Model 240. **FFL:** San Diego, Calif. **FF Crew:** Sam Shannon, pilot; Russell Rogers, copilot; and L. J. Bordelan and J. T. Ready, flight engineers. **Models/variants:** T-29A, B, C, D. AT-29C (later redesignated ET-29C). VT-29C. C-131A, B, D, E. JC-131B. VC-131D. RC-131F, G.
Powerplant: Two Pratt & Whitney R-2800-99W Double Wasp 18-cylinder, two-row radials of 2,500 hp.
Wingspan: 91 ft 9 in. **Length:** 74 ft 8 in. **Height:** 26 ft 11 in. **Weight:** 43,575 lb gross.
Armament: None.
Accommodation: Crew of four (pilot, copilot, and instructors) and 16 students. **Cost:** $635,000 (C-131D).
Max. speed: 299 mph. **Range:** Approx 1,000 mi. **Ceiling:** 24,000 ft.

T-33 Shooting Star

The two-place T-33 was the world's first jet trainer. It was developed from the single-seat F-80 fighter by lengthening the fuselage approximately three ft to accommodate a second cockpit. Lockheed undertook the design of the T-33 with $1 million of its own money. Entering service in 1948, the T-33 was the only Air Force jet trainer until the advent of the Cessna T-37 in 1957. The T-33 then went from being an advanced trainer to a primary trainer. The T-33 was eventually used by the navies and air forces of more than 20 countries. Many are still in use today. One modified T-33, designated NT-33, was used to simulate the handling characteristics of different aircraft; this particular aircraft was in use until the early 1990s, when it was replaced by the NF-16 Variable Stability In-Flight Simulator Test Aircraft. A number of the T-33s for export were modified to carry light armament. A number of T-33s were built under license in Canada. Untold thousands of pilots earned their wings on the T-33. The last Air National Guard T-33 was retired in 1987. *(Specifications for T-33A.)*

Photo by F. I. Stone via Warren Thompson

T-33 Shooting Star

Contractor: Lockheed Aircraft Co. **Location built:** Burbank, Calif. **Number built (USAF):** 5,691 plus 1,046 license-built aircraft (approx 3,980).
FF: March 22, 1948. **FFM:** TP-80C. **FFL:** Van Nuys, Calif. **FFP:** Tony LeVier. **Models/variants:** T-33A. DT-33A; NT-33A; RT-33A. QT-33.
Powerplant: One Allison J33-A-23, or -25 (or later -35) turbojet of 5,200 (5,400 on the -35) lb of thrust.
Wingspan: 38 ft 10½ in. **Length:** 37 ft 9 in. **Height:** 11 ft 7 in. **Weight:** 12,000 lb gross.
Armament: Two fixed .50-cal. machine guns.
Accommodation: Crew of two (student and pilot in tandem). **Cost:** $123,000.
Max. speed: 525 mph. **Range:** 1,275 mi. **Ceiling:** 47,500 ft.

Helicopters

YG-1

The YG-1 was the first practical rotorcraft procured by the Air Corps. Two Kellet KD.1 civilian autogyros were acquired and were given the designation of YG-1 and YG-1A. Both of these open-cockpit aircraft crashed. Seven additional aircraft (with slight changes) were ordered, and these aircraft were delivered to Wright Field, Ohio, for evaluation in 1938. These seven were designated YG-1B. A much-improved version, the XO-60, was ordered in 1942. This version featured a Jacobs R-915-3 of 300 hp, an enclosed, bulged cockpit to allow the crew to look down (along with windows in the floor), taller landing gear to increase the angle of attack on takeoff, and two vertical fins attached to the horizontal stabilizer for better stability and performance. Both of these types could make a near-vertical takeoff (a takeoff roll followed by "jumping" to become airborne). In flight, the rotor blades, which were driven by the engine, were disengaged, and the aircraft's propeller took over. The XO-60s (six of which were later redesignated YO-60) were sent to Florida, Georgia, California, New Mexico, and Wright Field for evaluation. What is believed to be the last XO-60 is now in the collection of the National Air and Space Museum in Washington, D. C. *(Specifications for YG-1.)*
Contractor: Kellett Autogiro Corp. **Location built:** Philadelphia, Pa. **Number built (USAF):** Nine (nine).
FF: 1936. **FFM:** YG-1. **FFL:** Most likely Wright Field, Dayton, Ohio, or, possibly, Philadelphia, Pa. **FFP:** Unconfirmed. **Models/variants:** YG-1.
Powerplant: One Jacobs R-755-3 nine-cylinder radial of 225 hp. **Rotor Diameter:** 40 ft 0 in. **Fuselage Length:** 28 ft 10 in. **Height:** 10 ft 3 in. **Weight:** 2,250 lb gross.
Armament: None.
Accommodation: Two (pilot and observer in tandem). **Cost:** Unknown.
Max. speed: 125 mph. **Range:** 360 mi. **Ceiling:** 14,000 ft.

R-4 Hoverfly

The world's first production helicopter, the first helicopter designed specifically for the military, and the only US helicopter to see action in World War II, the XR-4 was developed from the VS-300, the world's first practical helicopter. To demonstrate what a giant leap the XR-4 was over the VS-300, company pilot C. L. "Les" Morris flew the prototype 761 miles from the Stratford, Conn., factory to Wright Field, Ohio, in five days and 16 flights. Igor Sikorsky was the passenger on the last hop from Springfield, Ohio, to Wright Field. Orville Wright was present when the XR-4 was formally accepted on May 30, 1942. Three YR-4As and 27 YR-4Bs were ordered in 1943. These were sent to Burma (six), Alaska, Wright Field (six), and other places and other services (three in all to the Navy and designated HNS) to test the aircraft in various conditions. The first landing on a ship came on May 6, 1943, when USAAF Capt. H. Franklin Gregory touched down on the stern of the tanker SS *Bunker Hill* riding at anchor in Long Island Sound. The first combat rescue came on April 25–26, 1944, when 2d Lt. Carter Harman lifted a downed L-1 pilot and the three injured British soldiers he was flying out of the jungle in Burma. Col. Philip Cochran, commander of the 1st Air Commando Group, later wrote, "Today, the 'egg-beater' went into action, and the damn thing acted like it had good sense." One hundred R-4Bs were ordered, and the type was used by the AAF, US Navy and Coast Guard (as HNS-1s), and the British Royal Navy. Later, the R-4s were used for helicopter training. Some were in use as late as 1948. *(Specifications for R-4B.)*
Contractor: Vought-Sikorsky Division of United Aircraft. **Location built:** Stratford, Conn. **Number built (USAF):** 131 (73).
FF: January 14, 1942. **FFM:** XR-4. **FFL:** Stratford, Conn. **FFP:** Unconfirmed but likely C. L. "Les" Morris or possibly Igor Sikorsky. **Models/variants:** YR-4B, R-4B.
Powerplant: One Warner R-550-3 Super Scarab seven-cylinder radial of 200 hp. **Rotor diameter:** 38 ft 0 in. **Fuselage Length:** 35 ft 5 in. **Height:** 12 ft 5 in. **Weight:** 2,540 lb gross.
Armament: None.
Accommodation: Two (pilot and observer/passenger, side by side). **Cost:** Unconfirmed.
Max. speed: 81 mph. **Range:** 230 mi. **Ceiling:** 8,000 ft.

H-19 Chickasaw

The H-19 was the first helicopter to be procured in quantity by the Air Force. It was also the world's first helicopter to have a nose-mounted engine, which left the main cabin free for cargo, troops, or litters. A long drive shaft, running up through the elevated cockpit, turned the rotor. The H-19 entered service in 1951 and saw extensive service in the Korean War. Shortly after it entered service, Capts. Joseph D. Copper and Russell Winnegar, with some South Koreans, lowered an H-19 into a canyon 35 miles behind North Korean lines. The South Koreans fieldstripped a crashed MiG-15 and hooked the carcass on the H-19's external winch. Overloaded, the crew lifted off and, flying through heavy ground fire, returned safely to base. In April 1953, Capt. Joseph McConnell, Jr., who would go on to be the leading ace of the Korean War, was pulled out of the Yellow Sea by an SH-19B (as the dedicated rescue aircraft were designated) crew. H-19 crews were also heavily involved in Special Operations in Korea, including retrieving agents who had parachuted into North Korea. On January 15, 1953, Capt. Lawrence A. Barrett and Lt. R. F. Sullivan flew more than 100 miles behind North Korean lines to rescue a downed F-51 pilot. On July 13–31, 1952, two Air Force crews, Capts. Vincent McGovern and Harry C. Jeffers and Capt. George O. Hembrick and Lt. Harold Moore, flying two H-19s nicknamed *Hopalong* and *Whirl-o-Way*, made the first crossing of the Atlantic by helicopter. The crews flew from Westover AFB, Mass., to Prestwick, Scotland, in five stages, covering 3,535 miles in 42 hours, 25 minutes. The H-19/S-55 series was also flown by the US Navy, Marine Corps, Coast Guard (as HRS and HO4S), and Army (H-19D, which carried the official nickname of Chickasaw), as well as 35 other nations. License production took place in Britain, France, and Japan. The H-19s were redesignated UH/HH-19 in 1962 when the Department of Defense standardized the designation system. The last Air Force UH-19s were taken out of service in 1964. *(Specifications for H-19B.)*
Contractor: Sikorsky Aircraft Division of United Aircraft Corp. **Location built:** Bridgeport, Conn. **Number built (USAF):** Approx 1,600, incl civilian models and licensed production overseas (334).

FF: November 10, 1949. **FFM:** S-55. **FFL:** Bridgeport, Conn. **FFP:** Unconfirmed. **Models/variants:** H-19A, B (later redesignated UH-19A, B). SH-19B (later redesignated HH-19B).
Powerplant: One Wright R-1300-3 Cyclone seven-cylinder radial of 700 hp. **Rotor Diameter:** 53 ft 0 in. **Fuselage Length:** 42 ft 3 in. **Height:** 13 ft 4 in. **Weight:** 7,200 lb gross.
Armament: None.
Accommodation: Crew of two (pilot and copilot, side by side) and 10 passengers or six litters. **Cost:** $150,000.
Max. speed: 112 mph. **Range:** 360 mi. **Ceiling:** 15,000 ft.

HH-43 Huskie

The first helicopter purchased by the Air Force specifically for airborne fire-fighting and air base crash rescue. The twin intermeshing, counter-rotating rotors made the Huskie very stable in flight, and in fact, the downwash actually helped suppress fires. The Navy first bought the Huskie (designated HOK-1 for the Marines and HUK-1 for the Navy) as a general-purpose helicopter. The Air Force H-43A could carry only four passengers, as it was powered by a 600-hp engine that occupied a large part of the cabin. However, the smaller, roof-mounted turboshaft on the HH-43B freed up much interior space. Deliveries of the HH-43B began in 1959, and the type was used for base crash rescue for all flying commands. A number of Huskie crews set time-to-climb, altitude, and distance records. A Huskie crew could become airborne in a minute, taking 30 seconds to get airborne and 30 seconds to pick up the fire-suppression kit (foam and water bottle, nitrogen pressure bottle, and hose), and would often beat the fire trucks to a crash scene. In mid-1964, three units were transferred from the Philippines and Okinawa to Southeast Asia for combat rescue. The 33d Air Rescue Squadron assigned to Nakhon Phanom RTAB, Thailand, was the first to begin combat rescue operations, in June 1964. The HH-43F (nicknamed Pedro) featured 800 pounds of titanium armor plating, an uprated engine, and some carried a flexible-mount .30-cal. machine gun for this expanded mission. Most of the B model aircraft were later brought up to HH-43F standard. After the introduction of the Jolly Green Giants (HH-3s), the HH-43s reverted to air base crash rescue duties. HH-43s were also flown by Burma, Colombia, Morocco, Pakistan, Thailand, and Iran. The last of the USAF HH-43s were retired by the early 1970s. *(Specifications for HH-43B.)*
Contractor: Kaman Aircraft Co. **Location built:** Bloomfield, Conn. **Number built (USAF):** 264 (253).
FF: September 27, 1956. **FFM:** Navy HOK. **FFL:** Bloomfield, Conn. **FFP:** Unconfirmed. **Models/variants:** H-43A. HH-43B, F.
Powerplant: One Lycoming T53-L-1B turboshaft of 860 shp. **Rotor Diameter:** 47 ft 0 in. **Fuselage Length:** 25 ft 0 in. **Height:** 15 ft 6 in. **Weight:** 9,150 lb gross.
Armament: None.
Accommodation: Normally four (pilot, copilot, and two fire fighters) or up to 10 passengers or four stretchers with attendants. **Cost:** $304,000.
Max. speed: 120 mph. **Range:** 235 mi. **Ceiling:** 25,700 ft.

CH/HH-3

The CH/HH-3 was a long-range, amphibious transport helicopter that performed a number of duties for the Air Force for more than 30 years. However, the H-3's most prominent role was combat rescue in Southeast Asia. Developed as a US Navy antisubmarine warfare platform, the H-3 was first used to fill an Air Force requirement for a support aircraft for its Texas Tower radar sites located in the Atlantic and to recover drones in the Gulf of Mexico. These six CH-3Bs were virtually identical to the Navy's Sea Kings. The first USAF-specific version was the CH-3C, which featured a redesigned fuselage, a rear cargo ramp, and tricycle landing gear and was first flown on June 17, 1963. The first CH-3Cs were sent to Vietnam in 1965, primarily for clandestine missions along the Ho Chi Minh Trail. The definitive Air Force version was the CH/HH-3E, which featured an uprated engine, more than 1,000 pounds of titanium armor, additional tankage, and an in-flight refueling boom. Eventually, all CH/HH-3Cs were brought up to this standard. The HH-3Es, universally known as Jolly Green Giants because of their green-and-tan camouflage schemes, were used on 496 of the 980 aircrew rescues made between 1966 and 1970 in Southeast Asia. On May 31–June 1, 1967, two Air Force crews flying HH-3Es made the first nonstop flight across the Atlantic by helicopter. The 4,271-mile flight took 30 hours, 46 minutes and required nine in-flight refuelings. Lt. Col. Herbert E. Zehnder, the pilot on one of the HH-3Es on the transatlantic flight, flew that same aircraft in the raid on the Son Tay prisoner of war camp near Hanoi on November 20–21, 1970. The Jolly Greens had some limitations and were mostly replaced by the HH-53. The CH/HH-3s continued to serve in ANG and AFRES and with Air Force Special Operations Forces into the 1990s. One Reserve HH-3 unit served in Operation Desert Storm. All the HH-3s were retired by 1995. *(Specifications for CH-3E, except as noted.)*
Contractor: Sikorsky Aircraft of United Technologies. **Location built:** Stratford, Conn. **Number built (USAF):** Approx 825, incl civilian models and license production overseas (134).
FF: March 11, 1959. **FFM:** XHSS-2. **FFL:** Stratford, Conn. **FFP:** Unconfirmed. **Models/variants:** CH-3B, C, E. HH-3C, E.
Powerplant: Two General Electric T58-GE-5 turboshafts of 1,500 shp each. **Rotor Diameter:** 62 ft 0 in. **Fuselage Length:** 57 ft 3 in. **Height:** 18 ft 1 in. **Weight:** 22,050 lb gross.
Armament: Up to three .50-cal. machine guns or three 7.62-mm M60 Miniguns (HH-3C/E only).
Accommodation: Crew of two or three (pilot, copilot, and flight engineer/loadmaster) normally, plus gunners and pararescuemen as necessary (HH-3C/E only), plus 25 troops or 15 litters or 5,000 lb of cargo. **Cost:** $796,000.
Max. speed: 162 mph. **Range:** 465 mi on internal fuel, 779 mi with external tanks. **Ceiling:** 11,100 ft.

