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AIR FORCE MAGAZINE

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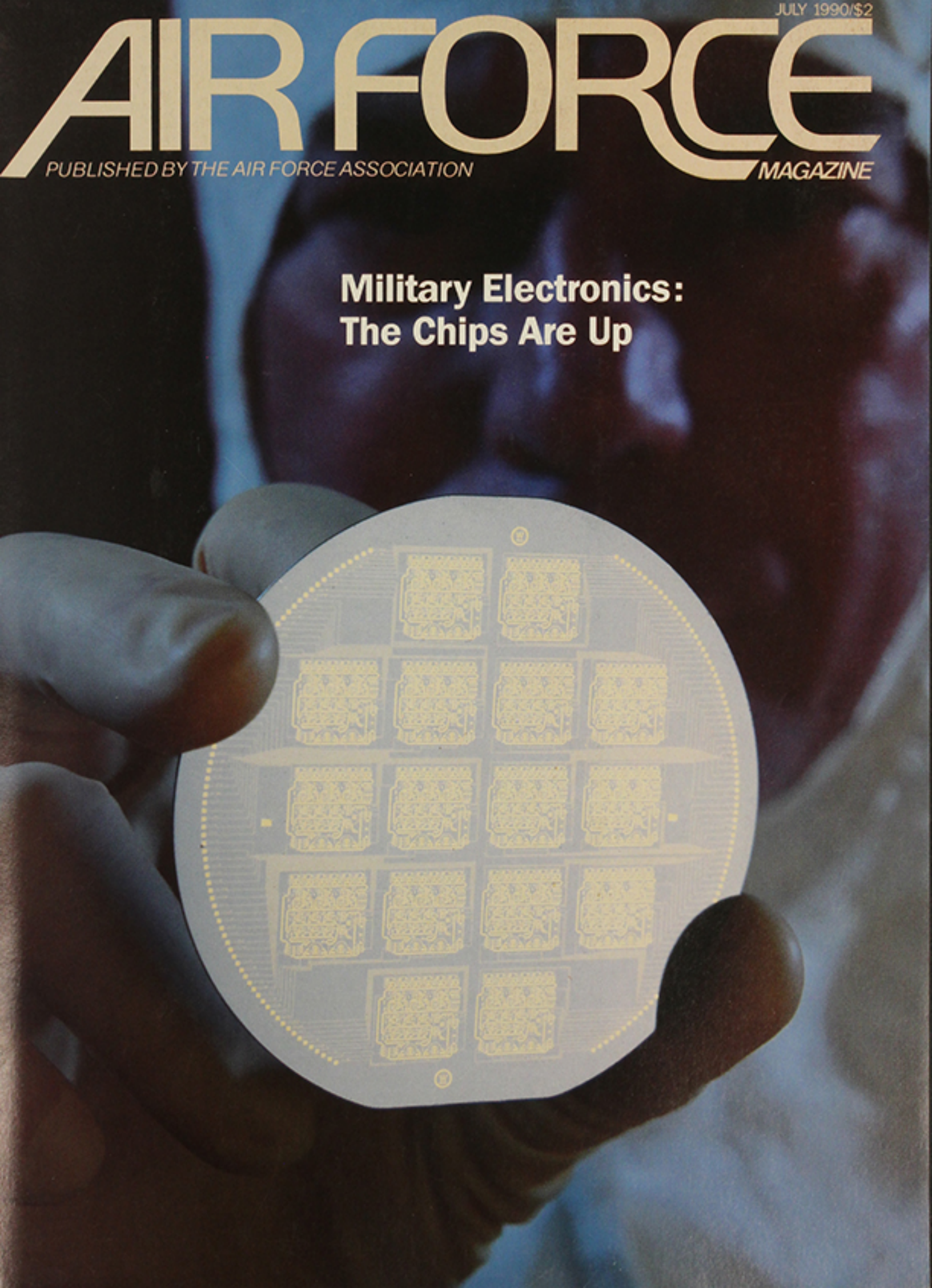
Military Electronics: The Chips Are Up



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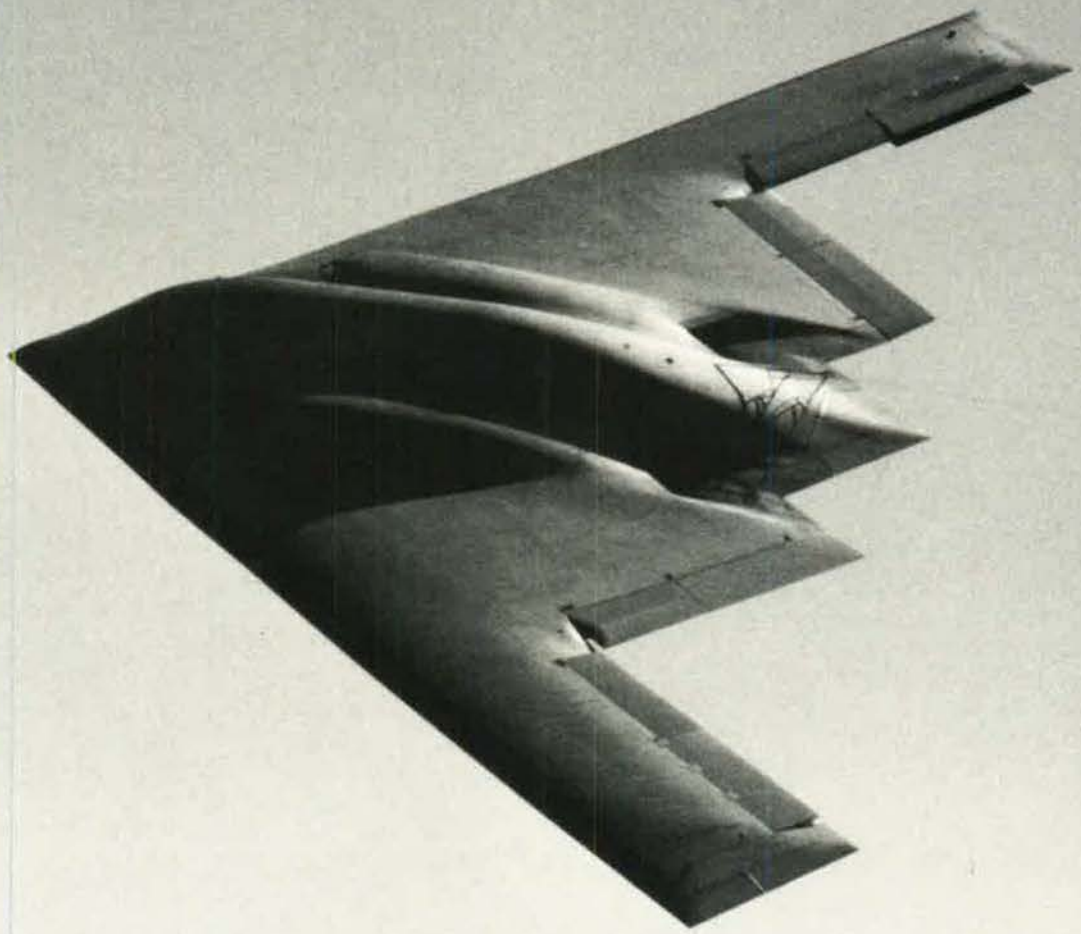

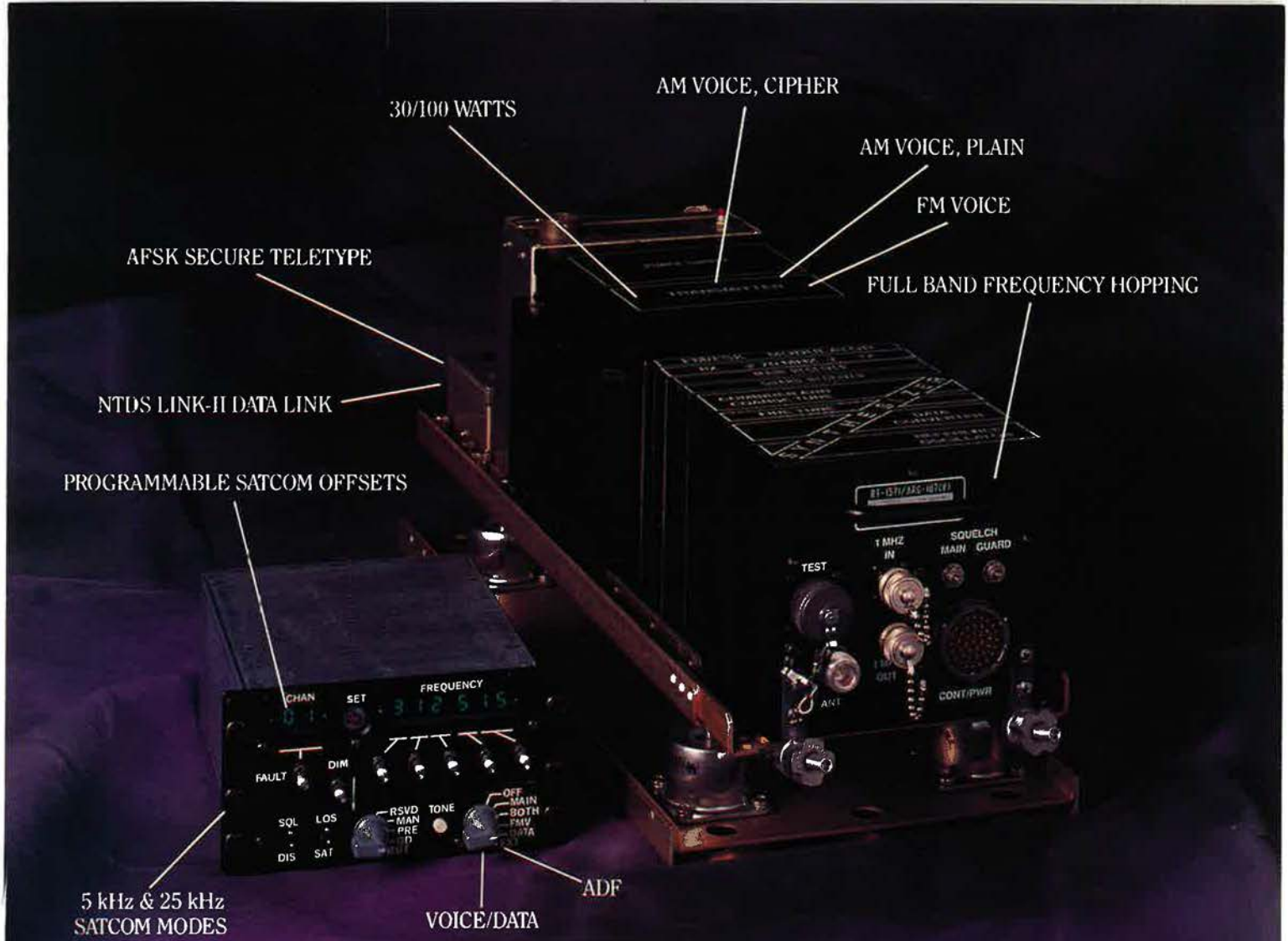

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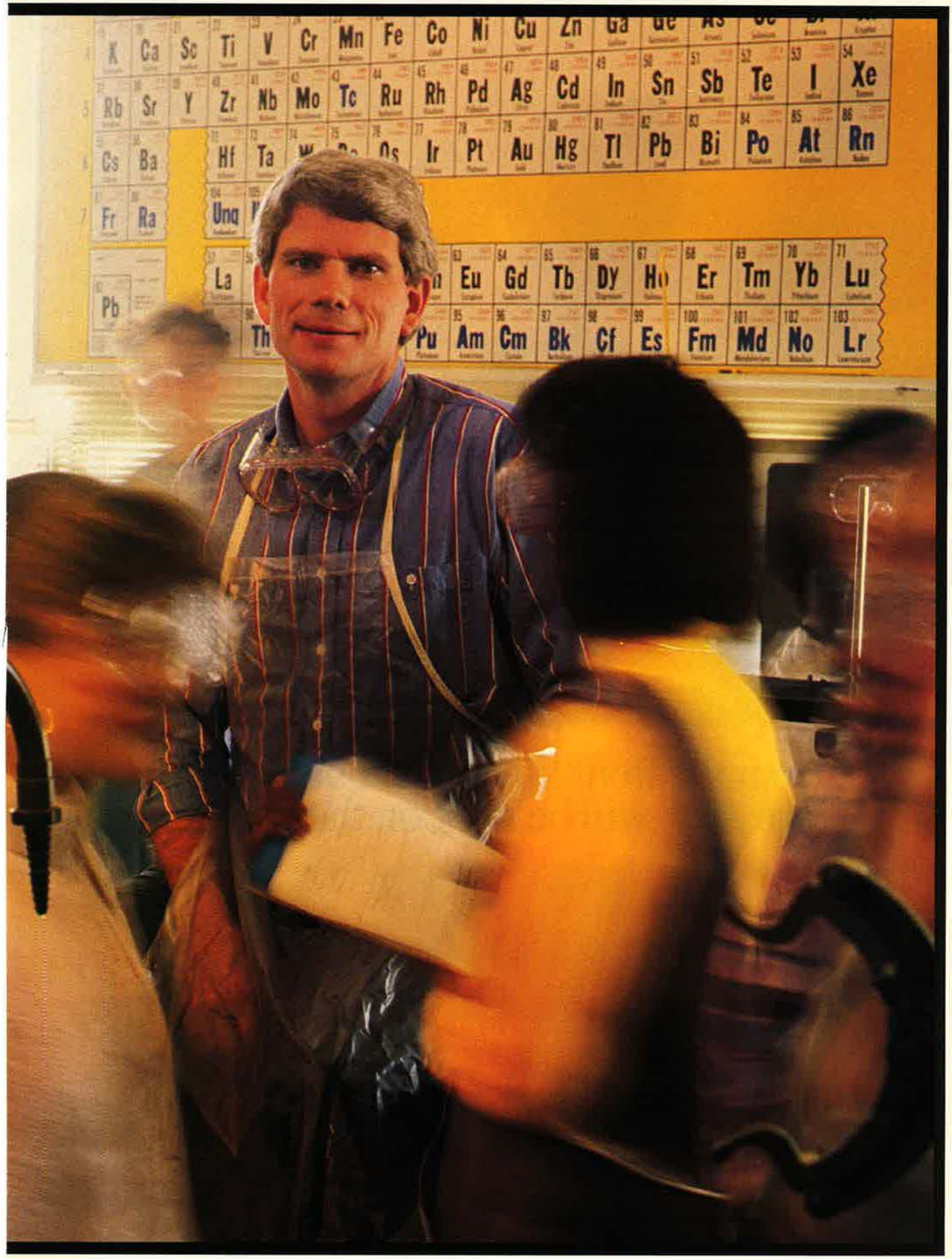

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L T V : L O O K I N G A H E A D

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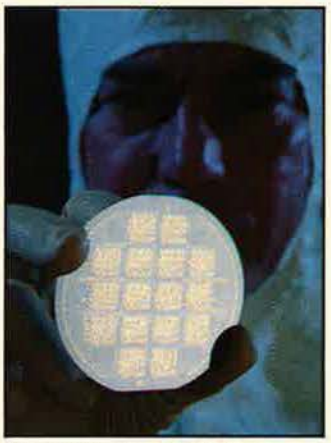

About the cover: This three-inch-wice gallium arsenide wafer contains sixteen complete radar transmit/receive cells. The assembly was fabricated by scientists at the Westinghouse Science & Technology Center in Pittsburgh.

Military Electronics: The Chips Are Up

Departments

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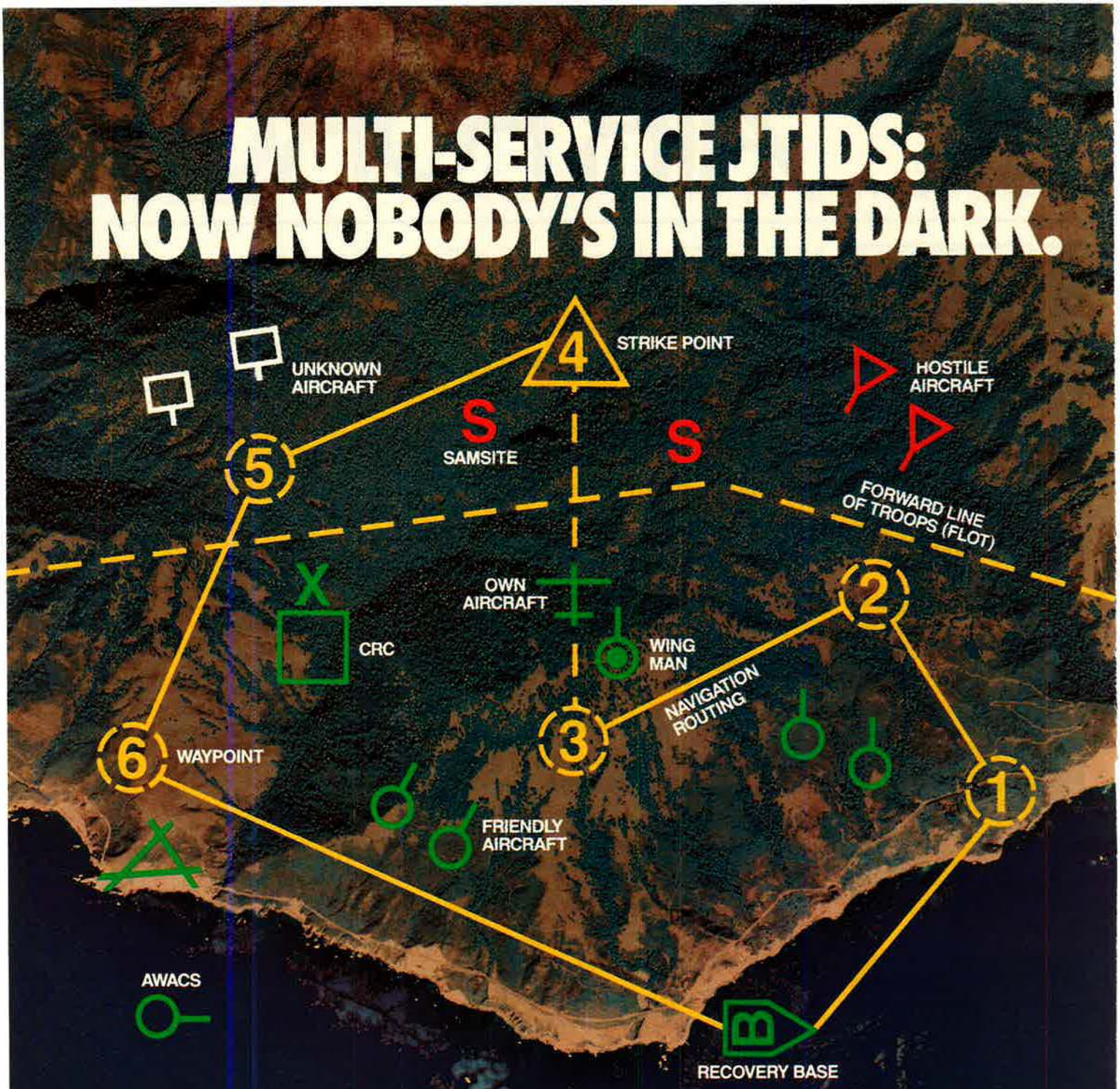

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Editorial

By John T. Correll, Editor in Chief

Our Fig Leaf Is Slipping

A BILL introduced May 22 by Sen. Edward M. Kennedy (D-Mass.) proclaims a peace dividend of $211 billion. The bounty, to be harvested from defense over the next five years, would go into a trust fund reserved for social programs and other "fundamental investments."

Meanwhile, the Joint Economic Committee of Congress is in less exuberant spirits. After reviewing the latest data, the Committee predicted May 8 that the federal deficit for Fiscal Year 1991 will be $180 billion—about three times higher than the Administration was forecasting just a few months ago.

The unvarnished reality is harsher yet. If a Social Security trust fund "surplus" is factored out of the calculations, the deficit probably approaches $260 billion.

By October 16, the deficit must be within a $10 billion tolerance of the $64 billion ceiling set for this year by the Gramm-Rudman-Hollings Act. Otherwise, automatic provisions of the law take over and allocate cuts—potentially more than $100 billion worth—by formula.

Last year, the government struggled mightily to resolve a deficit that, by official (and incredibly contrived) accounting, was only $16.1 billion over the limit. In June, with eight months of Fiscal Year 1990 elapsed, major questions about FY 1990 outlays were still hanging.

The government is in no position to cope with a reduction six times the size of last year's, much less to begin distributing any peace dividend. As an Administration budget official puts it, a sequester of FY 1991 outlays would be so huge that "it would blow the doors off everybody."

Gramm-Rudman calls for the deficit to disappear altogether by 1993. Government leaders believe that balancing the budget, even allowing another five years to do it, would take about $500 billion in further cuts and revenues. If the savings and loan crisis gets worse, the bill would be considerably higher.

The nation worked itself into this mess by stages, beginning with enactment of Gramm-Rudman in 1985. The politicians abrogated their basic responsibility. They created an automatic process to make decisions they refused to make themselves. Furthermore, fearful of antagonizing powerful blocs of voters, they exempted more than half of the outlays, entitlement programs in particular, from reduction.

The truth about the deficit can't be hidden much longer. As one worried official says, a sequester in FY 1991 would "blow the doors off everybody."

It would be possible, the nation convinced itself, to eliminate the deficit, avoid taxes, and preserve social programs intact. The trick was to finance the fantasy with reductions to defense.

The nation also decided that defense was to blame for the deficit. Based on that trumped-up logic, Gramm-Rudman stipulated that half of any automatic cuts must fall on defense. It was somewhere around this point that the fantasy began to turn on its keepers. It put them on a path that could not possibly lead to honest answers.

Even now the nation persists in its demand for a painless solution. The public is opposed to higher taxes, yet it is unwilling to curb its appetite for entitlements. Those who preach a peace dividend encourage belief in options that do not exist.

Senator Kennedy charged in February that "America paid a high price here at home" for defense spending in the 1980s and that it was high time to cut defense in favor of "our enormous unmet national needs." The New York *Times* sings in harmony with him: "For too long, domestic needs have been shortchanged by spending for military security."

The facts say otherwise. In 1969, the federal budget balanced. In the years that followed, defense took a generally declining share of federal outlays. This was especially true in the Gramm-Rudman period, from 1985 on, when defense spending fell sharply. The big growth has been in entitlement programs, which, protected from reductions, climbed through the top of the budget charts.

Defense and discretionary accounts in other federal departments have taken massive cuts. Social and entitlement programs, on the other hand, have continued to expand. Naturally enough, the nation's financial problems did not go away.

Little more than a fig leaf remains to cover the pretense, and the leaf has begun to slip as we approach the $64 billion deficit limit for FY 1991. It is not feasible for the government to reduce outlays by $100 billion—or even by a somewhat smaller sum that the politicians may pretend is the deficit—by October 16, and everybody knows it.

Radical defense cuts can't make a dent in the problem. If the Pentagon released another 100,000 troops, laid off 100,000 civilian employees, and canceled more than a dozen of its prime weapons programs, the outlays saved would amount to less than four percent of the projected deficit.

Gramm-Rudman and the fantasies that go with it have run their course. Even the false comfort they have been providing is about to disappear. It's time we tried a more realistic approach. ■

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Letters

How to Crew a B-2

It is disturbing to read that the Air Force has decided to substitute a second pilot in place of the Navigator/Weapon Systems Officer (WSO) in its B-2 bombers *[see "Aerospace World," May 1990 issue, p. 26].* My conversations with pilots who fly the B-2 indicate that the B-2 was designed for a single pilot/WSO crew and that the systems operator will be *heavily* tasked with performing non-pilot duties. The Air Force frustrated many pilots trying to do this in the F-4 and F/FB-111 and eventually found that employing dedicated systems operators (*i.e.*, WSOs) was a better solution. In the case of the B-2, the Air Force is going to be hard pressed to find pilots willing to undergo navigator, WSO, and EWO training and then devote the time necessary to *remain* proficient. The end result is the possibility of our multibillion-dollar bomber "going to war" with a crew less capable than it could be.

Using two pilots on the B-2 is not necessarily safer in a peacetime environment. The aircraft is so complex that all systems and procedures cannot be mastered by each aircrew member. The better approach is specialization. The pilot concentrates on being very proficient at flying, without the need to share flight time. The WSO is the systems expert. Each crew member backs the other in his areas of expertise. The advantage is that in an emergency situation there is an on-board expert with the knowledge and proficiency to cope with all contingencies. Roles are clear and defined, with no ambiguity about "who's got the stick."

Currently, US taxpayers are paying a hefty bonus in an attempt to stem the hemorrhage of pilots from the Air Force. How can this bonus be justified in light of decisions that will potentially exacerbate the situation, especially when more suitable aircrews are available at less cost?

The Air Force has chosen to make the systems operator the mission commander, recognizing that this person will have the "big picture." The Air Force need only look at its Naval brethren to see that navigators/WSOs are capable of being mission commanders. Within Naval aviation, Naval Flight Officers have demonstrated the capability to command military missions in a variety of aircraft. In the interest of national defense, fiscal responsibility, and eliminating job discrimination, the Air Force should field the B-2 with a pilot/WSO crew.

Jeffrey G. Canclini
Arlington, Tex.

A Unique Opportunity

The letter from Maj. Roger L. Smith in the April 1990 issue makes some very good points *[see "Meeting Today's Threat," p. 8].*

Preoccupation with a major central European conflict has driven US strategy, doctrine, and funding for more than forty years. Recent shifts in the Warsaw Pact countries demand a much needed change in theater capabilities. Reader Smith is correct [in saying] that the scaling down of American forces in Europe is a unique opportunity.

His overall theme, however, iterates the same tired future that some fiscal planners in Congress see. A peaceful, no fault, no threat world, with candy-coated superpower leaders that stand on only one platform—for everyone to be *nice* to each other. In the meantime, the Third World sells our children drugs and knocks down our "peaceful" aircraft with surface-to-air missiles.

Unless I missed something, our presence overseas is a balance between treaties that require American foreign policy to maintain a stabilizing influence on global affairs and the equally compelling need to react should that stability change. The number of Americans serving overseas is, and should be, low enough to maintain global stability and large enough to react properly to a vast complex of possible scenarios.

The possibility of major conflict in central Europe is not diminished as Warsaw Pact nations dissolve their political link with the Soviet Union and rebuild. The threat of conflict is increased. History tells us that these new governments will satisfy their own objectives at the expense of their neighbors if the need arises. As they wrestle with their own problems of shortages in natural resources, population control, and a strained economy, they might well see a confrontation as the means to an end.

Brian Green's column on "A Modified Estimate of the Threat" *[see "Capitol Hill," March 1990 issue, p. 89]* quoted CIA Director William Webster remarking that "by the year 2000, at least six countries probably will have missiles with ranges up to 3,000 kilometers; at least three of them may develop missiles with ranges up to 5,500 kilometers." Furthermore, four of these nations will have "either nuclear weapons or advanced nuclear weapons programs." With the emerging European democracies all vying for support from a willing American public and the technical explosion reaching around the globe, I would doubt that the capability Mr. Webster outlined will take ten years.

Finally, anyone who seriously thinks the Soviet Union cannot sustain an all-out offensive against the western European nations is simply not very well informed. As documented repeatedly in recent AIR FORCE Magazine articles and editorials, Soviet offensive capability has not diminished with the USSR's military withdrawal from the Warsaw Pact. The Soviets have returned to their heartland and scrapped some useless equipment, but, as Mr. Brent Scowcroft, National Security Advisor to the President, said in the March

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

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Letters

issue, "we have to be cautious," because actions speak louder than words, and from that standpoint, we have seen "almost no change" in the Soviet strategic setup.

The scaling down is an opportunity to revise doctrine, strategy, tactics, organization, and weapons development; but [in order] to meet new challenges, not to push the capability to defend Europe (and our other global responsibilities) into the history books.

SMSgt. David W. Duggan, Jr., USAF
RAF Lakenheath, England

Forty-Year Furor

Your article "Close Support Testbed" *[by Jeffrey P. Rhodes, April 1990 issue, p. 56]* was interesting, to say the least. Why would the CAS furor be puzzling to Air Force technologists? If my memory is correct, this debate has raged in varying degrees since 1947 and before, and the Army still has doubts about Air Force intentions and sincerity. It is no wonder. If Air Force officials are quoted accurately, the Army should be worried: "Once enemy planes are downed and targets deep behind enemy lines destroyed, US airpower will come down to making pinpoint CAS attacks on targets near friendly forces." What in the world are the grunts to do when in contact with a determined enemy and [in need of] close support from the Air Force? Wait until it has been decided that *all* enemy airplanes are downed and *all* enemy targets are destroyed? To add fuel to the fire, now the Air Force is going to make only one pass in the interests of survivability, apparently expecting the Army helicopter —stooging around at sixty knots in the same gun-infested area—to forward target information via the Automatic Target Handoff System (ATHS).

Which brings up another point: If the people at ASD really believe that digital data transmitted to a moving-map display is sufficient to allow a fast mover to attack an obscure enemy mortar or automatic weapon position in low visibility (the visibility is always poor) fifty yards or closer to our troops, they had better rethink the whole scenario and make sure that some fast-talking contractors aren't leading them down the garden path.

Lt. Col. E. L. MacQuarrie, USAF (Ret.)
Del Mar, Calif.

I take note of your comment concerning close air support aircraft in your article "Systems Under the Gun" *[by John T. Correll, April 1990 issue, p. 44]*. In discussing a replacement for the A-10, Mr. Correll reports that "the mudfighter concept does not match . . . the realities of modern combat. . . ." My observation is that the realities of modern combat, during the last forty years, validate the mudfighter concept. Modern combat has repeatedly been in the realm of insurgency or low-intensity conflict. And what can we expect during the next forty years? Maybe, just maybe, another full-blown theater war. But you can bet the bank we'll be involved in insurgencies or low-intensity conflicts. Since World War II, we have been planning, equipping, training, and spending to prepare for the least likely case, while time after time the "small ones" bite us in the pants. In special operations, A-10s, or mudfighters, have many of the qualities desired for close air support and other missions. If we plan and spend with the true reality of "the realities of modern combat" in mind, the A-10 may have significant utility for decades.

Capt. George I. Miller, Jr., USAF
Andrews AFB, Md.

Invaluable Training

Thank you for your nice article in the May 1990 issue on Colonel Duckworth *[see "Duckworth's Legacy," by C. V. Glines, p. 178]*.

After my return from an Eighth Air Force combat tour, I was fortunate enough to draw Bryan, Tex. The training I received proved invaluable throughout my career.

My first Instrument Pilot Certificate has an expiration date of September 13, 1945, and is signed on the lower right "J. B. Duckworth, Colonel AC (AAFIS-IP)." I carry it in my wallet and have ever since 1944.

Col. J. N. Booth, USAF (Ret.)
Carson City, Nev.

Taking a RISC

"The Airborne Supercomputer" in your May 1990 issue *[by John Rhea, p. 162]* contained a significant error in fact. It stated: "The two contractors add that they will apply a new technique known as reduced instruction set computing (RISC) to reduce the overall software requirements by doing more things in hardware, *i.e.*, in the chips themselves."

RISC computers are characterized by simple instructions, each of which takes very little time to run (using somewhat simplified hardware). How-

ever, this is accomplished by shifting the complexity into software (the compiler that translates the programmers' instructions into machine-executable code). Increasing the complexity of the compiler increases the likelihood that it will start making mistakes. It is only a program, subject to "bugs" like any other.

One of the strongest arguments against the "Star Wars" program is that the software cannot be built reliably because of its massive complexity. The program's opponents argue that we are too ignorant to know there is a problem. If one of your readers repeats an error such as that contained in the article to a knowledgeable person, the rest of his arguments will be dismissed, no matter how cogent. Please, in the future, be more careful in discussing technical matters. Even though yours is not a technical journal, those technical details that you include should at least be correct.

Maj. William R. Mussatto,
USAF
Parker, Fla.

The Military in Space

I can certainly see General Kutyna's point regarding the immediate utility of the Advanced Launch System over that of the Shuttle-C, especially given the upcoming budgetary battles *[see "Washington Watch," April 1990 issue, p. 14]*. However, I take issue with the overall tone of his comments as they pertain to the subject of manned spaceflight.

I freely admit a bias toward manned missions as a way of ensuring America's future in space. As part of a long-term national strategy, as opposed to a strictly military view, manned use of space is imperative if we are ever to escape the closed systems of resources on Earth. . . . Given the importance of the issue, manned spaceflight of any kind is well worth pursuing. What we need is a modern Admiral Mahan capable of showing how military and civilian concerns may be combined as an integrated whole.

In the meantime, should USSPACECOM need a near-term use for manned military spaceflight, may I suggest one—the maintenance and security of Strategic Defense Initiative facilities. Not everything is in high geosynchronous orbit. Simple extrapolation points to a time, once SDI is deployed, when it may be necessary to safeguard our system with a manned presence. The situation is analogous to the old argument about manned bombers and ICBMs. Should our system be threatened, a manned space fighter would give us a range of options short of blowing away the opposition.

General Kutyna is certainly right in stating that we need compelling reasons for the continuation of manned military spaceflight. We have better uses for our uniformed Ph.D.s than as glorified loadmasters. But for the future, let's remember that whenever our nation's commercial and cultural interests have moved into new arenas, so has our military mission. It will be so in space as well, provided that the idea of manned spaceflight is not stillborn.

Maj. Michael L. Spehar,
USAF
Scott AFB, Ill.

Designation Confusion

I enjoyed the annual Almanac issue; it gets better every year. However, one item has caused a fair amount of confusion: the designation and naming of the TTTS [Tanker/Transport Training System] aircraft the "T-1A Jayhawk."

The last three trainers developed in this country have been the McDonnell Douglas T-45, Fairchild T-46, and Cessna T-47. If USAF follows that sequence, the Beechjet should be the T-48A. If the Air Force goes by the 1962 DoD triservice system, it should be the T-3A. The T-1A designation has

already been assigned to the former T2V-1, and the T-2 Buckeye is the Navy's current primary jet trainer.

I get the funny feeling that, for whatever reason, someone is playing fast and loose with the designations again. To add insult to injury, the "Jayhawk" name has already been assigned to the US Coast Guard's HH-60J SAR [search and rescue] helicopter.

Somebody goofed on this one.

Mark Morgan
Fort Worth, Tex.

Marauders' Merits

"Valor: Epitaph for a Valiant Airman" by John L. Frisbee in the April 1990 issue is a wonderful story about a great airman.

Mr. Frisbee touched briefly on a very serious part of the World War II history of the B-26 Marauder, which had the reputation, as he says, of being "accident-prone." The "One a Day in Tampa Bay" syndrome was true. The raids [that ended low-level B-26 missions] were two to Ijmuiden, Holland, to bomb the sub pens there. The crews had been trained in the states in low-level tactics, bombing with an antiquated bombsight.

The unacceptable losses sustained in the two Holland raids forced the four groups in England to stand down. Awaiting orders to join those four were four others in the States. They, too, were put on hold for further assignment. The Air Staff then called on the experience of the three groups in the 12th Army Air Force in the Mediterranean, who had learned they must fly over land targets at medium altitude if the B-26 were to be effective. The Norden bombsight was brought into play and, with the increase to medium altitude, brought the B-26 into its own. They became a hard-hitting warrior clan all through the European theater, with very low accident rates, and could fly while shot to pieces by German flak.

The pilot-error accidents stopped; the maintenance accidents stopped. The whole thing was a matter of experience. . . .

Col. Hugh H. Walker,
USAF (Ret.)
Austin, Tex.

Philippine Heroism

I just received the May 1990 issue of AIR FORCE Magazine and was immediately attracted to your excellent article on Ed Dyess. As you quite correctly emphasize, he was a "Hero of the Philippines" *[see "Valor," by John L. Frisbee, p. 182]* and at the same time one of our earliest bona fide heroes of World War II.

While your article focused on Dyess and his strong, effective leadership, the characterization borrowed from "a senior officer" that other squadrons on Bataan were "disorganized and demoralized" seems unfair. Almost all those surviving fought as infantry in as professional, organized, and brave a manner as possible. The real experts on this era of Air Force and American military history seldom can be cajoled into talking much about it—except among themselves.

Incidentally, I do not believe General Putnam was yet a squadron commander at the time. [I do know that] Joe Moore and Benny Putnam as well as Buzz Wagner and Hank Thorne were all flying school classmates—June 1938!

Maj. Gen. J. D. Moore,
USAF (Ret.)
Brighton, Colo.

Hagan's Post

"Move Back Eighteen Feet" on p. 40 in the April issue contained a small error. Brig. Gen. Craig A. Hagan, USA, has been assigned as the Deputy Chief of Staff for Training, Headquarters, United States Army *Training and Doctrine* Command (TRADOC), not Forces Command, at Fort Monroe, Va., since January 1990.

Maj. John W. Oravis,
USA
Peachtree City, Ga.

Early Rockets

I greatly enjoyed the March 1990 "There I Was . . ." by Bob Stevens, because I went through the same experience [with primitive, folding-fin rockets] during Rocket School at Eglin AFB, Fla., in late 1944. We used A-20 aircraft firing air-launched missiles over Gulf of Mexico. At the time, I was armament officer of the 312th Fighter Squadron, stationed at Perry Field, Fla.

The ironic feature was that the Navy had a "zero" launch rocket with fixed fins that worked fine, but I guess

AIR FORCE ASSOCIATION BALANCE SHEET

	December 31,1989			December 31, 1988		
Assets	**General Fund**	**Life Membership Fund**	**Total**	**General Fund**	**Life Membership Fund**	**Total**
Current Assets						
Cash plus marketable securities at lower of cost or market	$ 4,622,610	$7,683,983	$12,306,593	$ 7,258,633	$7,015,649	$14,274,282
Receivables, prepaid expenses, etc.	1,752,449	556,766	2,309,215	1,509,874	620,104	2,129,978
Fixed Assets (land, building, etc.)	13,143,376		13,143,376	7,839,023		7,839,023
Funds on Deposit and Other Assets	4,584,901		4,584,901	3,481,059		3,481,059
Total Assets	**$24,103,336**	**$8,240,749**	**$32,344,085**	**$20,088,589**	**$7,635,753**	**$27,724,342**
Liabilities and Fund Balances						
Current Liabilities (including payables, accrued expenses, etc.)	$ 3,439,859		3,439,859	$ 3,518,513		$ 3,518,513
Deferred Revenue (including advance membership dues and magazine subscriptions)	1,623,126		1,623,126	1,463,327		1,463,327
Long-Term Debt	6,535,000		6,535,000	4,589,000		4,589,000
Fund Balance						
Unrestricted	10,873,698		10,873,698	8,154,603		8,154,603
Designated	1,631,653		1,631,653	2,363,146		2,363,146
Restricted		8,240,749	8,240,749		$7,635,753	7,635,753
Total Liabilities and Fund Balances	**$24,103,336**	**$8,240,749**	**$32,344,085**	**$20,088,589**	**$7,635,753**	**$27,724,342**

the Army Air Forces wanted to develop its own weapon. However, later on we did use the Navy's rockets on our P-51s.

R. E. O'Reilly
Fort Wayne, Ind.

A Reliable Partner?

I thoroughly enjoyed reading James E. Oberg's captivating article, "Yes, There *Was* a Moon Race" *[see April 1990 issue, p. 92]*. Bureaucratic problems still plague the Soviet space program, as evidenced by the recent failure of the Phobos mission to Mars. Fundamental changes in Soviet space policy and decision-making are a prerequisite before the United States can consider the USSR to be a reliable partner for a joint manned mission to Mars.

Capt. Christopher D. Zawodniak, USAF
Hanscom AFB, Mass.

A Gun to the Head

Before Capitol Hill decides to "bury" the list of base closures proposed by Secretary Cheney *[see "Capitol Hill," by Brian Green, April 1990 issue, p. 20]*, Congress should stand back and consider its own motives for allowing the proposal to "die on arrival."

It is clear that concern over closures of "Democratic bases" compared to "Republican bases" is a political attempt by Congress to manipulate the Pentagon.

What is the issue at hand? Are we concerned about deficit reductions, or are we concerned about some congressman's self-interest?

The House Armed Services Committee should realize that the Pentagon's putting a political "gun" to the heads of members of Congress is only reciprocity.

SSgt. Michael D. Warren, USAF
Ramstein AB, West Germany

Flight Officers in CAP

I enjoyed the article on the Third Lieutenants in the March 1990 issue *[see p. 100]*. It brought back stories that were told to me when I was a CAP [Civil Air Patrol] Cadet in the early 1960s. My CAP squadron commander was also a USAF Reservist who had been an enlisted pilot and then a flight officer. The young men and women of our unit could look up to him and the other officers who helped staff our squadrons. If we needed advice or someone to talk with, they were there.

Your readers might also be interested in knowing that the rank of flight officer is not dead. It is still used by the Civil Air Patrol; in fact, we use three grades of flight officer.

Lt. Col. Allan F. Pogorzelski, CAP
Pleasantville, N. Y.

Missing Aces

I notice the absence of two names from your list of American Aces of World War I in the Almanac issue of AIR FORCE Magazine. One is the name of A. Raymond Brooks, who had six victories in World War I and whose Spad XIII was restored at the Garber Facility in Suitland, Md., and is now on display in the Air & Space Museum.

I checked with Captain Brooks, who is now ninety-four and still very active, to confirm that none of his six victories was scored while he was a member of any of the organizations listed as having had victories deleted, and he confirms that fact.

Also missing from the list is the name of Kenneth Porter, now deceased, who also had six victories. Both these men are listed in *Fighter Aces* by Raymond F. Toliver and Trevor J. Constable, published by Macmillan in 1965.

I single out these two aces because I knew Ken Porter and I see Ray Brooks regularly. But apparently there are a great many others missing from your list. I counted 111 names on the *Fighter Aces* World War I list, and your list contains only thirty names.

I must say, I am curious over what created the great disparity.

Jack Elliott
Newark, N. J.

• *We have found that the passage of forty-five or even seventy years has done little to ease the controversy or contention surrounding the question of who is and who is not an ace. Faced with conflicting resources, we have chosen to rely on the USAF Historical Research Center as our definitive source. The list of aces in the Almanac issue was compiled with the aid of the Center's extensive records and documents. We acknowledge, however, that this controversy is unlikely to dim, even after another seventy years.*
—THE EDITORS

AIR FORCE ASSOCIATION
COMPARATIVE STATEMENT OF REVENUES AND EXPENSES

	Year Ended Dec. 31, 1989	Dec. 31, 1988
General Fund		
Revenue		
Aerospace Development Briefings	$ 1,207,079	$ 1,147,583
Building Operations	133,250	0
Convention	403,071	399,596
Data Processing Services	37,700	47,743
Industrial Associates	194,368	183,430
Insurance Programs	3,418,715	2,214,421
Investment	1,221,108	511,552
Land Rental	96,568	115,164
Magazine	2,862,002	2,941,112
Membership	3,107,445	3,239,581
Patrons	236,641	241,866
Other	605,252	534,434
Total Revenue	13,523,199	11,576,482
Expenses[1]		
Aerospace Development Briefings	505,032	506,664
Building Operations	650,777	0
Convention	738,245	557,133
Data Processing Service	90,949	174,055
Industrial Associate Program	111,000	114,081
Insurance Programs	3,387,509	3,006,135
Magazine	2,448,695	2,653,669
Membership	3,372,503	3,826,851
Patronship	239,187	293,194
Total Expenses	11,543,897	11,131,782
Excess (Deficit) of Revenue over Expenses	**$ 1,979,302**	**$ 444,700**
Life Membership Fund		
Revenue from Investments	601,424	520,629
Less: Transfer to General Fund for annual dues and other costs	580,496	552,559
Net Income (Loss), Life Membership Fund	**$ 20,928**	**($ 31,930)**

Treasurer's Note: The figures presented herein have been extracted from audited financial statements submitted previously to the Board of Directors of the Air Force Association.

[1]Expenses include chapter commissions, state commissions, and other direct support for field units totaling $602,233 in 1989 and $669,232 in 1988.

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Washington Watch

By John T. Correll, Editor in Chief

The Case for the B-2

You don't structure forces by intuition. You do it by matching weapons to target sets. Without the B-2, they may not match.

After a review of major aircraft programs last spring, the Pentagon announced a reduction, from 132 to seventy-five, in the planned production of B-2 Stealth bombers. Critics promptly attacked that decision as a half measure, arguing that the B-2 is unnecessary and unaffordable and ought to be canceled completely.

That kind of talk makes no sense to Gen. John T. Chain, Jr., who, as Commander in Chief of Strategic Air Command and Director of Strategic Target Planning, lives daily with the question of what's necessary and what isn't.

He says the B-2 is essential—more important, in fact, than modernization of the strategic missile force. At a press breakfast in April, General Chain said that the smaller fleet of seventy-five aircraft will be adequate by a "feather edge," but that if the program is cut much further, "my support for START [the Strategic Arms Reduction Treaty] will disappear."

His support for strategic arms reduction is *not* contingent on ICBM modernization, he said, although that would be "a good insurance policy for the nation."

General Chain told the Senate in March that even with START limits in effect, the Soviet Union will have "more than enough weapons for the initial attack." He has been on record for some time with the opinion that the United States "would be in sorry shape if we implemented START without the B-2."

The time is coming when Strategic Air Command must have either the B-2 bomber or a change in orders from the national command authorities. Without the B-2, SAC will not have enough weapons of the right kind to cover its assigned target sets, General Chain said at his meeting with reporters.

"If it wasn't for the budget driving it, the 132 number would never have come down," he said. "The budget drove it down, and what put the bottom line on 'you just can't go any lower' was the target base."

The weapons requirement mix is not some vague notion, with numbers picked out of the air. It is mathematically calculated against a specific list of targets, at specified probabilities of damage, in accordance with the Single Integrated Operational Plan (SIOP) and other guidance from the White House and the Pentagon.

"The target base can be divided into different categories that each have their own unique characteristics," General Chain told the Senate. "For example, some targets are time-urgent. They must be struck quickly. Others are highly defended.

"Still others are 'hard' targets that require weapons with high yield and accuracy, or 'broad' targets that still require high yield, but for which accuracy is not a premium. An especially complex target group are those that may or may not be at a given geographic coordinate—in other words, mobile targets, officially referred to as relocatable targets."

Some targets fall into what SAC calls the "look-shoot" category. "In this case, the bomber flies to the target," General Chain said. "Depending on the damage observed by the crew, they can strike it with a very accurate gravity bomb or short-range attack missile or pass it by and go to the next assigned target. Such targeting efficiency becomes even more important in a START environment of reduced strategic weapons."

It is not simply a matter of allocating ten weapons to ten targets. The strategic planner must calculate a string of probabilities, beginning with successful launch of a weapon and ending with expected damage to a target. If high probability of destruction is required in the case of a difficult, high-value target, several weapons may be assigned to it. Conversely, General Chain said, some targets "are bunched together, so one weapon may cover two or three of them."

In the aggregate, he said, the number of weapons required is higher than the number of targets, although the number of DGZs ("Designated Ground Zero" aiming points) is lower than the number of targets. The choice of weapon in a given instance depends on the characteristics of both the target and the weapons available.

The most logical weapon against time-urgent hard targets requiring speed, yield, and accuracy, for example, is the Peacekeeper ICBM. "Except for those targets that must be hit quickly, all target groups can be and are targeted with bombers," General Chain said.

While the B-2 is not specifically designed to attack strategic relocatable targets, General Chain said at the press session, the manned bomber is the only weapon system "today or tomorrow" that has "any hope" of carrying out such a mission.

Without a penetrating bomber of B-2 caliber, SAC will not be able to hold certain target groups within the Soviet Union at risk as air defenses become more efficient toward the end of the century. General Chain is less concerned that ballistic missiles might be rendered ineffective. "There's nothing happening inside the Soviet Union now or projected that's going to slow down the efficiency of an ICBM, whether it comes out of a silo, off a train, or out of the sea," he said. "They have not built systems to stop that."

The significant Soviet gains have been in countering the US bomber force. "Until a year and a half ago, we had 150 B-52Gs that could penetrate the Soviet Union," General Chain said. "We had to take them out of the penetrating role because they couldn't do it any more.

"A couple of years from now, we predict, we will have to take B-52Hs out of the penetrating role and move the B-1s out of the higher threat areas. Even though [the B-1s] will be able to

penetrate for many years, they won't be able to go into the same places that a B-2 can go."

The B-2 will also be important because of numbers. As General Chain said to the Senate, "Without the B-2, by the late 1990s we will have only ninety-seven penetrating bombers, and they will be effective only against the lesser defended targets." This concern would sharpen should a START treaty be adopted, limiting the number of ICBM and SLBM reentry vehicles. "If we eliminate the bomber, I've got 4,900 weapons," General Chain told reporters. "That isn't enough to do the job."

The value of each category of weapons, he said, must be weighed in three distinct time frames—deterrence, crisis, and wartime. Of these, Time Frame One, day-to-day deterrence of war, is the most important by far. In his Senate testimony, General Chain said that the United States can have a draw in war, as it did in Korea, or lose a war, as it did in Vietnam, but it can never afford to fight a nuclear war.

"I am not of the school that believes in nuclear warfighting," General Chain said. "I am of the school that if we end up in a nuclear war, we have lost. The war we have to fight is the war of deterrence."

In Time Frame One, he said, "I am very comfortable with ICBMs being in silos." The Soviet planner, looking at the United States, is confronted with 99.5 percent of the ICBMs on alert ("ready for a turn of the key at a moment's notice"), ballistic missile submarines deployed, and a significant share of the bombers on alert.

Fifty-five percent of the B-2 force will be on alert in peacetime, a considerably higher rate than for either the B-52 or the B-1. The B-2's mission at this point is to be loaded and ready so that it cannot be caught on the ground.

"If I were a Soviet planner," General Chain said, "there's no way, day to day, I can consider attacking the United States and thinking I could get away with it."

Should circumstances escalate to Time Frame Two, crisis, "we generate the rest of [the bombers] and also have the option of dispersing them to other airfields," General Chain said. "If it looks like the country is about to come under attack, we can launch them and put them airborne."

It is in the crisis time frame that mobile missiles reach their peak value and their greatest advantage over silo-based missiles. Moving mobile missiles out of garrison, "one at a time, a couple at a time, or flush them out where they can't be held at risk, is a defensive motion," General Chain said. "We don't add one warhead. No increase in offensive capability."

In his Senate testimony, he said that "making ICBMs mobile adds to stability so long as both sides do it. Because mobile systems are difficult to find, an attack against them is less likely. This means the world would be a more stable place."

If money were no object, General Chain said, he would like to have mobile missiles in his force, and his preference—budget considerations aside—would be the single-warhead MGM-134A Midgetman rather than the ten-warhead LGM-118A Peacekeeper in rail-garrison mode. "Because of funding, I prefer rail-garrison first, followed by the Small ICBM," he said.

Many of the targets remaining after an initial exchange would be mobile ones, against which the bomber force might be particularly effective.

He is not as concerned as some that US multiwarhead ICBMs are destabilizing. "People say it's such an attractive target," he said. "You can take out ten warheads with one- or two-warhead attackers. The Soviets are weapons-rich. I don't think they're going to worry about the posturing of our ICBMs. They've got more than enough weapons to do the task they need to do."

General Chain rejected a reporter's suggestion that he is bucking political policies that aim toward the eventual elimination of all MIRV (Multiple Independently Targetable Reentry Vehicle) warheads on land-based missiles.

He said that arms control is "the purview of the Washington community" and that his perspective is operational. He does not oppose eliminating multiwarhead missiles if that's what Washington wants to do. He added, however, that "I can't imagine the Soviets giving up their SS-18 or SS-24. They have built their land-based force around that. Except for the 200-plus SS-25s they have, they have postured their ICBM force to be a MIRVed force."

So far as US forces are concerned, he said, "I'm content with a MIRVed missile being in a silo during deterrence. I'm content with a MIRVed missile in a silo during warfighting."

The number of weapons mounted on a ballistic missile, like the missile's mobility, reaches peak significance during the in-between time frame of crisis.

Since a credible strategy of deterrence cannot be based on bluff, the United States must make plans for Time Frame Three, in which its strategic forces would go to war. Furthermore, it is the tangible preparations for this phase that set up meaningful deterrence in Time Frame One.

"We assume that the Soviets would probably not launch all of their weapons in the first volley," General Chain said. The expectation is that the Soviets would hold most of their mobile systems as a secure reserve.

US response against time-urgent targets would, of course, require use of ballistic missiles. Beyond that, either bombers or missiles might be used, and "the bomber carries the biggest warhead and has the option of warhead," General Chain said.

Many of the targets remaining after an initial exchange would be mobile ones, against which the bomber force might be particularly effective.

When a reporter expressed doubt that "a couple of pilots looking out their cockpit window, or with whatever aids they've got" could find relocatable targets, the General replied, "I have B-52s sitting alert today to go do exactly what you have just said."

Finding and attacking targets with aircraft is not a new idea. General Chain recalled his years of flying fighters and a mission "you call 'road recce.' You go search an area. You look out the window, and when you see it, you pop up and dive bomb it."

In time, B-2 crews may get more help from technology for the mobile target mission. As indicative of what might be possible, General Chain pointed to "absolutely remarkable" targeting information already produced by the synthetic aperture radar in the F-15E fighter-interdiction aircraft. He said a significant amount of money was being spent for research "on things that I can't go into."

Ideally, the B-2 mobile target system would be on some form of onboard sensor. General Chain said that "satellites are valuable, but they may or may not be there," since an enemy would make every attempt to destroy them early in the fighting.

Standoff weapons are useful, but not a complete solution. "The Advanced Cruise Missile, which has stealth characteristics, will have increased range and accuracy," General Chain said in an interview with *Airman* Magazine earlier this year. "But it must be programmed before leaving ground, and it cannot outthink defenses or know a target has been moved or destroyed. A manned penetrating bomber can recognize those things and deviate to accomplish missions. I'm not denigrating cruise missiles. It's just that every weapon system has its strengths and weaknesses. Total reliance on cruise missiles would be unwise."

One of the most pervasive arguments against the B-2 has been that it is too expensive. There is disagreement among the Pentagon, the Congressional Budget Office, and others about the total cost of the program. When the Defense Department proposed cutting back to seventy-five aircraft, critics were quick to state the obvious by pointing out that unit cost per aircraft would be higher than for a 132-bomber program.

In General Chain's view, the relevant measure of affordability should be *cost to go*. "The factory's been built, the engineering's been done, the tooling has been developed and is in place," he said. "If we had to write a check today [for the remaining cost] to get seventy-five B-2s, it would be for $28 billion."

He contrasted this expense for 1,300 "very flexible weapons" to the remaining cost of $28 billion for 500 weapons with Midgetman and said, "I don't hear anybody bad-mouthing the Small ICBM because of its cost to go." Cost to go for the Peacekeeper rail-garrison program, which would also provide 500 warheads, is about $4.7 billion, he said.

General Chain said that he supports Midgetman and thinks that ICBM modernization generally would be worth the money. Peacekeeper in rail-garrison deployment would be "an inexpensive way to get some mobility for these systems."

In his testimony to the Senate, General Chain described a "theoretically perfect force structure." It would consist completely of accurate, high-yield weapons with one warhead per delivery system—single-warhead ICBMs, one warhead per stealth bomber, one single-warhead missile on each submarine—full Strategic Defense Initiative protection, and air defenses situated well forward.

Such a force structure is obviously not possible, so defense planners must compare the relative value of investments. "I don't think we can spend money and buy more combat capability than to write a check for the B-2," General Chain told reporters.

Major changes in the strategic target set are possible, of course, but so far, there is little except optimistic speculation to suggest that this will happen.

"Strategic forces must provide certainty of US retaliation against what an aggressor most values under all scenarios. This is the essence of deterrence."

While the Soviet Union has made big cuts in its conventional force structure, strategic force modernization continues apace. In framing his alternative defense strategy this spring, Sen. Sam Nunn (D-Ga.), Chairman of the Senate Armed Services Committee, said he found Soviet behavior on strategic forces troubling, "if not inexplicable."

Two theories are generally offered to explain Soviet persistence in regard to nuclear forces. One is that the USSR intends to keep these forces relatively intact to guarantee its continued status as a superpower. The other theory holds that the Soviets are awaiting the next five-year plan to implement strategic force reductions.

In his *Airman* interview, General Chain said that "assuming a START agreement is in effect by 1997, [the Soviets] would have 100 percent modernized ICBMs, 100 percent modernized sea-launched ballistic missiles, and a ninety percent improved bomber force. They have structured their game plan for the advent of a START environment."

The SIOP is constantly reviewed and updated, and the target list changes, sometimes daily, General Chain said. Basic guidance comes from the White House. The next level of detail is determined by the Secretary of Defense, acting as agent for the President. The Joint Chiefs of Staff also participate in SIOP review.

"We actually have three SIOPs going at one time," General Chain said. "We have the one that's in being. We have one that will come into effect this coming October. And then we're working on the one that will come into effect in October 1991."

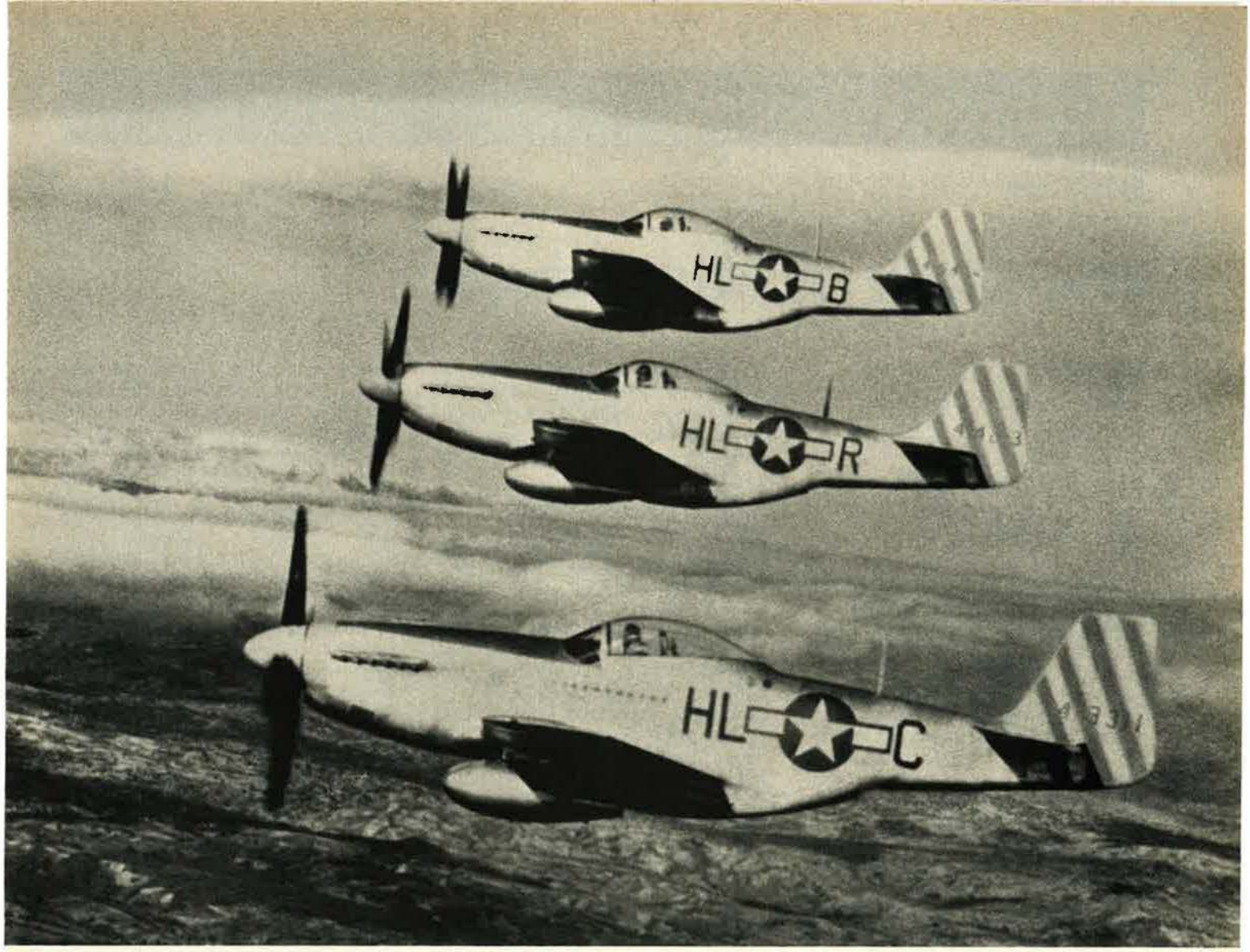
The Pentagon has people working full-time on SIOP policy, with a steady exchange of data flowing between Washington and SAC headquarters at Offutt AFB near Omaha, Neb. General Chain said that his headquarters makes regular adjustments—called "maintenance"—to the plan. If the Soviets pull a weapon from a silo today and take down the headworks, that silo comes off the target list tomorrow.

General Chain said that he has received no guidance leading to a major change in target sets or damage expectations against those target sets. "I don't see any review going on currently that will reduce the target list significantly against the current guidance," he said.

In his testimony to the Senate, General Chain reviewed the principles that, "regardless of changing doctrines or changing threats," are fundamental to a strategy of deterrence.

"To deter, the US must convince any potential adversary that they cannot achieve their aims by attacking American interests—that the costs far outweigh any potential gains," he said. "It is the aggressor's perception of US nuclear strength that determines if they will even consider attacking US interests or not. Because our national interests and potential challenges to those interests are worldwide, the US needs strategic forces capable of influencing events and thereby defending and sustaining those interests anywhere, anytime, at any level. Thus, the need for rapid power projection, escalation control, and earliest termination of hostilities on favorable terms will remain fundamental objectives of US forces.

"Offensive weapons will remain essential to these objectives. Deterrence based solely on defenses, for example, ensures that the worst thing that can happen to an aggressor is that his attack fails—in effect, he loses nothing, and stands to gain substantially, in any challenge to US interests. Strategic forces must provide certainty of US retaliation against what an aggressor most values under all scenarios. This is the essence of deterrence." ■



WHY DO WE NEED ANOTHER AIR SUPERIORITY FIGHTER?

In 1944 the P-51 Mustang was the meanest fighter in the sky, widely considered the pinnacle of air superiority. By war's end, though, the Mustang was being nudged into obsolescence by jet propulsion. And by 1952, F-86 Sabrejet and MiG-15 fighters had ascended the P-51's throne.

After WWII, America could have succumbed to the complacency that follows victory. Thankfully, the architects of American air power envisioned the future of air superiority and got there first with the F-86. Had we not kept pace with technology, the U.S. Air Force would have been woefully outgunned in a conflict no one expected: the Korean War.

As we approach the end of the 20th century, there is a lesson to be learned from history. Air superiority is still the lifeblood of conventional military strength. The prospect for peaceful coexistence between the superpowers is greater now than at any time since the end of WWII. Nonetheless, technology continues its ceaseless advance. This is no time for complacency.

Beyond-visual-range missiles, new radar advances, and the emergence of stealth technology demand an advanced tactical fighter to carry the banner of air superiority into the 21st century. Lockheed, Boeing and General Dynamics have forged the solution: the F-22. It is an advanced and affordable air superiority fighter with unparalleled capabilities. Agile, stealthy, and deadly, if called upon.

Does America need another air superiority fighter? The answer is unequivocal. It's the same today as it was in 1950.

F-22 ADVANCED TACTICAL FIGHTER
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Capitol Hill

By Brian Green, Congressional Editor

The Math of Midgetman

Senator Gore says arms-control numbers point us toward the Small ICBM. Other options to fit strategic forces within treaty limits are too risky, he believes.

Arms-control arithmetic is driving the US toward deployment of the single-warhead Midgetman Small ICBM, says Sen. Albert Gore, and he believes that he's got the numbers to prove it. Senator Gore, a Tennessee Democrat on the Senate Armed Services Committee, is a longtime Midgetman supporter.

Senator Gore, in a recent speech on the Senate floor, noted that, in the current START (Strategic Arms Reductions Talks) framework, the US will be limited to 4,900 ballistic missile warheads. Within that limit the US will have to fit both its submarine-launched ballistic missile (SLBM) force and its land-based ICBM force. The Navy, Senator Gore pointed out, wants to deploy twenty-one "START-accountable," *Ohio*-class Trident ballistic missile submarines. Each Trident boat carries twenty-four missiles, each armed with eight warheads. If all twenty-one are deployed, he said, the US "ICBM force [would have to] be cut from today's level of 2,450 to less than 900 warheads."

That, said the Senator, would be equivalent to "putting all our eggs in one basket" and would be a bad idea for several reasons. To rely almost exclusively on SLBMs to fulfill ballistic missile missions, one must assume that SLBM performance will improve and have faith that submarine-borne systems will not experience serious systemic failures. Furthermore, argued the Senator, "with all of the advances in science and technology, it would be foolhardy to assume that submarine survivability will continue indefinitely just as it exists today."

Senator Gore viewed as more positive the approach explored in a Congressional Research Service report. It postulates a force of eighteen Trident submarines and 1,400 ICBM warheads. The Pentagon has requested authorization for the eighteenth Trident boat in the Fiscal Year 1991 budget now under consideration and long lead funds for the nineteenth and twentieth. "With each successive Trident that Congress approves . . . the more firmly we will commit the strategic forces of the United States to a fundamental realignment of missions," said Senator Gore.

He sees even tougher problems ahead. If a follow-on to the START agreement cuts just another 1,000 ballistic missile warheads and Trident production continues, the US could end up with a ballistic missile force with just fifty Peacekeeper ICBMs on land. Furthermore, Senator Gore believes, reductions in multiwarhead missiles may well be a prominent goal of START II.