Strategic & Tactical Missiles

Kettering Aerial Torpedo

Designed by Dayton, Ohio, native and engineering genius Charles Kettering (who sat on the board of directors of the Dayton-Wright Co.), the Kettering Aerial Torpedo was the world's first guided missile and a precursor to today's cruise missiles. Nicknamed "Bug," the aerial torpedo was launched from a dolly running down a track pointed precisely in the direction of the target. With a fuselage made of wood laminate and papier-mâché, the Bug was guided to the target by a system of internal preset vacuum-pneumatic and electrical controls. After a preset length of time, an electrical circuit would close and shut down the engine. The wings would then be released, and the fuselage and warhead would fall on the target. Initial tests were successful, but World War I ended before the Bug could be used in combat. After the war, the Air Service conducted additional tests, but the lack of funds in the 1920s halted development. A reproduction of the Bug now hangs in the US Air Force Museum at Wright-Patterson AFB, Ohio.
Contractor: Dayton-Wright Co. **Location built:** Dayton, Ohio. **Number built (USAF):** Approx 50 (approx 50).
First Launch: October 2, 1918. **FFM:** Kettering Aerial Torpedo. **FFL:** Dayton, Ohio. **Models/variants:** Kettering Aerial Torpedo.
Powerplant: One DePalma V-4 of 40 hp.
Wingspan: 14 ft 11½ in. **Length:** 12 ft 6 in. **Height:** 4 ft 8 in. **Weight:** 530 lb gross. **Warhead:** 180 lb high explosive. **Cost:** Approx $400.
Max. speed: 120 mph. **Range:** 75 mi. **Ceiling:** Approx 300 ft.

TM-61 Matador

The TM-61 was the Air Force's first modern mobile, short-range, surface-to-surface tactical missile. The Air Force officially characterized all of the early missiles as types of aircraft, so Matador, as a point-to-point delivery system (or "pilotless bomber"), was originally designated B-61. However, the tremendous differences in maintenance and operations between bomber aircraft and missiles led to Matador's being redesignated TM-61, for "tactical missile," but keeping the bomber mission design series number. Development began in 1946. The Matador was launched from a 40-ft-long trailer, and the rocket booster would be jettisoned after liftoff. The missile would continue on with its jet engine. The missile was controlled from the ground station. Once at its target, the missile would begin a terminal dive. The first Pilotless Bomb Squadron (Light) was organized at Patrick AFB, Fla., in October 1951 for testing the new weapon and to train launch crews. In March 1954, the first two operational Matador units were deployed to West Germany to bolster NATO forces. Two other units were sent to South Korea and Taiwan. The 1,000th missile was delivered in 1957, but phaseout of the Matador began in 1959 when it was replaced by the more advanced TM-76 Mace missile. *(Specifications for TM-61A.)*
Contractor: Glenn L. Martin Co. **Location built:** Middle River, Md. **Number built (USAF):** More than 1,000 (more than 1,000).
FF: January 19, 1949. **FFM:** XB-61. **FFL:** Holloman AFB, N. M. **Models/variants:** TM-61A, B, C.
Powerplant: One Allison J33-A-37 turbojet of 5,200 lb thrust, plus one Aerojet solid fuel rocket booster of 57,000 lb thrust for zero-length launch.
Wingspan: 27 ft 11½ in. **Length:** 39 ft 8 in. **Height:** 9 ft 8 in. **Weight:** 13,593 lb gross at launch.
Armament: One 3,000-lb high-explosive conventional warhead or one W-5 nuclear warhead of approx 81 kilotons or one chemical or biological warhead. **Cost:** $132,000.
Max. speed: 600 mph (supersonic during terminal dive). **Range:** 690 mi. **Ceiling:** 44,000 ft.

CIM-10 BOMARC

The CIM-10 was designed as a supersonic, ground-launched missile to intercept large formations of bombers or incoming missiles. Its unusual name came from the two organizations that developed the system, Boeing for the missile (BO) and the University of Michigan's Michigan Aeronautical Research Center (MARC) for the aircraft warning system that linked the launch bases. The Air Force officially characterized all of the early missiles as types of aircraft, so BOMARC, as an interceptor, was originally designated F-99. However, the tremendous differences in maintenance and operations between fighter aircraft and missiles led to BOMARC's being redesignated IM-99, for "intercept missile," but keeping the fighter-mission design series number. The final redesignation came as the Pentagon added a third letter to the missile series to indicate how the weapons were launched, in this case in a reinforced concrete coffin with a rollback roof. At launch, the roof would roll back, and the missile would be raised to a vertical position and then launched. At launch, the rocket motor would propel the missile to a sufficient speed for the ramjet to operate. The missile was then guided to the vicinity of the target by ground control, where its internal seeker would then take over and guide BOMARC to the target. The CIM-10A was declared operational in 1960. On March 3, 1961, in a full-range operational test, a pair of BOMARCs with conventional warheads were launched from Eglin AFB, Fla., and intercepted both a supersonic GQM-15 Regulus II drone and a subsonic, radio-controlled QB-47 over the Gulf of Mexico. The improved CIM-10B became operational in 1961. By 1969, CIM-10Bs were operational at six Air Force bases in the US and two sites in Canada. Some BOMARCs were modified and flown as supersonic targets and were designated CQM-10Bs. The CIM-10 was phased out of service in October 1972. *(Specifications for CIM-10A, except as noted.)*
Contractor: Boeing Aircraft Co. **Location built:** Seattle, Wash. **Number built (USAF):** Approx 700, incl test rounds (approx 700, incl test rounds).
FF: February 24, 1955 (first fully instrumented flight). **FFM:** XF-99. **FFL:** Patrick AFB, Fla. **Models/variants:** IM-99A, B (later redesignated CIM-10A, B).
Powerplant: One Aerojet General LR59-AG-13 liquid fuel rocket of 35,875 lb thrust and two Marquardt RJ43-MA-3 ramjets of 1,408 lb thrust each (CIM-10A). One Thiokol solid fuel rocket of approx 50,000 lb thrust and two Marquardt RJ43-MA-7 ramjets of 6,000 lb thrust (unconfirmed) each (CIM-10B).
Wingspan: 18 ft 2 in. **Length:** 46 ft 10 in. **Height:** 10 ft 4 in. **Weight:** 15,619 lb.
Armament: Primarily one W-40 nuclear warhead with a seven- to 10-

kiloton yield; also could be fitted with a conventional warhead. **Cost:** $1.15 million.
Max. speed: 1,975 mph. **Range:** 260 mi. **Ceiling:** 65,000 ft.

HGM-16 Atlas

The first US intercontinental ballistic missile, Atlas was declared operational in 1959 and stood alert for nearly six years. On December 18, 1958, Project Score, an Atlas booster with a communications repeater satellite, was launched into Earth orbit. The satellite carried a Christmas message from President Dwight D. Eisenhower that was broadcast to Earth, which marked the first time a human voice had been heard from space. On May 20, 1960, an Atlas was launched from Cape Canaveral AFS, Fla., that carried a 1.5-ton payload 9,040 miles to the Indian Ocean, the greatest distance ever flown by a US ICBM. The missile found greater fame as an unmanned booster. However, on February 20, 1962, Marine Corps Lt. Col. John H. Glenn, Jr., made the first US orbital space mission when he was launched from Cape Canaveral on an Atlas booster and circled the Earth three times. The three later Mercury missions also used Atlas as a booster. Atlas was also used to launch the Ranger, Surveyor, and Mariner series of interplanetary probes. The stainless-steel structure on the booster was so thin that the tanks had to be pressurized with helium at all times to support the weight of its own skin. *(Specifications for HGM-16E.)*

AIM-4 Falcon with an F-102

Contractor: Astronautics Division of General Dynamics (Convair). **Location built:** San Diego, Calif. **Number built (USAF):** Unconfirmed (126 operational missiles at peak deployment).
FF: June 11, 1957. **FFM:** XSM-65A. **FFL:** Cape Canaveral AFS, Fla. **Models/variants:** SM-65A, B, C, D (later redesignated CGM-16A, B, C, D). CGM-16E. HGM-16F.
Powerplant: One Rocketdyne LR89-NA-3 liquid fuel sustainer engine of 57,000 lb thrust, two Rocketdyne LR105 liquid fuel booster engines of 150,000 lb thrust each, and two Rocketdyne LR101 liquid fuel vernier engines of 1,000 lb thrust each. **Height:** 82 ft 5 in. **Diameter:** 10 ft 0 in. **Weight:** 260,000 lb.
Armament: One Mk. 4 reentry vehicle with a W-38 nuclear warhead with a yield of three to four megatons. **Cost:** $1.7 million.
Max. speed: More than 16,000 mph. **Range:** More than 6,800 mi.
Max. altitude: 640 mi.

LGM-25 Titan

The Air Force's second major intercontinental ballistic missile program. Titan was the tallest ICBM, and the Titan II carried the largest warhead, in terms of physical size and yield, in the US nuclear arsenal. Titan I was operational from 1962 to 1966 at five bases (Lowry AFB, Colo., Ellsworth AFB, S. D., Beale AFB, Calif., Larson AFB, Wash., and Mountain Home AFB, Idaho). The missiles were housed in silos and were raised to the surface to fire, which took an average of 20 minutes. Titan II development began in 1958, and the missile was flight tested in 1961 and entered operational service in 1963. The Titan II featured storable liquid fuel, which reduced reaction time to about one minute. During its terminal dive, the warhead streaked toward the target at more than 15 times the speed of sound. Modified Titan IIs were used as the booster rocket on all of the Gemini manned space missions. Titan IIs were stationed at Davis-Monthan AFB, Ariz., McConnell AFB, Kan., and Little Rock AFB, Ark. On May 5, 1987, the last Titan II was taken off strategic alert at Little Rock. After being retired from service as ICBMs in 1987, 14 Titan IIs were refurbished to provide an expendable space-launch capability. Later developments, Titan III and Titan IV and the Titan 34 family, are still in use as satellite boosters. *(Specifications for LGM-25C, except as noted.)*
Contractor: Martin Co. (later Martin Marietta Aerospace). **Location built:** Denver, Colo. **Number built (USAF):** Unconfirmed (64 operational missiles at peak deployment).
FF: February 6, 1959. **FFM:** XSM-68A. **FFL:** Patrick AFB, Fla. **Models/variants:** SM-68A (later redesignated HGM-25A Titan I). LGM-25B, C Titan II.
Powerplant: First stage: one Aerojet General LR87 storable liquid fuel rocket of 430,000 lb thrust; second stage: one Aerojet General LR91 storable liquid fuel rocket of 100,000 lb thrust. **Height:** 103 ft 0 in. **Diameter:** 10 ft 0 in. **Weight:** 330,000 lb.
Armament: One Mk. 6 reentry vehicle with one W-53 nuclear warhead with a yield of nine megatons. **Cost:** $1.5 million (Titan I).
Max. speed: More than 17,000 mph. **Range:** 6,300 mi. **Ceiling:** 620 mi (Titan I).

AIR-2 Genie

Genie, an air-to-air unguided rocket for use against formations of enemy bombers, became operational in 1957. The weapon remained inert in a nuclear sense until it was armed in the air a few minutes before firing. On July 19, 1957, a Genie was launched from an F-89J, marking the only time in history that an air-to-air rocket with a nuclear warhead was launched and detonated. The test took place at 20,000 ft over the Nevada test site, and the rocket was fired at a point approximately 14,000 ft away. The Genie covered this distance in 4.5 seconds and was detonated by ground command. The Air Force had personnel standing directly under the blast in an attempt to demonstrate that a low-yield nuclear weapon could be used over cities. These people on the ground suffered no immediate ill effects from the experiment. Production of the Genie ended in 1962, and the rocket was phased out of service by 1986. A training version, designated ATR-2A, featured a white-cloud spotting charge instead of a nuclear warhead. These rounds were nicknamed "Ting-a-Lings." Carrier aircraft were F-89J, F-101B, and F-106A.
Contractor: Douglas Aircraft Co. **Location built:** Huntington Beach, Calif. **Number built (USAF):** Several thousand, exact number unconfirmed (all).
FF: 1956. **FFM:** Unconfirmed but possibly XMB-1. **FFL:** Unconfirmed. **Models/variants:** MB-1 (later redesignated AIR-2A).
Powerplant: One Thiokol SR49-TC-1 solid-propellant rocket of more than 36,000 lb thrust. **Length:** 9 ft 7 in. **Diameter:** 1 ft 5.35 in. **Finspan:** 3 ft 3½ in. **Weight:** 820 lb.
Armament: One W-25 nuclear warhead with a yield of approx two kilotons. **Cost:** Unconfirmed.
Max. speed: Approx 1,800 mph. **Range:** 6 mi. **Ceiling:** Limited to carrier aircraft.

AIM-4 Falcon

The Falcon family of missiles was the world's first air-to-air guided weapon to enter operational service. Development began in 1947 under the name Project Dragonfly, and the Falcon was first designated XF-98, as it was a "pilotless interceptor." The Air Force decided to build a fire-control radar first and then build the aircraft and weapons around it. Hughes was also selected to build the radar—the E-9 for the F-89H and the MG-10 for the F-102. The Falcon was first tested in 1954 and became operational in 1955. AIM-4A was radar-guided; AIM-4B was infrared-guided. AIM-4F/G, introduced simultaneously in 1960 to provide reduced susceptibility to enemy countermeasures and higher performance, was the primary armament for F-106. Falcon reached initial operational capability with Air Defense Command in mid-1956. The AIM-4F and G were retired along with the F-106 in 1988. AIM-26 was the nuclear-tipped version, using a similar warhead to the AIR-2A Genie, the major difference being that the nuclear Falcon was guided to a specific target, rather than a general area. *(Specifications for AIM-4F/G.)*
Contractor: Hughes Aircraft Co. **Location built:** Tucson, Ariz. **Number built (USAF):** Approx 60,200 (approx 48,000).
FF: 1954. **FFM:** YGAR-1. **FFL:** Unconfirmed but possibly White Sands Missile Range, N. M. **Models/variants:** GAR-1D (later redesignated AIM-4A) AIM-4B, C, D. AIM-4E, F, G Super Falcon. GAR-11 (later redesignated AIM-26) AIM-26A, B.
Powerplant: One Thiokol M46 two-stage solid propellant rocket motor; first stage of 6,000 lb thrust. **Length:** 7 ft 2 in (AIM-4F); 6 ft 9 in (AIM-4G). **Diameter:** 6½ in. **Finspan:** 2 ft 0 in. **Weight:** 150 lb (AIM-4F); 145 lb (AIM-4G).
Armament: One 40-lb high-explosive conventional warhead (AIM-4F/G) (One W-54 nuclear warhead with a yield in the low kiloton range on AIM-26). **Cost:** Unconfirmed.
Max. speed: Approx 1,500 mph. **Range:** Approx 7 mi. **Ceiling:** Limited to carrier aircraft.

BGM-109 Gryphon

The first Air Force weapon to be eliminated by treaty. Called ground-launched cruise missiles (GLCMs), this version of the Navy's Tomahawk sea-launched cruise missile was a mobile ground-to-ground missile that was developed to modernize NATO's intermediate-range nuclear forces (INF). Its characteristics included a small radar cross section, low-altitude flight profile, and all-weather capabilities. A total of 464 missiles was planned, but deliveries were halted at 19 flights—a flight consisting of four transporter-erector-launchers (TELs), each carrying four missiles (along with four spares), and two launch control centers—with the signing of the INF Treaty with the Soviet Union. Five bases were eventually operational with GLCMs—RAF Greenham Common, UK (established 1983), Comiso AB, Italy, and Florennes AB, Belgium (both 1984), Wueschheim AB, West Germany (1986), and RAF Molesworth, UK (1987). Under the INF Treaty, the first missiles were removed from Europe in September 1988, and the last were removed prior to May 31, 1991. The missiles (sans warheads), TELs, and control centers were flown to the Aerospace Maintenance and Regeneration Center at Davis-Monthan AFB, Ariz., where the missile engines and guidance sets were removed (and actually reused in Navy Tomahawks). The missile bodies were cut into pieces according to strict protocols and with on-site verification by the Soviet officials. The other US missile to be destroyed under the INF Treaty was the Army's Pershing II.
Contractors: Convair Division of General Dynamics Corp. and McDonnell Douglas Astronautics Co. **Location built:** San Diego, Calif., and St. Louis, Mo. **Number built (USAF):** 380 (380).
FF: 1980. **FFM:** BGM-109G. **FFL:** Unconfirmed but most likely the Pacific Missile Range Facility, Calif. **Models/variants:** BGM-109G.
Powerplant: One Williams International/Teledyne CAE F107-WR-400 nonafterburning turbofan engine of 600 lb thrust. One Atlantic Research solid fuel booster of 7,000 lb thrust for launch only.
Wingspan: 8 ft 7 in. **Length:** 20 ft 6 in (with booster). **Diameter:** 1 ft 9 in. **Weight:** 3,250 lb (with booster).
Armament: One W-84 nuclear warhead with a yield between 10 and 50 kilotons. **Cost:** Approx $1 million each.
Max. speed: Approx 500 mph. **Range:** 1,500 mi. **Ceiling:** Missile flew at low altitudes with terrain contour matching and inertial guidance. ■

The goal now at AFSPC is to turn out personnel well-versed in space *and* missiles.