Senator Gore contends that the arms-control process should have a central role in the shaping of US strategic forces. "The decisions Congress is shortly going to make must not only fit intelligently into a START agreement, but must potentially accommodate a range of possible options for a START II agreement. . . . Not every force posture that fits well into START will fit well into START II." He believes we should "avoid wasting money and effort" on programs that might be accommodated in START I but not in START II.

Senator Gore's bottom line is that "the United States will need the flexibility and survivability of single-warhead, mobile ICBMs as the means to organize a balanced nuclear deterrent in a successor agreement to START. . . . Any decision that Congress makes [that] eliminates this option now not only weakens the forces we will have after a START agreement, but casts a long and spreading shadow over our ability to pursue strategic arms control beyond START."

The Air Force still supports the two-missile ICBM modernization program, an approach that includes both rail-garrison basing for the Peacekeeper ICBM and continued development of Midgetman. Despite persistent reports that ICBM modernization might be eliminated in the future or that Air Force leadership will start to focus on single-warhead, silo-based ICBMs, there are no clear signals that such radical policy changes will take place soon.

Few in the Air Force would agree with the notion that incomplete arms negotiations should guide strategic programs. At the same time, however, Gen. John T. Chain, Jr., Commander in Chief of Strategic Air Command, does not oppose an arms-control-driven elimination of multiwarhead missiles. He has also testified that in the "theoretically perfect force structure . . . all land-based ICBMs would be single-warhead [and] mobile."

That theoretical force is, as General Chain said, out of fiscal reach. The Air Force continues to say that for reasons of cost it prefers the rail-mobile Peacekeeper. Midgetman, the Air Force believes, should come later.

The Small ICBM's cost will loom larger in the aftermath of potentially damaging cuts to the defense budget now incorporated into the House and Senate budget resolutions.

The Senate Budget Committee approved a budget resolution that cuts proposed defense outlays for FY 1991 (the amount that will actually be disbursed in FY 1991) by almost $10 billion, from the Administration's $303.3 billion to $293.9 billion. Sen. James Sasser (D-Tenn.), chairman of the Committee, supports an even lower outlay figure—$291 billion.

The House of Representatives narrowly passed a budget goal that cuts $8 billion in defense outlays and $24 billion in budget authority from the President's request. The plan aims at reducing real (inflation-adjusted) defense spending by about twenty-five percent over five years, with a view toward deeper cuts in the future. Differences between the House and final Senate resolution will have to be resolved in a House-Senate conference.

Secretary of Defense Richard Cheney indicated in congressional testimony that cuts of this magnitude would be very damaging to DoD programs. ■

STRAIGHT AND LEVEL

The Hawk, and soon the T-45A Goshawk, will be putting more and more student pilots straight into the front line. Thanks to the power of the Rolls-Royce F405 turbofan, they're trainers that combine safety and reliability with low fuel burn and high thrust. That all adds up to low cost, high quality training programmes for armed forces worldwide.

The Adour/F405 has over 3 million flying hours to its credit. Time and time again the engine demonstrates its dependability. With the world famous Red Arrows display team; or on the 80,000 mile deployment to the Australian Bicentennial Air Show, where two Hawks completed every sortie on schedule; but most of all, in every day use.

In service as advanced trainers in four continents, the Hawk and the T-45A will lead their students straight to the controls of the world's finest combat aircraft – the F-14, F-15, F-16, F-18, Harrier II, Tornado and A-12 – backed by the safe, reliable and economical power of the F405.

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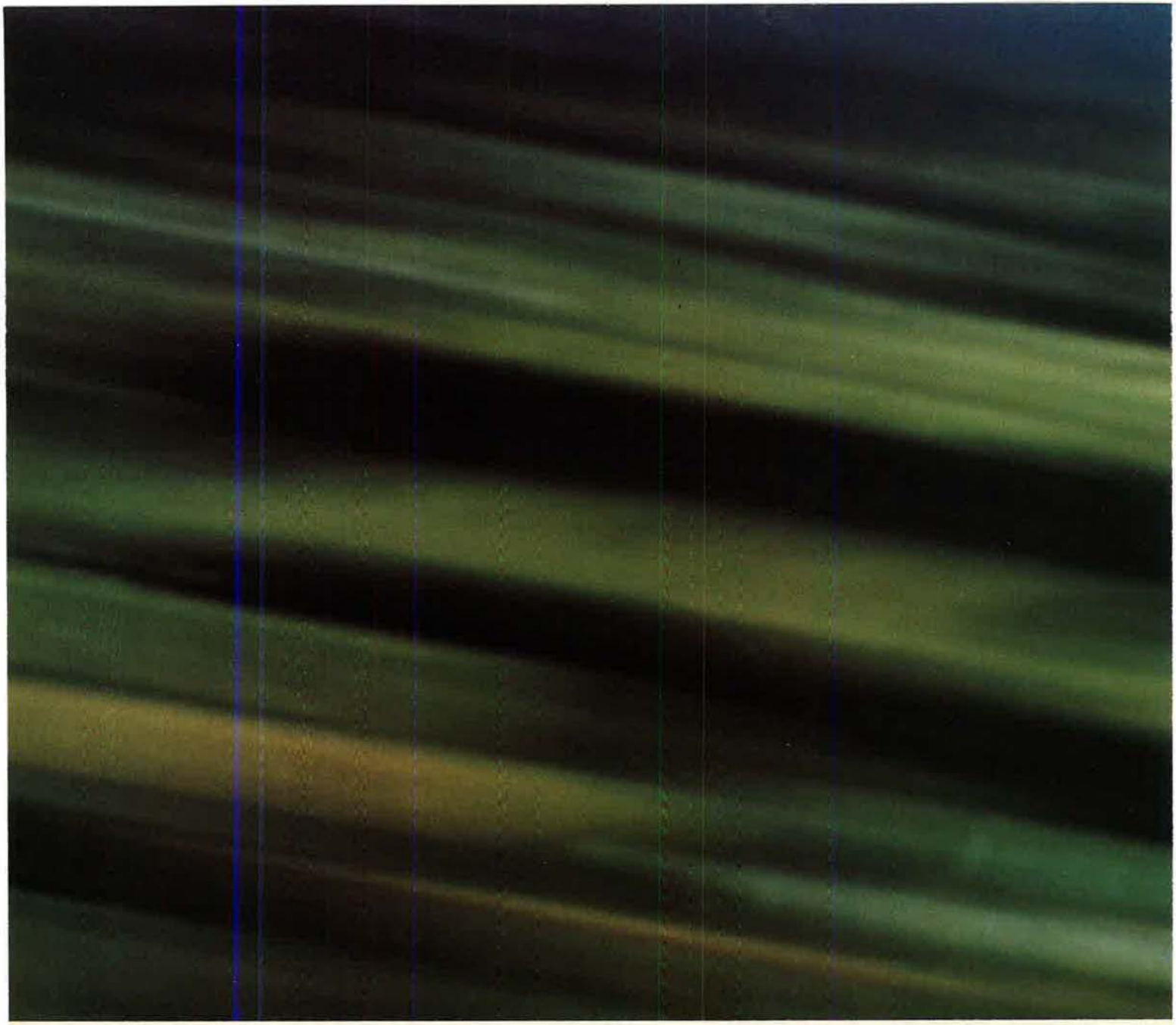

A round trip ticket into hostile territory:

Surface-to-air missile threats against tactical aircraft have grown more sophisticated. That means the U.S. Air Force needs improved self-protection capabilities for its aircraft.

The answer: Raytheon's ALQ-184. An update of an existing ECM jamming pod, the new system will enable aircraft to cope with any foreseeable radar-guided threat right through the 1990s.

The key to the ALQ-184 is Raytheon multibeam technology. Through its use, the older pod's single high-power transmitter tube was replaced by a bank of reliable mini-tubes that feed a high-gain antenna array.

Results: The new system has greater sensitivity, faster response time, and higher effective radiated power. It can detect threat signals and direct high-power jamming signals against multiple hostile radars.

And because the ALQ-184 uses multiple mini-tubes instead of a single big one, even the loss of several tubes will not disable the system.

Fully maintainable by Air Force personnel, the ALQ-184 and its support needs are now in production. It's another example of how Raytheon's

the ALQ-184.

long experience with system fundamentals can improve an older system's capabilities.

For more information, write Raytheon Company, Government Marketing, 141 Spring Street, Lexington, MA 02173.

The ALQ-184 jamming pod is being deployed on U.S. Air Force F-4s and F-16s.

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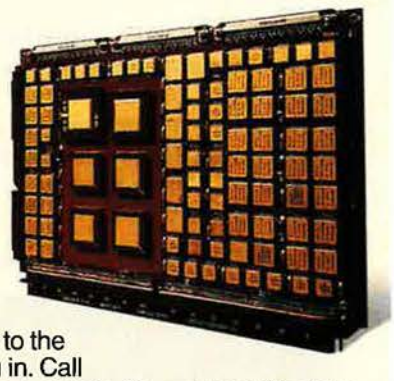

Control Data's new high performance data processor is already on board major Department of Defense programs.

It's called the Advanced Modular Processor (AMP) system. It combines a proven 32-bit RISC central processing unit, Ada software, and Control Data's MIL-SPEC packaging and manufacturing expertise. The result is a low-risk, fully militarized system with up to 20 times the performance of other systems.

The AMP system can be configured with one or multiple processor modules to meet your needs today, while allowing flexibility for change in mission requirements as well as planned technology insertion. And with proven off-the-shelf technology, your life-cycle costs are kept to a minimum.

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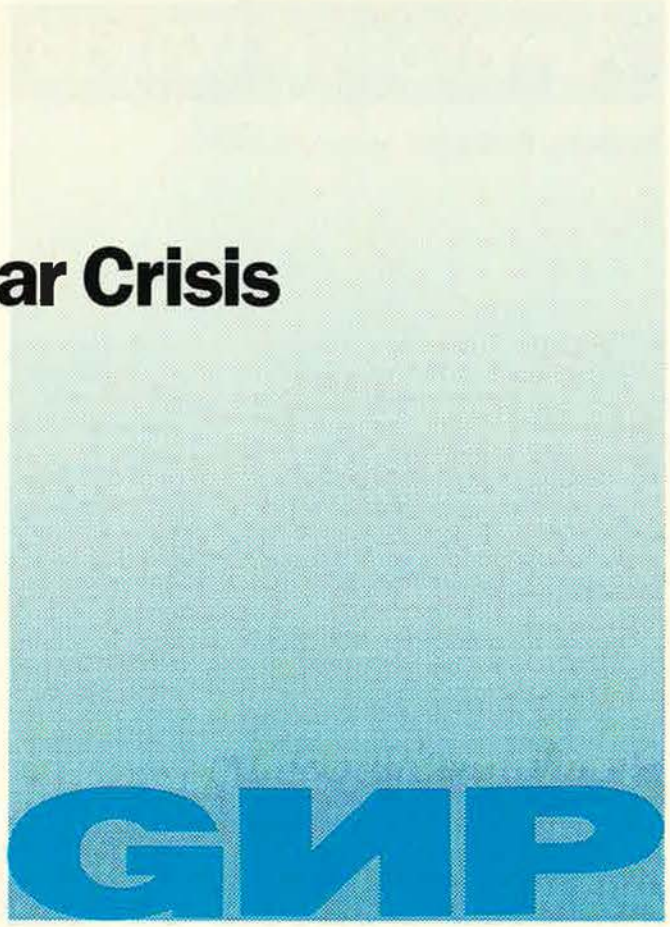
CONTROL DATA

Problems include bad planning and bad policy, aggravated by bad luck.

Soviet Economy Near Crisis



LAST August, a survey of state stores in the Soviet Union found that only 200 items from a list of 1,200 standard consumer goods were readily available. By the end of the year, the number of such items readily available had fallen to fifty. Prices were up by at least six percent, and some estimates pegged consumer inflation running as high as eleven percent.

The problems of the Soviet economy reached near-crisis proportions in 1989 as "the combination of inflation and shortages made daily life miserable for all but the most privileged segments of society," according to a US intelligence estimate published April 20.

Because of breakdowns in transportation and distribution, goods piled up in warehouses and on freight cars while store shelves were empty.

Even some of the good-sounding news was bad for Soviet leader Mikhail Gorbachev. Meat production, for example, was up by two percent—but part of that was attributable to slaughter of livestock because of a shortage of feed.

In their annual report to the Joint Economic Committee of Congress, the Central Intelligence Agency and the Defense Intelligence Agency said that conditions are likely to worsen in the year ahead and that long-term recovery would be a "tall order." They rate the situation as being so unstable that "a single major event could lead to a substantial drop in output and bring about chaos in the distribution of both producer and consumer goods."

Soviet economic failure, states the report, is the result of unrealistic planning and mistaken policies, aggravated to some extent by bad luck.

Attempting to increase the availability of consumer goods, Soviet officials continued their efforts to rechannel defense industries into civilian output. The results are not impressive. The US intelligence estimate predicts that production of consumer goods by the Soviet defense industry will not come close to the goal assigned for 1990. Mostly, plant managers have been told to convert their lines—but they have been given neither guidance on how to do it nor resources with which to retool.

As a result of the conversion program and reduction in the armed forces, overall Soviet defense spending fell by about five percent (adjusted for inflation) between 1988 and 1989. The biggest procurement cuts were in equipment for the land forces. Military spending is expected to decline through 1995.

The Soviet economic system seems to be a chain of weak links, synergistically dragging each other down. For example, closer examination of the transportation system—identified as a major culprit in the failure to get goods to market—finds that diesel locomotive production is down, mainly because of shortfalls in deliveries by the only manufacturer of crucial electrical parts.

The backlog of uncompleted construction projects grew in 1989. Additions to new capacity were far below plan in many industries, especially in the fuels and energy sector, which experienced a decline in total production for the first time since the 1940s.

Local authorities introduced rationing in many parts of the Soviet Union. Instances of strikes and other expressions of popular discontent are rising. The report says economic conditions may have been a factor in the upsurge of crime last year. Soviet authorities said that the total number of crimes increased thirty-two percent in 1989 and that thefts and violent robberies were up by seventy percent.

Aided by favorable weather and a good harvest, the Soviets were able to push aggregate production of goods and services to a level 1.5 percent higher than in 1988, but the intelligence report says "the match between what was produced and what consumers wanted widened considerably."

In one area, however, output rose by a big margin on a product that the consumers obviously did want. Mr. Gorbachev has apparently bowed to the inevitable and given up on his enforced temperance campaign. Production of alcoholic beverages increased by almost twenty percent in 1989. ■

Aerospace World

By Jeffrey P. Rhodes, Aeronautics Editor

★ The Air Force released artists' concepts and some further details about the two competing Advanced Tactical Fighter (ATF) prototypes at a Pentagon press conference on May 15. The disclosure was made before the two contractor teams began outdoor engine tests. The contractors will show the actual aircraft in separate unveilings scheduled for this summer.

The ATF will replace the McDonnell Douglas F-15 in the air-superiority role and is designed to make use of low-observable, or stealth, characteristics while retaining maneuverability. Both the Lockheed/Boeing/General Dynamics YF-22A and the Northrop/McDonnell Douglas YF-23A are to be twin-tailed, twin-engine fighters, but little detail was shown. The engine intakes and exhausts, highly radar-reflective in nonstealth aircraft, are obscured in the drawings.

The program is in the final year of a fifty-four-month demonstration/validation phase. Each team will build two airplanes and fly them in head-to-head competition for the right to proceed into full-scale development. Pratt & Whitney and General Electric are also competing to provide engines for the ATF. One airframe contractor team and one engine builder will be selected to proceed to FSD next summer.

Both aircraft will carry AIM-9M Sidewinder and AIM-120A Advanced Medium-Range Air-to-Air Missiles, as well as what was termed a "proven gun"—likely the M61A1 gun used in the F-15 and F-16.

Projected flyaway cost of the production ATFs is $43.5 million each, with a total program cost of $53.8 billion for 750 aircraft in FY 1985 dollars. In current dollars, the figures are $51.3 million per copy and a total cost of $63.5 billion. Under the major aircraft review just completed, the total ATF buy was not cut, but each yearly buy was reduced, and the program was stretched out. Production is now scheduled to start in 1996.

The Navy is working closely with the Air Force to develop a version of the ATF that will take advantage of commonality of engines, avionics, materials, and manufacturing processes. More involved development work on the NATF will begin once one airplane is downselected for FSD.

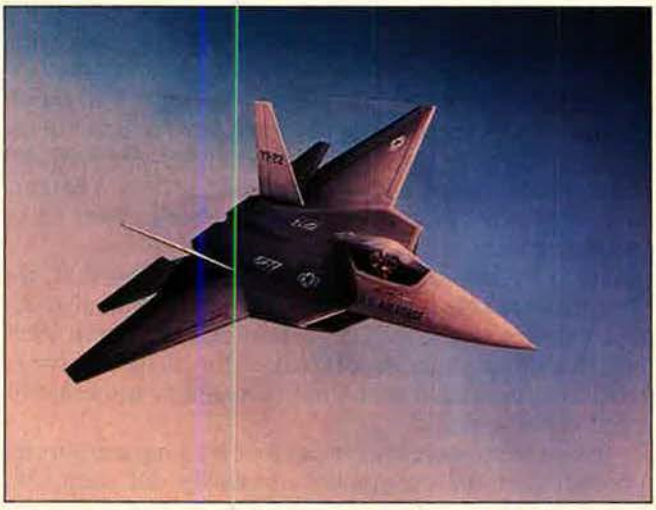
★ On May 4, the Hughes/Raytheon AIM-120A Advanced Medium-Range Air-to-Air Missile passed with flying colors a retest of its most demanding challenge. This test demonstrated the missile's ability to achieve multiple kills against multiple targets.

The test of four missiles vs. four targets (the so-called "World War III shot") in an electronic countermeasures environment over the Gulf Test Range near Eglin AFB, Fla., resulted in three direct hits and a lethal near-miss. In the same test last August, all four missiles missed by a wide margin.

The AIM-120As were launched from an F-15 flying at 15,000 feet at a speed of 650 mph. The four oncoming QF-100 drones were traveling at near Mach 1 but at lower altitudes than the shooter. Additional aircraft were in the area to attempt to jam the radar on both the F-15 and its missiles.

All four AMRAAMs were launched within seconds of one another. Two of the twelve-foot-long missiles were fired at QF-100s flying at 10,000 feet, while the other two missiles were loosed against a pair of drones flying at 5,000 feet. The second two targets were also carrying on-board jammers. The missiles guided correctly, and the F-15 pilot was able to make evasive maneuvers seconds after the last missiles left their stations.

The success was made possible by



The Air Force released these artists' concepts of the two Advanced Tactical Fighter prototypes in mid-May. Little detail was revealed about either the Lockheed/Boeing/General Dynamics YF-22A (left) or the Northrop/McDonnell Douglas YF-23A (right). The two aircraft will be pitted against each other in a fly-off; one airframe team and one engine builder (either General Electric or Pratt & Whitney) will be selected next summer to proceed to full-scale development.

correcting the F-15's targeting and tracking computer software and modifying the missile-guidance software.

★ After a scheduled layup that began last November 28, the Northrop B-2A Stealth bomber resumed its flight-test program at Edwards AFB, Calif., with four flights in less than a month this spring.

The flight on April 27 (the plane's ninth) lasted six hours and five minutes and was dedicated to systems checkout in preparation for further envelope-expansion testing. The crew took the aircraft to an altitude of 35,000 feet and a speed of 325 knots. It was refueled four times in midair by a KC-10 tanker crew.

The May 3 flight marked the first time an all–Air Force crew (Lt. Col. Tom LeBeau and Lt. Col. John Small) had flown the plane. During the flight, which lasted seven hours and twenty minutes, the B-2 reached a speed of .76 Mach and an altitude above 35,000 feet. In addition to envelope expansion testing, acoustic measurements and aerial refuelings were also carried out.

The eleventh flight was cut short because of high winds, and the B-2 was only aloft for three hours and forty-three minutes. Northrop pilots Bruce Hinds and Leroy Schroeder crewed the plan on the flight. Two aerial refuelings were made from a KC-10.

The fourth of the five to seven planned flights in this phase of the test program took place on May 17. Col. Frank Birk and Mr. Schroeder crewed the bomber on this six hour and thirty-six minute flight that included three aerial refuelings and performance tests with different centers of gravity at different speeds and altitudes. The flight brought the B-2's flying time to more than fifty-five hours.

Prior to the resumption of flying, hairline cracks were discovered in the plane's titanium aft deck near the engine exhausts. The cracks, believed to have been caused during engine runups, have been fixed. A long-term solution to the problem of thermal expansion in those areas is being explored.

In other B-2 news, the second aircraft is scheduled for completion by early fall. Northrop President and CEO Kent Kresa said in a speech to stockholders that each of the first eleven aircraft is more than fifty percent complete.

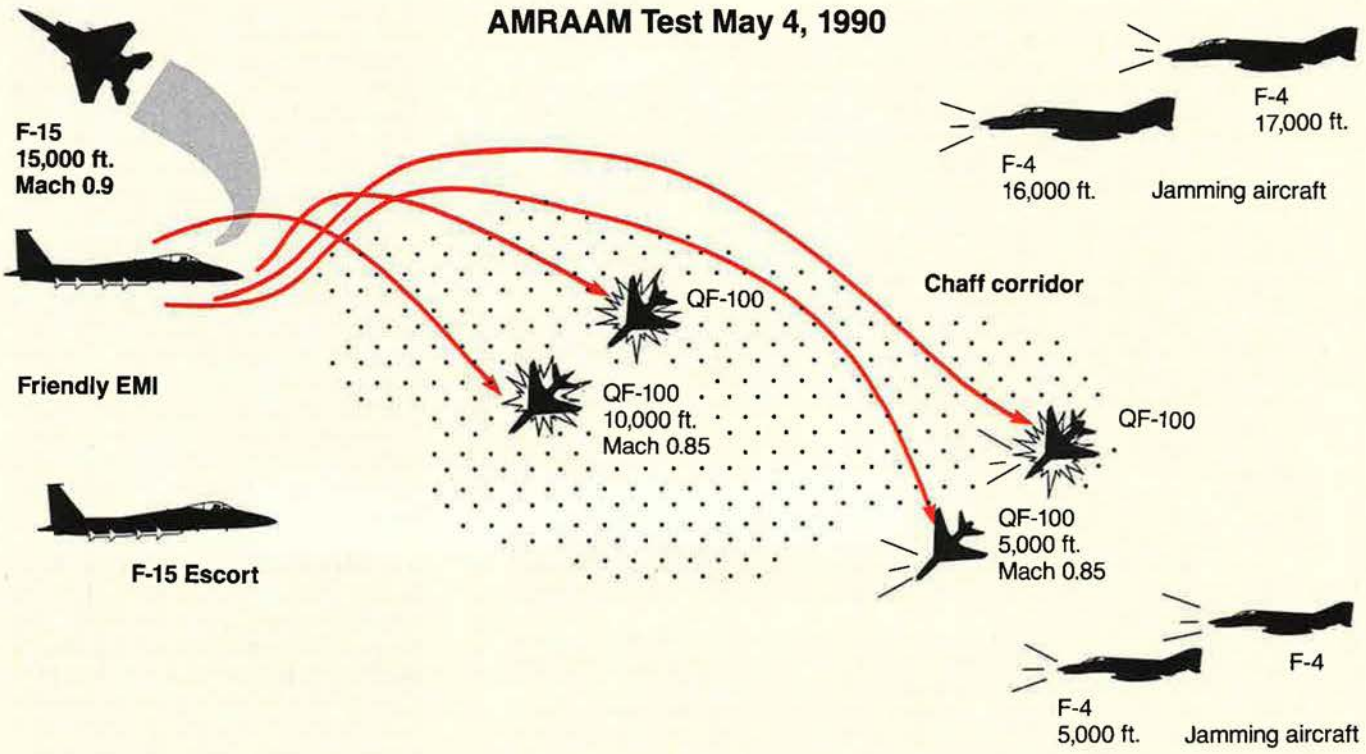
Also, members of the B-2 System Program Office at Wright-Patterson AFB, Ohio, braved a midwinter trip to Loring AFB, Me., and an early spring trip to Ellsworth AFB, S. D., to see firsthand how difficult it is to work in harsh climates. The B-2 SPO plans to modify existing weapons diagnostic units now used on B-52Gs for use with the B-2. This move is expected to save $14 million in acquisition costs.

★ An instructor, a rocket pilot, an engineer, and an innovator will all be enshrined in the National Aviation Hall of Fame in Dayton, Ohio, this month. These inductees bring the total number of aviation notables in the Hall to 130.

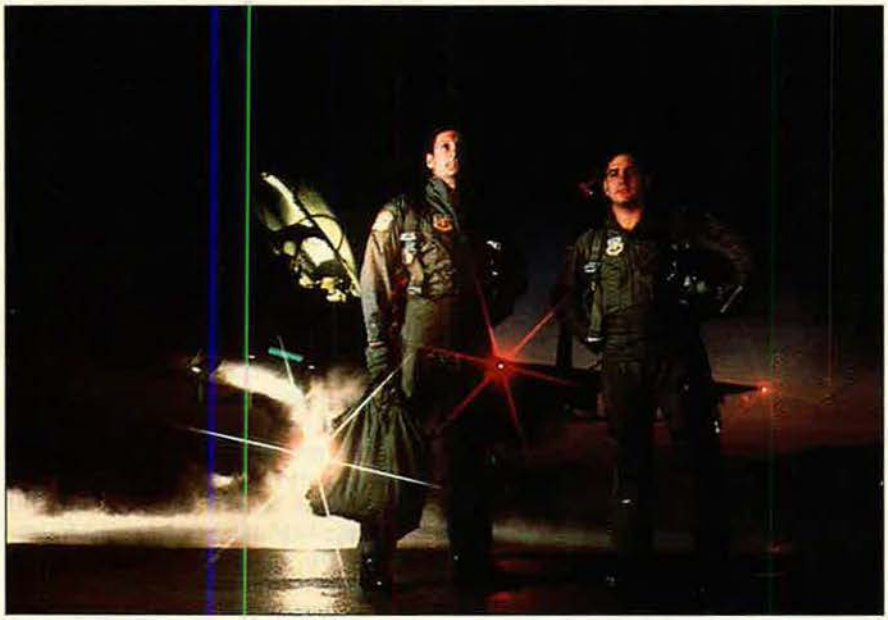
This year's Hall of Famers:

Elrey B. Jeppesen (born 1907) is famous for his development of manuals and charts that allow pilots to fly safely. While flying with the airlines, Mr. Jeppesen compiled information in a small notebook. He sold copies of his information to other pilots, and a cottage industry was born. After World War II, the demand for his "Airways Manual" soon made Mr. Jeppesen the world's leading aerial cartographer. The company he founded in his basement is now Jeppesen-Sanderson Co., one of the leading publishers of air navigational information and flight training systems.

Robert A. Rushworth (born 1924) is most famous for his record thirty-four flights in the North American X-15. He was the second Air Force pilot to attain astronaut wings for reaching an altitude greater than fifty miles. Also noted for his work in development, he



This is a diagram of the test of four missiles vs. four targets in an electronic countermeasures environment that was successfully carried out May 4 with the AIM-120A Advanced Medium-Range Air-to-Air Missile over the Gulf of Mexico. The first three missiles recorded direct hits, and the fourth passed within lethal range of the QF-100 targets.



TSgt. Mike Haggerty, a photographer assigned to Airman Magazine, was named Military Photographer of the Year in DoD's 1989 Military Pictures of the Year competition. His work (an example of which is shown here) was judged best from the field of 110 military photojournalists. SSgt. Alan Wycheck and TSgt. Bob Simmons gave the Air Force a sweep of the top three places, a first for the competition.

July Anniversaries

• *July 9, 1910:* Walter Brookins becomes the first airplane pilot to fly at an altitude greater than one mile. He reaches 6,234 feet in a Wright biplane over Atlantic City, N. J.

• *July 15, 1925:* The Dr. A. Hamilton Rice Expedition, the first group of explorers to use an airplane, returns to the US. The expedition, which used a Curtiss Seagull floatplane, discovered the headwaters of the Amazon River.

• *July 28, 1935.* Company pilot Les Tower makes the first flight in the Boeing Model 299, the prototype of the famed B-17 Flying Fortress. A company-funded effort, the airplane cost $432,034 and was developed in less than a year.

• *July 10, 1940:* The Luftwaffe begins making attacks on British shipping in the English Channel and limited raids against docks in South Wales. These actions are the first in what would become the Battle of Britain.

• *July 16, 1945:* At 5:29:45 a.m. Mountain War Time, the world's first atomic bomb is successfully detonated at Trinity Site, a desert location near Alamogordo, N. M. The weapon (referred to as "the gadget") was the prototype of the Fat Man plutonium bomb and had an explosive yield of nineteen kilotons.

• *July 24, 1950:* The first rocket is launched from the Joint Long-Range Proving Grounds at Cape Canaveral, Fla. The rocket, called Bumper 8, has a V-2 missile as its first stage and a WAC (Without Any Control) Corporal booster as its second stage.

• *July 11, 1955:* The first class of 306 cadets is sworn in at the Air Force Academy's temporary location at Lowry AFB, Colo.

• *July 20, 1960:* The first Lockheed UGM-27 Polaris sea-launched ballistic missile underwater launch is successfully carried out from the USS *George Washington* (SSBN-598) off the coast near Cape Canaveral AFS, Fla.

• *July 7, 1965:* Rockwell rolls out the first OV-10A Bronco counterinsurgency aircraft in ceremonies at its Columbus, Ohio, plant. First flight came on July 16.

• *July 8, 1965:* Famed Hollywood pilot Paul Mantz dies in a crash of a makeshift aircraft at Buttercup Valley, Ariz., during filming of the movie "Flight of the Phoenix." He was sixty-one.

• *July 10, 1965:* Two 45th Tactical Fighter Squadron crews, flying McDonnell Douglas F-4C Phantom IIs, record the first Air Force air-to-air victories in Vietnam. The four airmen combine to down two North Vietnamese MiG-17s.

• *July 15–24, 1975:* US astronauts Tom Stafford (a USAF brigadier general), Vance Brand, and Donald "Deke" Slayton meet Soviet cosmonauts Alexei Leonov and Valeri Kubasov in orbit during the Apollo-Soyuz test project. At fifty-one, Mr. Slayton, one of the original seven US astronauts, becomes the oldest man to fly in space. This is the last US manned mission until the first space shuttle launch in 1981.

served as AGM-65 Maverick program director, commander of the 4950th Test Wing, and later vice commander of AFSC's Aeronautical Systems Division, both at Wright-Patterson AFB, Ohio, and commander of the Air Force Flight Test Center at Edwards AFB, Calif. He has more than 6,900 flying hours in fifty types of aircraft. He retired from the Air Force in 1981.

Robert M. Stanley (1912–1977) was a pioneering developer of aircraft and survival equipment. An engineer by training and trade, he received his aeronautical engineering degree with honors from Cal Tech, working at Douglas to pay his tuition. After a stint as a Naval aviator, he started work at Bell and became the company's chief test pilot and later chief engineer. He started his own firm in 1948 and was responsible for downward-firing ejection seats, automatic-release lap belts, and the encapsulated escape seats used in the Convair B-58. He also set several sailplane records, including the US altitude record.

Dr. Hans P. von Ohain (born 1911) is credited, along with Sir Frank Whittle, with having co-invented the jet engine. He designed the HeS.3B engine that powered the world's first jet airplane, the Heinkel He-178, in 1939. He received a number of patents in the field of radial and axial-flow turbojet engines. He emigrated to the US in 1947 and became a research scientist at Wright-Patterson AFB, Ohio. He became chief scientist of the Aerospace Research Laboratory in 1963 and chief scientist in the Aero Propulsion Laboratory in 1975. He retired in 1979 and became a professor at the University of Dayton Research Institute.

In a related note, the National Museum of Naval Aviation at NAS Pensacola, Fla., inducted six people into its Hall of Honor in May. Induction ceremonies are held biennially. The new honorees are Coast Guard Capt. Frank A. Erickson, Navy Capt. Henry C. Mustin, Adm. James S. Russell, Rear Adm. Alan B. Shepard, Jr., Igor Sikorsky, and George A. Spangenberg.

★ **APPOINTED—Dr. William W. L. Taylor,** a researcher and assistant department manager with TRW, was named **chief scientist for the Space Station *Freedom*.** He will be the principal advocate for the space science community in the space station program. Dr. Taylor is the third person to hold this two-year job.

★ **AWARDED**—The Air National Guard Noncommissioned Officer

Academy Graduate Association awarded its **Maj. Gen. I. G. Brown Command Excellence Trophy to Lt. Col. John Birosak** (New Mexico ANG), **Lt. Col. Marinus M. Optiz** (Oregon ANG), **Col. Frank C. Khare, Jr.** (South Carolina ANG), **Col. Gregory J. Maciolek** (Michigan ANG), **Col. Gale O. Westburg** (South Dakota ANG), and **Brig. Gen. Robert G. Chrisjohn, Jr.** (Pennsylvania ANG). The Command Excellence Trophy goes annually to ANG commanders who have performed in an exemplary manner during the previous year. It is named for the late Maj. Gen. I. G. Brown, a former chief, Air Force Division, National Guard Bureau, and founder of the Guard's enlisted professional military education program.