Space Command's New Way of Training

By Suzann Chapman, Associate Editor

When Air Force Space Command was given control of USAF's intercontinental ballistic missile force, it took a logical step and combined the training of ICBMs and space units—the command's two operational elements. The command wants to breed future leaders who have experience in both missions.

Once a new officer completes the 10-week basic course in space and missile operations, he or she is permitted to choose from a list of available assignments, based on class standing. When the choice has been made, the new officer goes through more intensive initial training in missile operations, satellite operations, or space surveillance.

Lt. Col. Terence Tallent is deputy commander of the 381st Space and Missile Training Group, Vandenberg AFB, Calif., which handles AFSPC training. Getting experience in space and missile functions, he said, "is very much the way to go now." He added, "As a matter of fact, in just a short number of years, we hopefully won't have 'missile officers' or 'space officers.' They will be 'space and missile.' "

Vandenberg is now the home of all Initial Qualification Training (IQT) and recurrent training for space and missile functions for both officers and enlisted members.

Air Education and Training Command oversees and conducts this training, as it does with the Air Force's aviation elements. AETC's 381st Space and Missile Training Group comprises four separate training squadrons. They cover missile operations (392d Training Squadron), ballistic and cruise missile maintenance (532d TRS), space surveillance

Staff photo by Guy Aceto

Though space is a growth field in the Air Force and the end of the Cold War reduced the emphasis on strategic missiles, many graduates still choose to enter the missile field after completing Undergraduate Space and Missile Training.

and missile warning (533d TRS), and satellite operations (534th TRS).

The Basic Course

In addition to giving instruction in basic missile operations, the 392d TRS is also the first stop for all officers joining the AFSPC work force. The squadron teaches the 10-week introduction to space and missile operations, called Undergraduate Space and Missile Training (USMT).

The course is designed to give new officers a foundation in AFSPC's entire mission. All brand-new accessions—second lieutenants and occasionally a first lieutenant or captain—go through the USMT program at the 392d TRS.

In 1993, AFSPC took over the nuclear missile mission from Air Combat Command. Brig. Gen. (Maj. Gen. selectee) Gerald F. Perryman, Jr., now the director of Operations at AFSPC, was a missile operations division chief at ACC. He said that he got the chance to work the change-over and bring space and missiles "together as one team," at least the officer portion.

"I sat down with [AFSPC] folks at Keesler [AFB, Miss.], and . . . one of the earliest things we did was come up with the idea for a common basic training, which turned out to be USMT, from which weapon system–specific courses would flow," General Perryman said. "Our superiors bought the concept."

Before that time, USAF had conducted undergraduate space training at Lowry AFB, Colo., and undergraduate ICBM training at Vandenberg, which had both ICBM launch facilities and space-launch facilities. Lowry's training functions were relocated after it was added to the base closure lists.

The USMT course is basic but not a breeze. Competition among students is rigorous, especially since AFSPC launched its merit assignment program in October 1995.

"Merit assignments are something the flying portion of our Air Force has been doing for some time," said General Perryman. He said that students get their choice—consistent with the needs of the Air Force—based on their class standing. About two weeks before graduation from USMT, the students have the opportunity to look at the Air Force's needs and their own ranking. Then, the General said, "assignments are made in an open forum."

"What that does is cause the students to pay attention—causing them to work harder," he said.

Gen. Joseph W. Ashy, USAF (Ret.), former AFSPC commander, initiated the merit approach, contending it was one more way to emphasize the operational nature of the command.

General Perryman observed that the top graduates do not always opt for sunny climates or beautiful vistas. "You'll find that some of the missile bases [on the US high plains] and places like Thule [AB, Greenland, for space surveillance] have drawn the top grad" over the years.

A Good First Step

Though space is a growth field, USMT students do not automatically choose space jobs. The end of the Cold War reduced the emphasis on the Air Force's strategic nuclear missile force, but many graduates still see the missile field as a good first step. About two-thirds of the available jobs are in missiles and a third are in space.

General Perryman acknowledged that the top graduates typically go off to the space side. However, he said, future leaders must be familiar with both missions. "We tell them that, to be a leader in this organization, [they] should have experience in both the space operations portion and missile operations portion of the field."

In fact, the command encourages its officers to change from missile to space and vice versa, in what it terms "interflow." The General said that, while interflow is not mandatory, "we continue to look and continue to make adjustments to the program to make sure that we do grow enough of these folks to be leaders in the future."

He emphasized that, when young officers are competing for jobs, the additional experience is valuable. If two contestants are equal in everything else, a broader background, with both space and missile jobs, could be the deciding factor.

After serving an initial assignment in either missiles or space, an officer can apply for a job in the other function. If selected, he or she would then go back to Vandenberg for IQT in the new function.

First, they would return to the 392d TRS for a four-week bridge course that provides basic training in either the space or missile environments. Following that, the officer would go through IQT for a particular system. The IQT is the same whether the officer is on an initial assignment or coming in to interflow.

After completing IQT, which lasts about four months, the officer is classified as "near mission ready." Officers typically need about one month after reaching their first assignment to get acclimated to their unit's procedures.

According to Colonel Tallent, "mission ready" status for both officers and enlisted members trained at Vandenberg depends on the equipment the group has on hand. The 381st is working with AFSPC to get all the current equipment used in the field to "bring the people as near mission ready as we can."

At the 392d TRS during IQT for missile operations, students train on a Rapid Execution and Combat Targeting console similar to ones used in the field. It is slightly smaller than the actual REACT station, which provides side-by-side seating for two missile launch officers—a commander and deputy. Students take 25 six-hour rides over a four-month period in the REACT capsule, putting their academics into practice.

The 533d TRS conducts IQT for officers and enlisted members going into space surveillance and missile warning on basically the same type of computer and communications setup as in the field. One real difference: The unit uses its computer technicians to simulate contact with US Space Command units at Cheyenne Mountain AS, Colo., when a student works through a missile warning scenario.

Similarly in the 534th TRS—the satellite operations IQT unit—the computer consoles are like those used by the satellite operations squadrons at Falcon AFB, Colo. It is realistic down to a second—or in some cases a third—student sitting at identical consoles and keyboards who will verify all satellite commands before the first student enters them on his or her keyboard.

Side by Side

On the space side, enlisted members train with officers, much as they will work once they complete training. Several years ago, AFSPC realized that many of the space functions performed by engineers no longer required such expertise and that it did not require officers to perform what had become fairly routine tasks.

Now the command typically has a space crew of enlisted members commanded by a junior officer. General Perryman noted that enlisted crew members do fine work. "Twice a month," he said, "I get to go out and be a crew member, and I sit with people who really understand how the satellites work, how ground systems and communications systems work, and how we can support warfighters around the world."

The 532d TRS instructs all enlisted missile maintainers, whether for ICBMS or cruise missiles. The maintainers take a three-month electronic principles course at Lackland AFB, Tex., after completing basic training. They then come to Vandenberg where they learn how to run diagnostic checks and to take out and repair the engine and the guidance unit on their assigned missile. Those who will work on the Advanced Cruise Missile even learn how to repair the weapon's stealthy coating.

Enlisted members usually remain with the same system throughout their careers. However, it is possible for those in some specialties to cross over to others. For instance, some cruise missile maintainers make the transition to ICBMs, while some ICBM maintainers go to spacelift vehicles.

Vandenberg is in the process of converting its Launch Facility 08 to an enlisted missile-training facility. Colonel Tallent said once that is completed, the 532d will be able to certify maintainers on more tasks, getting them closer to mission ready before they go into the field.

On to the Weapons School

In June 1996, the Air Force incorporated AFSPC's Space Tactics School into the space division at the USAF Weapons School at Nellis AFB, Nev. Space Tactics had been part of the Space Warfare Center, located at Falcon AFB.

By combining the course with its Weapons School, the Air Force has taken another step to normalize space, emphasizing the growing convergence of air and space assets.

General Perryman said that people who work with spacepower must understand airpower, and vice versa. "To give [a theater commander in chief] really good support, we need to know what he's looking for, we need to be schooled in his problems—and we need to be schooled in the other systems he would employ," said the General. "[He], too, needs to be schooled in what we are all about and what we can bring to the battle."

The graduate course in space tactics accepts eight students per class twice a year. Graduates receive a weapons-coded prefix on their Air Force Specialty Code and are sent to W-coded assignments normally at operational jobs other than in space.

The placement of the space tactics division at the Weapons School permits airpower students to get acquainted with spacepower, an attractive proposition for the Air Force, said General Perryman. "If we're truly going to be an air- and spacepower force, we need to have young men and women who understand both aspects of our work." ■

AFSPC encourages its troops to move from space to missiles and vice versa in a process known as "interflow." A broad background in both disciplines can help advance the careers of both officers and enlisted personnel.

The Khobar Towers bombing demonstrated that for some adversaries, terrorism will be a preferred form of warfare.

TERRORISM and the Force

By Bill Gertz

THE Khobar Towers bombing in Saudi Arabia not only left 19 airmen dead and 500 wounded but also exposed a new fact of life for American forces: Forward-deployed combat units face a long-term, lethal threat from the modern breed of international terrorist.

Gen. John M. Shalikashvili, Chairman of the Joint Chiefs of Staff, said that the Khobar bombers had "a much higher degree of sophistication" than anyone expected, likely had foreign support, and were well trained and equipped. He warned that similar attacks by such terrorists will recur and that not all can be thwarted.

"The question," he contended, "is not whether another Khobar Towers will occur but when another Khobar Towers will occur."

Against this background, some senior officers have begun looking at terrorism in a new way—as deeds having real military significance, not just political impact. General Shalikashvili, for one, now refers to terrorism as "warfare," especially when used by rogue states against US forces.

"Terrorism . . . is a very effective tool for [outlaw nations] to use," he said. "For some groups and for some nations, this is now the preferred form of warfare against the United States."

Gen. Wayne A. Downing, the retired Army officer who led DoD's investigation of the Khobar bombing, was even more explicit in his claim that terrorism has acquired military value for the rogues. "It is their strategic weapon," he declared. "It is their force-projection capability." General Downing suggests that such terror attacks should be formally viewed as acts of war.

Secretary of Defense William J. Perry, who announced his resignation in December 1996, regarded the Khobar bombing and an earlier strike in Riyadh as attacks not only on US citizens but also on the US security strategy in the region. He maintained that the goal of nations like Iran and of local Saudi dissidents, who carried out the attacks, is to drive out the US military presence. "Terrorists normally prey on the weak," he noted, "but even militaries have vulnerabilities and present targets with high publicity value."

No More Taboos

Recently retired Sen. Sam Nunn, the Georgia Democrat who formerly chaired the Senate Armed Services Committee, noted that for decades terrorists were interested only in making political statements or drawing attention to a cause by carrying out small-scale acts of violence—assassinations, kidnappings, hijackings, and the like. Terrorists, he said, were eager to win over public opinion and viewed certain acts—use of chemical weapons, for example—as taboo. In Senator Nunn's view, everything changed in the 1990s and terrorists now seem bent on creating maximum casualties, especially among US forces.

The October 1983 suicide terrorist attack that killed 241 US servicemen in Beirut still ranks as the largest single act of terror to hit US

forces. However, the US contingent in Lebanon had an ill-defined peacekeeping mission and was lightly defended, and the attack was mounted to dramatize a political grievance. In contrast, the Khobar terrorists executed a sophisticated truck-bomb attack against a major US combat contingent, penetrating its defenses and bypassing concrete barriers erected 80 feet from the high-rise residential unit. The target—Operation Southern Watch—was military.

US leaders warn that the future may bring even deadlier attacks with unconventional weapons, from nerve gas and biological warfare agents to infectious diseases, radiological material, and even nuclear weapons. In fact, Secretary Perry said that he received a stack of intelligence reports every week on threats to US forces in the Middle East, including threats to use chemical and biological mortar attacks and large vehicle bombs.

"The threats—chemical, biological, very large truck bombs—are feasible," said the Pentagon chief. "Some people say this is worst-case planning, but I believe we have to be prepared for more attacks on our forces, not just in Saudi Arabia but all over the Gulf region—Saudi Arabia, Kuwait, Qatar, Bahrain. . . . We are going to prepare for a very intense threat."

With good reason. In recent years, as the US and other target nations have developed protective measures to thwart bombings and attacks, the most advanced terrorists have been busy devising new and more effective means to defeat them.

The terrorists operating in the Middle East and Persian Gulf region today "are much, much more sophisticated in terms of organization, technical skills, and bomb-making abilities," General Downing noted. "It used to be people were making very, very crude bombs, and now the bombs are extremely sophisticated—ingenious in some cases."

Impressive Work

In the Khobar Towers bombing, a gasoline truck filled with up to 8,000 pounds of high-explosive was lit off with a military-grade triggering device. Even more impressive than the advanced nature of the device was the planning required to mount such an attack in the tightly policed Saudi kingdom. "Smuggling that size explosive is not easy," said General Downing. He added that the bombers picked out the "perfect, vulnerable place" to focus their bloody assault.

According to Secretary Perry, the Khobar terrorists showed they were capable of "clandestinely accumulating and employing a large supply of explosive materials, developing sophisticated intelligence, maintaining tight operational security, and penetrating the extensive Saudi domestic security apparatus and the measures we had taken for force protection."

The most deadly form of terrorism today generally entails state sponsorship. Rogue nations, such as Iran, Iraq, Syria, and Libya, have been in the forefront of such activity, supplying the weapon materials, safe havens, training, and often inspiration and guidance for terror operations.

Today, a new threat has emerged from a shadowy network of Islamic fundamentalists in the Middle East, many of them battle-hardened *mujahedeen* fighters who spent long years fighting in Afghanistan, first against

the Soviet Union and then against secular Afghan leaders. US officials said the radicals are united in their extremism and exchange information regularly.

"These terrorists can communicate rapidly," said John P. O'Neill, chief of the FBI's counterterrorism section. "We have found that the vast majority of them now have cell phones, they use fax machines, they are on the Internet, and they have laptop computer capability. Some of them even have encrypted laptop computer capability."

The Khobar bombing was a shock to the American system, and it caused the Pentagon to set in motion a major new effort to combat terrorism worldwide, though its prime focus is the Gulf region. In the wake of the bombing, General Shalikashvili was designated as the central figure and chief advisor on protecting US forces against terrorism. In October, the Joint Staff created a new position—director for Combating Terrorism—headed by Brig. Gen. James Conway, USMC.

Today, the US has 15,000 military personnel in the Persian Gulf region, with about 5,000 of that number in Saudi Arabia. These troops remain on the highest state of alert in anticipation that terrorists will attempt to strike again. Former Secretary Perry directed US forces to maintain the high security level, which he described as an "attack is imminent" posture.

In Europe, US forces have decades of experience in dealing with terrorism, a result of leftist bombings and assassinations of the 1970s and 1980s. The large number of US forces in the Pacific region operate in what General Downing describes as a "placid lake" of stability, but they too are vulnerable, officers said. They point out that, during the 1991 Gulf War, Iraq attempted two terrorist actions against American forces in the Pacific—one in Manila and one in Jakarta.

Under the guidance of US Central Command, military units in the Middle East took immediate steps to prevent another Khobar-type bombing by tightening their security efforts. The US also seeks to develop new technologies, techniques, and training to avert similar disasters.

Wholesale Relocation

That bombing prompted security improvements at all Saudi bases. In addition, DoD launched a major force relocation effort that resulted in the rapid building of a new central air base at Al Kharj, located well away from Saudi cities in a remote part of the Arabian desert. *[See "Miracle in the Desert," January 1997, p. 60.]* American forces based in Riyadh also were moved to more secure facilities at Eskan Village.

In Kuwait, Air Force personnel in exposed positions were moved onto the Ali Al Salem AB. In the United Arab Emirates, Air Force personnel living in an urban hotel were relocated to a UAE air base that provided better force protection.

That was only the beginning. Secretary Perry ordered all commanders worldwide to reexamine force protection in light of what he termed, in a memorandum to the commanders, a "rapidly escalating" terror threat to US forces. The Secretary's order called on all commanders to question whether troops should remain in their existing locations or be moved away from urban areas. Also given scrutiny was the status of military dependents and whether they should be withdrawn, as many were from Saudi Arabia. Finally, commanders were asked to assess the focus of the nation's intelligence-collection effort to address the terrorist threat.

The Secretary also sought to have commanders examine how the military commands can work more effectively with host nations to protect US forces. As part of a force-protection policy put in place after the review, the commanders in chief recommended making the location of forces the critical factor in all force-protection planning. Antiterrorism training and intelligence sharing also will be stepped up.

General Downing surveyed US operating bases throughout the area and found security of Army and Navy units in high-threat areas to be adequate. He said that, for the Air Force, the Khobar attack "has been a big wake-up call." Yet he defended the Air Force's security operations in Saudi Arabia, noting that the local environment traditionally had been free of terrorist activity. In those circumstances, he said, "It's just hard to change your mindset." Others had pointed out that Air Force units dispatched on long-running "temporary" deployments, such as Operation Southern Watch, have not been provided the forces and systems needed for extremely tight security.

US military leaders have declared their intent to tap all sources for antiterrorist expertise. Britain and Israel, they said, are the world leaders in countering terrorism because of their respective experience with Irish militants and with Middle Eastern and Islamic terrorists. General Shalikashvili called on the US defense community to look to these nations for expertise in providing better protection for US forces.

Staff photo by Guy Aceto

USAF Security Police are on duty 24 hours a day in the Middle East, many of them teamed with bomb-sniffing dogs. Since the Khobar Towers bombing, US forces in the Middle East have assumed an "attack is imminent" posture.

Needed: New Tools

"Why is it that this great nation, that can build B-2s, the best submarines, . . . has to use a highway divider to put around buildings as the most advanced, most sophisticated piece of blast-deflection equipment that our industry can produce?" General Shalikashvili asked. He called for a major defense industry effort to develop better counterterrorism and security tools.

Pentagon officials noted that, for each tank that it produces, the Army allocates $1.2 million to install protection for the four-man crew and that the Air Force incorporates more than $1 million worth of protective devices in each F-16. Yet at Khobar Towers, according to General Shalikashvili, the officers in charge would not spend money to put antiblast film on windows.

"We are going to have to do things differently," he said.

More and better technological advances are needed to protect US forces, the General said. These include simple items, such as electronic alarms and seismic sensors, that can warn people of imminent attacks or detect terrorists' movements.

General Downing, in his report on the Khobar Towers bombing, took note of the relatively low-technology counterterrorism tools that were in use: concrete Jersey barriers and guards posted on rooftops using binoculars, often in 125° heat. "Compare that to what the British do," General Downing said, noting that, at one British base, a complete sensor system was installed to provide advance warning of terrorists or other intruders.

The Israelis are experts at hardening facilities against terrorist bombs and constructing new buildings that use antiterrorism security features, according to General Downing.

"We need to get with them and talk and see what they are doing and adopt those kinds of things that are relevant to us," General Downing said, adding that the military is beginning to make some security improvements since the Khobar bombing.

He favors dealing with terrorism as a form of warfare against the US, rather than as a particularly bloody form of crime. Only then, said the General, will Washington be in a position to deal seriously with the problem.

Staff photo by Guy Aceto

The Air Force is looking at both low-technology methods, such as erecting earthen berms, and high-technology methods, such as electronic alarms and seismic sensors, to thwart the more sophisticated terrorists around the world.

"If you consider the terrorist act an act of war against you, then you have a tremendous range of options available to you," said General Downing, a former commander in chief of US Special Operations Command. "To defeat terrorism, to keep it under control, we need to bring the power of the US government to bear—all agencies."

In his report, General Downing noted that timely and accurate intelligence is crucial. However, he said, intelligence-gathering efforts against terrorists have been hamstrung by recent restrictions that limit CIA field officers' ability to recruit unsavory characters with access to terrorists groups, or who are members of such groups. Most experts agree that intelligence penetration is the key to thwarting terrorists before they can strike. Planting spies within the groups has proved difficult but not impossible.

Intelligence analysis—the timely and accurate interpretation of raw intelligence "take"—is also vital. General Shalikashvili said DoD already has increased the number of analysts working in antiterrorism cells at every level from the Pentagon down to the Joint Task Force. Most of these cells are on a 24-hour watch.

"Terrorists will always search out and strike at the weakest link in our chain of defenses," Secretary Perry said. "Our goal is to find and strengthen those weak spots, and we are doing just that."

Even so, the Secretary warned that there will be future terrorist acts against US military forces, and some will result in tragic consequences because "no force-protection approach can be perfect."

Everyone acknowledges that the stakes are high. "Terrorism represents an undeclared war against the United States," General Downing said. "The military forces of this country are currently and clearly superior to all others in the world. Convinced of the futility of challenging our forces directly, some enemies are waging war against us asymmetrically. They use terrorism.

"Some of these enemies feel our greatest vulnerability is our intolerance for casualties. If we prove ourselves incapable of responding to terrorism, the terrorists will continue to represent a significant threat to us, especially to our servicemen and -women deployed overseas." ■

Bill Gertz covers national security affairs and defense for the Washington Times. *His most recent article for* Air Force *Magazine, "Miracle in the Desert," appeared in the January 1997 issue.*

By the time World War II ended, it was clear that the future of military aircraft lay with jet engines.

The Jet Age in Review

By Peter Grier

CLIFF Simpson thought that the prevailing wisdom about aircraft engine design was wrong. It was the early 1950s, a time of great ferment in aircraft development in general and jet propulsion systems in particular. Engineers around the world were tinkering with the technology of the turbofan—a new type of efficient jet that pumped a stream of cold "bypass" air around the engine's core turbine and combustion chamber.

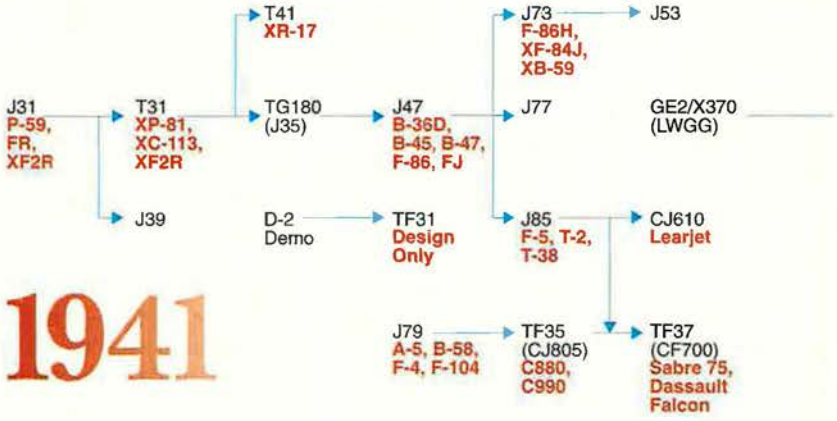
At the time, most propulsion scientists believed that the size of this bypass flow had to remain quite modest. They thought that building so-called "high-bypass" engines—where the amount of diverted cold air was 12 or even 15 times greater than the hot central exhaust—would be too hard to do. Inlet fans would be dauntingly large, for one thing. Airplanes capable of carrying the weight of such an engine might have to be huge.

One who was not convinced, however, was Ernest C. "Cliff" Simpson, a key member of the US Air Force's gas-turbine research and development team. He thought that the high-bypass engine was not only possible but also practical and probably es-

General Electric Turbine Engine Family Tree

KEY

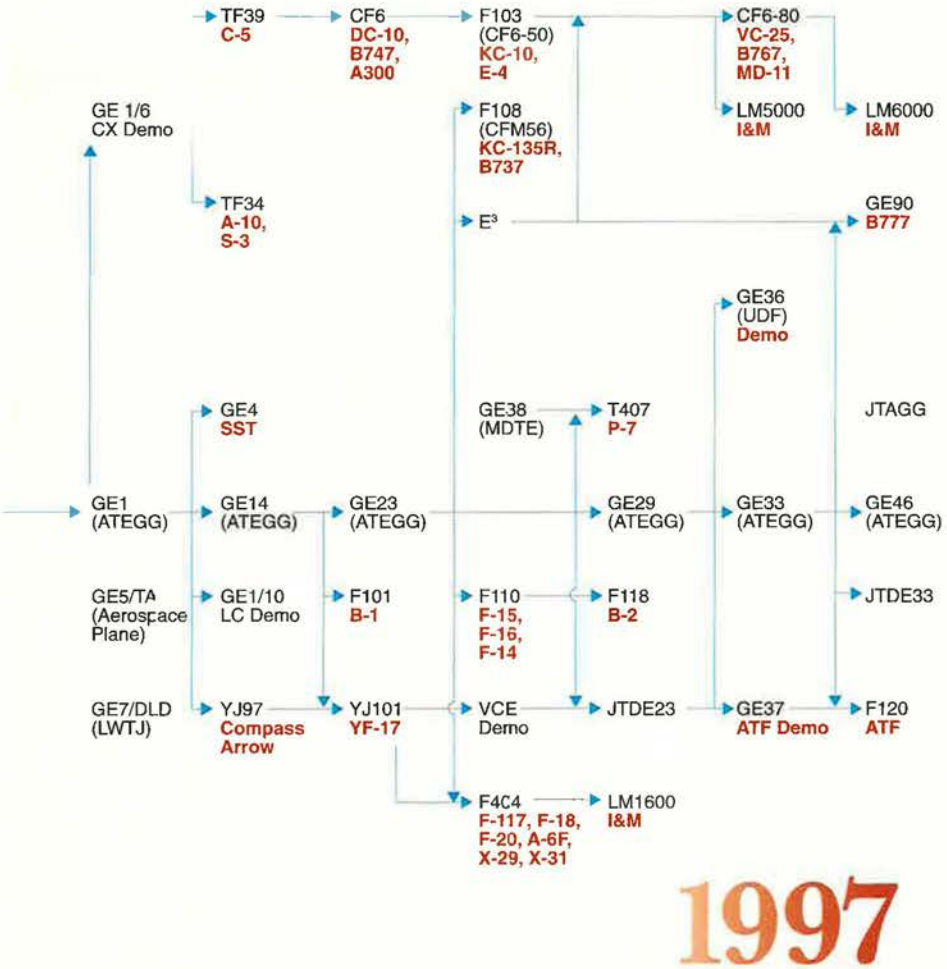
ATEGG	Advanced Turbine Engine Gas Generator
CX	Cargo Experimental
Demo	Demonstrator
I&M	Industrial and Marine
JTAGG	Joint Turbine Advanced Gas Generator
JTDE	Joint Technology Demonstrator Engine
LC	Lift Cruise
LWGG	Lightweight Gas Generator
LWTJ	Lightweight Turbojet
MTDE	Modern Technology Demonstrator Engine



Civil and military engines. Does not include all engines.

The first US jet powerplant—the P-59's J31-GE-5 turbojet—owed much to the research efforts of British propulsion pioneer Frank Whittle.

USAF engine experts and private-sector engine-makers have been focusing on new alloys, thrust-reversing, and fan-blade shapes in an effort to increase performance and reliability while holding the line on cost.



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sential. The engine's increased fuel efficiency, he maintained, might be needed for a coming generation of bigger aircraft.

Mr. Simpson, then a senior staffer in Wright Air Development Center's Power Plant Lab at Wright-Patterson AFB, Ohio, began pushing paper studies of the problem, despite widespread skepticism. Eventually, he conducted a small-scale test that proved a 12 to one high-bypass-ratio engine would indeed work as he predicted. The result: By the early 1960s, Air Force officials had demonstrated that they could build an efficient high-bypass engine that would make their big new C-5 airlifter feasible.

In the end, the engine technology pioneered by Simpson and the labs at Wright-Patterson helped to make possible a whole new type of civilian aircraft: the globe-circling jumbo jet transport.

On the Cutting Edge

This example is just one part of a larger story. From the beginning of the jet age in the years following World War II to today's race for twenty-first-century turbine performance, the Air Force R&D community has been at the cutting edge of turbojet propulsion. In concert with engine contractors, such as Pratt & Whitney and General Electric, to name only the most prominent, USAF

efforts have produced an impressive line of better turbines, improved fan blades, more efficient bearings, and similar advances in materials, components, and technology.

As Simpson noted in 1980 when he retired as chief of the Aero Propulsion Lab Turbine Engine Division, engine research consists of both big leaps—such as high-bypass technology—and inch-by-inch progress. "Turbine engines go in cycles," he said. "We'll get a whole flock of new engines, and then everyone starts to feel the pain. New engines usually have problems. So you work and work and finally get to the bottom of the problem, and someone says, 'We need a new engine.' So it's new engine, old engine, new engine, old engine."

Simpson himself was involved in the development of every major US jet engine of his time, including the C-5's GE TF39 and the F-15's and F-16's Pratt & Whitney F100. At his retirement ceremony, he accurately predicted the direction engine research would take after his departure, through such efforts as today's Integrated High-Performance Turbine Engine Technology initiative.

"It will be in the area of producing a lower-parts-count, lower-cost, reduced-weight engine," he noted. "New engines like that could be operational by the 1990s."

Development of the first practical jet engines began in pre–World War II Europe. In 1928, Englishman Frank A. Whittle published a thesis outlining his proposal for the use of gas turbines in aircraft. In its outline, the basic turbojet idea was a simple one, building on well-known physical principles. First, air would be scooped into a tube-shaped engine. Then it would be compressed by a spinning, fan-like compressor. The pressurized air, passing into a combustion chamber, would be mixed with a spray of fuel and then ignited. The resulting hot air would exit the chamber and pass over the blades of a turbine, which in turn would power the first-stage compressor via a central drive shaft. Exiting the back of the engine, the exhaust would still have enough energy to produce tremendous thrust.