In early May, **Tactical Air Command** was named as the winner of the **Presidential Award for Management Excellence.** This marked the first time that an Air Force organization has won the award, which is given to individuals and groups that have made significant improvements in the quality and productivity of federal operations and service to the public. TAC monitors productivity in operations and support throughout the command by means of a goal-oriented program.

Air Force Academy **Cadet James P. Dutton, Jr.,** was honored April 30 as one of the winners of ***Time* Magazine's College Achievement Award** in ceremonies in New York, N. Y. The annual awards, presented to twenty college juniors, are given for exceptional academic records and exemplary achievement in an area outside of the classroom. Cadet Dutton, a native of Eugene, Ore., is an astronautical engineering major with a 4.0 grade-point average. A private pilot, he finished fourth in the 1989 National Intercollegiate Flying Association competition.

★ **PURCHASES—Lockheed Missiles & Space Co.** received a $971 million NASA contract on May 11 for production of the **advanced solid rocket motors for the space shuttle.** The ASRMs will replace the current solid rocket, which were redesigned after the *Challenger* disaster. The new solid rockets are expected to increase the shuttle's payload capacity by 12,000 pounds to a maximum capacity of 65,000 pounds. Lockheed will produce one ASRM for fit checks, seven for qualification and ground tests, and twelve (six sets) for shuttle launches. Options valued at up to $1.388 billion call for an additional eighty-eight ASRMs. The first flight set is scheduled to be delivered in 1995. Aerojet, Thiokol, Babcock and Wilcox, and Rust International will be the major subcontractors.

Hughes claimed victory in the winner-take-all competition with Raytheon for the **final buy of AGM-65 Maverick** air-to-surface missiles. The $194 million contract, awarded May 11, calls for 3,006 AGM-65F/G rounds; seventy-five F model captive-carry training missiles; sixty-one G model guided training missiles; spare center, aft, and guidance sections; and eight missile-maintenance trainers. The totals include Mavericks for the Air Force, Denmark, Germany, New Zealand, and Spain. The contract is to be completed in December 1992. Maverick first entered service in 1968, and approximately 52,000 rounds have been built.

TRW received a $5.5 million contract from Air Force Systems Command's Space Systems Division in late April to build a **lightweight demonstration satellite** under the Space Test Experiments Platform (STEP) program. The satellite, which will weigh less than 1,000 pounds, is designed to last up to three years and

will be launched into an elliptical polar orbit. The satellite's four experiments will measure the propagation of radio frequencies in the ionosphere, take global electron density measurements, and collect data for drag and density modeling. The contract includes options for twelve additional spacecraft. First launch is scheduled for 1992.

A major dispute in the four-nation European Fighter Aircraft **(EFA)** program was finally settled May 8 with the **selection of the Euroradar ECR-90 radar** for the new fighter. The nose-mounted pulse-Doppler radar will be based on the Blue Vixen radar, now going into the Royal Navy's Sea Harrier update. Contract terms were not announced, but total value of the contract could be in the £1 billion to £2 billion ($1.7 billion to $3.4 billion) range. Euroradar is a consortium led by the English firm GEC Ferranti Defence Systems Ltd. and includes FIAR of Italy, Telefunken Systemtechnik of West Germany, and INISEL of Spain. The other candidate radar, the MSG-2000, would have been a derivative of the Hughes APG-65 radar used in the McDonnell Douglas F/A-18.

Learjet received a $9.4 million Air Force Logistics Command contract on May 1 for **continued logistic support for the Air Force's C-21A fleet.** The contract covers parts and maintenance work on the seventy-nine C-21s in Air Force service and the four C-21s used by the Air National Guard. The work will be done by Learjet's subsidiary company, GLASCO, at the sixteen bases around the world where the C-21s (a military version of the Model 35A executive jet) are stationed. The contract has four one-year options that could total $140 million.

★ **DELIVERIES—Boeing Military Airplanes** delivered the **200th re-engined KC-135R tanker** to the Air Force on April 25. The R model modification includes replacing the KC-135A's Pratt & Whitney J57-P-59W engines with more fuel-efficient and quieter CFM International F108-CF-100 turbofans and installing new struts, nacelles, 12.2 miles of wiring,

Senior Staff Changes

RETIREMENTS: B/G Clifton C. **Clark,** Jr.; B/G Keith B. **Connolly;** B/G John P. **Dickey;** M/G Robert F. **Durkin;** Gen. Monroe W. **Hatch,** Jr.; B/G Thomas G. **Jeter,** Jr.; L/G George L. **Monahan,** Jr.; B/G W. John **Soper;** M/G Joseph K. **Stapleton;** Gen. Larry D. **Welch.**

PROMOTIONS: To be **General:** John M. **Loh;** Robert C. **Oaks.**
To be **Lieutenant General:** John E. **Jaquish.**

CHANGES: Col. (B/G selectee) Jerrold P. Allen, from USAF Member, Chairman's Staff Gp., Office of the Chairman, JCS, Washington, D. C., to Ass't DCS/Ops., Hq. SAC, Offutt AFB, Neb., replacing B/G Phillip J. Ford . . . **B/G Richard A. Browning,** from DCS/Log.; and Staff Dir., Log., PACOPS, Hq. PACAF, Hickam AFB, Hawaii, to Cmdr., Def. Construction Supply Ctr., DLA, OSD, Columbus, Ohio . . . **B/G William E. Collins,** from Spec. Ass't for R&M to Ass't Sec'y of the Air Force for Acq. and to DCS/L&E, OSAF, Washington, D. C., to Spec. Ass't for R&M to Ass't Sec'y of the Air Force for Acquisition, OSAF, Washington, D. C. . . . **Gen. Michael J. Dugan,** from Cmdr., AAFCE; CINC, Hq. USAFE; and Air Force Component Cmdr., USEUCOM, Ramstein AB, West Germany, to Chief of Staff of the Air Force, Hq. USAF, Washington, D. C., replacing retired Gen. Larry D. Welch.

Col. (B/G selectee) Kenneth E. Eickmann, from Dir., Maintenance, Sacramento ALC, AFLC, McClellan AFB, Calif., to DCS/Log.; and Staff Dir., Log., PACOPS, Hq. PACAF, Hickam AFB, Hawaii, replacing B/G Richard A. Browning . . . **L/G Thomas R. Ferguson, Jr.,** from Principal Dep. Ass't Sec'y of the Air Force for Acquisition, OSAF, Washington, D. C., to Cmdr., ASD, AFSC, Wright-Patterson AFB, Ohio, replacing L/G (Gen. selectee) John M. Loh . . . **B/G Charles E. Fox, Jr.,** from Cmd. Dir., NORAD Cmbt. Ops. Staff, J-31, Hq. NORAD, Cheyenne Mountain AFB, Colo., to Vice Dir., NORAD Cmbt. Ops. Staff, J-31, Hq. NORAD, Cheyenne Mountain AFB, Colo., replacing B/G James P. Ulm . . . **Col. (B/G selectee) Jerry D. Gardner,** from Dir. of Dental Services, Wilford Hall USAF Med. Ctr., Joint Mil. Medical Ctr., San Antonio, Lackland AFB, Tex., to Dep. Ass't Surgeon General for Dental Services, Hq. USAF, Bolling AFB, D. C.

B/G Thomas R. Griffith, from Cmdr., 836th AD, TAC, Davis-Monthan AFB, Ariz., to DCS/Plans; Dep. Dir. of Plans, TACOS; and DCS/Plans, USAFLANT, Hq. TAC, Langley AFB, Va., replacing B/G Richard B. Myers . . . **M/G William K. James,** from Dep. USCINCSO, Hq. USSOUTHCOM, Quarry Heights, Panama, to Dir., Defense Mapping Agency, OSD, Fairfax, Va., replacing retired M/G Robert F. Durkin . . . **M/G (L/G selectee) John E. Jaquish,** from Dir., Tactical Prgms., Ass't Secretary of the Air Force for Acquisition, OSAF, Washington, D. C., to Principal Dep. Ass't Sec'y of the Air Force for Acquisition, OSAF, Washington, D. C., replacing L/G Thomas R. Ferguson, Jr. . . . **Col. (B/G selectee) Nicholas B. Kehoe III,** from Spec. Ass't for Base Closure Issues, Hq. ATC, Randolph AFB, Tex., to Dep. Dir., Regional Plans & Policy, DCS/P&O, Hq. USAF, Washington, D. C., replacing B/G Graham E. Shirley.

L/G (Gen. selectee) John M. Loh, from Cmdr., ASD, AFSC, Wright-Patterson AFB, Ohio, to Vice Chief of Staff, Hq. USAF, Washington, D. C., replacing retired Gen. Monroe W. Hatch, Jr. . . . **B/G (M/G selectee) James C. McCombs,** from Dir., Transportation, DCS/L&E, Hq. USAF, Washington, D. C., to Spec. Ass't for Transportation to DCS/L&E, Hq. USAF, Washington, D. C. . . . **B/G James W. McIntyre,** from Dir., NORAD Planning Staff, Hq. NORAD, Peterson AFB, Colo., to Staff Dir., 7th Quadrennial Review of Mil. Compensation, OSD, Washington, D. C. . . . **B/G Richard B. Myers,** from DCS/Plans; Dep. Dir. of Plans, TACOS; and DCS/Plans, USAFLANT, Hq. TAC, Langley AFB, Va., to DCS/Requirements, Hq. TAC, Langley AFB, Va., replacing B/G (M/G selectee) Joseph W. Ralston.

L/G (Gen. selectee) Robert C. Oaks, from Cmdr., Hq. ATC, Randolph AFB, Tex., to Cmdr., AAFCE; CINC Hq. USAFE; and Air Force Component Cmdr., USEUCOM, Ramstein AB, West Germany, replacing Gen. Michael J. Dugan . . . **B/G (M/G selectee) Joseph W. Ralston,** from DCS/Requirements, Hq. TAC, Langley AFB, Va., to Dir., Tactical Prgms., Ass't Secretary of the Air Force for Acquisition, OSAF, Washington, D. C., replacing M/G (L/G selectee) John E. Jaquish . . . **B/G Harold H. Rhoden,** from Dep. Cmdr., Joint Task Force Middle East, USCENTCOM, Navy Mobile Units, to Dep. IG, Hq. USAF, Washington, D. C., replacing retired M/G Joseph K. Stapleton . . . **Col. (B/G selectee) Eugene D. Santarelli,** from Exec. Officer to Air Force Chief of Staff, Hq. USAF, Washington, D. C., to Cmdr., 836th AD, TAC, Davis-Monthan AFB, Ariz., replacing B/G Thomas R. Griffith.

B/G Graham E. Shirley, from Dep. Dir., Regional Plans & Policy, DCS/P&O, Hq. USAF, Washington, D. C., to Vice Cmdr., Hq. ESC, San Antonio, Tex., replacing B/G Paul L. Roberson . . . **Col. (B/G selectee) Arnold R. Thomas,** from Cmdr., Southeast Air Defense Sector, TAC, Tyndall AFB, Fla., to Cmd. Dir., NORAD Cmbt. Ops. Staff, J-31, Hq. NORAD, Cheyenne Mountain AFB, Colo., replacing B/G Charles E. Fox, Jr. . . . **B/G James P. Ulm,** from Vice Dir., NORAD Cmbt. Ops. Staff, J-31, Hq. NORAD, Cheyenne Mountain AFB, Colo., to Dir., NORAD Planning Staff, Hq. NORAD, Peterson AFB, Colo., replacing B/G James W. McIntyre . . . **M/G Walter E. Webb III,** from Vice Dir., Ops., J-3, Joint Staff, Washington, D. C., to Dir., Ops., Hq. DNA, OSD, Washington, D. C., replacing retiring M/G John C. Scheidt, Jr.

ANG CHANGE: M/G Donald L. Owens, from Ariz. Adjutant General, ANG, to Ariz. Adjutant General, ANG, and Reserve Forces Policy Board.

SENIOR EXECUTIVE SERVICE (SES) CHANGES: Louis K. Dumas, from Dep. Dir., Directorate of Materiel Management, ALC, Hill AFB, Utah, to Ass't Dep. C/S, P&P, Hq. AFLC, replacing Ronald Hovell . . . **William Maikisch,** from Ass't for Acq. Mgmt. and Competition, Hq. Space Systems Div., AFSC, Los Angeles AFB, Calif., to Dep. C/S, Program Management, Hq. Space Sys. Div., AFSC, Los Angeles AFB, Calif.

SCIENTIFIC AND TECHNICAL (ST) CHANGES: Edwin B. Champagne, from Principal Scientist (GM-15), Wright Research and Development Ctr., ASD, AFSC, Wright-Patterson AFB, Ohio, to Chief Scientist, Electronics Technology Lab, Wright Research and Development Ctr., ASD, AFSC, Wright-Patterson AFB, Ohio . . . **George C. Mohr,** from Research Medical Officer (GM-15) HSD, Texas, to Chief Scientist, Deputate for Science, Technology, and Operational Aeromedical Support, HSD, Brooks AFB, Tex. . . . **Dennis B. Richburg,** from Technical Advisor, Air Force Cryptologic Support Center, Hq. ESC, San Antonio, Tex., to Technical Advisor to the Cmdr., Hq. ESC, San Antonio, Tex. ■

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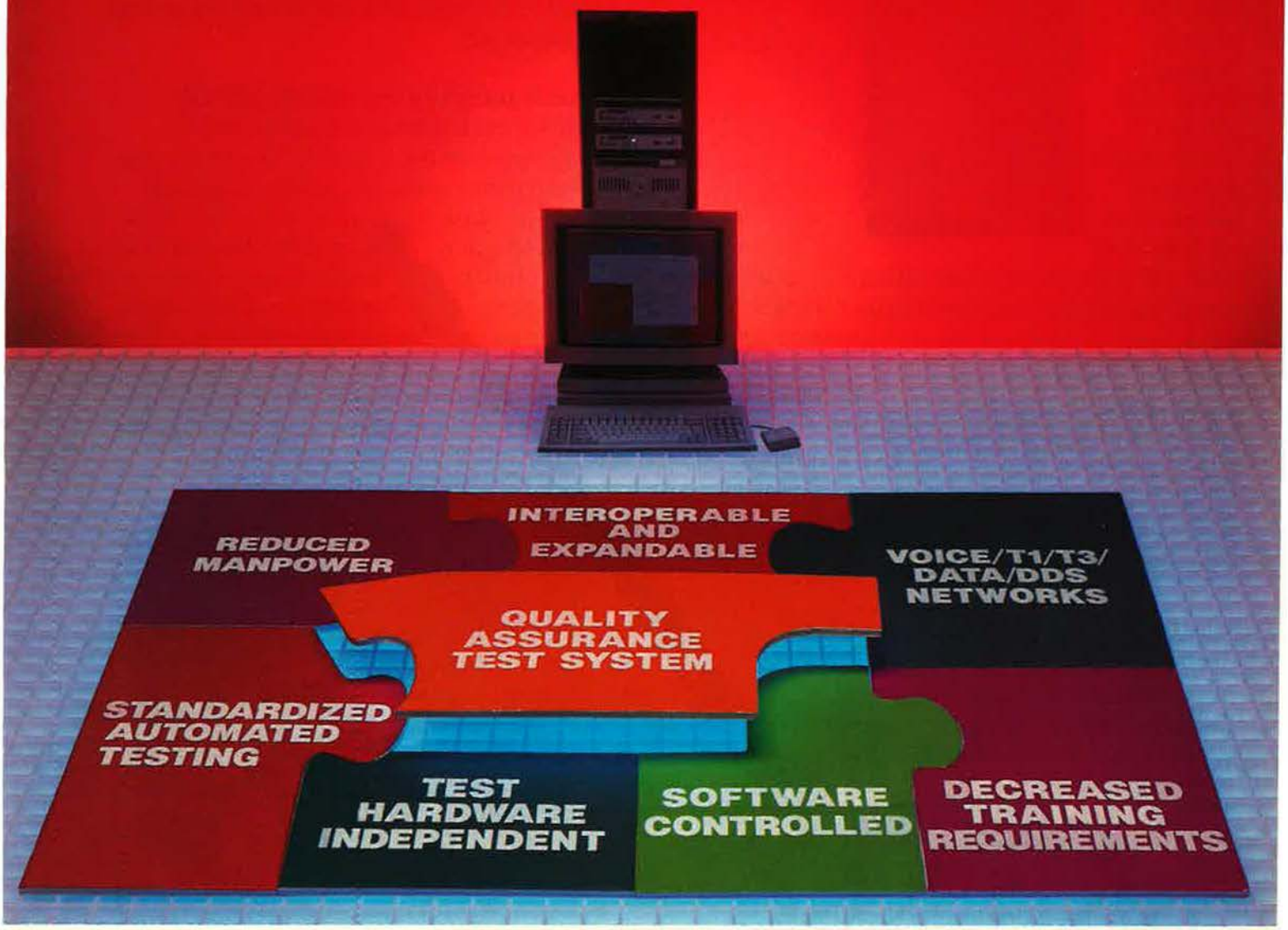

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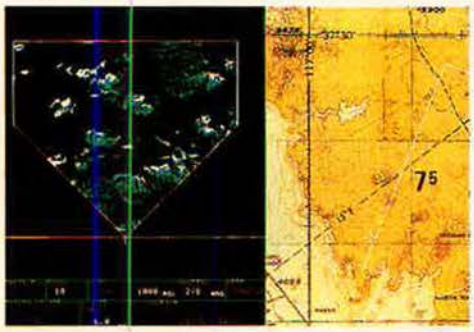

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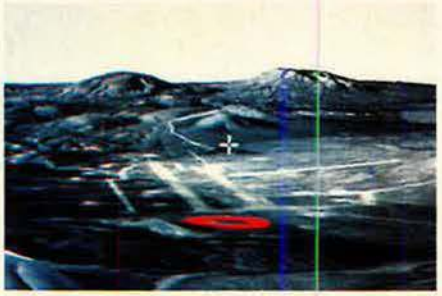

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and other components totaling nearly 54,000 parts. Boeing is currently under contract for 306 modification kits and installation on 237 airplanes, but the Air Force wants to reengine the entire 634-aircraft KC-135 fleet. The milestone KC-135R was delivered to the 340th Air Refueling Group at Altus AFB, Okla.

McDonnell Douglas delivered the **first two-seat, night-attack F/A-18D Hornet** to the Marine Corps in ceremonies at MCAS El Toro, Calif., on May 11. Unlike most F/A-18Ds, which are used for training, these new Hornets will fly tactical missions. The Naval Flight Officer (the backseater) has two hand controls to operate the sensors and equipment that enable the crew to make low-altitude attacks and fly close air support missions at night. The Marines plan to purchase ninety-six F/A-18Ds. The airplanes will replace A-6s in the near term and will serve as a substitute for the new A-12A, which the Marines have opted not to buy. The F/A-18Ds will also replace the OA-4M and RF-4 in the observation and reconnaissance roles.

LTV's **Sierra Research Division** delivered the first of six **British Aerospace C-29A** Combat Flight Inspection **(C-FIN) aircraft** to the Air Force in ceremonies at the company's plant in Buffalo, N. Y., on April 24. The C-29A, a modified BAe 125-800 executive jet, will be used to inspect and calibrate en route and terminal air traffic control and landing facilities at military airfields to ensure that systems are working properly. The other five C-29s are scheduled to be delivered by September, and they will replace the CT-39s and C-140s now used in the C-FIN role. The aircraft will be assigned to Scott AFB, Ill., Rhein-Main AB, West Germany, and Yokota, AB, Japan. Sierra Research installed the automatic flight-inspection equipment on the planes. Garrett General Aviation Services will maintain the aircraft under a contract that runs through 1997.

★ **MILESTONES**—The Air Force's senior member in terms of length of service, **Maj. Gen. John E. Griffith,** the director of operations and logistics for US Transportation Command, **retired** in ceremonies at Scott AFB, Ill., June 1. General Griffith joined the barely one-year-old Air Force on December 10, 1948, and spent nearly nine years as an enlisted man before earning his commission in 1957. His assignments included stints as transportation chief at Tan Son Nhut AB, Vietnam, chief of operations for the "Special Express" that moved air munitions in Vietnam by USAF-owned landing craft, and command of the Defense Fuels Supply Center. The General's goal at one time was to make master sergeant and retire after twenty years.

The **first pictures of the cosmos taken by the Hubble Space Telescope** turned out to be two times better than expected. The "first light" pictures taken May 20 had been expected to achieve a resolution of 1.5 arc seconds but instead achieved a resolution of about .7 arc seconds. The two images, a one-second and a thirty-second exposure, were engineering photos to check the function of the telescope's wide field/planetary camera. Nothing of scientific value was anticipated. However, the shots, when compared to an image of the same star cluster (NGC3532) taken from an Earth-based telescope, revealed the existence of previously unknown stars and proved that an unexplained blur on the Earth-based shot was really a double star.

On April 23, in a small ceremony at Travis AFB, Calif., the Air Force celebrated **the twenty-fifth anniversary of the Lockheed C-141 StarLifter's entering operational service.** The first operational aircraft (serial number 63-8075) that was delivered to the 60th Military Airlift Wing at Travis in 1965 "got the day off" and served as a backdrop to the ceremony. That particular aircraft has accumulated a total of 39,000 flight hours. Lockheed completed its last of 284 C-141As in 1968. Starting in 1978, the aircraft were stretched and given the ability to be refueled in flight. Conversion of the entire fleet (except for four aircraft) to the B model standard was completed ahead of schedule in June 1982. The fleet (which now numbers 266 aircraft) has accumulated well over 8.5 million flight hours and has a Class A mishap rate of .37 per 100,000 flying hours, one of the best safety records in Military Airlift Command history.

The **KC-10 Aircrew Training System** (ATS), the Air Force's first contract-run "schoolhouse," **celebrates its tenth anniversary this summer.** In 1980, Strategic Air Command came to McDonnell Douglas Training Systems (then called American Airlines Training Corp.) for the ATS, which would guarantee the quality of the graduates at a fixed price. Since its inception, 99.6 percent of the students have passed the course (with Air Force evaluators) on the first try. Trainees have completed 22,000 training courses. The three KC-10 simulators, based at Seymour Johnson AFB, N. C., Barksdale AFB, La., and March AFB, Calif., have been in operation for 162,500 hours with an in-commission rate of 99.8 percent, well exceeding the ninety-five percent rate called for in the contract.

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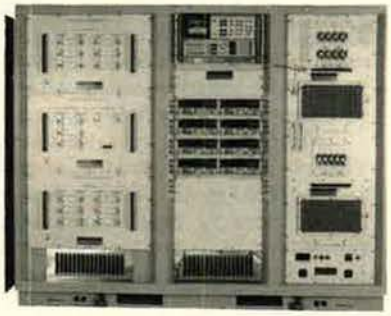

AAI's FAMES system integrates the Signal Generation Subsystem of the AN/ALM-234 with Hewlett-Packard's Frequency Agile Signal Simulator (HP FASS) to deliver a moderate density, high fidelity threat generator totally compatible with the AN/ALM-234 system threat database.

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THE SENSIBLE SOLUTION

The aircraft carrier **USS *Coral Sea* (CV-43) was decommissioned** in ceremonies at Norfolk, Va., on April 30. The ship, dubbed the "Ageless Wonder," went into service in 1947 and was previously decommissioned in 1957 to undergo a major modification effort completed in 1960. It was the first carrier to be fitted with the Phalanx close-in weapon system. *Coral Sea* will be towed to the Philadelphia Navy Yard where it will be mothballed and, most likely, eventually scrapped.

★ **NEWS NOTES—"Lancer" is now the official nickname of the Rockwell B-1B bomber.** Strategic Air Command chose the name because it invokes the spirit of the plane's mission. Much like the lancers of yesteryear who were at the leading edge of the battle, the B-1B is at the leading edge of SAC's bomber force. The B-1 is the second military aircraft to be called Lancer. The World War II-era Republic P-43 fighter also carried the moniker. Fairchild Aerospace, the successor to Republic, gave the Air Force permission to use the name for the B-1.

A new major command, **Air Force Special Operations Command, will be established** at Hurlburt Field, Fla., by early summer, the Air Force announced on April 30. The new command, to be made up primarily of Military Airlift Command's 23d Air Force, will be the first new major command created since 1982, when Air Force Space Command was established. Special Operations Command will be the Air Force component of the US Special Operations Command and will answer directly to the Air Force Chief of Staff. The new command is part of the realignment of Air Force special operations activities and will streamline operational lines of authority.

On April 24, the Defense Advanced Research Projects Agency (DARPA) announced that the **Boeing Condor unmanned autonomous aircraft** had successfully completed a series of eight flight tests as part of the **high-altitude, long-endurance technology effort.** The tests were conducted over eastern Washington state late last year, and the announcement came after an analysis of the collected data was made. The final test included carrying an unspecified payload to reaffirm payload compatibility with the air vehicle and to observe preselected ground-located signals for evaluation. The Condor vehicle, which has a wingspan greater than that of a 747, began flight testing in October 1988 and has amassed 141 flying hours, including one mission that lasted nearly sixty hours. Condor holds two world piston-engine altitude records, including the maximum altitude mark of 67,028 feet.

Work is progressing on construction of the **first McDonnell Douglas C-17A airlifter.** As of late May, the vertical stabilizer and four major sections of the aircraft were in place. The transport's forward and center sections were joined in late February, the wings were attached in March, the aft fuselage section was added in April, and the stabilizer was slid onto its spars on April 28. The nosegear has been installed, and the main bogies are to be attached by early June. The airplane is scheduled for completion late this year, with first flight to be made by June 1991.

The **fourth Bell-Boeing V-22 Osprey prototype made its first flight** on May 8 at Bell Helicopter's Flight Research Facility in Arlington, Tex. Bell pilots Roy Hopkins and Dean Borg

crewed the tilt-rotor on its seven-minute flight in the helicopter mode. This V-22's main flight-test role will be exploring flight loads, vibration, and acoustics. The most heavily instrumented of the six flyable Osprey prototypes, this aircraft will also go to sea for carrier compatibility trials.

The **Air Force successfully carried out the third operational test of the LGM-118A Peacekeeper** intercontinental ballistic missile on May 16. The missile was cold-launched from Launch Facility 08 at Vandenberg AFB, Calif., by a 90th Strategic Missile Wing crew from F. E. Warren AFB, Wyo., at 11:01 a.m. After a flight of approximately thirty minutes, the missile's reentry vehicles hit 4,200 miles away in the Kwajalein Missile Test Range in the southwest Pacific.

It required congressional action, but the **crew of the USS *Pueblo* (AGER-2) was recognized with the Prisoner of War Medal** at a ceremony in San Diego, Calif., on May 5. Sixty-three members of the eighty-three-man crew were in attendance to receive their medals. On January 23, 1968, the *Pueblo,* a surveillance ship operating off the coast of North Korea in international waters, was attacked by North Korean gunboats and planes. The crew was taken prisoner and detained for eleven months. The Pentagon refused to award the POW Medal to the ship's crew, saying they were not involved in armed conflict, but a bill introduced by Rep. Nicholas Mavroules (D-Mass.) and Rep. Jim Slattery (D-Kan.) made the crew eligible. ■

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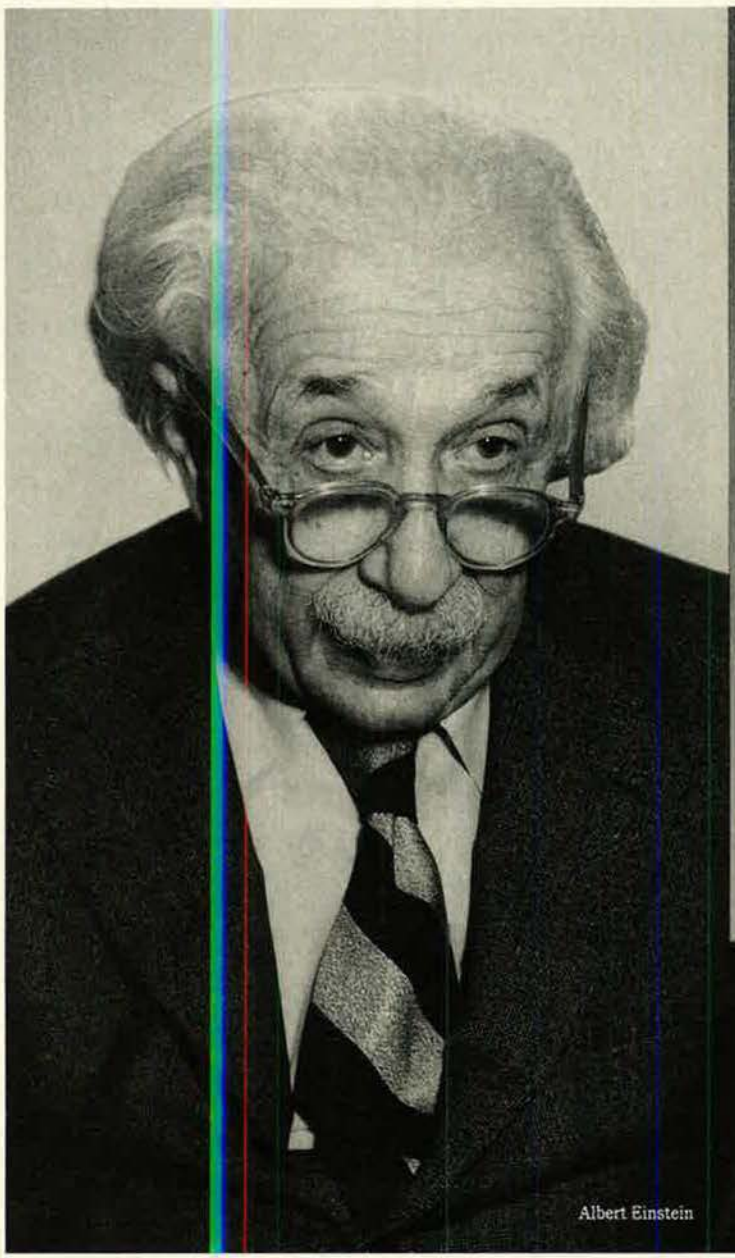
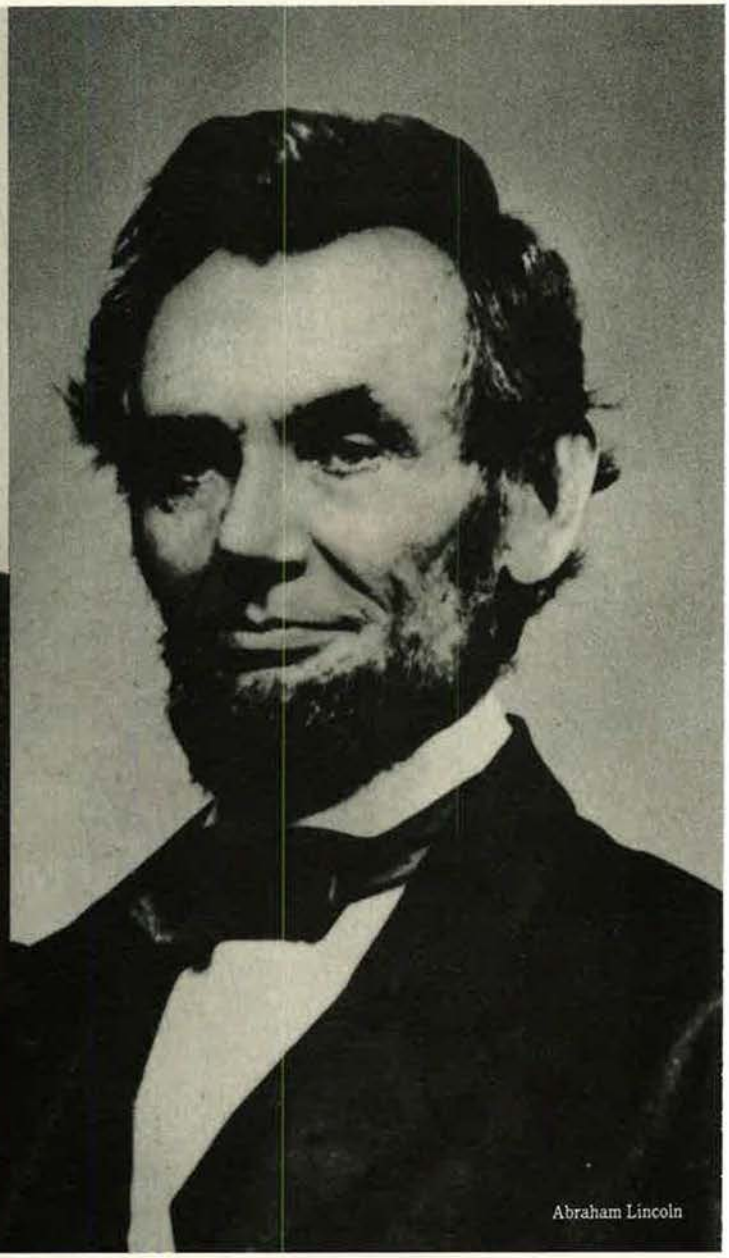


Albert Einstein



Abraham Lincoln

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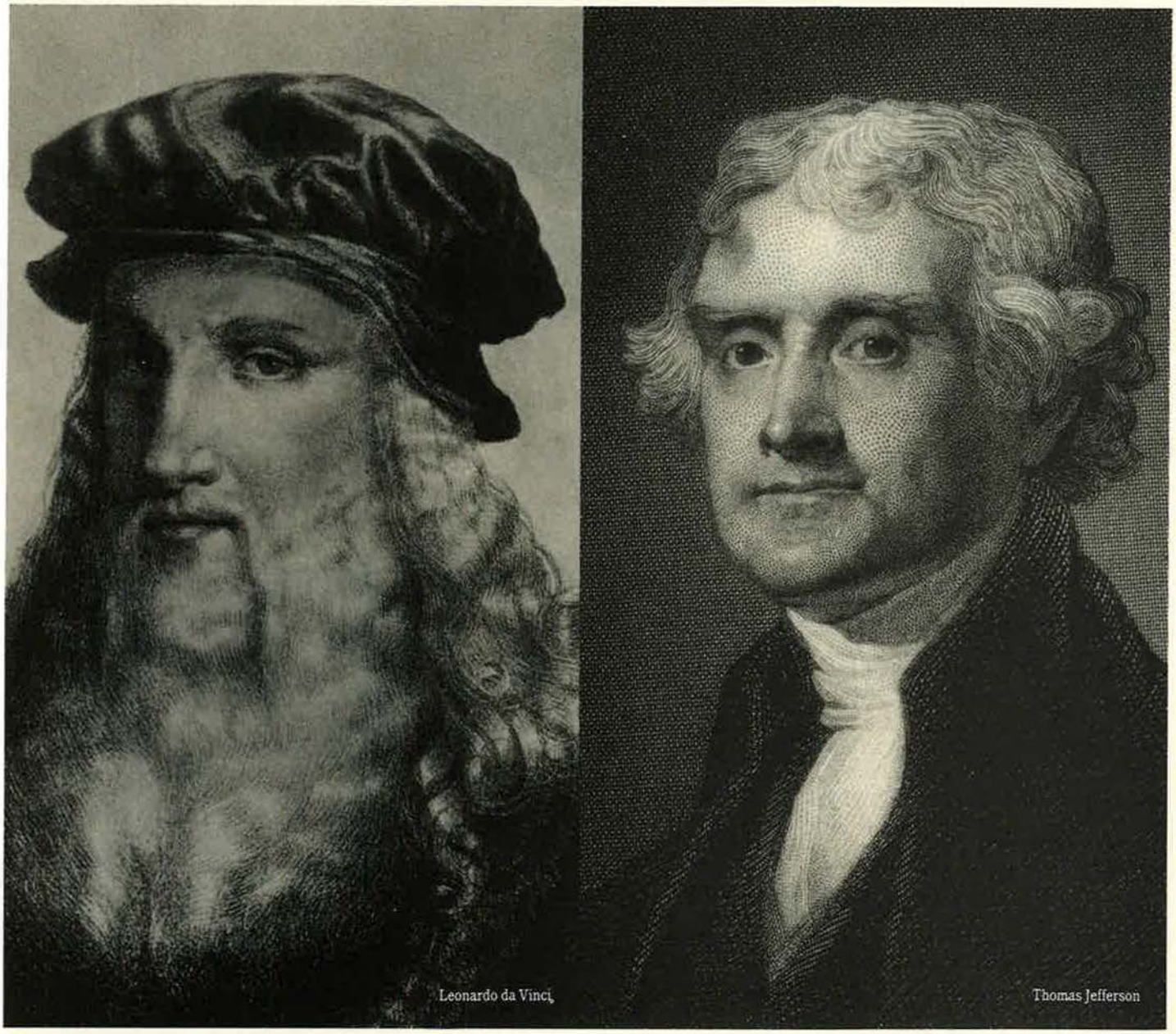

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A company of leaders.