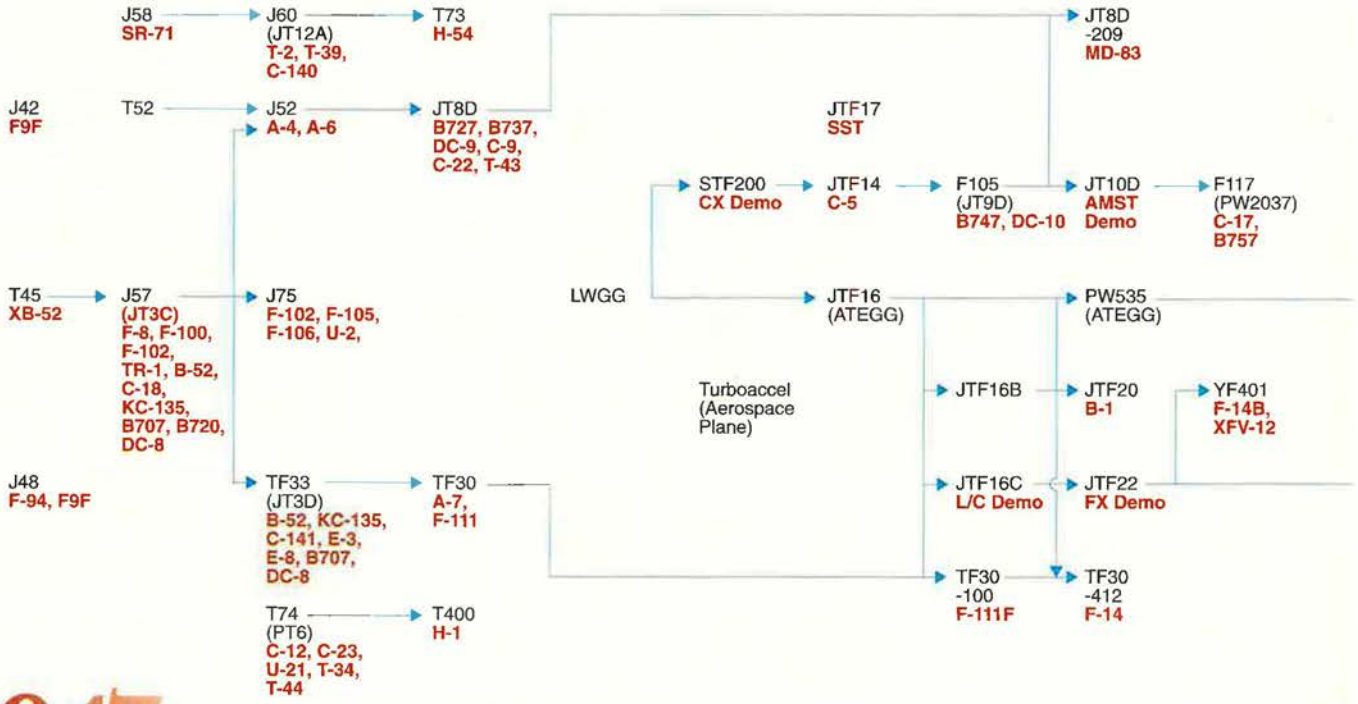
Mr. Whittle took out jet-engine patents in 1930. Meanwhile, a young German engineer named Hans P. von Ohain was proceeding along similar lines. The first flight of a jet-powered aircraft took place in Nazi-ruled Germany, at Rostock, on August 27, 1939. Mr. Von Ohain's He S.3b turbojet performed perfectly, although the landing gear of the Heinkel He 178 aircraft which carried it failed to retract.

Coming to America

Whittle's first engine, the W-1, flew in a Gloster E.28/39 Pioneer at Cranwell, UK, on May 15, 1941. A prototype W-1 was flown to the US in June 1941 and copied by General Electric. Bell Aircraft hurried through an experimental airframe to carry the engine, and on October 1, 1942, a Bell XP-59A made the first jet flight in the US from Muroc Dry Lake, Calif.

The German high command, however, was more interested in rock-

Pratt & Whitney Turbine Engine Family Tree



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etry than in jet engines, even though jet-powered Messerschmitt Me-262 fighters were produced in quantity and appeared in combat near the end of World War II. Britain's Gloster Meteor twin-jet was rolling off factory lines by 1945 but never saw actual combat. A few US jet fighters deployed to Europe for a demonstration, but World War II ended before the aircraft could be employed in combat.

Still, by 1945 it was clear that turbojets would power the next generation of military aircraft. Frank Whittle, appearing as an honored guest at a Wright-Patterson AFB symposium in 1978, recalled the enthusiasm of a top British Air Ministry official after he witnessed a W-1 engine demonstration. "I had a curious experience as I took him back to the station in my car. He was telling me all the advantages of the engine—free of vibrations, run on almost any fuel, this, that, and the other. . . . He was a VIP, so I just said, 'Yes sir, yes sir.' I was really thinking, 'You're telling me?' "

When the war ended, Allied intelligence officers were scouring Germany for scientists whose work had possible military implications. Many were brought to the US and became key players in defense-related American industries. One was Hans von Ohain himself. By the mid-1970s, the co-inventor of the jet engine was the Aero Propulsion Lab's chief scientist. Appearing with Whittle at the 1978 symposium, von Ohain said that, without the pressure and the money stemming from defense needs, progress in jet technology—which by then had revolutionized air travel—would have been greatly slowed.

"Not necessarily the war, but definitely the military" was the force behind the development of the most important aviation technology of the last 50 years, said von Ohain.

One of the first tasks for Air Force and contractor scientists as they planned the initial generation of operational US jet engines was to do all they could to improve fuel consumption and component life span. The demonstration engines produced by Whittle and von Ohain lasted only a few hours, after all. The greatest technical difficulty, at first, was burned-out combustors. Later, the jet-age pioneers were plagued by high-frequency component fatigue and failures of impellers and turbine blades.

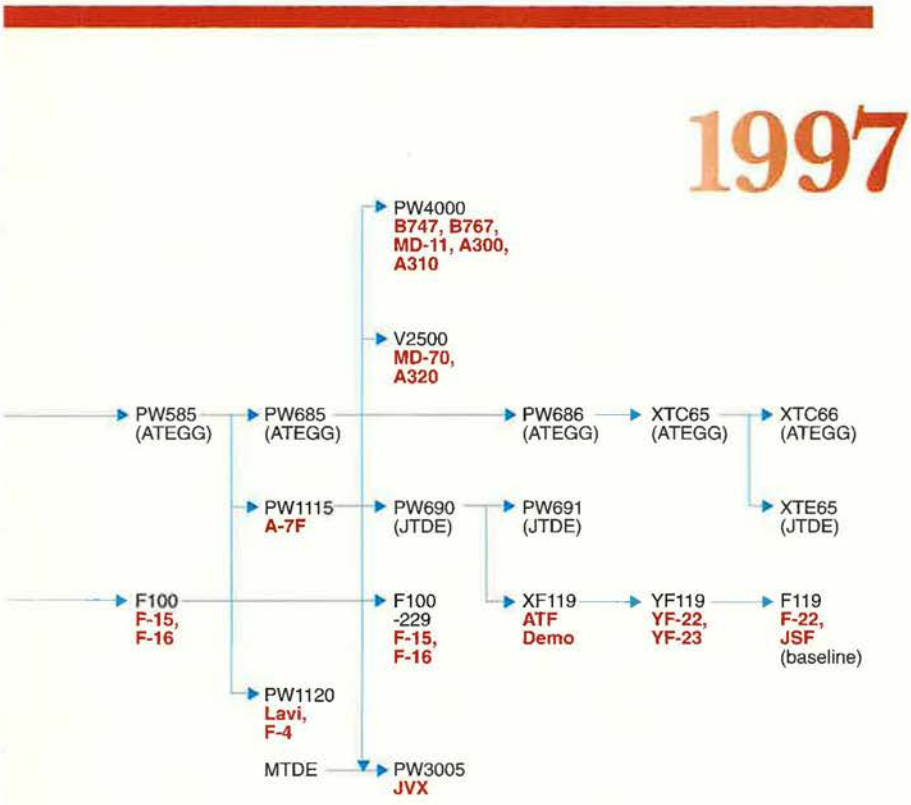
Family Resemblances

Even so, within only a few years, the life span of some turbojets had reached 1,000 hours. The improvement was the result of patient advances in design, materials, and many other technologies. It was a pattern of gradualism that propulsion engineers follow to this day, resulting in "family trees" of engines that can trace their ancestors back through years, if not decades, of models.

"Once you get a compressor proven, then maybe you put on a better combustor," explained Fred Oliver, chief of the Technology Management Division at the Aero Propulsion and Power Directorate of Wright Laboratory. "By the time you've got that down, maybe you improve the turbine. It's like that old story about the 200-year-old hammer whose head has been replaced five times and its handle three times."

The first turbojet engine to be produced in quantity in the US was the GE J31. Derived from Whittle's designs, it powered the pioneering P-59 fighter. Like all early jet engines, it featured a single-stage centrifugal compressor, in which the incoming air was swirled around and thrown out at the compressor blade tips. Centrifugal compressors were rugged and simple, but to obtain the compression necessary for jet propulsion they needed to be fairly large in diameter, which created unwanted drag.

So GE decided to take the J31 and insert an axial-flow compressor, in which air is compressed and pushed straight back, as it is in an electric fan. Axial-flow compressors are more sophisticated and complicated to build than their centrifugal counterparts, but GE engineers knew that the payoff in reduced drag through a narrower profile would be considerable. The result was a milestone in aerospace development: the J35, the first US axial-flow turbojet. Co-produced by Allison, it powered the X-5 series of research aircraft and the F-84 Thunderjet series of fighters.



In the late 1940s, the J35 was refined into the J47, which remains the most-produced US jet engine of all time. More than 30,000 were built before the assembly line shut down in 1956. Aircraft outfitted with J47s ranged from the F-86 to the B-47. A J47 variant was the first axial-flow engine approved for commercial use in the US.

Pratt & Whitney jumped into jet-engine production a few years later than GE. Unlike its competitor, Pratt & Whitney had been busy producing piston-powered aircraft production engines during the war. Furthermore, GE had much more World War II experience with turbosuperchargers. Superchargers are not as complicated as turbojets, but they feature many of the same basic components, such as compressors and turbine assemblies.

At first, P&W built British turbojet designs licensed from Rolls-Royce. Then, in the early 1950s, the firm developed the J57—the first jet engine in the world to produce 10,000 pounds of thrust.

Two Spools

Dual-spool technology was one of the keys to the wasp-waisted J57's power. Other powerplants of the day, in cross section, looked something like a spool of thread, with the fan of the compressor on the front of the combustion chamber and the fan of the turbine mounted on the back. The J57, however, had two compressors, which rotated independently. The first fan in this "dual spool" compressed air sweeping into the inlet; the second compressed it even further, producing higher performance.

The J57 powered the F-8 and F-100 fighters, the KC-135 tanker, and early models of the B-52 bomber, among other American aircraft. Pratt & Whitney was awarded the 1952 Collier Trophy, the nation's highest aviation award, for the engine's design. Eventually, the J57 pointed the way to a whole new class of engine—the turbofan.

The transition went like this: Pratt & Whitney took the first, low-pressure compressor in their two-spool engine (the first stage that air hits) and made its blades much bigger. That let some of the compressor's airstream bypass the engine's central combustion chamber altogether. "All that bypass stream does is produce thrust. That way you can get more thrust without burning more fuel," said Oliver of Wright Laboratory.

Engine designers had long thought that this type of turbofan engine design would show markedly better fuel consumption figures than pure turbojets. Critics had countered that drag from the larger nacelles necessary to house turbofans would offset any fuel gains.

Pratt & Whitney's modification of the J57 into the TF33 turbofan proved the engine designers right. Retrofitted into B-52s, it reduced specific fuel consumption by 19 percent. Gains in commercial applications were even larger.

The next step was determining the optimum size of the bypass stream. Initial studies showed that the amount of air flowing past the combustion chamber should be about 1.5 times the amount of air flowing through it.

But the Aero Propulsion Lab—pushed by Cliff Simpson—thought this bypass ratio should be much, much higher. Their small-scale test proved their case. High-bypass engines would have to burn hundreds of degrees hotter than low-bypass ones, however, so Wright technicians developed advanced cooling techniques that allowed engines, such as the C-5's TF39 turbofan, to operate at temperatures 600° above the point at which its turbines ordinarily would melt.

Both GE and Pratt & Whitney transformed the military high-bypass engine designs into civilian versions for a new generation of wide-body airliners. "Simply put, Air Force technology made these airplanes possible by reducing fuel consumption up to 30 percent, compared to low-bypass engines," concludes an Air Force turbine-engine history.

Secret Weapon

Technology demonstration programs have long been one of the Air Force's secret weapons in the gas-turbine development effort. One of the most successful of these was the Lightweight Gas Generator (LWGG) program, which began in the late 1950s. Focusing on the engine's core turbine and combustion parts—its "gas generator"—this Aero Propulsion Lab–directed effort worked on such evolutionary improvements as new fan-blade shapes. Within three years, the LWGG program showed it was possible to build engine cores with thrust-to-weight ratios of 10 to one, more than double the performance of most large engines of the time.

"LWGG provided a proven [technical] base to help upgrade existing engines," says Fred Oliver.

LWGG advances contributed to the design of an afterburning, low-bypass turbofan with 25,000 pounds of thrust, an engine intended for use in a vertical-takeoff-and-landing fighter. Though the VTOL aircraft itself was never built, some of its engine technology lives on in the powerplants of the F-15 fighter and B-1 bomber.

Eventually, the LWGG program metamorphosed into Wright Lab's long-running Advanced Turbine Engine Gas Generator (ATEGG) program. Over the years, ATEGG has contributed something to just about every US military engine currently in the air, according to the Air Force. The family tree of the F-22's Pratt & Whitney F119 engine reaches back to ATEGG, for instance, via a USAF-Navy Joint Technology Demonstrator Engine program that used ATEGG cores. Among the Aero Propulsion and Power Directorate–developed items in the F119 are turbine disks of advanced nickel alloy, abrasive turbine-blade-tip coatings, and a rectangular thrust-vectoring nozzle.

Today's Integrated High-Performance Turbine Engine Technology program now aims for yet another doubling of powerplant performance. Short, squat, compressor blades with unusual shapes hold out the promise of increasing aerodynamic efficiency, for instance. New materials will likely further reduce engine weight.

"People keep saying, 'What's going to replace the turbine engine?' " says Fred Oliver. "That's being achieved by evolutionary means." ■

Peter Grier, the Washington bureau chief of the Christian Science Monitor, *is a longtime defense correspondent and regular contributor to* Air Force Magazine. *His most recent article, "In the Beginning, There Was ARPANET," appeared in the January 1997 issue.*

He is the twelfth to wear the special stripes of Chief Master Sergeant of the Air Force.

Chief Benken

By CMSgt. Charles Lucas, USAF (Ret.)

USAF photo by MSgt. Joe Juarez

CMSAF Eric W. Benken (right) talks with Security Policemen on temporary duty at Aviano AB, Italy. The troops are in Italy as part of Operation Decisive Edge to implement the peace in Bosnia-Hercegovina, an operation he terms "an outstanding success."

With 26 years of service under his belt, CMSgt. Eric W. Benken was beginning to think that his assignment at Ramstein AB, Germany, as Senior Enlisted Advisor for US Air Forces in Europe, would be the end of his Air Force career. Two years earlier, he had completed an SEA stint for 12th Air Force at Davis-Monthan AFB, Ariz. The only place left to go was the Pentagon.

"To be perfectly honest, it's a place I tried to avoid all those years," said Chief Benken.

However, Gen. Michael E. Ryan, USAFE's commander, had other ideas. When the Air Force last August called for nominees for Chief Master Sergeant of the Air Force, General Ryan told the 45-year-old Benken that he was his choice. A month later, Chief Benken was one of three finalists interviewed at the Pentagon by his soon-to-be new boss, Gen. Ronald R. Fogleman.

In November, the Air Force Chief of Staff administered the oath of office to Benken—as the twelfth CMSAF. He replaced CMSAF David J. Campanale, who retired.

"No job is more important than Chief Master Sergeant of the Air Force," General Fogleman said as the new Chief and his wife, Johnne, and other family members looked on. "The troops depend upon that person in that position to represent them to the senior leadership. That person also has to convey the vision and ideals of the Air Force to the enlisted force."

On that day, Chief Benken recalled a fateful afternoon in Houston, Tex.,

in 1970. He was 18 years old and had been pondering his future for some time. As he and his mother were driving through downtown, traffic was snarled and they came to a halt. A colorful Air Force recruiting poster caught his eye. The young Benken got out of the car, telling his mother he wanted to check something. He returned home with the news that he had enlisted in the Air Force.

The Way Up

"I was 18 years old with no money to go to college," said Chief Benken. "I was working in a low-level job with no skills when I joined the Air Force. It's been a great way of life ever since."

Chief Benken recalls that the aura of the Air Force's top enlisted man made an early impression. "From basic training on, we always knew who the Chief Master Sergeant of the Air Force was, but you didn't really begin to understand their impact until you actually saw one," he said. "My realization came when Tom Barnes [CMSAF, 1973–77] visited Bergstrom AFB, [Tex.,] and addressed us in the base theater."

While impressed with this introduction to the top man, there was never any thought of attaining that position himself. "It was never on my scope, nothing that I had ever aspired to do," Chief Benken said.

Benken was at Bergstrom AFB when he faced his first reenlistment decision. It wasn't much of a hurdle to get over. "I looked around as to what I might do on the outside," he remarked. "I thought Air Force life had been pretty good. I liked the people I was working with. I liked my commander. I had just made staff sergeant, under four, which was a big plus." He signed the papers.

Chief Benken sees the Senior Enlisted Advisor structure as essential. "A lot of times a commander will get caught up in some of the more cosmic things that go on in our Air Force. The advisor can then bring certain morale, health and welfare, and other issues not only to the service members but to their families.

"The enlisted corps constitutes 80 percent of the Air Force, so it is very important that the commanders have that ear to the ground, if you will, as to what's going on. I think we've been very effective so far in bringing those issues to the forefront."

The same week that Chief Benken took the oath of office in the Pentagon, one of his predecessors, retired CMSAF James M. McCoy (1979–81), assumed chairmanship of the Air Force Retiree Council. Heretofore an infrequent subject for the CMSAF, "I can expect to hear a lot on retiree issues now that Jim is in the chair," the Chief said. "He is the first [former] enlisted person to chair the council, and [he is] a solid choice."

Education continues to be a high-priority item for the new CMSAF. While in Europe, Chief Benken helped target funds to improve airman leadership schools. "These mentorship seminars put our senior NCO corps in touch with our midgrade NCOs to help them develop professionally," he said.

The American Edge

"Professional military education [PME] is what sets us apart from other militaries in other countries. In Europe, for instance, military members from other nations would visit our NCO academies and leadership schools to see how they could better their enlisted corps. Right now, they don't have the structure to do so. We would water their eyes every time they would visit one of our academies."

A 1989 graduate of the Air Force Senior NCO Academy at Maxwell AFB, Gunter Annex, Ala., Chief Benken sees a bright future for the institution. "We now have master sergeants going there, and I see nothing but pluses in the months ahead."

His first trip in his new position was to Gunter Annex. Addressing senior NCOs in the academy auditorium, he recalled that he had become an NCO overnight. "One day I was an airman first class and the next day buck sergeant. In those days, there was no PME. There was no formal way of giving you the tools to become a noncommissioned officer."

The new Chief believes the Air Force has stabilized after continued personnel reductions in 1996 brought active-duty strength figures below the 400,000 level for the first time since 1948.

"At the same time, the missions that we have now require us to be more flexible. We also have to begin to think long range, and we have to begin to think what our air and space force is going to be and begin to focus on what our enlisted force is going to be. We must understand that we may be called upon to go anywhere at any time."

Increased reliance on the Air Force Reserve and Air National Guard is certainly part of the new streamlined force. "This integration of forces has been tremendous," Benken said. "At 12th Air Force, for instance, we had counterdrug operations where we utilized Guard and Reserve forces. Also, in Bosnia[-Hercegovina] and in other operations, we had about 40 percent Guard and Reserve forces."

Evidence of the integration is some-

USAF photo by MSgt. Joe Juarez

Chief Benken, who served in Europe before assuming his current post, talks to SrA. Travis M. Dick and TSgt. Martin Benton, also assigned to Aviano. He views overseas duty as "a great thing to do."

USAF photo by MSgt. Joe Juarez

Chief Benken gets the views of Amn. Brian Van Hoose about duty at Aviano. Chief Benken believes that it is his job to "help shape our . . . enlisted corps, so we can enter the next century and fulfill General Fogleman's strategic vision."

times hard to see. "Every time you go out to talk to the troops in Europe, you don't know from one minute to the next whether you're shaking the hand of a Guardsman, a Reservist, or an active-duty person. We have blended that well. When you talk Total Force, I would say we are absolutely Total Force concept now."

Chief Benken steps up his enthusiasm when you mention Bosnia. "I think our operations there have been an outstanding success. I have never been more proud than I have been with the Air Force people who participated. Under very austere conditions, where the immediate concern was for food and for water, we overcame those obstacles. We had the RED HORSE [Rapid Engineer Deployable, Heavy Operational Repair Squadron, Engineer] team from Hurlburt [Field, Fla.,] that came in and built a life-support area for us.

"The airlift continued round the clock. Security Police forces went in and integrated very well with military police units. In my mind, it was an outstanding team effort, from a joint perspective."

Even with the reduced number of installations now maintained by the Air Force in overseas locations, Chief Benken sees foreign duty as a great experience. The Cincinnati, Ohio, native should know. He has served in Taiwan, South Korea, Vietnam, Germany, and a joint-service tour at Supreme Headquarters Allied Powers Europe in Mons, Belgium.

Overseas Duty a Plus

"Serving overseas is still a great thing to do," he said. "From a housing standpoint, I think we face the same challenges throughout the Air Force. There are obviously unique challenges [to] living overseas. But I think getting involved in the culture and getting involved in the life that particular country has to offer more than compensates for the minor inconveniences."

He added, "The quality of life at some bases in Germany took a back seat in some areas from 1989 to 1994 as the drawdown occurred and there was uncertainty as to which bases would be retained. We have reversed that, and there have been a lot of quality-of-life improvements since then."

Another subject Chief Benken is pleased to respond to is the role of women in today's Air Force. "I have watched the role of women evolve in the last six years, as the Air Force took the lead in opening up its career fields. It has had a positive effect on our recruiting. I think about one in four new enlistees today [is a woman]. More than 99 percent of our career fields are open to women. We've just about reached parity."

On the issue of sexual harassment, the Chief has a simple, two-word response: "zero tolerance." He sees his role on the subject as a reinforcement of the obvious. "We do not tolerate sexual harassment in the United States Air Force, and we respect that concept."

Chief Benken said it behooves every member of the Air Force to be acutely aware of this issue. "We need to continually recognize the fact it is much better to meet this thing head on, deal with it, and focus on the truth."

He noted that for more than two years, USAF has maintained a toll-free hot line (800-558-1404) to ensure that military and civilian members have easy access to report any concerns of improper behavior. The hot line is in addition to established processes for reporting allegations of misconduct.

Away from his primary career field of information management since 1988, Benken still has the highest regard for Air Force advances in electronic technology. He recalls that in 1972, a quarter-century after the Air Force had been established as a separate service, he was fulfilling his administrative specialist duties with an Underwood manual typewriter.

Today, he has two manual typewriters—in storage. He relies heavily on electronic mail to keep in touch with the enlisted force. "I find it a good way to take communications and broadcast it to the troops. I think as we further develop that capability, we're going to rely on it more and more."

During a farewell dinner for Chief Benken before he left Germany, the emcee read from the Chief's first efficiency report. His supervisor had noted that "Airman Benken has the attributes to make a good airman, should the Air Force decide to retain him." That supervisor proved prophetic.

"I believe I am responsible to the enlisted corps as a role model, as the epitome of accountability," said Chief Benken. "Our goal is to help shape our Air Force enlisted corps, so we can enter the next century and fulfill General Fogleman's strategic vision that encompasses people, capabilities, and infrastructure." ■

CMSgt. Charles Lucas, USAF (Ret.), was an editor with the Air Force News Service and is a member of AFA's Veterans/Retiree Council. This is his first article for Air Force *Magazine.*

AFA/AEF National Report

By Frances McKenney, Assistant Managing Editor

AFA in the Hall of Fame

The National Aviation Hall of Fame has selected AFA as the 1997 recipient of its Milton Caniff Spirit of Flight Award. The award recognizes outstanding contributions and accomplishments in aviation.

"The Air Force Association has continually served, both inside and outside the Air Force, as a strong advocate, a persuasive critic, a guiding voice of reason, and, many would say, the conscience of the Air Force," according to a Hall of Fame announcement.

Located in Dayton, Ohio, the National Aviation Hall of Fame began honoring aviation pioneers when it inducted Wilbur and Orville Wright in 1962 as part of a Dayton, Ohio, Chamber of Commerce program.

The award presentation to AFA will take place in July at a president's reception and dinner at the US Air Force Museum at Wright-Patterson AFB, Ohio. AFA Executive Director John A. Shaud is scheduled to accept the award on behalf of the Association.

The Spirit of Flight Award is named for Milton A. Caniff, who drew the "Steve Canyon" and "Terry and the Pirates" comic strip series.

In receiving the Spirit of Flight Award, which has been given to one organization a year since 1981, AFA will join the ranks of such notable past recipients as the Tuskegee Airmen, US Navy's Blue Angels, and Women's Airforce Service Pilots.

LA Ball Celebrates Silver Anniversary

At a time of converging anniversaries, the theme chosen for the 1996 Los Angeles Air Force Ball embraced them all: celebration. And indeed, it was an occasion to celebrate. As every AFA member knows, 1996 was the fiftieth anniversary of the Air Force Association; 1997 is the fiftieth anniversary of the United States Air Force; and 1996 marked the twenty-fifth year that the AFA Air Force Ball has raised funds for education.

Staff photo by Jim Simpson

AFA President Doyle E. Larson held a planning and strategy session with AFA's national vice presidents and national officers in December at West Point, Miss. Front row (l–r): Walter E. Scott, AEF President, Dolores F. Vallone, Northeast Region V. P., Doyle E. Larson, and Thomas J. McKee, AEF Chairman of the Board. Second row: Frank M. Swords, European Region V. P., Craig R. McKinley, Southeast Region V. P., and Arthur F. Trost, Far West Region V. P. Third row: Mary Anne Thompson, National Secretary, Gene Smith, AFA Chairman of the Board, Kenneth W. Calhoun, Southwest Region V. P., and Ivan L. McKinney, South Central Region V. P. Fourth row: Dr. Phillip J. Sleeman, New England Region V. P., Daniel C. Hendrickson, Rocky Mountain Region V. P., Charles H. Church, Jr., National Treasurer, Vic Seavers, North Central Region V. P., Charles G. Durazo, Central East Region V. P., and John A. Shaud, AFA Executive Director. Anton D. Brees, Great Lakes Region V. P., John J. Politi, Midwest Region V. P., and I. Fred Rosenfelder Northwest Region V. P., were unable to attend the meeting.

The late founders of this event, California AFA leaders Martin M. Ostrow and Edward A. Stearn, saw a special need among the children of people in the armed services who had been POWs, MIA, or KIA. And so they started a tradition of providing scholarships to those offspring, a tradition that now is their legacy. Also, over the years—and as its main focus today—the ball has helped support programs of AEF, which, through scholarships, grants, and awards, boosts aerospace education activities in communities across the nation. All in all, the ball has raised more than $2 million, money that has been well invested in deserving students and teachers who contribute to America's future.

Honored at the ball in October with awards were two special people. Ball General Chairman Kent Kresa, chairman, president, and chief executive officer of Northrop Grumman Corp., along with AFA National President Doyle E. Larson, first presented AFA's Distinguished Aerospace Industrial Leadership Award to C. Michael Armstrong, board chairman and CEO of Hughes Electronics Corp.

Mr. Armstrong was honored for his more than 35 years of outstanding leadership in electronics, aerospace, telecommunications, and defense technologies.

Next, the Distinguished Aerospace Leadership Award was presented to the RAND Corp. for Project Air Force. Accepting was RAND President and

CEO James A. Thomson. The citation read: "For 50 years, RAND has provided high-quality research and innovative thinking in support of national, military, and Air Force needs. Especially significant is RAND's Project Air Force. Established in 1946 by Gen. H. H. 'Hap' Arnold, it focuses the efforts of civilian scientists, technologists, and analysts in a program of research to support our nation's defense."

The two military hosts for the ball, Lt. Gen. Roger G. DeKok, commander of Air Force Space and Missile Systems Center, and Lt. Gen. Charles T. Robertson, Jr., commander of 15th Air Force, presided at the event.

Rep. Jane Harman (D-Calif.), Under Secretary of the Air Force Rudy de Leon, Air Force Chief of Staff Gen. Ronald R. Fogleman, Gen. Walter Kross, commander in chief of US Transportation Command and commander of Air Mobility Command, and Gen. Richard E. Hawley, commander of Air Combat Command, also attended the ball.

Tim White, Emmy Award–winning journalist, host of the internationally popular "Sightings" television program, and an Air Force Reserve member, served as master of ceremonies. The presentation of the colors was by the University of California, Los Angeles, AFROTC color guard, and AFJROTC cadets from Del Campo High School, Fair Oaks, Calif., led the Pledge of Allegiance. In 1994, 1995, and 1996, Del Campo won AEF's annual video contest, which highlights how the unit is assisting their community, school, and nation.

Continuing an honored tradition, the ball presented a check for $50,000 to AEF Chairman of the Board Thomas J. McKee and President Walter E. Scott.

This year's event will take place November 14, 1997.

—James A. McDonnell, Jr.

USAF photo by Ron Hall

Celebrating at the Los Angeles Air Force Ball's silver anniversary were (l–r) AEF Chairman of the Board Thomas McKee and Trisha McKee, AFA Chairman of the Board Gene Smith and Rae Smith, USAF Chief of Staff Gen. Ronald Fogleman and Miss Jane Fogleman, AFA President Doyle Larson, and Becky Scott and AEF President Walter Scott.

Kitty Hawk Commemorations

AFA National Director James E. "Red" Smith was wired for sound at the dedication of *Spirit of Kitty Hawk* at Seymour Johnson AFB, N. C., on December 16. Because of his role in naming the thirteenth operational B-2, the Air Force News Service wanted to capture everything the **Scott Berkeley (N. C.) Chapter** member said at the ceremony.

Mr. Smith began lobbying for the *Spirit of Kitty Hawk* name in April 1995, working with Air Combat Command commanders, Air Force Chief of Staff Gen. Ronald R. Fogleman, and North Carolina Republican Sens. Jesse Helms and Lauch Faircloth and Rep. Walter Jones, Jr. (R–N. C.).

General Fogleman and the North Carolina Congressional delegation joined Gen. Richard E. Hawley, commander of Air Combat Command; Governor James B. Hunt, Jr.; Kent Kresa, Northrop Grumman Corp. chairman, president, and CEO; and Brig. Gen. Lance L. Smith, commander of 4th Fighter Wing, at Seymour Johnson AFB for the naming ceremony.

In addition to Mr. Smith, AFA dignitaries who joined the crowd of 4,000 at the B-2 dedication included John A. Shaud, AFA Executive Director; Thomas J. McKee, AEF Chairman of the Board; Robert S. Johnson, National Director Emeritus; James M. Keck, former AEF President; Charles G. Durazo, National Vice President (Cental East Region); and John W. White, North Carolina state president.

The next day, they gathered at the Wright Brothers National Monument at Kitty Hawk, N. C., for an annual flyby that for the past 13 years Alton V. Jones of the **Kitty Hawk (N. C.) Chapter** has arranged. This year, it was to feature 26 Air Force and Navy planes, but fog and rain led to its cancellation. The B-2 nevertheless flew alone, 35,000 feet above the monument, to commemorate the occasion.