Within three minutes, fighter pilots calling from the scene had an answer from the President.

To Command, You Must Control

By James W. Canan, Senior Editor

IN Operation Just Cause in Panama late last year, USAF's 28th Air Division "carried the Tactical Air Command battle flag" and brought off "an amazing feat in fulfilling every minute of the tasking required."

So said the 28th AD's Commander, Brig. Gen. William J. Ball, but that was all. As to specifics, the unit's tasking and accomplishments remain under wraps.

Air Force Secretary Donald B. Rice recently alluded to the mission, noting that "command and control aircraft orchestrated the air operation." Certain things about it seem obvious.

The 28th AD's role in Just Cause captured the essence of military campaigns, following a truism that Gen. Colin Powell, Chairman of the Joint Chiefs of Staff, once summed up for his unit leaders while commanding an Army corps.

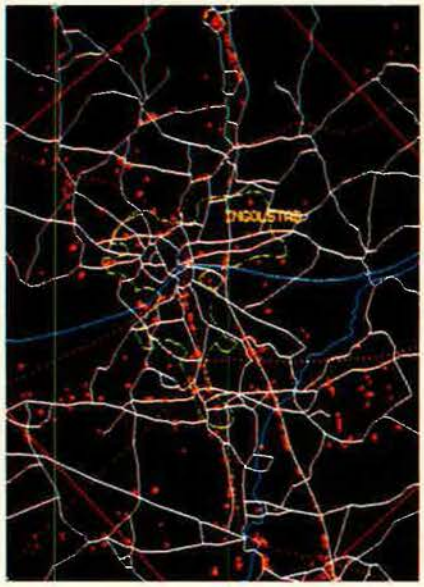
"You must command," he said. "To do so, you must control. To control, you must have communications. Because of change, you're dead without intelligence."

The package is called C³I, for command, control, communications, and intelligence. The 28th AD contributed mightily to C³I for USAF in Just Cause and helped take it away from the enemy. C³I was the stuff of the Air Force's success in that operation, and it is being counted on more and more to make other such operations succeed in the future.

Headquartered at Tinker AFB, Okla., the 28th AD is made up of geographically dispersed units: the 552d Airborne Warning and Control Wing at Tinker, the 7th Airborne Command and Control Squadron at Keesler AFB, Miss., and the 41st Electronic Combat Squadron at Davis-Monthan AFB, Ariz. All played major roles in the Panama operation, and the AWACS role seems the most obvious.

Just Cause featured Air Force airlifters, tankers, and gunships, their accomplishments highly publicized ex post facto. Their air routes to Panama from the US took them within easy range of interceptors out of Cuba, should any show up. So the Air Force planes had to have fighter escort.

The 552d's E-3 Sentry AWACS planes, on the lookout for hostile



Above, a Joint STARS scope screen shows moving targets (larger red dots) along roads and railways (white lines and red dotted lines). During Operation Early Look, the Joint STARS aircraft (next page) flew four missions, collecting radar data from target areas over Germany.

aircraft and directing air traffic over the Gulf of Mexico, were the key to the coherence of that fighter cover and to the safe passage of all US aircraft in the operation. The AWACS planes also are said to have teamed with the 7th's EC-130Es, operating as airborne battle-management platforms, in coordinating ground actions with air traffic, which was dangerously dense in tightly confined airspace. The 41st's EC-130H Compass Call jammer aircraft were called on for countermeasures to addle enemy fire.

The Air Force takes heart from the success of those missions as it contemplates the likelihood of more of the same kind of combat in other Third World trouble spots, most likely much farther away than Panama. In USAF's scenarios for such operations, command and control (C^2), and the communications and intelligence that turn C^2 into C^3I and make it tick, play headline roles.

Doing More With Less

C^3I is on the rise among Air Force priorities because it is seen as the key to the service's ability to do more with less, a requirement brought on by the conflicting combination of weaker budgets and stronger demands on capabilities.

All the services are in the same straits and now have heartier appetites for C^3I. This is why Defense Secretary Richard Cheney recently noted, in discussing defense-budget trends, that "functions involving intelligence, command, control, and communications are the only ones that have thus far continued on a course of real growth rather than real reduction."

Gen. Larry D. Welch, while Air Force Chief of Staff, confirmed in a recent interview that "all aspects of C^3I will be more critical" to USAF as it "gets smaller and has somewhat less forward basing," yet prepares to answer the bell anywhere in the world with "highly responsive, agile, lethal forces."

General Welch described the fundamental functions of C^3I as "first, through surveillance, to enable us to understand the situation, then to deploy the right kind of force, and, finally, to direct that force in the best possible fashion."

For surveillance in strategic and tactical settings, the Air Force will rely more and more on satellites and, many think, on unmanned aircraft. But USAF's kingpin systems for on-the-spot, here-and-now surveillance are expected to be the time-tested AWACS, for airborne targets, and the Joint Surveillance and Target Attack Radar System (Joint STARS), for ground targets. Big jobs are shaping up for both in the treaty-verification and drug-interdiction arenas as well.

AWACS is being upgraded and outfitted with new gear, not only to make its radar capable of detecting much smaller targets, but also, among other things, to enhance its communications and passive aircraft-sensing capabilities. Joint STARS development is steadier, now that the major airframe-selection hurdle has been cleared and flight testing has begun.

There is no question about the capability of the Joint STARS system, but doubts have arisen in some quarters about the need for it in Europe. On the contrary, the Air Force and the Army, Joint STARS cosponsors, claim that the anticipated drawdown of front-line forces in Europe could make Joint STARS all

the more useful there. They also see major roles for the high-tech airborne surveillance platform in other parts of the globe.

General Welch called AWACS and Joint STARS "crucial to our ability to look from on high and see the comprehensive air and land pictures" and added that both will be "very, very important [in conjunction] with smaller forces."

"No one could have known how great the demand would be for AWACS to do its job around the world, and I predict the same thing for Joint STARS," the Chief of Staff asserted.

The responsibility for developing AWACS, Joint STARS, and most other USAF tactical and strategic C³I systems rests with Air Force Systems Command's Electronic Systems Division (ESD) at Hanscom AFB, Mass. Through the 1980s, much of ESD's work was oriented to developing strategic systems that would make the US better able to endure and wage nuclear war—more capable of detecting, assessing, withstanding, and countering nuclear attack.

Beefing up strategic C³I systems was the key to that, and results are many and impressive. To name a few, communications systems serving the Worldwide Military Command and Control Center, Strategic Air Command, and North American Aerospace Defense Command have been or are being sharply upgraded and made more secure. Over-the-Horizon Backscatter (OTH-B) radar for detecting bombers and cruise missiles approaching the east coast of the US went into operational service in Maine last April. Other OTH-B installations, looking west and south, are in the offing. New North Warning System radars and vastly improved Ballistic Missile Early Warning System (BMEWS) radars have been brought into play to detect bombers and ICBMs, respectively, on their likely northern approaches.

Not the least of ESD's accomplishments in strategic C³I is the installation, now in its final phase, of the Ground Wave Emergency Network. GWEN is in the process of becoming a nationwide network of antenna-tower sites for assuring that the national command authorities and Strategic Air Command will be able to communicate via low-frequency ground waves should a nuclear attack disrupt other channels for emergency-action messages.

Critic-Resistant Systems

All such air-and-land systems, together with spaceborne satellites for communications, surveillance, early warning, and attack assessment, are the elements of a tightly knit strategic C³I setup that seems fairly critic-resistant, if not wholly sacrosanct. Budget problems and the promise of arms-control advances make it possible, even likely, that some US strategic C³I systems, such as the emerging network of OTH-B radars and the planned constellation of Milstar communications satellites, will be cut back. But even if the US and the USSR agree to sharp reductions of warheads, a great many nuclear weapons are bound to remain, and C³I systems for deterring, waging, and surviving nuclear war will continue to be necessary.

Those strategic systems are not being slighted at ESD. At the moment, though, their tactical counterparts seem to be generating more attention. The reason is that tactical, or battle-fighting, situations are seen as much more likely than strategic, or warfighting, scenarios in the years immediately ahead.

ESD's Commander, Lt. Gen. Gordon E. Fornell, tells an illustrative story. He recalls being in the National Military Command Center at the Pentagon in 1988 on the day that Iranian gunboats attacked an American-operated oil rig in the Persian Gulf. US rules of engagement forbade the intervention of Navy A-6 attack jets on the scene. Frustrated, the leader of the A-6 formation radioed his aircraft carrier, requesting permission to attack the gunboats. His request was flashed through the fleet to the Chairman of the Joint Chiefs of Staff, Adm. William J. Crowe, at the NMCC.

General Fornell remembers Admiral Crowe "leaning over in his chair and telling [Defense] Secretary [Frank] Carlucci, who got on the phone to General Powell at the White House." General Powell, then the President's National Security Advisor, went right to President Reagan, who said, "Go ahead."

The A-6 pilots got the message, swooped to the attack, sank one of the gunboats, and drove off the rest. The remarkable part of the story is the speed of communications.

"The message changing the rules of engagement got back to the pilots within three minutes of their call, and, to me, that's what C³ is all about," declares General Fornell. "It's about being able to execute missions worldwide within minutes, not waiting for hours, not droning around while fleeting targets disappear."

Given diminished likelihood of war in Europe, General Fornell believes that the Air Force must prepare to "protect the national interest" against all comers, including, possibly, the "still very powerful" Soviet Union, "wherever we'll have to—maybe in nontraditional, uncharted places, at the ends of long lines of communication and travel."

In such circumstances, and assuming a smaller Air Force, "the importance of C³I becomes even greater, even more focused," he asserts. "We will need absolute connectivity—communications and command and control—for increasing the leverage of our forces, for doing better with what we've got—and we're not going to be pounding on drums and making smoke signals."

It all starts with surveillance, which breeds intelligence data. "We can't do without the 'I' part of C³I, because intelligence, the surveillance, enables us to respond in a timely manner with all the rest of it," General Fornell declares.

Enter AWACS. ESD's upgrading of those aircraft infuses them with the products of individual projects brought to fruition at Hanscom, for other types of air systems as well, in recent years. All are aimed at improving the capabilities of AWACS radars, communications, aircraft identification, and navigation. Notable among these are Have Quick radios and the communications setup called JTIDS, for Joint Tactical Information Distribution System.

The Air Force operates thirty-four E-3B and E-3C AWACS aircraft, the first of which entered service in 1977. NATO operates eighteen such planes with multinational crews in Europe. All the planes are Boeing 707s crammed with comput-

ers and display consoles and with huge, distinctive radomes housing Westinghouse radars atop their fuselages.

From its customary orbiting altitude of about 29,000 feet, an AWACS plane can keep track of airborne attackers all around the compass at ranges of nearly 400 miles, or roughly the distance between Washington, D. C., and Hartford, Conn., and can vector friendly fighters to intercept them.

Air-and-land systems, together with spaceborne satellites, are the elements of a tightly knit strategic C³I setup that seems fairly critic-resistant, if not wholly sacrosanct.

A Decade of Modernization

The Air Force began modernizing its AWACS fleet in the early 1980s, spurred on by the progressively smaller radar cross sections of Soviet fighters and cruise missiles. As a result of recently completed upgrades, twenty-four of USAF's original E-3As have been redesignated as E-3Bs; the rest, as E-3Cs.

Five radar consoles have been added inside each plane, making fourteen consoles all told. Console screens now display objects in five colors, a major improvement over the former monochromatic images. Moreover, targets that show up on the screen flash on and off in order to catch console operators' attention.

Several stations for radio operators have been added to each plane as well to accommodate new, improved Have Quick ultrahigh-frequency voice-radio sets. Each set embodies seventeen black boxes and offers additional frequencies, software improvements, increased memory, more power, and faster frequency-hopping to avoid jamming.

Last September, ESD awarded Westinghouse a $224 million contract and Boeing a $59 million contract to launch the AWACS Radar System Improvement Program. Expected to cost $626 million, RSIP should prove to be money well spent. Its goal is to nearly double the sensitivity and range of the Westinghouse APY-1 and APY-2 radars, mainly by virtue of a new, much more powerful, Control Data radar-surveillance computer, changes in radar signal-processing techniques, and modifications of radar waveforms and bandwidths.

All such changes "will enable the current radars to see smaller targets at greater ranges—to do more with the power they have," declares Col. Pat Craig, ESD's AWACS program director. The first major design review of the AWACS RSIP is scheduled to take place next month.

Meanwhile, ESD is forging ahead with yet another AWACS-upgrade program aimed at making the system much more capable in many other ways.

An Electronic Support Measures (ESM) subsystem called Quick Look, developed for the Army by UTL of Dallas, will be incorporated in AWACS aircraft to enable their crews to do a better job of identifying aircraft.

Quick Look, expected to move AWACS way up in class as an air-battle manager, seems relatively uncomplicated. Each AWACS plane will be equipped with four new antennas, positioned to provide 360-degree coverage. They will take in signals from microwave emitters of other aircraft in the airspace covered by the Sentry aircraft and will feed them into AWACS on-board consoles. This should enable the console operators to identify the emitters and, thus, the aircraft. The ESM system is slated for NATO AWACS as well.

For the Air Force AWACS, there is more. All memory units of the IBM CC-2 central data processor on each plane will be replaced by chip memories, working in tandem with an all-embracing magnetic bubble memory storage system, to provide "enormous improvements in memory and computational capability," says Colonel Craig. He also points out that the changes will free up twenty cubic feet of space in each plane, and will cut aircraft weight by 100 precious pounds.

With USAF's constellation of Navstar Global Positioning System satellites finally approaching full-bodied shape in space, the Air Force is moving to provide AWACS aircraft with Rockwell Collins GPS receivers. The ultraprecise navigation data—time, velocity, and position—available from the receivers will be relayed by new antennas to AWACS cockpits and navigation crew stations.

Finally, breadbox-sized JTIDS Class 2 terminals developed by ESD will replace JTIDS Class 1 terminals the size of home refrigerators.

The upgraded JTIDS system also will go aboard all E-8 Joint STARS platforms, each a reconstituted Boeing 707-300 drawn from commercial service. The roughly $7.9 billion Joint STARS program—$6.7 billion for twenty-two electronics-crammed radar aircraft, $1.2 billion for a welter of Army receiver stations, called Ground Station Modules, in vans—is expected to do as much for the management of land warfare as AWACS has done for the orchestration of air combat.

Boeing is the contractor for Joint STARS radomes, canoe-shaped affairs twenty-four feet long, slung under the fuselage. Grumman Melbourne Systems Division is the airborne systems integration contractor. Norden builds the side-looking phased-array radar, which is said to have a range of several hundred miles when beamed from the Joint STARS operating altitude of about 33,000 feet.

Aboard each aircraft are seventeen operations-and-control con-

soles, two of them doubling as communications stations, that display color-coded images of behind-the-lines terrain and of wheeled and tracked vehicles moving anywhere on it. The idea behind Joint STARS in the first place was to seek out rear-echelon enemy armor in Europe, keep track of its positions and movements, and target it in real time for interdiction by NATO air and ground weapons.

Success in Early Look

Throughout the Joint STARS development program and in flight-testing thus far, there has been nothing to suggest that the system falls short. On the contrary, initial tests in Europe late last February—in Exercise Early Look, involving several flights out of RAF Mildenhall in Britain to preselected patrol stations over West Germany—left program officials "really excited," says Col. Harry H. Heimple, Joint STARS program director.

The only question is whether the job for which Joint STARS was conceived—targeting rear-echelon forces in Europe—will any longer be necessary in the wake of mutual force reductions.

"The results were superb," he declares. "It was most enjoyable for us to see the system come up, stay up, and do the job in orbit for hours at a time. We had no problem with electromagnetic interference in a very cluttered EMI environment, which was the main thing we wanted to test."

The euphoria resulting from those tests was a far cry from the dark mood around the program only a few months earlier, when it seemed that Joint STARS might never get off the ground for lack of airplanes.

Faced with an abrupt, unexpected end to commercial orders for its latest line of 707s, Boeing decided to cancel production. This was unsettling to the Joint STARS program, which had counted on buying twenty new planes for operational service, one of them already in hand as the third and final test aircraft. That aircraft was being outfitted and was looking good, but its cost had soared. These setbacks and a few others incurred heavy criticism of the program within the Defense Department acquisition hierarchy.

ESD and Grumman, the prime contractor, took another route. In December, they went hunting around the world for used—but not overused—707-300 aircraft that they might be able to buy. To their delight, they found an ample supply.

"Most of them are freight haulers," Colonel Heimple says, "and they're in good shape." In any case, life expectancy of the 707 is not a problem, he explains, because "it is the only commercial jet that has no flying-hour limit. It was designed back at a time when there were no computers for designing airplanes with lowest weights for maximum efficiency. So Boeing made the 707 stronger than it had to be—overdesigned it, overengineered it, and overbuilt it, with a tremendously thick skin—just to be sure."

Besides, says Colonel Heimple, "Joint STARS airplanes won't be overworked. Ordinarily, they'll have enough fuel for ten-hour missions, so they'll take off at pretty heavy gross weights, but they'll just be doing a lot of orbits at 33,000 to 42,000 feet."

Program critics seem mollified by the prospect of bargain prices for secondhand but shipshape airplanes. They also seem more persuaded than ever, well in advance of full-scale developmental testing to begin late next year, that the high-tech Joint STARS will do the job, and that its state-of-the-art technical sophistication will be well worth the price.

The only question, a big one, is whether the job for which Joint STARS was conceived—targeting rear-echelon forces in Europe—will any longer be necessary in the wake of mutual force reductions foreseen in that theater.

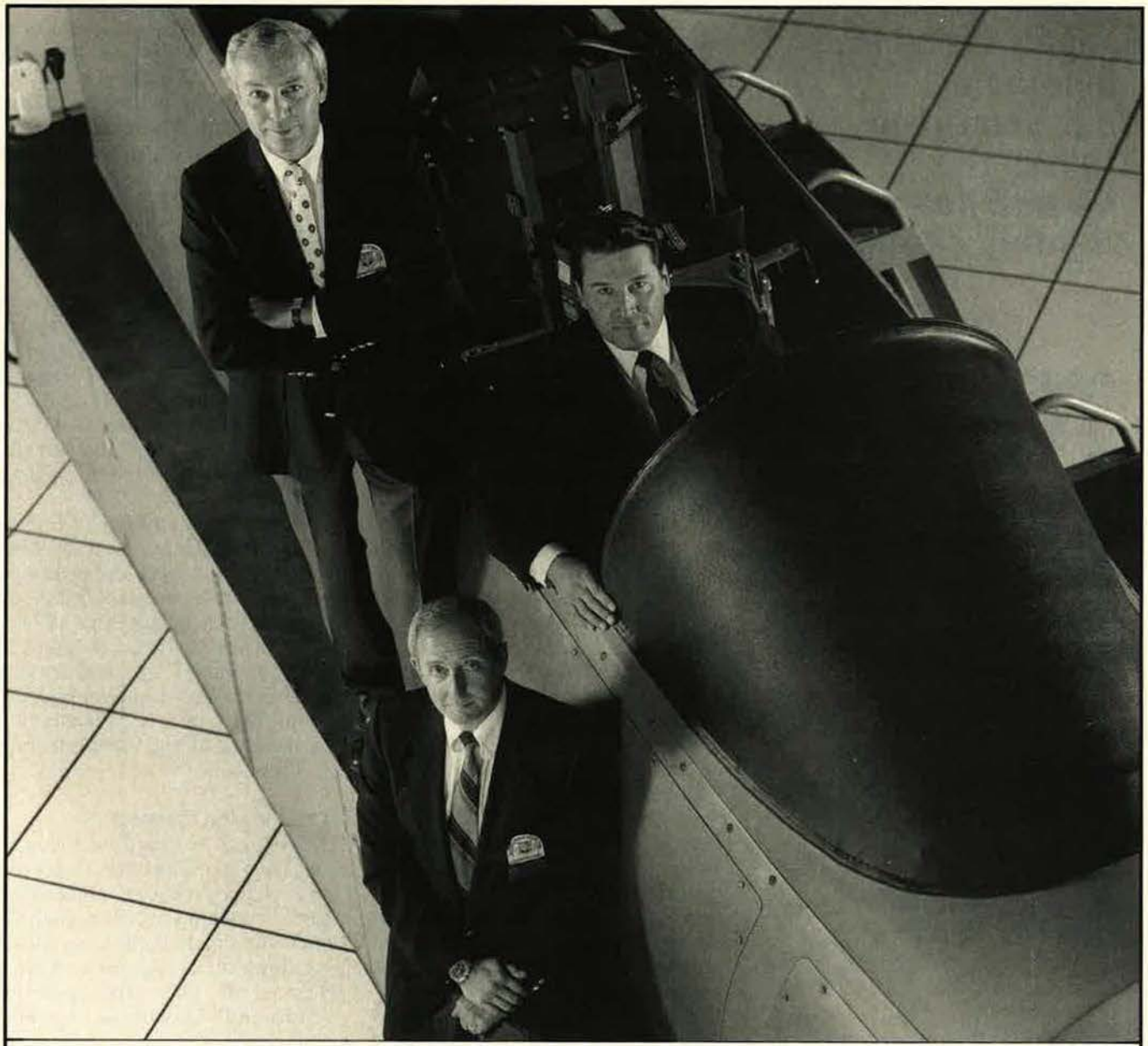
Joint STARS champions postulate that such reductions will make the system all the more necessary, not only to spot movements of still-formidable military units remaining on the other side, but also to verify that such units are not being built up or augmented on the sly in violation of a CFE (Conventional Forces in Europe) treaty.

Says General Fornell, "Joint STARS would enable us to take deep looks, at whatever intervals we chose, along rail and road arteries, to make sure nothing military is moving up. But central Europe is by no means the only place where Joint STARS would be useful. We could employ it as a monitor around the flanks of NATO too. I can see a major role for Joint STARS in Third World contingencies as well."

Even the staunchest supporters of Joint STARS expect it to be cut back by five or more operational aircraft, leaving fifteen to seventeen in the end. But hardly anyone expects the program to be killed.

Support for Joint STARS is strongly grounded in the military's growing need for surveillance, the stickum of C^3I, in these times of force reductions and far-reaching responsibilities. Such support is evident in high political places outside the Pentagon.

Not long ago, in a striking series of Senate speeches on national defense, Sen. Sam Nunn (D-Ga.), Chairman of the Senate Armed Services Committee, struck a blow for Joint STARS and for surveillance in general. He declared, "The services need to continue to give high priority to the new generation of sophisticated sensors and smart munitions. This includes programs like Joint STARS that will greatly improve tactical intelligence." ■



EXPERIENCE-IT'S A NATIONAL RESOURCE

McDonnell Douglas's 18 contract instructors at Luke AFB represent over 61,000 hours in fighter aircraft with a total of 27 combat tours and three MIG kills.

Experience like that is hard to find on active duty these days—but it is a resource too important to waste. That's why the Tactical Air Command selected McDonnell Douglas Training Systems Inc. to provide academic and simulator instructors for the F-15 and F-15E Eagle training programs. McDonnell Douglas retains professional resources like these Luke instructors for A-10, OV-10, F-111/EF-111, and F-4 training programs. It also trains SAC KC-10 aircrews and is going to train crews for the MAC C-17 airlifters. And now McDonnell Douglas has been selected by the U. S. Navy to train aircrews for the E-6A.

Retaining human resources is good for everyone. It's good for the retirees whose skills are saved. It's good for the students who learn from experienced instructors. It's good for the Air Force which achieves new cost efficiencies in its training programs. Everyone wins!

Among the leaders training leaders, Steve Harris, top; Jim Lentzkow, in cockpit; and Rob Van Sickle, bottom.

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Japan's lead is increasing, but Sematech thinks the US still has a fighting chance.

The Chip War Isn't Over

By Robert S. Dudney,
Executive Editor

RARELY has a Pentagon study struck harder. "Semiconductor Dependency," produced in 1987 by the Defense Science Board, had a simple but stark message: Silicon microchips are critical to US weapons. US chipmakers are fading fast. For the most advanced chips, the Pentagon will soon depend on foreign suppliers—mostly the Japanese.

Today the situation is worse. Three more years of Japanese advances have now left eighty-five percent of the leading-edge manufacturing capacity in the Far East. "Should Japan decide to sell its chips to the Soviet Union instead of the US," claims one of Tokyo's more outspoken politicians, Shintaro Ishihara, "that would instantly alter the balance of military power."

It sounds grim. Yet there are mounting signs that the game isn't over. The trends have jolted US chipmakers, most notably fourteen giants who make up the Austin, Tex., research venture Sematech. They have always been resourceful, but now, if events at Sematech are any guide, they're mad as hell and won't take it anymore.

Far from giving up, the Sematech Fourteen are embarked on a massive, coordinated get-well drive, comprising fifty-seven joint projects to create everything from precision tools to smarter workers, from purer silicon to state-of-the-art processes. Their goal: Overtake Japan's chipmakers—and regain high-tech manufacturing leadership—in 1993.

They have a fighting chance. There is evidence that, while many obstacles remain, US chipmakers are revitalizing themselves in ways that soon could make them more competitive. Already, Sematech has demonstrated—and given its members—new ways to build superclean fabrication facilities and to make advanced memory chips efficiently. It has helped develop improved lithographic and planarization tools and systems to make cleaner water and chemicals. It is pushing advanced X-ray techniques.

On June 3, however, the consortium suffered a blow. Robert Noyce, its president and chief executive officer since mid-1988, died of a heart attack. The sixty-two-year-old Noyce, a legendary inventor of the integrated circuit and gray eminence of a $15-billion-a-year US chip industry, provided Sematech's intellectual firepower and its operating style. Noyce also gave the venture credibility in Washington. Loss of such a pivotal figure is sure to slow Sematech progress, at least over the short term. The search for a successor is under way.

Going into his third year at Sematech, Noyce had become certain the project would succeed. In a long interview with AIR FORCE Magazine just weeks before his death, he claimed the consortium "is working extremely well" and that member companies "are dispelling many doubts."

Under Noyce, the consortium became an R&D effort like few others. Member firms represent eighty percent of the US chipmaking base and include such behemoths as IBM, AT&T, Hewlett-Packard, Intel, Digital Equipment Corp., and Texas Instruments. With each firm providing talent, the consortium has built an Austin staff of 600, which includes professionals.

The Foreign Concept

Sematech is based on a concept new to US chipmakers: "precompetitive cooperation." Once, members competed fiercely at each step of the chipmaking process, closely guarding all techniques. Now, at Sematech, they pool generic, "front-end" know-how to achieve economies of scale and faster absorption of new technologies.

Members provide half the $200 million budget. The Pentagon funds the rest, sending $100 million through the Defense Advanced Research Projects Agency (DARPA). With the Department of Defense accounting for three percent of US chip sales, why should it provide such support?

"Think of the Empire State Building," says Sematech Chief Administrative Officer Peter Mills. "Military applications may be the top twenty floors, but you have to have that commercial base on the first eighty floors."

Pentagon involvement in the chip industry is not new. In the late 1970s, DoD launched its Very-High-Speed Integrated Circuits (VHSIC) program, in which a number of con-

tractors produced highly advanced semiconductors. The program, which proved highly successful, was a means of acquiring military-qualified chips for a wide variety of US weapons and systems. Though geared specifically to military products, the VHSIC program also had a commercial impact. In Sematech, however, there is a much more intense focus on advanced manufacturing technologies needed for mass, factory-scale, commercial chipmaking.

Sematech members are pursuing an ambitious technical plan. They must. Today, a tiny chip might have millions of microscopic components. In a few years, it will have billions. The question now is who will make these exotic new semiconductors first.

Experts agree that the US still boasts the most gifted designers. The US, in fact, leads the world in low-volume "custom" chips.

However, most say that the key to long-term leadership in semiconductors lies in high-volume production of standardized chips—mainly memory devices. Here Japan excels. The manufacturing art, pressed to the limit, becomes technology's leading edge and pulls the rest of the industry along with it.

Experts note that in dynamic random access memory (DRAM) chips, a bellwether of mass-production skill, the US share of the world market fell from ninety-five percent in 1975 to today's five percent. In static random access memory (SRAM) chips, the story is much the same. Meantime, Japan's share in both soared.

Sematech focuses heavily on new technologies to match Japan's memory capabilities, which stem from the ability to inscribe extremely narrow circuit lines and to get high yields per lot.

Same as a Shriveled Pea

In the latter area, Sematech has given members valuable data. Example: Processes and specifications for building a "clean room" to block out airborne impurities that can ruin chips. So pristine is Sematech's clean room that, in an average cubic foot of air, no more than one particle is found, and that particle is no wider than one two-millionth of a meter. That is equivalent to a cubic mile of air containing one shriveled pea.

The first recipient of clean-room data was the National Security Agency, which incorporated it in construction of a new semiconductor facility. Motorola, Hewlett-Packard, and National Semiconductor also used the technology.

In its push to shrink circuit widths, Sematech has a three-stage strategy. Phase One, now complete, demonstrated processes for high-yield, factory-scale production of today's premier DRAM, which stores four million bits of data, and the leading SRAM, which stores 256,000 bits. The circuit line of a four-megabit DRAM measures 0.8 micron (a human hair is 100 microns wide).

Sematech was given access to production technologies for four-megabit and 256-kilobit chips. These were contributed by IBM and AT&T, respectively. A production line was set up and processes unveiled. Sematech used a modular, flexible line able to build DRAMs, SRAMs, or logic chips. This program, says experts, advanced member knowledge by six to twelve months.

Sematech intends to demonstrate far narrower circuits. Plans call for Phase Two, now well under way, to produce 0.5-micron line widths needed for the next-generation, 16-megabit DRAM. In Phase Three, Sematech is to produce circuits of 0.35 micron width, tiny enough to permit production of a 64-megabit DRAM.

If Phase Three efforts pay off as planned in 1993, the US will leapfrog Japanese firms by up to twelve months, claims Sematech. In the chip industry, even a six-month lead is considered large.

Equally important are Sematech's efforts to shore up a vital part of the chipmaking base: the supplier infrastructure. Indeed, signs are that chipmakers view the state of the supplier base with mounting alarm. The consortium will pour $108 million—half its budget—into projects to stabilize the network of 150 second-tier firms.

Creation of advanced semiconductors takes huge amounts of pure materials and precise and reliable tools. Sematech officials argue that the base should be US-owned; Japanese chipmakers, it is said, have first call on new high-quality Japanese supplies and equipment. "Without a competitive infrastructure," Noyce repeatedly warned, "the US semiconductor industry is squarely in harm's way."

The supplier base is eroding. Though US chipmakers have forty percent of the world semiconductor market, the market share of US materials and tool suppliers falls well short of that. In materials, six of the world's top ten firms are Japanese. In most tools, US share of the global market is less than twenty-five percent.

Sematech is struggling to halt the decline. It assigns paramount importance to what it calls Joint Development Projects (JDPs) and Equipment Improvement Programs. In these, Sematech and a supplier jointly fund fixes to make the firm more competitive. New equipment or material is then made available to Sematech members.

One example: Sematech has sponsored an advanced system to produce deionized water that is far cleaner than the industry standard and has passed on the knowledge. A team comprising a division of Union Carbide, Hercules Corp.'s Semi-Gas Systems, and Wilson Oxygen developed a system to produce gas with the world's highest purity at point of use, at reduced cost.

Fixing the "Showstoppers"

When it comes to equipment, Sematech has focused on "showstoppers" such as stepper-aligners, scanning electron microscopes, and memory testers.

The most obvious success story is the rehabilitation of GCA Corp., a Massachusetts producer of lithographic steppers, which are the key to the transfer of tiny circuit patterns on to silicon chips. In 1981, GCA produced 175 of 240 steppers sold worldwide, compared with fifteen for Nikon. Four years later, Nikon sold 145, and GCA but 115. GCA's slide continued; both Nikon and Canon surged.

Under Sematech, GCA has upgraded its current-generation CCS ALS 200 stepper, redesigning it for greater reliability. Now, says Sematech, it is a credible supplier. Its reputation had been going down steeply but is now stable.

In addition, this summer GCA introduces a new stepper, able to achieve a 0.5-micron line width. This is the result of an extensive JDP orchestrated by Sematech. The stepper will come out a full year earlier than originally planned.

Sematech is trying to resuscitate another foundering lithography concern, a unit of Perkin-Elmer Corp. recently bought by a US group. It is also working with Genus of California to boost reliability and cut costs on its vapor-deposition system and with Lam Research to enhance its Rainbow 4600 etcher.

Sematech has just completed a joint project with ATEQ Corp. of Oregon, one in which the reliability of its existing electron-beam tool rose by a factor of four. Another JDP helped Westech of Phoenix quadruple the productivity of a special planarizing tool. In the assessment of Sematech's Peter Mills, the Westech tool now is "absolutely world-class, best of breed in the world."

In reviving the supplier base, Sematech has some distance to go. Several names on its original list—Monsanto Electronic Materials Co., Materials Research Corp., AVX Corp., to name a few—have been purchased by overseas firms. Nippon Sanso is trying to buy Semi-Gas, Sematech's erstwhile JDP partner.

The supplier base, Noyce had concluded, "is still very shaky."

When it comes to basic research in commercial semiconductor manufacturing, Sematech's immediate contribution was to establish priorities and mobilize US universities and federal laboratories.

Sematech allocates about $11 million a year to fund eleven university-based Sematech Centers of Excellence (SCOEs). Research is long-term, two technology generations into the future. A prime case in point is the University of Wisconsin's SCOE; it focuses on X-ray lithography, which is critical for the late 1990s.

Sematech sifts the work of Sandia National Laboratory in New Mexico and Oak Ridge Laboratory in Tennessee, looking for technology applicable to commercial needs. Sandia's considerable experience with reliability testing of nuclear devices led to establishment of a Semiconductor Equipment Technology Center there.

Challenging as it is, the purely technical struggle may be the least of the recovery problems for Sematech members.

The National Advisory Committee on Semiconductors asserts, for example, that US chip-producers face a fundamental, long-term customer problem. Each year, warns NACS, more of the customer base—industries that buy chips—migrates to the Far East, mainly to Japan. Only six years ago, notes NACS, sixty-three percent of world chip output was consumed by products made in the US and Europe. The figure today has plummeted to forty-seven percent. US standing as the world's largest chip market was usurped by Japan, the result of the Asian nation's rise to preeminence in consumer electronics.

The drift of electronics production to Japan, says NACS, is of great importance to US chipmakers. They still encounter difficulty selling in Japan, having only a ten percent share of sales. As production shifts to Asia, their market shrinks.

The Irresistible Chips

Japan's share of the US chip market rose in the 1980s from five to thirty percent. High quality and low price evidently make Japan's chips irresistible to US computer firms, a situation Noyce had long regarded as evidence of dangerous short-term thinking that ignores the potential for a Japanese takeover of the computer market itself.

"These [computer] companies," he warned, "are buying their disk drives, their tubes, their keyboards, their memory chips. They think it's an American business. All the components come from Japan. The computer industry will wind up the same as the television industry. There just isn't any in America."

The financing and profit structures of US firms pose yet another problem, especially for small US concerns. Japan's chipmakers usually are part of huge industrial combines with lots of staying power. Smaller, independent US firms must turn a profit quickly or shut their doors. This tends to focus US chip producers on short-term problems, rather than long-term strategies. Also afflicting US chipmakers is the higher cost of capital. Even Sematech members are tying up overseas deals.

Sematech confronts ideological critics who question the propriety of government involvement in what is essentially a commercial venture. While support for Sematech is strong on Capitol Hill and within DARPA and certain other parts of the Bush Administration, the Pentagon at large has not shown great enthusiasm. At the White House, Budget Director Richard Darman and other officials are said to oppose what they consider attempts to implement US "industrial policy" through entities such as Sematech. The sentiment flared last spring and led to the abrupt sacking of DARPA Director Craig Fields, a supporter of government-industry collaboration in certain areas.

Within the chip industry itself, a small but vocal minority opposes Sematech. One faction argues that it could unduly centralize semiconductor investment and decision-making. Another sees excessive emphasis placed on big, entrenched firms at the expense of smaller companies. Yet another group believes that the involvement of a clumsy, suffocating, government bureaucracy in the fast-moving world of semiconductor manufacturing poses a threat to innovation, the lifeblood of the industry.

Noyce was not blind to the dangers or deaf to the criticisms. He argued, however, that critics overlook areas where Sematech has disproven the conventional wisdom.

"One of the criticisms leveled at the beginning was that competitors won't work together," said the late Sematech president. "I think that the experience of bringing people from many different firms into a common facility, having them work side by side, has been an eye-opening experience for everybody."

Strength of member commitment—especially in assignment of able personnel—is another surprise. Companies are sending top talent and not expendable personnel.

"The final judgment of success is whether America has a healthy semiconductor industry," explained Noyce. "That is the bottom, bottom line. I don't see any reason to keep [Sematech] alive if it's not successful." ■

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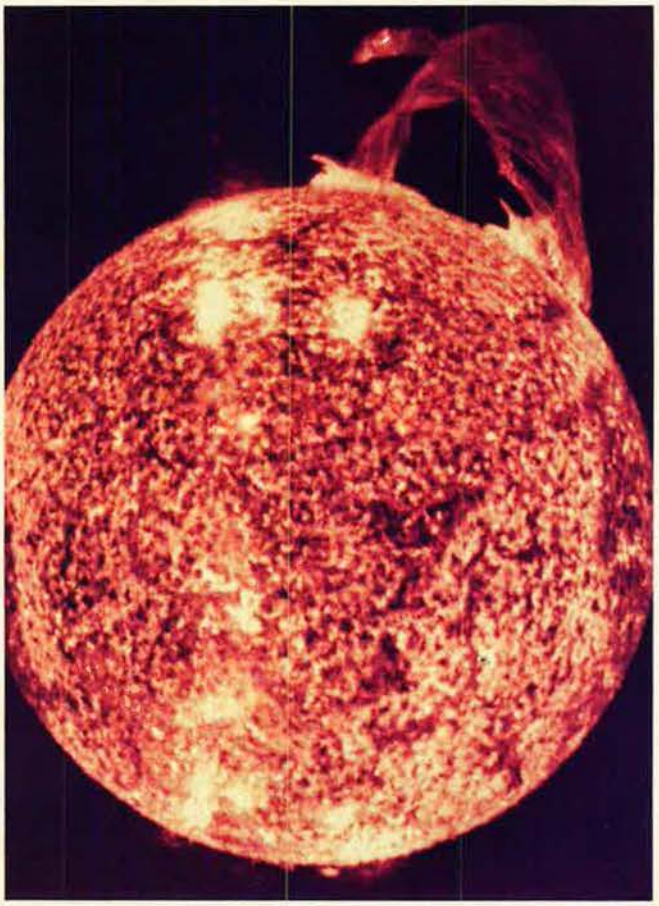
Every eleven years, the sun reaches the peak of a violent cycle that plays havoc with satellites and earthbound electronics.

Solar Max

By Colleen A. Nash, Associate Editor



Above, portrait of an angry sun. NASA's Solar Maximum Mission satellite (next page) became the first satellite to be captured in orbit for in-flight repair. Launched in 1980 to study solar flares over a full sunspot cycle, the satellite met an early death in 1989 due to the increased flare activity associated with the solar max.

IN July 1979, the US space station Skylab tumbled prematurely from orbit and burned up in the Earth's atmosphere. In December 1989, an unmanned satellite also began falling early, dropping half a mile each day. This spacecraft crashed into the Indian Ocean.

The premature deaths of these two space systems were no accidents. They were direct results of increased activity within a massive, distant thermonuclear reactor: the sun.

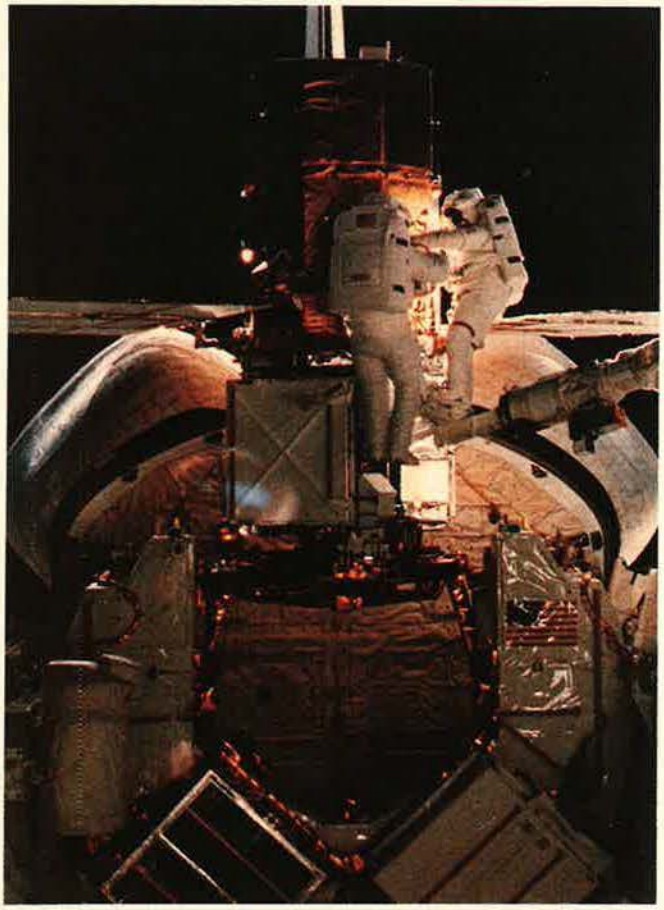
Every eleven years or so, the sun pitches a spectacular tantrum. It spits out a prodigious number of huge solar flares, some packing the equivalent energy of 100 million hydrogen bombs. The sun also operates in high gear just before and after this spike of activity.

Scientists have a name for this period of extraordinary solar friskiness; they call it the "solar maximum." It was to the force of solar max that the two ill-fated spacecraft fell victim.

Sun vs. Services

For the US Air Force and other services, the solar maximum is a big problem that gets close attention from scientists, commanders, and systems-makers. The reason can be discerned by looking at a handful of the many incidents recorded during two weeks of especially turbulent solar activity just last year:

- Technicians at US Space Command lost track of some 1,400 space objects. About three weeks passed before trackers could relocate all of them.
- Three Navy satellites went into uncontrolled tumbles.
- The Navy's MARS (military affiliate radio system)



suddenly went blank in the ten to twenty megahertz span of the high-frequency range.

- Several power disruptions afflicted LORAN (Long-Range Aid to Navigation), the Coast Guard's radio navigation system.
- Three polar-orbiting weather satellites began to exhibit serious stability problems.

Some solar maximums are more intense than others. The sun currently is at or near the peak of a humdinger solar max—perhaps, say those who study the problem, one of the all-time greats. USAF pays keen attention to the sun and particularly to the solar maximum when it occurs. During this period, solar flare activity is greater, and the flares can disrupt everything from Air Force early warning and communication systems to satellite orbits and hardware.

Says Dr. William Swider, Deputy Director of the Space Physics Branch of USAF's Geophysics Laboratory, Hanscom AFB, Mass., the effects of solar flares are "what really causes the problem for the Air Force."

At the heart of the problem is the phenomenon of sunspots, which are dark imperfections on the sun's surface. Ever since the Italian astronomer Galileo discovered sunspots in 1610, sky-watchers have recorded their number and location. Over the years, they have discovered a pattern. Sunspot activity waxes and wanes at regular intervals. The extreme of the solar cycle repeats itself about every eleven years. Sunspots become most numerous during a solar max. When one of these solar blemishes bursts, it spews an awesome solar flare.

When a solar flare erupts, three types of emissions can reach Earth's atmosphere: electromagnetic radiation, very-high-energy particles, and plasma (a highly ionized gas of lower energy particles). "This results in several different kinds of impacts on US Space Command and NORAD systems," explains Capt. Devin J. Della-Rose, with Air Force Space Command's Directorate of Weather.

Electromagnetic radiation, traveling at the speed of light, takes about eight minutes to traverse the 93,000,000-mile gulf between the sun and this planet. Thus, just a few minutes after a solar flare erupts, the Earth is bombarded by an intense dose of solar radiation.

These extra waves are made up principally of powerful ultraviolet and X-ray radiation. They can cause a "sudden ionospheric disturbance," or SID. A SID can greatly disrupt USAF communications in the half of the world that happens to be in sunlight at the time the energy arrives.

Thickening the Ionosphere

The Earth's ionosphere is divided into three layers of varying density. Each layer acts as a reflector for certain wavelengths. Short-wave—that is, high-frequency (HF)—radio signals normally travel through the less dense lower layers of the ionosphere, then bounce off the top layer of the ionosphere. The signal then returns to a terrestrial point far over the horizon from the source of the signal.

However, explain scientists, the big dump of X rays sent out by a solar flare "thickens" the lower layers of the ionosphere—layers that HF radio signals ordinarily penetrate with ease. As a result, these newly thickened lower layers cause HF radio signals to weaken and return faintly to Earth. This process, explains Captain Della-Rose, tends to "really decrease the strength of the radar signal." If the onslaught of solar radiation is powerful enough, it may absorb some signals altogether.

Dr. David Anderson, a top USAF Geophysics Lab physicist who specializes in matters pertaining to the ionosphere, maintains that the problem is especially important when it comes to using the new Over-the-Horizon Backscatter radar system, constructed to detect at great distances the approach of Soviet bombers. The OTH-B radar, says Dr. Anderson, "actually needs the ionosphere to operate, and you have to know what the ionosphere is doing to be able to set your frequencies correctly." Fortunately, says Dr. Swider, the SID phenomenon is rather short-lived, typically lasting about twenty minutes.

This X-ray and ultraviolet barrage also causes the upper ionosphere to heat up and expand, increasing friction on low-orbiting satellites. This additional resistance, or "drag," exerted on a spacecraft can cause it to slip from its orbit, losing altitude.

Emissions from the higher end of the electromagnetic spectrum are not the only problem caused by the flares. Also certain to cause difficulties are radio waves, radiation from the lower end of the spectrum. Radio waves sent from a solar flare most notably affect Earth-based radars and thus endanger USAF's target detection activities.

Captain Della-Rose points specifically to problems that could befall USAF's early warning radars. "If a radar has the sun in its field of view and a [solar] radio

burst occurs," he explains, "then the radar antenna will receive some of the solar radio waves. These radio waves will raise the noise level of the radar, and that can definitely impair the radar's ability to detect a target."

Proton Rain

In addition to electromagnetic radiation, solar flares also spew miniscule, extremely high-energy particles, mostly protons. When a flare erupts, this planet can experience, sometimes within a few minutes, what scientists call a "proton event." This means that the concentration of the more energetic particles is so great that an invisible shower of these subatomic bits of matter pummels the upper reaches of Earth's atmosphere.

These deluges of highly energetic particles can cause the Air Force some serious problems. Dangers include physical damage to the delicate workings of various application satellites and the temporary "blinding" of satellite sensors. The disruption or even destruction of polar HF communications systems is possible. What's more, an astronaut in space in the path of a proton event could be killed, say Air Force physicists.

Satellite systems are especially vulnerable. Lt. Col. Robert Coman, chief of aerospace science for AFSPACECOM's Directorate of Weather at Peterson AFB, Colo., tells why. "If a high-energy proton comes screaming through and happens to penetrate a chip, it can upset its memory," he says, noting that the impact could change a computer's binary instructions by flipping a one to a zero and vice versa. The Air Force calls this a "bit flip" or "single-event upset." Bit flips can even cause a slight change in the software.

When this occurs, explains Colonel Coman, the Air Force might need to transmit an entirely new set of commands to the wounded satellite.

"Very seldom are any of these [bit flips] fatal," says Colonel Coman, "but they are a nuisance, and they cause people to go to extra effort to try to keep things on track." Even so, warns the Geophysics Lab's Dr. Swider, "it's possible that you could get enough damage that it will just wipe out an element of your satellite."

Energetic particles pose a particularly menacing threat to satellites used for military communications and surveillance. The reason: These satellites are held in higher, geosynchronous orbits and thus receive less "protection" from the Earth's natural magnetic shield. The situation is especially worrisome since the nation's most critical applications satellites tend to operate at these extremely high altitudes, around 22,300 miles.

Space-based ballistic missile defense systems, such as the one being developed as part of the US Strategic Defense Initiative, could encounter serious problems. "The trouble with this 'Star Wars' business," contends Dr. Swider, "is that objects sent up into space for long periods of time *are* going to get damaged. It's not a healthy environment." This is especially true, he says, for systems operating in the higher, less protected orbits.

The new generation of tiny, lightweight computer chips, valuable though they may be in modern spacecraft, nonetheless are more susceptible to the effects of energetic particles. Because microcircuits pack much more information in much less space, explains Dr. Swider, a direct proton "hit" could ruin an information-ultrarich chip.

Not only hardware is affected. These superaccelerated protons, like X rays and ultraviolet emissions, also disturb the ionosphere. Energetic particles tend to stream into the polar regions, where the Earth's powerful magnetic field lines pull in particles of all types. There the high-energy protons can thicken the ionosphere to a more severe degree than the X rays can.

At the poles, says Dr. Swider, "there is so much ionization going on that it can wipe out certain frequencies altogether." The effects can last for days.

A Nervous Breakdown

In addition to electromagnetic radiation and extremely high-energy particles, a solar flare throws out a third troublesome product. It is "solar plasma," an invisible, highly ionized cloud of less energetic protons and electrons.

This plasma cloud, unlike electromagnetic emissions, takes days to reach the Earth. It travels at about 3,000 miles per second, far slower than the 186,000-miles-per-second speed of the sun's X-ray and ultraviolet emissions. Like the flare-accelerated protons, the plasma cloud naturally gravitates to the polar regions, says Dr. Anderson.

When the plasma cloud arrives, the results can be dramatic. It causes geomagnetic storms that intensify and greatly expand auroras. It heats the atmosphere, and the ionosphere undergoes a kind of nervous breakdown.

Problems begin cropping up immediately. Northward-looking radars see false images. Satellites slow down and begin descending. Tracking systems lose sight of various objects in space. The higher latitude regions sometimes suffer total power losses. Communication systems go haywire.

Because the atmosphere is inundated with charged particles during a geomagnetic storm, says Captain Della-Rose, a static charge can build up on satellite surfaces. When it releases this pent-up energy, he says, "the discharge can damage solar cells and surface coatings. It can also blind certain sensors or cause a sensor to activate or deactivate on its own."

Dr. Swider points out that a geomagnetic storm creates so much heat that it causes the atmosphere to expand and thus increases the drag on satellites. If the storm is big enough, it can cause satellites and spacecraft to descend rapidly to unexpected altitudes, as was the case with Skylab. This extra heat not only threatens to shorten the life span of a satellite, but also places many in unanticipated positions, making it more difficult for US Space Command to track their whereabouts.

The plasma cloud has a discernible effect on the Aurora Borealis, which usually exists only at high latitudes. When the plasma cloud hits in force, however, the Aurora Borealis expands, moving as far south as Mexico. The larger and more powerful aurora can wreak havoc on radio signals trying to pass through it.

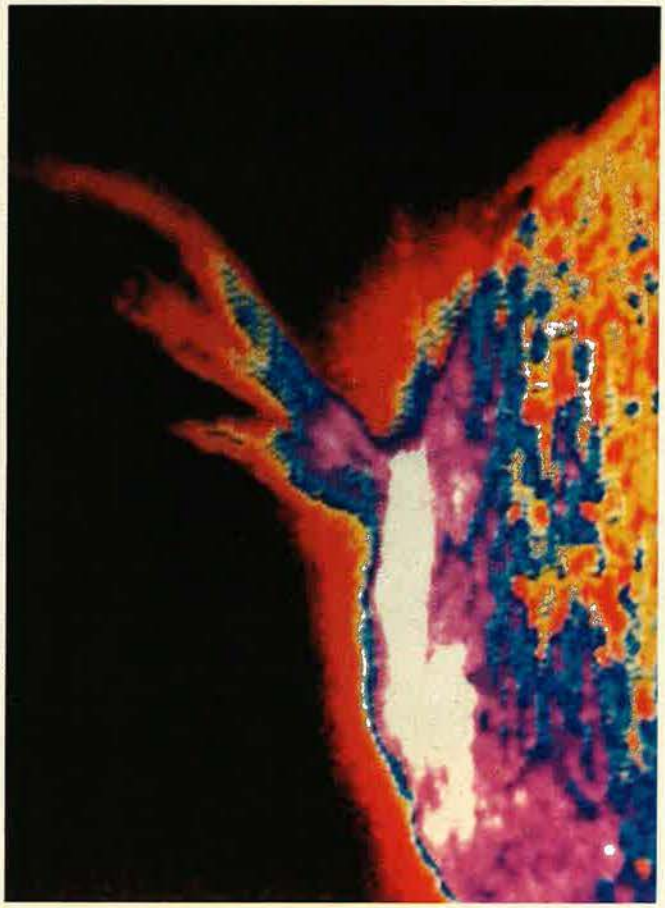
AFSPACECOM's Colonel Coman explains that the aurora is a semitransparent reflector. Energy striking it comes back toward the sender. "You see that as clutter," he notes, "because the aurora is moving around very rapidly and distorts your own energy. So it's like you are jamming yourself. Your own energy hits the aurora, comes back at you, and raises the interference or noise level."

Dr. Swider offers this explanation: "If you have an aurora and the ionosphere is changing like crazy, then not only is the ionosphere more intense but it is [also] highly variable, and there are differences in density." He explains that this can cause problems with the relatively small part of the OTH-B radar covering the storm. "You may just get a signal back that is scrambled."

Battling the Effects

The Air Force spends much time and money to understand the sun so that future USAF systems can be designed with the solar max and its effects in mind. Solar experts also strive to become better able to predict when a flare will erupt.

The Air Force has found ways of dealing with a temperamental ionosphere. One method is to scan the electromagnetic spectrum in search of a particular frequency not yet disturbed by the flux of solar radiation and particles. If one is found, then sometimes communications can be rerouted to make use of the workable frequency. Knowing when a solar flare will erupt and when a geomagnetic storm will strike contributes to effective "frequency management" reduction of signal loss.



The Combined Release and Radiation Effects Satellite (shown, top right, in an artist's concept), a joint USAF and NASA program, will travel in and out of the Van Allen belts, regions above Earth's atmosphere where high-energy particles like those released from solar flares are trapped, to see how a sophisticated package of microelectronic devices holds up. The colors of the sun's surface (above) indicate various intensities of extreme ultraviolet radiation, released in force when solar flares erupt.

"It's been a gradual learning experience," says Colonel Coman. "With each new generation of satellites that goes up, the Air Force learns a little more about the impacts. Some of the early communication satellites we put up were operated at fairly low frequencies—300 to 500 megahertz. We found out pretty quickly that those frequencies are severely impacted by solar flares, so we started moving to even higher frequencies, up into the upper UHF [ultrahigh frequency]," says the Colonel. Many of the most critical military satellites are now designed to use the higher, more reliable, frequencies.

In addition, Colonel Coman says that the Air Force is now able to "harden" certain integrated circuits or chips, making them less sensitive to effects of particles. Some satellites now carry two sets of programs so that if one is damaged, operators can go to a backup.

Scientists at the Geophysics Lab continue to study the problem. Spacecraft like the Combined Release and Radiation Effects Satellite (CRRES), due to be launched in June 1990, will monitor effects of solar radiation and particles on 460 state-of-the-art microelectronic devices.

"The best way to help the Air Force in the end is to understand when the sun is going to have an eruption so that we can give the best early warning to the Air Force to protect its assets," concludes Dr. Swider. ■

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GENERAL DYNAMICS

A Strong Company For A Strong Country

USAF pilots need warning when passive infrared missiles are on the way.

Seeking the Heat Seekers

By David S. Harvey

MAJ. Gen. John Corder, USAF, knows what it's like to be shot down. He remembers the wrecked, shuddering, only-just-flying F-4 Phantom II that he brought out of North Vietnam, hydraulics out and canopy shot away, and the nail-biting wait for the Jolly Green Giant helicopter crew to pick him up along the Laotian border. "That was my ninety-fourth mission," he says, "and it was a 23-mm AA shell that put an end to it. We'd seen the SA-2 missile coming up and were beginning to outfly it. But while I was avoiding it, I ran head-on into the gunfire."

General Corder was a captain then—"a lucky one that day," he notes—but now, as commander of the USAF Tactical Air Warfare Center (TAWC) at Eglin AFB, Fla., he is hoping to change the rules of the game more in the fighter pilot's favor, spurred not a little by the memories of that long-ago day five miles south of Hanoi. His quest now is to provide current-generation, front-line fighters with off-the-shelf missile warning systems, devices that will go one step beyond what today's radar warning receiver (RWR) systems provide. Today's systems warn of active, radar-guided threats. The new type will warn of passive, usually infrared-guided ones.

"We've got to look at the threat of passive missiles more seriously than we have done," says the General. "Here they come, their motors burned out, homing on your heat emissions. How the heck are you going to see them? We've got to find the answer to this problem."

General Corder's approach has been typically forthright: Ask in-

dustry to "come forward" with solutions. In return for providing the equipment for a series of tests he wants to run, the contractors will get something more valuable than money: data. The plan is to fly the trials against QF-100 drones, using both AIM-9 (infrared) Sidewinder and AIM-7 (radar) Sparrow air-to-air missiles. Instead of warheads, the missiles will come equipped with telemetry packs.

Fishing in the Gulf

The idea is to trigger the target aircraft's missile warning system and see if it can spit out the necessary amount of chaff and flares to fool the mix of incoming missiles. "If the [warning] systems work, you can have the data," General Corder tells the participating firms. "If they don't, you can go fish them out of the Gulf."

"It's an unorthodox way of doing things, and it's expensive, but we're going along with it," reports Loral President Frank Lanza. Loral is one of a number of firms ready to show its stuff to General Corder. Says Mr. Lanza, "I admire the way he's attacking the problem. It's good leadership."

General Corder's plan has moved forward on schedule. The first contractor at bat, Sanders, has already tested its AN/ALQ-156 Missile Warning System on the drones and scored six successes out of six tries. "The Sidewinder acted like a Soviet AA-9," says General Corder. "The -156 picked up the missiles and deterred them with the right mix of countermeasures on each of six missions. You can say I'm encouraged."

Early this spring, Loral was getting ready to test its AN/ALQ-199, with Westinghouse scheduled to put its AN/ALQ-153 system on line in the summer. Both ITT and General Electric are said to be interested in participating. In fact, tough though General Corder's bargain may be, there appears to be no shortage of takers. "It's a prestige matter for the contractors as well," says Mr. Lanza. "To be aboard the Air Force's top-line fighter is a feather for anyone's cap."

Interestingly, some of this equipment is already at work in other platforms, sometimes belonging to other services. Strategic Air Command B-52s, Military Airlift Command transports, Army and Navy helicopters, Special Operations Forces aircraft, Israeli fighters—in fact, anybody currently going "in harm's way" seems to be using missile warners. Why are they not on Tactical Air Command fighters?

The answer to that question, observes General Corder, "lies in the mysteries of ASPJ development and the vagaries of electronic warfare contracting in recent years." ASPJ stands for Airborne Self-Protection Jammer, a long-running joint program that has run afoul of high costs and technical difficulties. "We tend to be the victims of our own sophistication," General Corder adds. "Now it's time to be simpler, take it one step at a time."

General Corder, who says "he made his opinion known" at every stage of ASPJ's developmental throes, regrets that "$750 million was spent before any testing was done. What we have a chance to do now is find out what other people already know about missile warning and see what could apply to us." General Corder believes that, in contrast with the pricey ASPJ, it would cost about $30 million in nonrecurring costs to develop an effective passive missile warning system for TAC's F-16 fleet and $300,000 per aircraft to install it.

A Tight "Real Estate" Market?

To naysayers who resist any further moves to put new equipment aboard the F-16 because of lack of space, General Corder's answer is "baloney, but respectful baloney." He simply doesn't think the fit is getting tight. "There's plenty of real estate on the F-16," the General maintains. "We went through that already when we looked at the Falcon Eye [IR sensor] recently." His ideas on what needs to be added to a modern fighter to render it less vulnerable to today's proliferation of smart weapons don't stop with missile warning. The on-board real estate argument could get hotter yet.

The missile warning systems signed up for the trials thus far work on a common principle: radar. They are, in effect, made up of groups of radar emitters. When something enters the radiated "envelope" around the aircraft, alarms are sent to the pilot and, if the system is integrated, countermeasures such as chaff and flares are set off.

At least one contractor, Loral, wants to extend the principle further. One "flaw" in the missile warning argument is that, by nature, radar emissions are "active" regardless of how they may be modified electronically to give them a low-probability-of-intercept capability. Loral recently purchased the rights from Honeywell to another type of detector—a passive one, which essentially reacts to the IR signature given out by the plume from a missile's motor. That system, called an AAR-47, has found a niche in Army and Navy helicopters and is also used to provide protection for MAC's C-130 transports.

Explains Loral's Mr. Lanza, "We want General Corder to give this system a try as well. We're coming to an era, I believe, of multimode missiles, ones which combine all sorts of 'smarts' to get their job done. The totally passive warning sensor has a role to play."

General Corder's planning looks even further ahead. He intends to start looking at options for providing fighters with self-protection against laser-guided missiles.

"There's not a lot of laser-guided air-to-air missiles out there, I agree," the General acknowledges, "but we are concerned with something we're now calling a 'silent attack,' which is a Soviet-developed tactic. There's evidence that their fighters use their IRST [infrared search and track] systems to come in passively, and then they combine it with a laser range finder to target their missile. That combination could be devastating to a pilot, because there's just no way he could get any warning of what was about to happen. If he knew he was being painted by a laser, he would have a chance."

The same kind of contractor "deal" will be struck. A laser warning system will be installed in a Pave Tack pod and flown aboard an F-4E, which will then make runs against ground and airborne laser sources. TAWC pilots have already flown a system developed by Santa Barbara Research Center. Others developed by Tracor, Messerschmitt-Bölkow-Blohm of West Germany, and Perkin-Elmer are set to follow. General Corder told attendees at the Air

Force Association's Tactical Air Warfare symposium in February that the Santa Barbara system worked five times out of five.