Later, representatives of North Carolina's AFA chapters gathered for their December state executive board meeting traditionally held at Kitty Hawk, where Mr. McKee spoke about AEF's activities. At the annual black-tie Wright Anniversary Ball that night, Mr. Jones presented Mr. McKee with a model of the universe, a foot and a half in diameter, mounted on a stand. Executive Director Shaud said it sym-

USAF photo by A1C Richard E. McSheffrey

Men at work: In December, AEF President Scott (left) and AFA President Larson (third from right) donned hard hats at Scott AFB, Ill., to visit USAF's first dormitory being built to DoD's new "one plus one" standard for single airmen. Pairs of the dorm's 132 private rooms will share a kitchen and bathroom.

bolized the idea that we must have as much of a far-reaching vision as we progress into space as the Wright brothers did when they made their first flight.

Falcone's Fiftieth

It's a golden anniversary for Joseph R. Falcone, too.

National Director Joseph A. Zaranka, National Vice President (New England Region) Dr. Phillip J. Sleeman, and other AFA leaders in New England came up with the idea for a dinner this fall, honoring Mr. Falcone for 50 years of AFA service. Ronald E. Palmer, Connecticut State President; Craig Hancock, state vice president; Harry C. Levine, state secretary; John E. Zaleski, state vice president for aerospace education; R. L. Devoucoux, National Director; Robert N. McChesney, former National Vice President (New England Region) and a former National Director; ANG Brig. Gen. George A. Demers; and Brig. Gen. Armand A. Korzenik, USAF (Ret.), were among those attending the anniversary dinner, held at the Officers' Club at Connecticut's State Armory in Hartford, Conn.

Mr. Falcone, a former technical sergeant, enlisted at 17 and served in the US Army Air Forces in the Asian and Pacific theaters of operations during World War II. On October 15, 1946, the **Flying Yankees (Conn.) Chapter** member was a 19-year-old aircrew member at Clark Field, the Philippines. A young enlisted man came around on that day—which Mr. Falcone recalls because it was his birthday—seeking members for AFA. Mr. Falcone says when told that Jimmy Doolittle had founded the organization, "that's all I had to hear." He signed up by paying six Filipino pesos (the equivalent of $3) and thus began 50 years of volunteer service to AFA.

In those five decades, the AFA charter member has served in countless offices, including National Vice President and National Director. He is a permanent member of the Board of Directors and founded five AFA chapters in Connecticut—**Northern Connecticut, Flying Yankees, Central Connecticut, General Bennie L. Davis,** and **Sergeant Charlton Heston**—and one in Florida: **West Palm Beach.** He also was a cofounder of the **General George C. Kenney (Conn.) Chapter.**

The Best in Black Tie

The fifteenth annual **Tennessee Ernie Ford (Calif.) Chapter** awards banquet in November brought out 240 guests in their black-tie best.

Gen. Thomas S. Moorman, Jr., USAF vice chief of staff, headed the list of award recipients. He received the Tennessee Ernie Ford Distinguished Achievement Award for his role in the development and use of space systems from 1987 through 1994. Mrs. Beverly Ford and Gen. Russell E. Dougherty, USAF (Ret.), National Director and former Executive Director, presented the award.

Tennessee Ernie Ford, who was a popular radio and TV entertainer until his death in 1991, served as a bombardier on B-29s with General Dougherty during World War II. Before presenting the award named for the entertainer, the General spoke about some of their experiences. He also recalled the formal charter dinner in 1979, when the chapter was renamed in honor of Mr. Ford. His

Beverly Ford helped (l–r) Tennessee Ernie Ford (Calif.) Chapter President John Wickman, Chapter Vice President for Membership Gerald Chapman, USAF Vice Chief of Staff Gen. Thomas Moorman, Jr., and AFA National Director Russell E. Dougherty present awards at the chapter's annual banquet.

wife, Beverly, has continued to sponsor the annual award.

Air Force personnel from Onizuka AS, the 129th Rescue Wing (ANG) at Moffett Federal Airfield, and cadets from San Jose State University, Oak Grove High School in San Jose, Calif., and the Civil Air Patrol also received awards at this event.

Following a pre-banquet tradition, General Moorman met informally with many of these cadets, giving them a chance to ask questions and talk one-on-one with him.

The list of distinguished guests at the dinner included Lt. Gen. John P. Jumper, deputy chief of staff for Plans and Operations; Gen. Michael P. C. Carns, USAF (Ret.), former vice chief of staff; Arthur F. Trost, National Vice President (Far West Region); George M. Douglas, National Director and former National President and Chairman of the Board; and William W. Spruance, National Director. Ken Munechika from NASA's Ames Research Center at Moffett Federal Airfield and M. Sam Araki from Lockheed Martin Missiles and Space in Sunnyvale, Calif., were among the attendees representing industry.

Sen. Paul Wellstone (D-Minn.) and General E. W. Rawlings (Minn.) Chapter members 2d Lt. Kristi Hynes (left) and Capt. Pernell Watson (right), were among several special guests at Veterans Day ceremonies in Minneapolis.

Veterans Day in Minnesota

AFA President Larson was guest speaker at a Veterans Day program held at the Minnesota Veterans Home–Minneapolis. He addressed an audience of more than 200 that included four of Minnesota's Congressional delegation: Republican Sen. Rod Grams and Democrats Sen. Paul Wellstone, Rep. Bill Luther, and Rep. Bruce F. Vento.

Honored guests at this service included veterans from World War II, the Korean War, the Vietnam War, Operation Desert Storm, and four World War I veterans who each have a century of experience: Lawrence J. Oswald, 104 years old, Clarence E. Ohmann and Glen G. Tyson, both 102, and 100-year-old Robert V. Plant.

General E. W. Rawlings (Minn.) Chapter President Clayton C. Pyle said Doyle Larson was "blunt and to the point" in his speech, reminding the audience that we need to keep the promises made to our nation's veterans.

Mr. Pyle invited as his personal guests to this Veterans Day program chapter members Capt. Pernell B. Watson of the 342d Recruiting Squadron in Minneapolis and 2d Lt. Kristi L. Hynes, assistant regional director of Admissions at AFROTC Det. 410, University of Saint Thomas in Saint Paul, Minn. Lieutenant Hynes wrote that afterward, "a man in a wheelchair grabbed my hand and said, 'Thank you' to me. Imagine, on a day . . . when we should be the ones honoring him for his service, he thought first of his country and thanked me for protecting it today."

The chapter also recently donated $1,000 toward a Korean War Veterans Monument whose winning design was unveiled later that Veterans Day. The monument will be built on the grounds of the state capitol.

Honored by Michigan

The Michigan Aviation Hall of Fame enshrined Maj. Gen. Lucius Theus, USAF (Ret.), at an October ceremony, recognizing his 36-year Air Force career dedicated to improving military administration, logistics and training operations, and human relations in the armed services.

The **James H. Straubel (Mich.) Chapter** member serves on AFA's Audit Committee.

Chapter members who helped honor General Theus at the enshrinement included Alexander Jefferson, Nathaniel Carr, Walter L. Robinson, Walter M. Downs, and Carl E. Carey.

A Conclave of Cadets

Arnold Air Society Area II AFROTC cadets from Delaware, Maryland, New Jersey, Pennsylvania, Virginia, and the District of Columbia gathered for their annual conclave in November. This year's meeting, in Rosslyn, Va., was sponsored by the chapters from Howard University in Washington, D. C., and the University of Maryland College Park.

Lt. Gen. Richard B. Myers, USAF, assistant to the Chairman of the Joint Chiefs of Staff, served as keynote speaker, addressing a luncheon sponsored by AFA's Central East Region. Charles G. Durazo, National Vice President (Central East Region), said that the General had been in France, Belgium, and Switzerland but had made a special effort to return to Washington, D. C., to honor his commitment to the cadets. He was chosen as the conclave's speaker because he has "always been a friend of AFA and was a product of the ROTC program," Mr. Durazo said. General Myers is a member of the **Nation's Capital (D. C.) Chapter** and was commissioned through the Reserve Officer Training Corps program at Kansas State University in 1965.

The cadets were told ahead of time to be prepared with questions to ask General Myers, Mr. Durazo said, and he added that they came through with some thoughtful ones.

Cadet Charles Churchville of the University of Maryland College Park and a **Thomas W. Anthony (Md.) Chapter** cadet member, coordinated the event, which involved 80 students. Among the special guests were Cadets Kendra Chase and John Nugent, both from Howard University and the Nation's Capital (D. C.) Chapter, and Kristofor D. Kelly of the University of Maryland and the **College Park Airport (Md.) Chapter.**

More Chapter News

At a black-tie gala, more than 500 people joined the **Colorado Springs/Lance P. Sijan (Colo.) Chapter** in celebrating USAF's forty-ninth anniversary on November 1 at the chap-

ter's annual Air Force Ball. Special guest was Lt. Gen. Patrick P. Caruana, Air Force Space Command vice commander, who joined Amn. Cynthia Vigil, the guest most junior in rank, in cutting an anniversary cake. Ceremonies at the ball also included the High Frontier Honor Guard from Peterson AFB, Colo., and a Prisoner of War/Missing in Action remembrance service by the Forrest L. Vosler Professional Military Education Center's staff, from Peterson. A local musical group and the US Air Force Band of the Rockies provided the evening's entertainment.

In October, at the US Air Force Academy's Community College of the Air Force graduation ceremony, Charles P. Zimkas, Jr., president of the Sijan Chapter, presented an AEF Eagle Grant of $250 to TSgt. Pablo Rodriguez, Jr. Sergeant Rodriguez, from the 10th Aeromedical Squadron at the Academy, plans to earn a degree in bioenvironmental engineering. Mr. Zimkas also presented five Eagle Grants at Peterson AFB to MSgts. Beverly Holt and Gary J. Babcock, TSgt. Barry Trowbridge, and SrAs. Craig Manus and Edward Edmonson. Sergeants Holt, Babcock, and Trowbridge will go on to earn degrees in information management, while Airmen Manus and Edmonson will continue studies in electronic systems technology.

Rep. Ed Bryant (R-Tenn.) gave a legislative update to the **Everett R. Cook (Tenn.) Chapter** in September. Also at the fall meeting, chapter member Cloy E. Stevenson presented an AFROTC scholarship, established in 1994 in the memory of her late husband, Dr. Everett E. "Steve" Stevenson, to Cadet William H. Allen, Jr., from Christian Brothers University, Memphis, Tenn. Dr. Stevenson was an AFA National Vice President, Tennessee state president, and president of the Cook Chapter. The group also recognized Cadet Eric Roentgen as the top student in Aerospace Science 100 at the University.

The **Orange County/Gen. Curtis E. LeMay (Calif.) Chapter** honored Debby James as California Teacher of the Year 1996–97. Ms. James teaches the fifth grade at Valencia Elementary School in Laguna Hills, Calif. Roy C. Redman, the chapter vice president for Education, presented Ms. James with a plaque. Eric Hazzard and Brian Biggott, freshmen at Laguna Hills High School, attended the ceremony. As students in Ms. James's first class at Valencia in 1992, they entered an essay contest as part of the *USA Today*–AEF Visions of Exploration program. They were among eight national winners that year.

CMSgt. Robert D. Chandler, ANG, vice president of the **Chuck Yeager (W. Va.) Chapter,** was named a Distinguished West Virginian of the Year in November. Chief Chandler, a C-130 loadmaster and Senior Enlisted Advisor for the 130th Airlift Wing, Yeager Airport, W. Va., was honored because of his volunteer work on two presentations: He serves as narrator for a history of American flags, and he created a slide-and-music show on Operations Desert Shield and Desert Storm. A full-time Air National Guardsman and a Vietnam War veteran, Chief Chandler took the photos used in the Persian Gulf War presentation, which he has performed in front of civic and school groups more than 500 times.

"On behalf of all Americans, I thank you for your dedication to improving our world," read the note from President Bill Clinton to Charles X. Suraci, Jr., the **Thomas W. Anthony (Md.) Chapter** vice president and the state vice president for Aerospace Education. Mr. Suraci received the letter from the President, in acknowledgement of his nomination for the 1996 President's Service Award. Fellow chapter member William H. Thomas nominated him because of Mr. Suraci's Civil Air Patrol and AEF volunteer work. Mr. Suraci, a CAP colonel, serves as inspector general for the CAP's midatlantic region.

Joseph C. Bates of the **Eugene (Ore.) Chapter** recently donated $300 to AEF as his way of remembering pilots, crew chiefs, and mechanics of Republic Aviation's P-47 Thunderbolt.

Information Please

AFA has had a home page on the World Wide Web at http://www.afa.org/ for more than a year.

Specific Association departments are also accessible through e-mail, using a department abbreviation followed by afa.org. Some examples of addresses are MbrServ@afa.org (for Membership Services), NDI@afa.org (for National Defense Issues), COM@afa.org (for Communications), or MAG@afa.org (for *Air Force* Magazine).

Now, AFA also has an e-mail address to use when you don't know exactly who can answer your question: information@afa.org.

Have AFA/AEF News?

Contributions to "AFA/AEF National Report" should be sent to *Air Force* Magazine, 1501 Lee Highway, Arlington, VA 22209-1198. Phone: (703) 247-5828. Fax: (703) 247-5855. ■

Unit Reunions

Air Force Field Mobileer. June 12–15, 1997, at the Holiday Inn Hotel and Suites in Wichita Falls, Tex. **Contacts:** Lt. Col. Jim Kincaid, USAF (Ret.), 511 S. Hilltop Cir., Burkburnett, TX 76354. Phone: (817) 569-0408. SMSgt. Leo V. Watts, USAF (Ret.), 2 Kevin Cir., Wichita Falls, TX 76306. Phone: (817) 855-2906.

Air Transport Command Hump Pilots, China-Burma-India theater. April 13–17, 1997, in Charleston, S. C. **Contact:** Lt. Col. Arthur W. Sutton, Jr., USAF (Ret.), 2154 Tudor Castle Way, Decatur, GA 30035-2164. Phone: (770) 981-4640.

American Defenders of Bataan and Corregidor. April 28–May 4, 1997, at the Hyatt Orlando in Kissimmee, Fla. **Contact:** Charles L. Pruitt, 1231 Sweetwater Vonore Rd., Sweetwater, TN 37874. Phone: (423) 337-5190.

RAF Chicksands, UK, Alumni Ass'n. March 4, 1997, in Fort Meade, Md., and September 25–27, in San Antonio, Tex. Please provide self-addressed, stamped envelope for information. **Contact:** William C. Grayson, P. O. Box 4053, Crofton, MD 21114.

USAF Aggressors, twenty-fifth anniversary. August 22–24, 1997, in Las Vegas, Nev. **Contact:** 414th Combat Training Squadron, 3662 Tyndall Ave., Nellis AFB, NV 89191-6022. Phone: (702) 652-2052 or DSN 682-2052. Fax: (702) 652-9689 or DSN 682-9689.

11th Bomb Group Ass'n. May 28–June 1, 1997, in Tucson, Ariz. **Contact:** Robert E. May,

P. O. Box 637, Seffner, FL 33583-0637. Phone: (813) 681-3544.

19th Fighter Squadron (World War II). May 15–18, 1997, at Wright-Patterson AFB, Ohio. **Contact:** James G. Weir, 321 Kittanning Pike, Pittsburgh, PA 15215. Phone: (412) 963-8131.

29th Air Service Group Ass'n, 13th Air Force, and all attached units. July 6–12, 1997, at the Regency Inn in Massillon, Ohio. **Contact:** Frank Pace, 315 W. 15th St., Dover, OH 44622. Phone: (330) 343-7855.

Class 43-E Ass'n. June 19–21, 1997, at Wright-Patterson AFB, Ohio. **Contact:** Paul J. Murphy, 7013 Bellrose N. E., Albuquerque, NM 87110-1425. Phone: (505) 884-5687.

44th Air Refueling Squadron (Chennault AFB, La., and Selfridge AFB, Mich.). April 18–20, 1997, at the Holiday Inn in Bossier City, La. **Contact:** MSgt. Marvin B. Schavrien, USAF (Ret.), 1809 Dennis St., Bossier City, LA 71112-4119. Phone: (318) 741-3948.