"These systems are real small," he explained, "and they can be mounted almost anywhere, even perhaps on the canopy."

Avoiding Laser Blindness

It will be critical, however, for the pilot to avoid looking directly into the laser beam and thus sustaining critical eye damage. Here General Corder is presented with another problem.

"How do I (A) tell the pilot he's being lit by a laser beam and (B) tell him where it's coming from?" asks the General. "What he's going to do is look at the threat source to try and outmaneuver it. That'll be instinctive."

One way to deal with the problem may be to have the cockpit warning indicator show a return on a sector of the threat azimuth display other than the one being illuminated. "That way," says General Corder, "he'll look away from the threat, but [he'll] know it's there."

I asked an active-duty F-16 pilot how he'd react to a warning displayed in that fashion. His answer was not very supportive. Pilots like to *see* the threats they're dealing with. General Corder's response was that he was all for "productive controversy" on the matter. "Look, I'd say to the guys: 'You tell me how you'd like to do it.' I'm open to suggestions. That's the beauty of what we're doing here. It's a process. None of this equipment is my bright idea. What I'm trying to do is find out what works and what doesn't."

That process is already turning out some winning ideas. This summer should see the release of an RFP for a unique electronic warfare simulator that would fly along on an airplane and give the pilot a full electronic workout. Called OBEWS (on-board electronic warfare simulator), the system is mounted in an AMRAAM-sized pod and is programmed before the flight with lots of "pop-up" EW threats, including simulated missiles.

The system includes digital map data, so it can tell when a pilot drops below line of sight when trying to break lock. Debriefing is easy: The pilot removes a data recorder and then replays both the threat and his performance back at base.

"The key to this, in contrast to the way EW simulation is done now, is that we end up here with a picture of exactly what went on in the cockpit during the maneuvers," General Corder notes. "That's enormously valuable from a training standpoint. The system gives 'credit' for correct responses, so it reinforces training."

General Corder sees it as being complementary to the "heavy lifting" EW experience gained on Red Flag-type ranges at Nellis AFB, Nev., and elsewhere. "We need that, don't get me wrong. But right now, the first time one of our guys meets an SA-8 is out there on the range, and it's not a great learning environment. We want him to know all about the SA-8 *before* he goes out there."

Yet another project under TAWC control is the "EW Aggressor" program, designed to test the radar jammers on today's fighters.

"We've got lots of EW pods out there," General Corder explains. "But let's face it: It's like all mechanical things. Some work better than others."

The Aggressor is a two-stage process. "Two of our bright sergeants at TAWC came out with this, and it's great," says the General. "The first part is to place a little test cap over the endcap of an EW pod and then feed it all good radar emissions it's supposed to lock on to. Then we measure the output that comes back out of the pod, the waveform and so on, and put it through a spectrum analyzer. Then we keep real tight records on each individual pod, so we end up knowing the intimate details of each one."

Overcoming "Bad Actors"

Jammer pods suffer from transient failures, the kind that make maintenance people extremely anxious. A pod will fail at 300 feet on a fast run in, but when it gets back to base, technicians can find nothing wrong. General Corder explains, "They're called 'bad actors.' What we do is take all those pods and have the pilots fly over specially located test equipment, just make a ten-minute diversion in their mission, and then we run the same battery of tests again and get all the records again. This year we've serviced four TAC wings and will do eight, including a trip to the Philippines to visit PACAF units there. Eventually all fourteen TAC wings will go through the EW Aggressor program. Right now we've looked at a total of 290 pods."

Up to now, TAC fighters used to make a single pass over a jammer testing range whenever they were flying at Eglin. With EW Aggressor, the amount of testing is many times more thorough and can be performed at almost any time.

The results are worth the effort and expense, General Corder says, because EW Aggressor has already identified a ten percent failure rate across the entire range of TAC jammers. "It's just a commonsense thing to do," he says, "but it's already broadened the experience of the ground people, made them a lot smarter about how to fix those things. It's a scrubdown program, so we get all the bugs out now, *before* anything urgent or nasty crops up."

In General Corder's world, electronic combat is the key to the future. "The lessons of the eighties have been learned, there's light at the end of the tunnel, all that sort of thing," he says. "What we've really learned in EC [electronic combat] today is that you have to evolve, not have all these revolutions, generational changes in technology we used to toss around so lightly.

"Now I'm not talking about what's around the corner in stealth fighters or ATF [Advanced Tactical Fighter] and so forth; I'm talking about the here and now of our present inventory. Right now we are at least even with, and may be a little ahead of, the Soviets in terms of electronic combat capability, one of the few times, in fact, we may have pulled into the lead. The decade of the nineties is going to be much better than the eighties in this respect. The tools are all there. It's just a matter of deciding to use them." ■

David S. Harvey is Washington Editor of Defense Science and Electronics *magazine. His last article for* Air Force *Magazine was "Talking With Airplanes" in the January 1988 issue.*

ZEUS: The complete, integrated, ready for action EW suite.

ZEUS is already in operational service in Harrier aircraft declared to NATO by the UK. In trials Royal Air Force commentators reported that the aircraft has the "most effective internal countermeasures suite – currently well ahead of any Western fighter aircraft, and probably the best in the world".*

What does this mean for F16 pilots? Good news.

ZEUS matches the latest F16 installation using existing antennas and cabling. ZEUS gives the F16 a fully integrated internal countermeasures suite. It is already in production and includes intelligent multi-mode, range denial, deception and repeater jammers.

ZEUS has already proved its powers on US ranges. For the F16, it is a fully developed option.

ZEUS and the F16 make a great team. Both are proven, reliable winners, and ready for action right now. * 'AIR CLUES' Journal of the RAF, September 1989

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Wing joined to main fuselage March 1, 1990.

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Electronic Systems Checklist

Compiled with the assistance of the Electronic Systems Division, Hanscom AFB, Mass.

Acquisition Integration Office
Provides a "system of systems" quality assurance function for AFSC. Responsibilities include interface assessment, transition planning and engineering analysis for 800 series programs in Missile Warning, Atmospheric Warning, and Space Warning mission areas. **Contractor:** None. **Status:** Ongoing.

Advanced HF Concepts
Development and acquisition of new technologies for existing high-frequency radios; narrowband and wideband items for uses after 1995. **Contractor:** MITRE. **Status:** Concept definition.

Advanced Tactical Battle Management System
Program to identify alternatives to satisfy future tactical C^3 needs. **Contractor:** None. **Status:** Research.

Advanced VLF Receiver
Program to provide B-2 bomber force with highly survivable capability to receive NCA directives. **Contractor:** None. **Status:** Full-scale development.

AI-Derived Technologies
Program to develop three knowledge-based planning and scheduling systems for Military Airlift Command and Air Force Space Command. **Contractor:** MITRE. **Status:** Validation.

Airborne Battlefield Command and Control Center III
A C-130-based, automated, airborne command and control system for TAC use in forward battle areas and with special operations forces. **Contractor:** Unisys. **Status:** Production.

Airborne Warning and Control System (E-3)
A major upgrade program for the AWACS surveillance and battle management aircraft. Includes additional sensors, antijam communications, and radar systems upgrades to keep the plane in service into the next century. **Contractors:** Boeing, Logicon, Westinghouse. **Status:** Full-scale development, production.

Aircraft Alerting Communications Upgrade
An EMP upgrade program designed to provide assured communication from CINCSAC to alert aircraft squads, secure from effects of electromagnetic pulse. **Contractor:** BDM Corp. **Status:** Full-scale development, production.

Air Defense Initiative
Definition, development, and demonstration of new technologies required for future construction of comprehensive active air defense system. Emphasis is on technologies for surveillance, battle management, and C^3I against advanced air vehicles. **Contractors:** Multiple. **Status:** Concept definition.

Air Situation Display System
Procurement of system composed of six operator display positions used at Allied Tactical Operations Center at Sembach AB, West Germany. **Contractor:** COMPTEK Research. **Status:** Production.

AF JINTACCS
USAF input to a program for joint interoperability of tactical command and control systems, designed to ensure that Air Force standards are included in the program. **Contractors:** JTC^3A, Martin Marietta. **Status:** Full-scale development.

AF SAFE Program
Procurement of physical security equipment for deployment to seventy USAF bases and 210 sites overseas. **Contractor:** None. **Status:** Deployment.

AF Tactical Shelter Systems Development Office
This Air Force focal point for all mission systems requirements for mobility and transport gives early engineering support to all program offices that use Mobile Tactical Shelters. This office is overall manager of R&D on shelters. **Contractors:** Multiple. **Status:** Full-scale development.

Air Traffic Control and Landing System
Development of an AN/GPN-20 electronic countermeasures program to protect approach-control radar performance against countermeasures. **Contractor:** None. **Status:** Concept definition.

AF Worldwide Military Command and Control Information System
The C^3 systems planning and engineering center for USAF elements of the defense-wide system. **Contractors:** GTE, IBM. **Status:** Full-scale development.

Air Logistics Centers Local Area Network
Provides for development, installation, testing, and integration of a local communications system connecting the five Air Logistics Centers. **Contractor:** TRW. **Status:** Deployment.

Air Operations Center Communication System Definition
Provides nation of Bahrain with review and revision of system requirements for Air Operations Center and long-haul communications. **Contractors:** MITRE, Booz-Allen Hamilton. **Status:** Ongoing.

Alaskan HF Networking Demonstration
An eleven-node, high-frequency networking demonstration, conducted with Alaskan Air Command, using ESD software. **Contractor:** MITRE. **Status:** Conceptual.

Automated Message Handling System
Program to provide an intelligence analyst with capabilities for local electronic message handling and access to databases. **Contractor:** None. **Status:** Full-scale development.

Automated Tactical Aircraft Launch and Recovery Systems
Development of a system to automate air traffic control and to integrate aircraft systems. Would

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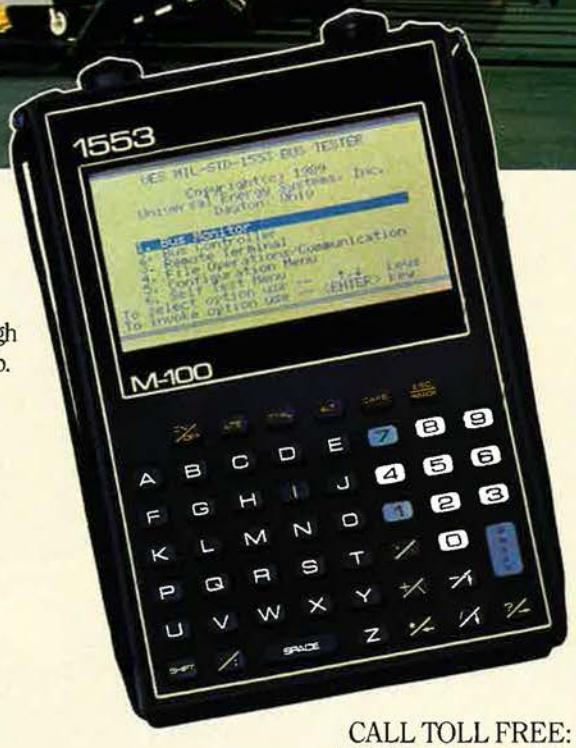

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control independent landing locations and integrate the battle management systems. **Contractor:** Transportation Systems. **Status:** Concept definition.

Automated Weather Distribution System
Program to enhance the Air Weather Service's meteorological support for the Army and Air Force by using advanced computer technology and graphic presentation software. **Contractors:** Unisys, Contel, Federal Electric. **Status:** Production.

Automated Weather Distribution System P^{3}I
Preplanned Product Improvement to AWDS, focused on improved graphics, interoperability, and communications. **Contractor:** None. **Status:** Concept definition.

Avionics Intermediate Shop Mobile Facility
Program provides for developing shelter systems for F-15, F-16, A-10, and F/EF-111 avionics maintenance. **Contractor:** Medley Tool & Model Co. **Status:** Production.

AWACS Interface System
Program to provide Royal Saudi Air Force with interface to its E-3 AWACS Sentry aircraft. **Contractor:** Boeing. **Status:** Deployment.

Base Air Defense Ground Environment
Program to provide engineering technical support to the Japan ASDF for a BADGE upgrade. **Contractor:** MITRE. **Status:** Deployment.

Battlefield Weather Observation and Forecast System/Prestrike Surveillance Reconnaissance System
A tactical decision-aids system for providing weather observation from enemy areas and other inaccessible areas. **Contractor:** None. **Status:** Conceptual.

Battlefield Weather Observation and Forecast System/Tactical Decision Aids
Program to provide decision aids in assessing weather effects on various weapon systems in specific battle situations. **Contractor:** None. **Status:** Full-scale development.

BMEWS Modernization Program
Program to upgrade the Ballistic Missile Early Warning System radars in Greenland and the UK, plus modernization of BMEWS radar in Alaska. **Contractor:** Raytheon. **Status:** Full-scale development, production.

Caribbean Basin Radar Network
Program to upgrade US air surveillance in the Caribbean via transmission of radar data via satellite and land links to US C^3 centers. **Contractor:** Westinghouse. **Status:** Production.

Cheyenne Mountain Upgrade Programs
Integrated management of five existing upgrades to Integrated Tactical Warning/Attack Assessment system of systems. **Contractor:** None. **Status:** Ongoing.

Cobra Dane Modernization
Upgrade to replace aging computers and software and improve processing of land-based, phased-array radar at Shemya AFB, Alaska. **Contractor:** None. **Status:** Full-scale development.

Combat Communications Access for Support Elements
Program to develop system for transfer of logistic information within battle areas and between battle areas. **Contractor:** BBN Communications Corp. **Status:** Production.

Combat Identification System/ Indirect Subsystem
Program to develop and deploy NATO-compatible system for accurate and timely target identification to battle commanders. **Contractor:** None. **Status:** Full-scale development.

Comfy Sword
Program to develop a jamming and deception system for training aircrews to operate in electronic environment. **Contractor:** Tracor Flight Systems. **Status:** Deployment.

Command Center Evaluation System
Program to provide central facility to evaluate technologies that might meet needs of USAF command centers. **Contractor:** None. **Status:** Conceptual.

Command Center Processing and Display System Replacement
A replacement system, part of the ballistic missile warning network, to receive warning information from sensors and produce integrated warning and attack assessment displays for Cheyenne Mountain AFB and SAC headquarters. **Contractor:** TRW. **Status:** Full-scale development, production.

Communications System Segment Replacement
A replacement system to improve the reliability, capacity, and flexibility of Cheyenne Mountain communications processing. **Contractor:** GTE. **Status:** Full-scale development, production.

Computer Resource Management Technology
Engineering development program to translate the software advances of industry, university, and laboratory into use in USAF weapon systems dependent on computer resources. **Contractor:** HH Aerospace. **Status:** Full-scale development.

Constant Source
Development of means to correlate and display intelligence information to unit-level forces. **Contractor:** None. **Status:** Conceptual.

Deep Space Surveillance Radar
Program to develop radars that will gather surveillance and warning information on critical synchronous-altitude space assets; expected to be an integral part of US Deep Space Surveillance Network. **Contractor:** None. **Status:** Concept definition.

Deployable Strategic Mission Data Preparation System Shelter Group
Program to provide SAC with capability to transport computer system able to create Mission Planning Data Transfer Unit Cartridges for B-52, B-1, B-2, ALCMs, and ACMs. **Contractor:** Sacramento ALC. **Status:** Full-scale development, production.

Digital Brite
System that will replace the existing Brite display system with more reliable equipment displaying alphanumeric beacon data. **Contractor:** Unisys. **Status:** Production.

Digital European Backbone
Incremental upgrade to portions of the European Defense Communications system from insecure analog systems to secure digital systems. **Contractors:** GTE, Gould, TRW. **Status:** Production, deployment.

Diversity Reception Equipment
System to improve low-frequency communications for the Worldwide Airborne Command Post fleet. **Contractor:** Sonicraft Corp. **Status:** Full-scale development.

DoD Base and Installation Security System
RDT&E program to develop physical security equipment for DoD sites worldwide. **Contractor:** None. **Status:** Full-scale development.

DoD Software Engineering Institute
Program to develop and disperse technology and means to improve quality of software in mission-critical computer systems. **Contractor:** Carnegie-Mellon U. **Status:** Full-scale development.

Dual-Frequency MEECN Receiver
Program to build receiver that will allow C^3 reception in VLF/LF band to strategic launch control centers, despite high-altitude nuclear detonations. **Contractor:** None. **Status:** Full-scale development.

Egyptian Encryption Acquisition
Acquisition of commercial digital encryption devices to link Egyptian E-2C aircraft and the ground-based air defense system. **Contractor:** Rockwell. **Status:** Full-scale development.

Egyptian E-2C/776 Interoperability
Technical assistance to Egypt on how to coordinate the E-2C Hawkeye aircraft and the 776 Ground System. **Contractor:** Hughes. **Status:** Deployment.

Egyptian Radar Repair and Upgrade
Program provides Egypt with capability to repair, reengineer, and refurbish air defense radars. **Contractor:** EG&G. **Status:** Production.

EIFEL
Program to develop follow-on telecommunications and automated data-processing capabilities to the EIFEL I system at the ATOC, Sembach AB, West Germany, and at associated bases. Common undertaking of the US, West Germany, Belgium, the Netherlands, and the UK. **Contractor:** Dornier Systems. **Status:** Full-scale development.

FAA/Air Force Radar Replacement
Joint effort to replace 1950s-type surveillance and height-finding radars with modern three-dimension radars. **Contractor:** Westinghouse. **Status:** Production.

GET PRICE
Program to reduce cost of USAF electronic C^3 systems via advanced manufacturing technologies. **Contractors:** Westinghouse, Electronic Systems & Data Communications, Rockwell, Raytheon, GE, Boeing, Grumman. **Status:** Production.

GEODSS
A ground-based, electro-optical, deep space surveillance system that will extend Air Force Space Command's spacetrack capabilities involving objects up to 20,000 miles in space. **Contractor:** TRW. **Status:** Deployment.

Granite Sentry
Program that will replace the current NORAD computer system and modular display system and will upgrade command post, air defense operations center, battle staff support center, and weather support unit in Cheyenne Mountain. **Contractors:** AFSPACECOM & DEC. **Status:** Full-scale development.

Ground Mobile Forces SATCOM Terminals
Program to produce highly mobile satellite communications terminals for the tactical air forces and others. **Contractors:** GE, Harris. **Status:** Production, deployment.

Ground Wave Emergency Network
C^3 program to provide US strategic forces with long-range communications that can continue to function even in the presence of electromagnetic pulse. **Contractors:** GE, CONTEL. **Status:** Full-scale development, production.

Have Quick II/IIA
An upgrade to the Have Quick antijam UHF voice

communications radio. **Contractors:** Multiple. **Status:** Full-scale development, production.

Have Sync
Development of a single-channel ground and airborne radio system (SINCGARS) for antijam, secure voice VHF/FM/AM communications to replace the AN/ARC-186 radio. **Contractor:** Cincinnati Electronics. **Status:** Full-scale development.

Have What
Program to develop systems architecture for the integration of Defense Department C^3I assets to support drug-interdiction efforts. **Contractor:** Classified. **Status:** Concept definition.

High-Power Microwave
Program to develop a tactical, point-defense, high-power microwave for protection of C^3I assets. **Contractor:** MITRE. **Status:** Conceptual.

Information Processing System
Provides automated support for command and control functions at the top six MAC command echelons. **Contractor:** Computer Science Corp. **Status:** Full-scale development.

Integrated Tactical Warning and Assessment System
Acquisition of new systems and upgrade of existing systems of the Integrated Tactical Warning and Assessment System. **Contractor:** None. **Status:** N/A.

Intelligence Work Station
Joint ESD/Rome Air Development Center project to replace standard intelligence terminals with modular, stand-alone stations. **Contractor:** Contel Federal Systems. **Status:** Production.

Intratheater Imagery Transmission System
Program to develop a hard-copy image dissemination system to allow the tactical air forces to transmit photographs and other intelligence information swiftly by electronic means. **Contractors:** GE, Litton. **Status:** Full-scale development, production.

Joint Intelligence Center
Program to develop and implement a wartime protected theater intelligence system to support unified and specified commands. **Contractor:** None. **Status:** Concept definition.

Joint Services Imagery Processing System
Development of a ground station to receive, process, and disseminate national, strategic, or tactical imagery to combat commanders. **Contractor:** E-Systems. **Status:** Full-scale development.

Joint Surveillance Target Attack Radar System
A joint Air Force/Army program to develop the primary sensor needed to carry out the AirLand Battle doctrine; integrates a sensitive, side-looking multimode radar into an E-8A platform to create a targeting system able to detect ground-based objects, whether stationary or moving. **Contractor:** Grumman. **Status:** Full-scale development.

Joint Tactical Fusion Program
An evolutionary program to develop the Air Force's Enemy Situation Correlation Element and the Army's All-Source Analysis System, two programs that use data from numerous sources to create a picture of the battlefield. **Contractors:** NASA, JPL. **Status:** Full-scale development.

Joint Tactical Information Distribution System
A program to develop a high-capacity, jam-resistant, secure digital information system that will permit the distribution of intelligence data among fighter aircraft, surveillance aircraft, ground air defense units, and naval vessels. **Contractors:** Plessey, Hughes, IBM, Rockwell. **Status:** Full-scale development.

Joint WWMCCS Information Systems
Development of system to replace and modernize current WWMCCS automatic data processing. **Contractors:** GTE, IBM. **Status:** Full-scale development.

JTIDS Multifunctional Information Distribution System
Low-volume terminal program to provide a highly jam-resistant, secure digital information distribution system for US and NATO aircraft. **Contractor:** Plessey. **Status:** Conceptual.

Logistics Information Management System
A program to produce logistics information architecture and recommendations for helping to keep USAF weapons in a high state of readiness. **Contractor:** Transportation System Center. **Status:** Concept definition.

MAC Global Decision Support System
Program to upgrade MAC's six principal command centers. **Contractor:** NASA. **Status:** Deployment.

Microwave Landing System
A four-part DoD program to develop and produce landing systems to replace existing Instrument Landing System and Precision Approach Radars. **Contractors:** Multiple. **Status:** Full-scale development.

Milstar Satellite Terminals
Development of reliable, antijam, and survivable EHF satellite communications terminals for strategic and tactical use among all services. **Contractor:** Raytheon. **Status:** Full-scale development.

Miniature Receive Terminal
A program to develop survivable, low-frequency terminals to upgrade communications among NCA, SAC, and SAC bombers; terminals will be designed to work even in a nuclear environment. **Contractor:** Rockwell. **Status:** Full-scale development, production.

Modular Control Equipment
Development of a transportable, modular, automated air command and control system. **Contractor:** Litton Data Systems. **Status:** Production.

Modular Control Equipment Preplanned Product Improvements
Design development, fabrication, integration, and test of improvements to the MCE components. **Contractor:** Litton Data Systems. **Status:** Full-scale development.

NATO Air Base SATCOM Terminal Program
Development of survivable terminals for wartime communications between NATO Air Operations Centers and allied airfields. **Contractors:** Harris, Ford. **Status:** Production, deployment.

NATO AWACS Program
Development, production, and enhancement of NATO's eighteen AWACS Sentry planes; installation of a major upgrade, Electronic Support Measures, to provide a passive sensor system as a complement to active radar sensors. **Contractor:** Boeing. **Status:** Deployment.

Networking Capabilities
Program to provide wide-range support to various local area networks and network-associated systems. **Contractor:** None. **Status:** Concept definition.

New Mobile Rapcon
Program to acquire new approach-control radar systems to replace aging mobile AN/MPN-14 systems. **Contractors:** Unisys (Radar AN/TPS-73), Aydin Computer System (NMR OPS). **Status:** Production (Radar AN/TPS-73), full-scale development (NMR OPS).

North Atlantic Defense System
Program to provide four long-range radars to enhance ability of Air Forces Iceland to perform NATO missions. **Contractors:** GE, TechDyn Systems, Hughes Aircraft, Whittaker Electronic Systems. **Status:** Deployment.

North Warning System
A program to develop new long- and short-range radars that will replace the aging Distant Early Warning (DEW) Line and provide continuous coverage from the northern slopes of Alaska across Canada and down the east coast of Labrador. **Contractors:** Unisys, GE. **Status:** Full-scale development, production.

Over-the-Horizon Backscatter Radar
Program to develop and deploy a series of four radar systems for long-range detection, early warning, and attack assessment of bomber and cruise-missile threats. **Contractor:** GE. **Status:** Full-scale development, production.

PACAF Interim National Exploitation Segment
Program aimed at providing an interim soft-copy exploitation capability. **Contractor:** Hughes. **Status:** Full-scale development, production.

Pakistan Aircraft Early Warning Study
A joint survey of Pakistan's requirements for aircraft early warning systems; detailed comparison of candidate systems to meet these needs. **Contractor:** None. **Status:** N/A.

Pave Paws
A program to develop and deploy advanced, large-scale, phased-array radar systems to provide precise early warning and attack characterization of enemy sea-launched ballistic missiles from all directions. **Contractor:** Raytheon. **Status:** Production, deployment.

Peace Shield
Development and acquisition of a ground-based C^3 system for the Royal Saudi Air Force; includes equipment, facilities, and support units that will link up with existing Saudi tactical radars, the Saudi AWACS planes, and elements of other Saudi military forces. **Contractor:** Boeing. **Status:** Full-scale development.

Rapid Execution and Combat Targeting
Program to modify Minuteman and Peacekeeper launch-control centers. **Contractor:** GTE. **Status:** Full-scale development.

Royal Thai Air Defense Systems
Program aimed at upgrading and automating existing Royal Thai Air Defense System and expanding its long-haul communications network. **Contractor:** Unisys. **Status:** Full-scale development.

Saudi Arabian AWACS
Program to acquire and outfit five US-built AWACS E-3 aircraft for the Royal Saudi Air Force. **Contractor:** Boeing. **Status:** Deployment.

Scope Shield Phase I
Program to create a security police communications system that will replace radios currently used by USAF security police in air base defense, weapon system security, and law enforcement. **Contractor:** Magnavox. **Status:** Production.

Scope Shield Phase II
Program to provide better communications for

When it absolutely, positively has to be there on time

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LTV Missiles and Electronics Group
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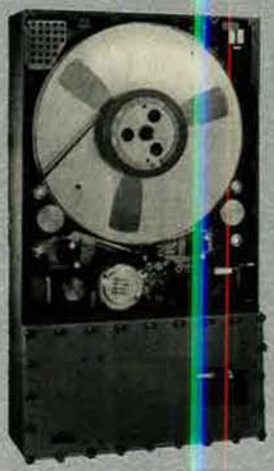

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USAF security police and other forces. **Contractor:** None. **Status:** Production.

Security Pro
A security products program to design and develop secure computing systems able to meet war-planning, intelligence, and force-management requirements generated by Strategic Air Command. **Contractor:** None. **Status:** Validation.

Seek Score
Development of a radar bomb-scoring system made up of a ground radar that tracks aircraft and a computer that determines the bomb impact point after a simulated bomb release. **Contractor:** LTV. **Status:** Production.

Seek Screen Arm Decoy
Program to build a decoy that would protect the AN/TPS-43 radar from destruction by incoming antiradiation missiles. **Contractors:** Multiple. **Status:** Full-scale development.

Seek Screen Ultra-Low Sidelobe Antenna
Development of modification kit to provide enhanced electronic counter-countermeasures and performance for the AN/TPS-43E tactical radar. Kit will make this radar more resistant to enemy aircraft's jamming, increase the radar's range and sensitivity, and make it more survivable. **Contractor:** Westinghouse. **Status:** Production.

Sentinel Aspen Phase I
Fabrication of a general-imagery intelligence training system for Air Training Command. The system uses computer-aided instruction in preparing imagery analysts for operational systems. **Contractor:** Loral. **Status:** Full-scale development.

Sentinel Aspen Phase II
Program to modernize the Air Intelligence, Targeting Indications, and Warning and Fusion Training conducted by Goodfellow Technical Training Center. **Contractor:** None. **Status:** Full-scale development, production.

Sentinel Bright I
Development and acquisition of a voice-processing training system with 460 workstations for the training of cryptologic linguists. **Contractor:** Engineering Research Co. **Status:** Deployment.

Sentinel Bright II
Design, development, and acquisition of a classified training system with 275 workstations and an unclassified training system with 113 workstations; used to train operators, analysts, and maintenance technicians for modern crypto systems. **Contractor:** American Systems Corp. **Status:** Full-scale development.

Sentinel Byte
Program to provide unit-level intelligence support system focused on automated use of data in tactical air force units. **Contractor:** Infotec Development. **Status:** Deployment.

Small Business Innovative Research
Program to stimulate technological innovation in private research and technological firms. **Contractors:** Various. **Status:** Ongoing.

Soft-Copy Exploitation System
Development of a common family of workstations for exploitation of digital imagery; a DoD program managed by ESD. **Contractor:** Classified. **Status:** Production.

Space-Based Radar C^3
Program to develop terrestrial C^3 architecture for transmitting SBR data to worldwide users. **Contractor:** None. **Status:** Concept definition.

Space Defense Operations Center
Program to develop new SPADOC at Cheyenne Mountain AFB; central C^3I element of the Space Defense Command and Control System to be used to collect and distribute information on space status and warning. **Contractor:** Ford. **Status:** Full-scale development.

STARS
Program known as Software Technology for Adaptable, Reliable Systems; pursues DoD goal of dramatic improvements in weapon software quality while reducing costs. **Contractors:** Boeing, IBM, Unisys. **Status:** Full-scale development.

SOF Automated Mission Planning System
Program to develop, procure, and deploy third-generation system to replace minicamp hardware now in use. **Contractor:** None. **Status:** Full-scale development.

Special Project II
Classified project. **Contractor:** None. **Status:** Full-scale development.

Strategic Defense Initiative Planning
Analysis of and experimentation with promising concepts and technologies for C^3 and battle management of a future strategic defense system. An experimental version of Strategic Battle Manager will be used. **Contractor:** Sparta, Inc. **Status:** Concept definition.

Strategic Mission Data Preparation System
Program to provide interface management and IV&V support to SAC for all strategic missile planning. **Contractor:** Boeing. **Status:** Full-scale development.

Survivable Base Communication System
Program aimed at dramatically reducing the time required to assess damage and direct efforts of air base recovery teams; combines communications equipment and computers for effective command of recovery personnel. **Contractor:** None. **Status:** Full-scale development.

Survivable Communications Integration System
Development of a multimedia management and control system for sending missile warning data between sensor sites and command authorities. **Contractor:** E-Systems. **Status:** Full-scale development.

System Trainer and Exercise Module
Development of trainer for personnel operating CRC/CRP AN/TSP-91 radars; provides capability to prepare exercise scenarios simulating flights of tactical aircraft. **Contractor:** GTE Sylvania. **Status:** Production.

Tactical Digital Facsimile
System to receive transmission of and reproduce photographs, maps, fingerprint replicas, and other forms of hard-copy images; compatible with standard modems. **Contractors:** Litton, Amecon. **Status:** Production.

Technical On-Site Inspection
Program to investigate technologies and concepts for on-site inspections of international arms-control agreements; procurement of prototype for continuous monitoring system supporting this goal. **Contractors:** Sandia Laboratory, Hughes. **Status:** Full-scale development, deployment.

Tower Restoral Vehicle/ Surveillance Restoral Vehicle
Program to provide highly mobile, rapid restoral equipment for air traffic control towers and radar approach controls. **Contractor:** None. **Status:** Full-scale development.

Tracking and Imaging Large Aperture Radar Systems
Classified, one-of-a kind radar system. **Contractor:** None. **Status:** Full-scale development.

TRI-TAC AN/TRC-170
Development and production of digital troposcatter radio terminals for use by tactical forces; provides secure transmission of messages; performs analog and digital voice transmission and transmission of digital data over a range of up to 200 miles. **Contractors:** Raytheon, Unisys. **Status:** Production, deployment.

TRI-TAC Communications Nodal Control Element
CNCE program to enhance technical assessment and control of tactical communications; capability to monitor performance, rapidly restore essential communications after failures, and rapidly reconfigure communications to meet changing circumstances. **Contractor:** Martin Marietta. **Status:** Production, deployment.

TRI-TAC Joint Tactical Communications
Program to investigate and acquire new ground-based tactical digital communications equipment for multiservice use. **Contractors:** Multiple. **Status:** Production, deployment.

TRI-TAC United Arab Emirates
Program to modify and develop an AN/TRC-170 troposcatter radio set with support equipment for the UAE Hawk missile program. **Contractor:** Raytheon. **Status:** Production.

UHF Satellite Terminal System
Development of a deployable, multiple-access communications system based on a single UHF satellite channel for Military Airlift Command and DoD users. **Contractor:** M/A-COM Government Systems. **Status:** Full-scale development.

Ultrawideband Radar
Program to develop improved surveillance sensor and communications for DoD and to permit "silent" radar surveillance and very-low-probability-of-intercept communications. **Contractor:** MITRE. **Status:** Concept definition.

Universal Modem
Program to develop an antijam, nuclear-hardened modem for use in all SHF SATCOM terminals that use the Defense Satellite Communications System. **Contractors:** Raytheon, M/A-COM. **Status:** Full-scale development.