57th Bomb Wing Ass'n, which includes the 310th Bomb Group (379th, 380th, 381st, and 428th Bomb Squadrons), 319th BG (437th, 438th, 439th, and 440th Bomb Squadrons), 321st BG (445th, 446th, 447th, and 448th Bomb Squadrons), 340th BG (486th, 487th, 488th, and 489th Bomb Squadrons), and 308th Signal Wing. August 18–24, 1997, at the Sheraton–Park Place Hotel in Minneapolis, Minn. **Contact:** Robert E. Evans, 1950 Cunningham Rd., Indianapolis, IN 46224-5341. Phone: (317) 247-7507.

60th/337th Fighter-Interceptor Squadron (Westover AFB, Mass.). October 9–12, 1997, in Phoenix, Ariz. **Contact:** Norm Lockard, 4907 W. Royal Palm Rd., Glendale, AZ 85302. Phone: (602) 931-2133.

64th Fighter-Interceptor Squadron. September 25–27, 1997, at the Radisson Hotel in Hampton, Va. **Contact:** Holt Evans, 675 Poquoson Ave., Poquoson, VA 23662. Phone: (757) 868-0510. Fax: (757) 850-1732.

Mail unit reunion notices well in advance of the event to "Unit Reunions," *Air Force* Magazine, 1501 Lee Highway, Arlington, VA 22209-1198. Please designate the unit holding the reunion, time, location, and a contact for more information.

69th Fighter-Bomber Squadron (Korea). June 19–22, 1997, in San Diego, Calif. **Contact:** Roger Warren, 7550 Palmer Rd., Reynoldsburg, OH 43068. Phone: (614) 866-7756 or (813) 345-8254.

69th Fighter Squadron Ass'n, 5th Air Force (World War II). May 29–June 2, 1997, in Milwaukee, Wis. **Contact:** George E. Mayer, 7445 Thomas Ave. S., Richfield, MN 55423-3513. Phone: (612) 866-6073.

73d Bomb Wing Ass'n, 497th, 498th, 499th, and 500th Bomb Groups; 65th, 91st, 303d, and 330th Service Groups; and attached units, Saipan (World War II). May 22–25, 1997, at the Little America Hotel and Towers in Salt Lake City, Utah. **Contact:** 73d Bomb Wing Ass'n, 706 Starcrest St., New Braunfels, TX 78130.

Class 87, AFROTC Det. 845. May 1997, in Fort Worth, Tex. **Contact:** Capt. Karl Clauser, AFRES, 6505 Poco Ct., Fort Worth, TX 76133. Phone: (817) 571-6454 or (817) 294-5170.

92d Bomb Wing (Fairchild AFB, Wash.). August 8–9, 1997, at the Coeur d'Alene Resort in Coeur d'Alene, Idaho. **Contact:** Col. Guy D. Perham, USAF (Ret.), 2820 E. Snowberry Lane, Spokane, WA 99223. Phone: (509) 535-9865.

99th Bomb Group Historical Society (World War II). April 30–May 4, 1997, at the Granada Inn in Ormond Beach, Fla. **Contact:** Morton G. Magee, 8 Butternut Cir., Ormond Beach, FL 32174–6039. Phone: (904) 673-8549.

327th and 768th Bomb Squadrons, (Larson AFB, Wash.), 1960–66. August 8–10, 1997, in Coeur d'Alene, Idaho. **Contact:** W. W. Leesburg, 11001 147th St. E., Puyallup, WA 98374. Phone: (206) 845-3096.

364th Fighter Group Ass'n, 8th Air Force, Honington, UK (World War II), and support units. September 23–28, 1997, at the Hilton Desoto in Savannah, Ga. **Contact:** Dan Leftwich, 6630 Caldero Ct., Dayton, OH 45415. Phone: (937) 890-3641.

410th Bomb Group, European theater (World War II). April 30–May 3, 1997, at the Holiday Inn Hotel and Conference Center in Hampton, Va. **Contacts:** John McDonagh, 6013 Rembert Dr., Hanahan, SC 29406. Phone: (803) 747-2404. Bill Lorimer, 125 Darnley, Moon Township, PA 15108. Phone: (412) 457-2359.

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Unit Reunioons

417th Bomb Group, 5th Air Force. September 17–19, 1997, in Dayton, Ohio. **Contact:** Lt. Col. Robert N. Kunselman, USAF (Ret.), 1825 W. Lakeview Dr., E-46, Johnson City, TN 37601. Phone: (423) 282-9749.

474th Tactical-Fighter Wing, "Roadrunners," Nellis AFB, Nev., or Takhli RTAB, Thailand (1967–77), F-111-era aircrews and officers. September 24–28, 1997, in Las Vegas, Nev. **Contact:** William G. Meyer, 3676 Monte Verde St., Las Vegas, NV 89121-3528. Phone: (702) 458-5736.

511th Aircraft Control and Warning Group, 613th, 847th, and 848th Aircraft Control and Warning Squadrons. September 4–8, 1997, in Colorado Springs, Colo. **Contact:** Donald D. Simmons, 704 S. Grove Rd., Richardson, TX 75081-5116. Phone: (972) 231-6518.

555th, 563d, 564th, 566th, and 573d Signal Aircraft Warning Battalions (World War II). August 28–30, 1997, in Pittsburgh, Pa. **Contact:** James D. Lynn, 3855 Utah Pl., St. Louis, MO 63116. Phone: (314) 771-2928.

The following reunions will be held in conjunction with USAF's fiftieth-anniversary celebration:

RAF Station Manston, UK. April 22–26, 1997, in Las Vegas, Nev. Units stationed at Manston, including the 513th and 514th Fighter-Interceptor Squadrons and the 92d Fighter-Bomber Squadron, are invited. **Contact:** Maj. Milton J. Torres, USAF (Ret.), 11200 S. W. 99th Ct., Miami, FL 33176. Phone: (305) 238-3342.

Sampson AFB, N. Y., Veterans Ass'n, 3650th Basic Military Training Wing (1950–56). April 23–25, 1997, at the Somerset House Motel in Las Vegas, Nev. **Contact:** Walt Steesy, P. O. Box 299, Interlaken, NY 14847. Phone: (607) 532-4204.

5th Bomb Group Ass'n, 13th Air Force, Pacific (World War II), including the 23d, 31st, 72d, and 394th Bomb Squadrons and 4th Reconnaissance Squadron. April 21–25, 1997, at the Tropicana Resort and Casino in Las Vegas, Nev. **Contact:** Dag Larsen, 410 Church Rd., Ojai, CA 93023. Phone: (805) 646-8761.

Class 52-D (Webb AFB, Tex.). April 22–26, 1997, in Las Vegas, Nev. **Contact:** William J. Oliphant, P. O. Box 10541, Knoxville, TN 37939-0541. Phone: (423) 525-7948.

Pilot Class 53-B. April 22–26, 1997, at the Monte Carlo Resort and Casino in Las Vegas, Nev. **Contact:** Erroll L. Williams, 1716 Greenbriar Rd., Glendale, CA 91207. Phone: (818) 246-3094.

AFROTC Det. 025, Arizona State University. Seeking contact with classes 1986, 1987, and 1988 for a reunion September 1997. **Contact:** Jamie Contes, 3056-A Minuteman Way, Hill AFB, UT 84056. Phone: (801) 776-0421.

Pilot Class 54-Q (Marana AFB, Calif., and Williams AFB, Ariz.). Planning a reunion for fall 1997. **Contact:** Lt. Col. Daniel A. Riley, USAF (Ret.), 14 Maple Ave., Shalimar, FL 32579. Phone: (904) 651-1998.

355th Tactical Fighter Wing. Seeking contact for a reunion in October 1997, in Indianapolis, Ind. **Contact:** Gene Carlson, 1944 Tanglewood Dr., Lafayette, IN 47905-4183. ■

Pieces of History

Photography by Paul Kennedy

1/32d-Scale Dreams

Model aircraft have been around for a long while. Legend has it that a small flying top sparked Orville and Wilbur Wright's interest in aviation in 1878. The twentieth century's more sophisticated models can be wooden, metal, or plastic (and paper remains a time-honored aircraft material for frugal or traditionalist model enthusiasts), already assembled or knocked down in kits, motor-powered or static displays. Many career aviators can trace their lifelong fascination with aircraft to the day they assembled their first Testors B-17 or Revell RF-4C. Today, the intricacy, accuracy, and expense of the top-end models put them at a far remove from childhood playthings.

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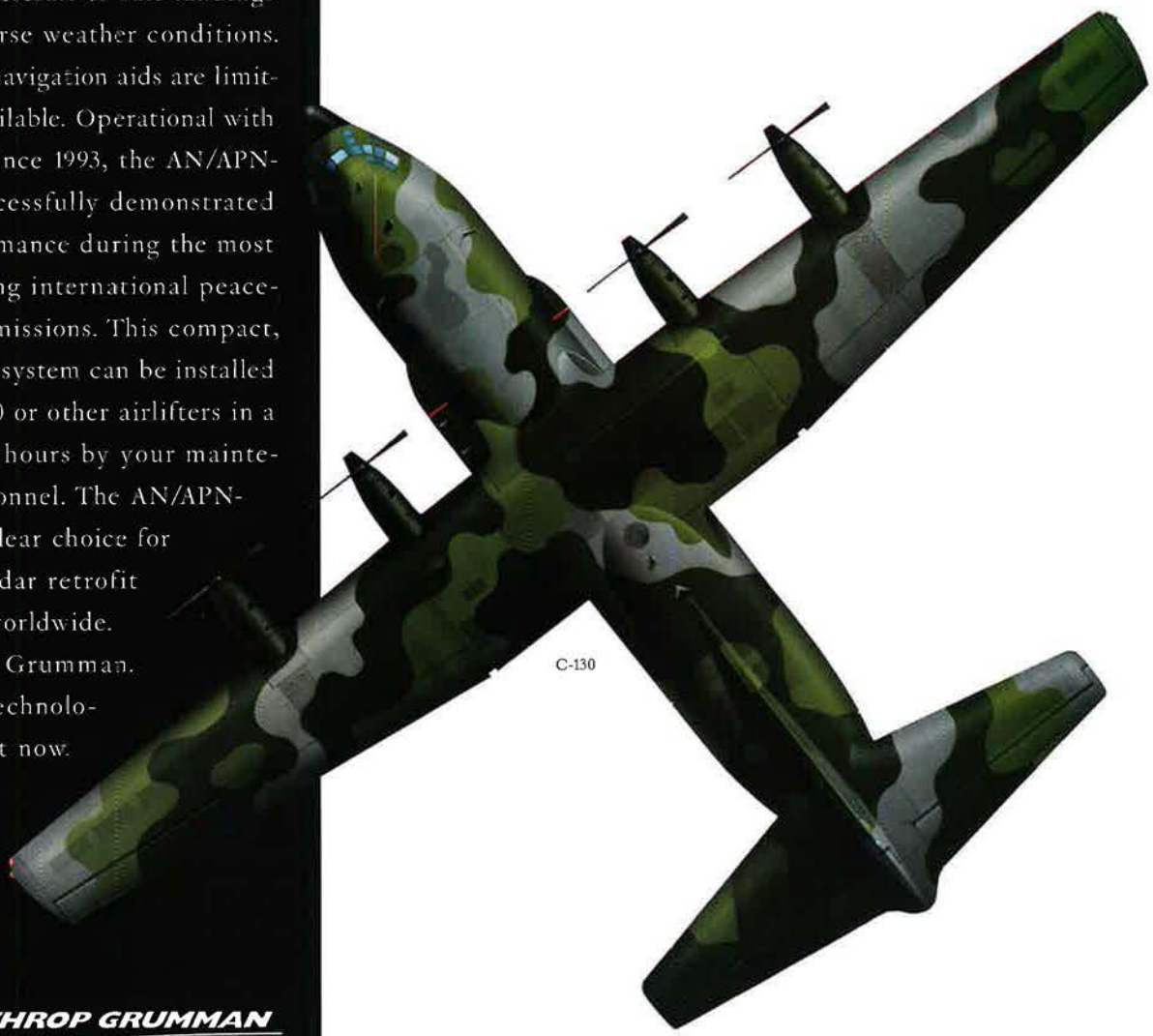

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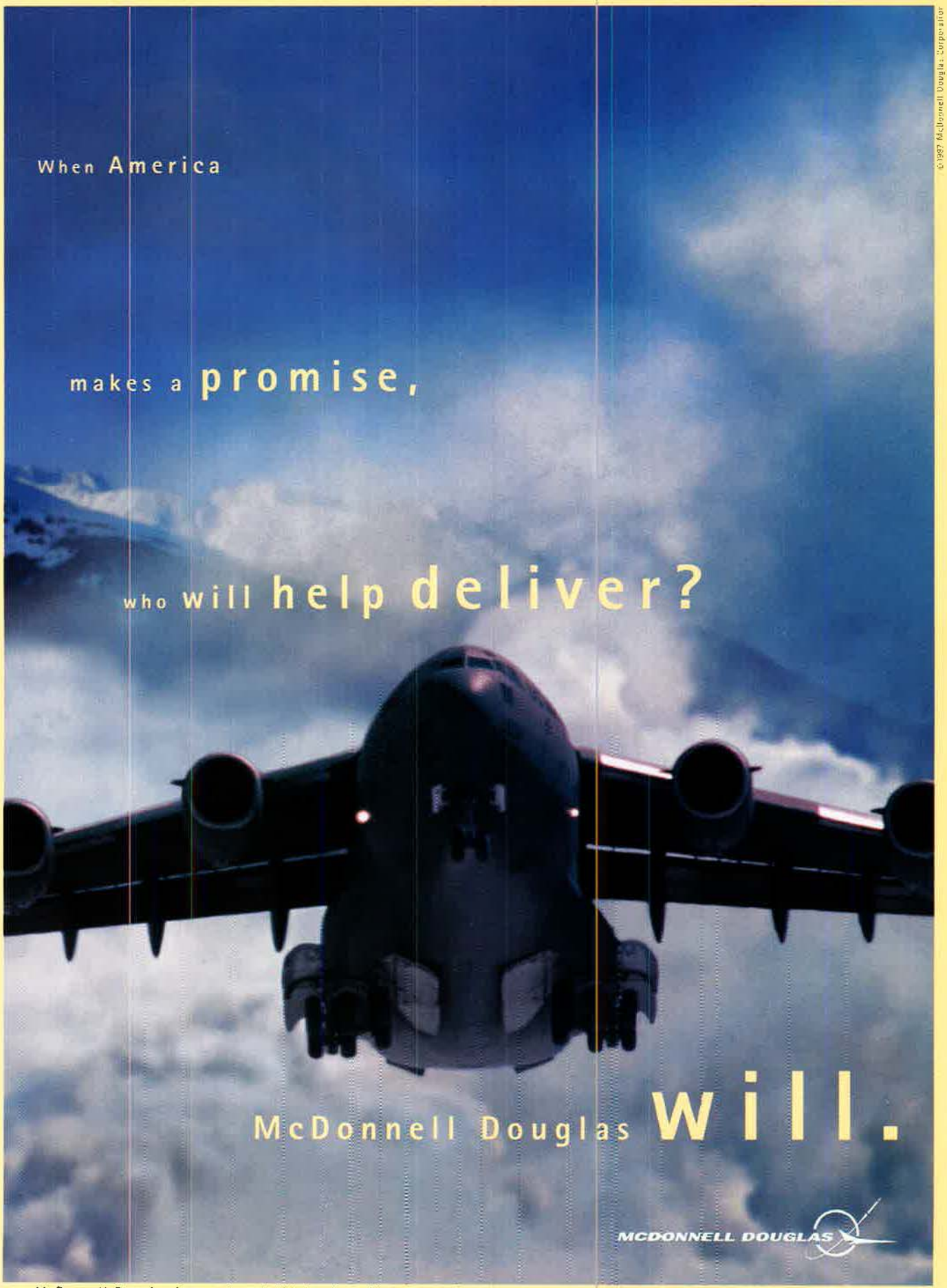

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