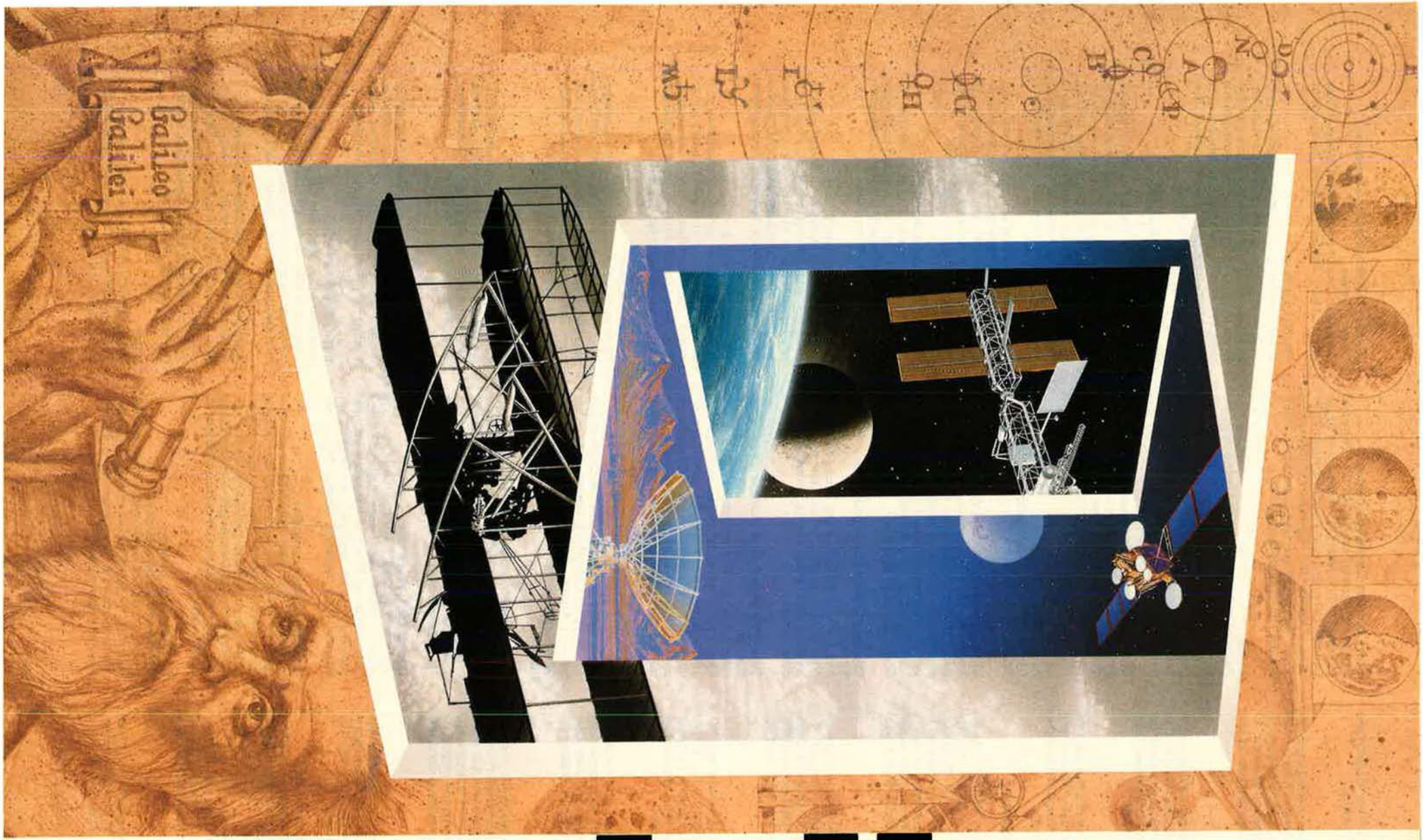
Unified Local Area Network Architecture Phase I
Program to develop standard local area networking components used to create data communications networks on USAF bases. **Contractors:** EDS, TRW. **Status:** Ongoing.

Unmanned Air Vehicle
Program to support DoD UAV Joint Program Office with data links, data distribution capability, mission planning, and ground stations. **Contractor:** MITRE. **Status:** Concept definition.

USTRANSCOM C^2 Study
Development support for US Transportation Command's effort to deploy new command and control systems linking various parts of its structure. **Contractor:** None. **Status:** Conceptual.

Weapons Storage and Security System
Research effort to determine new ways to provide dispersed, unattended tactical weapons storage using hardened vaults beneath the floors of aircraft shelters. **Contractor:** Bechtel National. **Status:** Production.

316 F
Development, procurement, and deployment of data-collection radar. **Contractor:** General Electric. **Status:** Deployment. ■



evolution

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After nearly ten years of flying—and one combat mission—the F-117 finally appears in public.

The Black Jet

By Jeffrey P. Rhodes, Aeronautics Editor

THE Air Force and Lockheed got the F-117A fighter built and flying in a mere thirty-one months, but kept it under wraps for eleven years. Now the world is getting its first close look at one of history's most unusual combat aircraft.

Nearly a dozen years ago, in December 1978, the Air Force decided to develop a full-scale, radar-evading fighter. First flight came in June 1981. Only in November 1988, however, did the Pentagon even acknowledge that the F-117A existed, and then it said little more than that the aircraft had been built for maximum stealthiness.

This spring, the curtain of secrecy finally began to part. On April 21, two F-117 pilots flew their planes from Tonopah Test Range, Nev., to Nellis AFB, Nev. They circled, touched down, and taxied to a reviewing stand filled with onlookers. It was the first time anyone outside the program, including the families of the unit's pilots and maintainers, had seen the mysterious F-117 up close.

In the mid-1970s, the Defense Advanced Research Projects Agency provided funding for development of an airplane that would feature low radar, optical, and infrared signatures to counter the increasing sophistication of Soviet radar and surface-to-air missiles. The classified program, called Have Blue, produced and flew several subscale proof-of-concept air vehicles.

Soon after, the Air Force decided to proceed into full-scale development. Lockheed's Advanced Development Projects (ADP) section—popularly known as the "Skunk Works"—got the task of building a production "stealth" fighter. "It is an odd-looking flying machine," says Ben Rich, Lockheed's executive vice president and general manager of the Skunk Works, "but we got it operational in record time."

Fast Track, Tight Secrecy

Using streamlined management methods and operating under tightest secrecy, cadres from Lockheed and Air Force Systems Command's Aeronautical Systems Division cooperated closely to get the F-117 built and flying just two and a half years after work began. Bill Park, Lockheed's chief test pilot, took the F-117 aloft for the first time on June

—Staff photos by Guy Aceto

The Lockheed F-117A may look as if it were built for use by alien beings, but it is actually flown by flesh-and-blood humans like Capt. Phil McDaniel (above), a pilot with the 37th Tactical Fighter Wing.


COL TONY TOLIN
RESCUE

18, 1981, Mr. Rich's fifty-sixth birthday.

The buildup of aircraft was swift. The 37th Tactical Fighter Wing (known then as the 4450th Tactical Group) achieved initial operational capability with the F-117A on October 26, 1983, a mere twenty-eight months after first flight.

"Using proven components from other aircraft allowed us to reduce risk," notes Mr. Rich. "This gave us confidence to proceed concurrently with full-scale development and low-rate production." Such components either were transferred directly to the F-117 or were used in modified form.

Some of the components modified for the F-117 include its quadruple-redundant flight-control system (based on the one in the General Dynamics F-16) and cockpit environmental control system (a portion of the ECS in a Lockheed C-130). The F-117's two General Electric F404-GE-F1D2 engines are nonafterburning derivatives of the powerplant in the Navy's McDonnell Douglas F/A-18 fighter/attack aircraft.

Examples of direct transfers include the F-117's inertial navigation system (the same highly accurate one used on a B-52), its ejection seat (the McDonnell Douglas ACES II seat found in F-15s, F-16s, and A-10s), and its brakes (the same type used on a Gulfstream III executive jet). Many of the plane's avionics black boxes were also taken directly off the shelf.

"The Skunk Works gave us a perfectly usable product as quickly as possible," says Lt. Gen. Peter T. Kempf, commander of 12th Air Force. He adds that Lockheed did not attempt to deliver a "perfect" airplane, an effort that surely would have brought long delays in deployment of a "good enough" aircraft.

For developing and fielding the F-117 in complete secrecy and at such a rapid pace, the National Aeronautic Association awarded the 1989 Collier Trophy, the most prestigious award in American aviation, to Mr. Rich and the entire Air Force/Skunk Works team this past spring.

Hide in Plain Sight

"The F-117A is a one-mission, unique aircraft," says Col. Tony Tolin, the 37th TFW Commander. "It is flown autonomously at night, to go after high-priority targets with pinpoint accuracy. It is not a close air support platform." The Colonel concedes, however, that "it sure doesn't look like any other aircraft."

What gives the F-117 its unusual look is its faceted design. The planar surfaces set at unusual angles scatter incoming radar beams instead of reflecting them to a source. This dramatically reduces the aircraft's radar cross section, which is an object's "footprint" on a radarscope. The Northrop B-2 Stealth bomber, on the other hand, uses compound curves to achieve the same effect.

Additionally, the F-117's primary structures, thought to be made mostly of aluminum, are covered by radar-absorbent material (RAM). The material soaks up radar beams, yielding minimal reflection. Other major F-117 structures, such as fully movable (above the fuselage join) V-tail ruddervators, are made of radar-resistant composites.

Designers also "buried" the engines in the fuselage and put the highly radar-reflective turbine blades behind intake screens equipped with faceted crosspieces. The F-117 has auxiliary intake doors on the fuselage above and behind intake screens. They are opened on taxi, takeoff, and landing to allow more air to feed into the engines.

The plane's infrared (heat) signature has been reduced. First, hot engine exhaust mixes with bleed air to cool it. Then the air is dispersed through baffles in the harmonica-like tailpipes. In addition, a "ledge" fixed on the bottom of the fuselage directs the exhaust upward, further reducing the IR signature. The nozzles can only be seen from above.

Two other methods of detecting aircraft—visual and acoustic—have been addressed. RAM on the exterior offers a dull black finish that reflects little light, and the engines produce almost no smoke. Buried engines and absence of afterburners make the F-117 extremely quiet. At the Nellis flyby, the two aircraft sounded much like business jets as they circled. Only when the first pulled up after its near touch-and-go landing was any significant noise heard.

Little detail emerged about how the airplane performs its mission. The aircraft does have what appears to be a steerable forward-looking infrared set under the windscreen (allowing the pilot to see at night or in bad weather). The F-117 apparently does not have a radar.

The cockpit features a head-up display; Capt. Joe Salata, a 37th TFW pilot, notes, "We are very proficient on instrument flying." Officials would not comment on the use

Any way you look at it, the F-117A is an unusual aircraft. Its design and development were also out of the ordinary. The F-117 is the first aircraft to exploit low-observable, or stealth, technology. Here, an F-117 tanks up in flight, just as those on their way to and from Panama did several times last December.

of or need for night vision goggles. The digital avionics suite is complemented by a specially developed automated mission planning system.

The glazing in the rear-hinged, upward-opening canopy has a reddish-bronze tint, indicating electromagnetic interference protection. "You can't see much of the fuselage from the cockpit," says Capt. Philip McDaniel, a 37th TFW pilot. "It's like riding on the tip of a spear." The canopy's apex appears to be either a periscope for improved rearward

—Staff photo by Guy Aceto

The "TR" on this F-117 means it is based at Tonopah Test Range, Nev., where much of what goes on remains shrouded in mystery.

visibility or a light to illuminate the air-refueling receptacle.

A shallow depression on the fuselage underside on the right side of the nose-gear well appears to be a laser designator for directing the plane's ordnance, which is carried in an internal bay. The F-117 has been described as being capable of carrying a wide variety of tactical weapons, including some specifically designed (or, more likely, modified) for the airplane.

Officials did not disclose what types of munitions are used. The two F-117s used in Operation Just Cause (the F-117A's first use in combat) each dropped a single BLU-109/B 2,000-pound bomb. Officials say the F-117 has a self-defense capability, but close examination did not reveal an external gun port. Self-defense may hinge on the plane's stealthiness and evasive tactics, though it probably has an internal jammer and chaff and flare dispensers.

The size of the F-117 slightly exceeds that of an F-15, both in wingspan (the F-117's forty-three feet, four inches, vs. the F-15's forty-two feet, 9.75 inches) and in length (sixty-five feet, eleven inches, vs. sixty-three feet, nine inches). With a height of twelve feet, five inches, the F-117 stands shorter than the F-15's eighteen feet, 5.5 inches. The F-117, at 52,000 pounds gross, weighs in 18,000 pounds under the F-15C.

The F-117's wings feature split, wide-chord flaps, swept back at an angle of about sixty-seven degrees. The aircraft, which flies on JP-4 aviation fuel, has a tailhook for barrier engagements and, in a throwback to earlier days, a drag parachute. The parachute, located in a recessed fuselage compartment just forward of the fins, is released when the nose wheel hits the ground on landing. The main canopy is pulled clear of the tail by a small drogue.

Just Call It "Black Jet"

All of the 37th TFW pilots present at the ceremonies at Nellis this past spring praised the aircraft's handling and maneuverability. They strongly refuted claims that the airplane is not very nimble, a belief that has led some outsiders to coin the name "Wobbly Goblin" for the F-117A. Captain Salata maintains that its handling is similar to that of other Air Force aircraft. "We take offense at the term 'Wobbly Goblin.' We just call it 'the Black Jet.'" The F-117 has no official nickname, though "Nighthawk" is in popular use among crews and maintainers.

Getting the F-117 on the ramp is one thing, but learning to operate and fix it is another. The F-117 program, in fact, had more concurrency (simultaneous procurement and development of a system) than the B-2 development effort has now. "The learning curve was just not there in the beginning," notes Colonel Tolin. "But we are now close to maturity with the aircraft."

In the eighty-one months since the F-117A achieved IOC, mission reliability (the probability of successful completion of a mission and dropping weapons with specified accuracy) has improved forty-eight percent. Maintenance hours per flight hour has improved sixty-nine percent. The wing's fully mission-capable rate now compares favorably with that of a typical F-15 or F-16 wing.

One maintenance item peculiar to the 37th TFW is the radar-absorbent material. All F-117 access panels are covered by RAM, which must be removed to reach the F-117's insides (and must later be replaced). Ninety-five percent of needed tools come right out of the standard toolbox, but some special items, possibly for working with RAM, are needed.

"We learned as we went along," says TSgt. Randy Charland, an F-117 crew chief. "The more we learned, the better we got, and the easier it became. All the systems are fairly accessible and are very reliable."

"There is no depot maintenance program so far," says Capt. William Ogden, the officer in charge of the 37th TFW's 415th Aircraft Maintenance Unit. "What we have been doing is upgrading the aircraft. The airplanes are taken to Palmdale [Calif., to Lockheed's facility at Air Force Plant 42] to do the upgrades, and we will continue to do that." The Sacramento Air Logistics Center at McClellan AFB, Calif., oversees upgrades.

Every Plane Is Different

Each aircraft emerged from Lockheed's Burbank, Calif., assembly plant slightly different from every other. One F-117 would get, for example, a new type of digital moving map, color multifunction displays, or autopilot, and the system would later be retrofitted on others. One modification in progress will replace the aircraft's rudervators with fins made of a new, stronger, thermoplastic graphite composite.

The last of fifty-nine F-117As will be delivered soon. The Air Force recently revealed the final cost of the program (called Senior Trend in classified budget documents) to be $6.56 billion in current dollars—nearly $2 billion in development costs, $4.27 billion in total procurement costs, and $295.4 million in military construction costs. By Air Force calculations, the F-117's unit cost came to $42.6 million.

The faceted shape and radar-absorbent material covering give the F-117 its low radar cross section. The plane's exhaust (to the left of the movable ruddervators) can only be seen from above. Several measures, such as "burying" the engines and dispersing exhaust through baffles, are taken to reduce the efflux.

To date, every F-117 has been delivered in unusual fashion—at night, in the cargo hold of a C-5—to its base at Tonopah, Nev., 160 miles north of Las Vegas. The airfield is about ten years old and has a 12,000-foot runway, fifty-four hangars, and about a dozen other buildings. Once part of a California oil-drilling site, the buildings were bought from Chevron for $1.5 million and packed off to Tonopah. A separate housing area for the wing's 2,500 military personnel and 1,000 civilians was later constructed.

Once a week for eight years, F-117 pilots and maintainers living on or near Nellis would pack up, say goodbye to families, board a contract 727 run by Key Air, and go to work. Four days later, they would return. Wing members could not tell anyone, except those directly involved in the program, where they had been or what they had done.

Flyers and fixers adapted to a night-shift routine. "On Monday night, when we are unsure about their crew rest, pilots only fly one sortie, and they are finished early," says Colonel Tolin. "On Tuesday, when we have a guarantee of their crew rest, we can go longer into the night." Dorms are locked and have blacked-out windows to ensure that the crews get enough sleep.

Early on, work often did not begin until an hour after sunset, the better to ensure secrecy. "After the plane was revealed, we could start at sunset and fly longer," adds Colonel Tolin. "We could also fly and train in the day. It is a lot easier, especially on your first ride in a single-seat airplane, if you can see outside."

First flight is aided by a highly realistic simulator built by Link. "We don't have any two-seat F-117s," says Colonel Tolin, "so if you can fly the simulator, you can fly the aircraft." The simulator is also helpful in developing cross-check habit patterns for the F-117's unusual cockpit layout.

The F-117's cockpit-panel design is cited as a contributor to two operational accidents, in July 1986 and October 1987. Spatial disorientation was the primary cause of both. A third F-117 was lost in an accident prior to delivery. Three mishaps in nine years of flying gives the F-117 one of USAF's best safety records.

Nothing but Volunteers

All 37th TFW personnel are volunteers who undergo thorough screening before starting their three-year tours. Pilots must have at least 1,000 hours of flight time, an indicator of maturity in the cockpit. Pilots fly with one of two operational squadrons, the 415th and 416th TFS. The F-117 "schoolhouse," the 417th Tactical Fighter Training Squadron, familiarizes pilots with the plane.

Each month, pilots in the two operational squadrons get fifteen to twenty hours of flying (mostly at night) and perform two or three night air refuelings. Dual-qualified pilots get an additional five or six hours in Northrop AT-38Bs assigned to the wing. These totals are slightly less than TAC's average.

New maintainers enter a school at Tonopah, complete with part-task trainers, and come out fully qualified. They then go through an on-the-job training program at one of the aircraft maintenance units.

To further incorporate the F-117 into the operational warplans, the wing has participated in one Blue Flag (tactical air warfare battle management) and two Red Flag (basic tactical fighter employment) exercises in recent months.

The F-117 has also been involved in one real-world action, with less than stellar results. Prior to the Army attack on the Panamanian Defense Force barracks at Rio Hato during Operation Just Cause, two F-117 pilots were to drop their bombs within fifty feet of the building to "stun, disorient, and confuse" PDF troops. The attack plan changed at the last minute, and, as a result of confused communications, the first F-117 pilot dropped his bomb where the second pilot was to drop his. The second pilot, thinking the attack had reverted to the original plan, dropped his bomb 325 yards wide.

The Air Force, violating a cardinal tenet of air warfare, apparently did not perform a battle damage assessment, and word of "direct hits" was passed to Washington. When Secretary of Defense Richard Cheney was shown pictures of the locations of the craters, he ordered an investigation, the results of which had not been concluded by late spring.

The F-117 surely will become more visible. In the third quarter of FY 1992, the 37th TFW is scheduled to move to Holloman AFB, N. M., which is a much more accessible and public base. The 37th TFW will replace the 479th Tactical Training Wing at Holloman, which will be deactivated. The move will eliminate the need for Key Air, which is currently flying 22,000 passenger trips on 300 flights to Tonopah per month. ■

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Grumman Corp.
Grumman Data Systems Corp.
GTE Government Systems Corp.
GTE Government Systems Corp, C^3 Sector
GTE Government Systems Corp., Electronic Defense Sector
GTE Government Systems Corp., Strategic Systems Div.
Gulfstream Aerospace Corp.
Harris Electronic Systems Sector
Harris Government Communication Systems Div.
Harris Government Support Systems Div.
Hawker Pacific Inc.
H. B. Maynard & Co.
Hercules Missiles, Ordnance and Space Group
Honeycomb Co. of America, Inc.
Honeywell Inc.
Howell Instruments, Inc.
HR Textron, Inc.
Hughes Aircraft Co.
Hughes Danbury Optical Systems, Inc.
IBM Corp., National Federal Marketing Div.
IBM Corp., Systems Integration Div.
Information Systems & Networks Corp.
Ingersoll-Rand Co.
Israel Aircraft Industries Int'l, Inc.
Italian Aerospace Industries (U.S.A.), Inc. (Aeritalia)
Itek Optical Systems, A Division of Litton Industries
ITT Defense
ITT Defense Communications Div.
Jane's Information Group
John Deere Technologies Int'l, Inc.
Kaman Aerospace Corp.
Kollmorgen Corp., Electro-Optical Div.
Kollsman
Lear Astronics Corp.
Learjet Corp.
Litton Aero Products
Litton-Amecom
Litton Applied Technology
Litton Data Systems
Litton Guidance & Control Systems
Litton Industries
Lockheed Aeronautical Systems Co.—Burbank
Lockheed Aeronautical Systems Co.—Georgia
Lockheed Aircraft Services Co.
Lockheed Corp.
Lockheed Engineering & Sciences Co.
Lockheed Missiles & Space Systems Group
Lockheed Space Operations Co.
Logicon, Inc.
Loral Corp.
LTV Aircraft Products Group
LTV Missiles and Electronics Group, Sierra Research Div.
Lucas Aerospace Inc.
Magnavox Government & Industrial Electronics Co.
Martin-Baker Aircraft Co. Ltd.
Martin Marietta Astronautics Group
Martin Marietta Corp.
Martin Marietta Electronics & Missiles Group
Martin Marietta Energy Systems, Inc.
Martin Marietta Information Systems Group
Matra Aerospace Inc.
MBB
McDonnell Aircraft Co.
McDonnell Douglas Corp.
McDonnell Douglas Electronic Systems Co.–ISS
McDonnell Douglas Missile Systems Co.
McDonnell Douglas Space Systems Co.
McGuire, Woods, Battle & Boothe
Megatek Corp.
MITRE Corp., The
Motorola, Inc., Government Electronics Group
NavCom Defense Electronics, Inc.
Northrop Corp.
Northrop Corp., Aircraft Div.
Northrop Corp., B-2 Div.
Northrop Corp., Electronics Systems Div.
OEA, Inc.
Olin Ordnance
Orbital Sciences Corp.
Oshkosh Truck Corp.
Pan Am World Services, Inc., Aerospace Div.
Parker Hannifin Corp., Parker Bertea Aerospace
Pilatus Aircraft, Ltd.
Planning Research Corp.
Plessey Electronic Systems Corp.
Products Research & Chemical Corp.
RAND Corp., The
Raytheon Co.
RBI, Inc.
RECON/OPTICAL, Inc., CAI Div.
Reflectone, Inc.
Republic Electronics Co.
Rockwell Int'l Aerospace Operations
Rockwell Int'l Collins Government Avionics Div.
Rockwell Int'l Corp.
Rockwell Int'l Electronics Operations
Rohr Industries, Inc.
Rolls-Royce plc
Rosemount Inc.
Sabreliner Corp.
Sanders Associates, Inc.
Scheduled Airlines Traffic Offices, Inc. (SatoTravel)
Schwem Technology
Science Applications Int'l Corp.
Short Brothers USA, Inc.
Smiths Industries, Aerospace & Defence Systems Co.
Snap-On Tools Corp.
SofTech, Inc.
Software AG Federal Systems, Inc.
Southwest Mobile Systems Corp.
Space Applications Corp.
Standard Manufacturing Co., Inc.
Stewart & Stevenson Services, Inc.
Sun Microsystems Federal, Inc.
Sundstrand Corp.
Sverdrup Corp.
Systems Control Technology, Inc.
Systems Research Laboratories/ Defense Electronic Systems
Systron Donner, Safety Systems Div.
Talley Defense Systems
Technology Applications, Inc.
Teledyne, Inc.
Teledyne Power Systems Group
Teledyne Ryan Aeronautical
Texas Instruments, Defense Systems & Electronics Group
Textron
Textron Aerostructures
Textron Defense Systems
Thiokol Corp.
Thomson-CSF, Inc.
Tracor Aerospace, Inc.
Trident Data Systems
TRW Defense Systems Group
TRW Federal Systems Group
TRW Inc., Electronic Systems Group
TRW Space & Defense Sector
TRW Space & Technology Group
UNC, Inc.
Unisys Corp., Defense Systems
United Technologies Corp.
UTC, Advanced Systems Div.
UTC, Hamilton Standard
UTC, Norden Systems, Inc.
UTC, Pratt & Whitney
UTC, Research Center
UTC, Sikorsky Aircraft
UTC, Space Transportation Systems
Universal Propulsion Co., Inc.
UTL Corp.
Varo Systems
Vega Precision Laboratories
Vitro Corp.
Walter Kidde Aerospace Inc.
Watkins-Johnson Co.
Westinghouse Electric Corp.
Williams International
ZF Industries, Inc.

The first self-sufficient system that can monitor and neutralize electrical charge buildup on the surface of satellites has been delivered to the U.S. Air Force. The Flight Model Discharge System (FMDS), developed and built by Hughes Aircraft Company, will monitor the outer surface of space satellites, quickly detecting and neutralizing excess electrical charges caused by ionized gases. These charges can send sparks arcing around the spacecraft, possibly damaging the delicate electronic circuits inside. FMDS can sense the onset of charging and neutralize within 30 seconds. When the charging has been neutralized, FMDS returns itself to monitoring mode.

The innovative deployment of a new sonar system provides an improved means of detecting, identifying, and tracking of ocean targets. The Surveillance Towed Array Sonar Segment (SURTASS), developed by Hughes for the U.S. Navy, allows antisubmarine warfare commanders to have capabilities never before possible for the collecting and processing of undersea acoustic data. The system consists of a long line of sonar arrays towed behind a noncombatant craft. Target data is transmitted through a satellite link to land-based centers where operators can review the data on a detailed display.

Advanced polishing techniques and a dry etching process are combining to improve the yields of Gallium Arsenide Microwave/Millimeter Wave Monolithic Integrated Circuits (MIMIC). In the final processing steps, MIMIC wafers must be reduced in thickness from .025 inches to .004 inches, keeping the upper and lower surfaces parallel, and via holes must be created through the wafer for future electrical connections. With technology developed by Hughes, wafers are embedded in wax during polishing, and holes are created using reactive ion etching, a dry rather than wet etching process. These processes can reduce the number of wafers that have to be scrapped, significantly improving the yield of MIMIC technology.

A new missile that allows aircraft to attack targets from ranges in excess of 50 nautical miles has performed flawlessly during its first three airborne launches. The Stand-off Land Attack Missile (SLAM), manufactured by McDonnell Douglas Missile Systems Company, incorporates a production version of the Hughes-built Maverick imaging infrared seeker, a global positioning satellite receiver/processor, and a Walleye video data link for aircraft control of the missile during the final moments of flight. The SLAM is designed for deployment from carrier-based aircraft and allows the aircraft to attack land targets, ships in port, or ships at sea from great distances, increasing the chances of success for the mission.

A night vision system has demonstrated it can increase the operational effectiveness and survivability of M1 Abrams tanks and Bradley Fighting Vehicles. The Driver's Thermal Viewer (DTV), under development at Hughes for the U.S. Army, is a low-cost thermal imaging system that enables drivers to see through darkness, dust, battlefield smoke, haze, and rain. During simulated combat exercises, the DTV demonstrated that it improved both vehicle maneuverability and crew safety and target acquisition. The DTV, designated AN/VAS-3, can replace the existing AN/VVS-2 image intensifier driver's viewer without modification to the vehicle's armor or driver station.

For more information write to: P.O. Box 45068, Los Angeles, CA 90045-0068

HUGHES

Subsidiary of GM Hughes Electronics

The US has several options—none of them ideal—if basing rights are lost at Clark and Subic Bay.

Fallback From the Philippines

By Stewart M. Powell

It's a blistering day in the Philippines, and Air Force Capt. Billy Uhle is briefing a ready room full of US pilots. His subject is the huge training exercise that is about to give aircrews a taste of modern warfare without the risks. There's no hint that there is anything different about the event, certainly nothing to indicate that it might be one of the last of its kind staged in the Philippines.

Today, notes Captain Uhle, ninety-four US combat aircraft will take part in the exercise. "Aggressor" planes will rendezvous over the South China Sea, then sweep in over uninhabited Philippine jungle and mountains. Air Force, Navy, and Marine Corps pilots, drawn from US bases in Japan, South Korea, and Alaska, as well as from the US carrier *Midway*, will locate and then launch strikes against mock bunkers and airfields.

The pilots are among 1,000 or so aircrew members who each year use Clark AB as the hub for exercises at Crow Valley Range, fifteen miles away. "Nowhere else," says Lt. Col. Bob Dierker, of the 432d Tactical Fighter Wing at Misawa AB, Japan, "will my wing's pilots get realistic training like this, except in actual combat."

Increasingly, however, it appears that the United States will be forced to look elsewhere. US access to Clark, to the massive Subic Bay Naval Base, and to four smaller Philippine facilities is no longer assured. The American presence is governed by a US-Philippine agreement that expires in 1991. In order to stay longer, Washington must negotiate a new accord. The prospects are so bleak that the US has already prepared a fallback plan.

Opposition is Growing

Though the bases provide Manila $1 billion a year in fees and other revenue, few Filipino politicians openly support a continued US presence. In the words of Defense Secretary Dick Cheney, "It's difficult to find elected leaders willing to stand up publicly and embrace the continuation of the current arrangement."

Surging Filipino nationalism, anger at unmet promises of US aid, frustration with Washington's backing for President Corazon Aquino,

and reduced concern about Soviet military power in the Pacific contribute to rising opposition to the American presence. The 19,000-member New People's Army also is challenging the US's future presence. In an effort to exacerbate American fears, poison the political atmosphere, and drive out American forces, Communist guerrillas have killed at least ten Americans in the past few years.

No one is yet writing off the US bases. All agree, however, that the outlook is cloudy. The stakes are very high, and US options are limited.

Clark AB, a serene outpost for US Army cavalry troops after the Spanish-American war and a base for the fledgling US Army Air Service after World War I, is a vital link in the chain of US overseas bases. For years, US pilots and weapon systems officers have been dodging "enemy" aircraft and simulated missiles at Crow Valley to bomb, strafe, and rocket targets on the 44,000-acre preserve that costs US taxpayers only $10.5 million a year to operate. The 150 sorties a day flown during Cope Thunder exercises, staged seven times a year, do wonders to sharpen pilot skills.

In addition to providing training for US aircraft based in densely populated Asian nations, Clark serves as a linchpin of Air Force operations across east Asia. More than 8,000 USAF personnel are based at the 10,341-acre facility north of Manila. Horse-mounted guards patrol the twenty-six-mile perimeter. Edwardian houses with screened porches and tin roofs line straight, tree-lined streets, giving parts of the installation a turn-of-the-century ambiance.

Clark is headquarters for the 13th Air Force and home to the 3d Tactical Fighter Wing, with its two squadrons of F-4s, one equipped for the air-to-ground interdiction mission (F-4E), the other for "Wild Weasel" defense suppression (F-4G). Additional USAF aircraft deploy throughout the western Pacific as "aggressor" trainers. Also on hand are C-130 airlifters and special operations aircraft. Each month, some 3,500 aircraft use the 10,500-foot runway.

Not far away, equally important US Navy operations are staged from Subic Bay, a mountain-rimmed port that serves as the centerpiece of the Navy's Seventh Fleet operations in the Pacific and Indian Oceans. Ten of the fleet's eighty ships are in port on any given day, replenishing for a high tempo of operations across fifty-two million square miles of ocean, where US warships called on ninety-eight ports in twenty-eight countries last year alone. Six massive dry docks line the waterfront of the 26,034-acre facility, where a highly skilled Filipino work force of 37,000 handles bow-to-stern overhauls at a fraction of the cost of comparable work in Japan and the US.

The two bases, the largest US overseas bases in the world, not only account for sixty-five percent of all training by US forces in the western Pacific, but also serve as the foundation for a US security umbrella that has stretched across east Asia for forty-five years. This enables Air Force planes and Navy warships to range along the Pacific Rim and deep into the Indian Ocean to secure the flow of oil from the Persian Gulf and monitor Soviet operations.

Plans to Scale Back

The US could lose it all. Faced with impediments to a new agreement, senior US officials see little hope that an accord will emerge from the negotiations that began with a get-acquainted session last May in Manila and are expected to last another year. Although the Pentagon plans to make reductions across east Asia, withdrawing at least 15,000 of the 135,000 soldiers, sailors, airmen, and Marines in the Pacific and in South Korea, Japan, and the Philippines by 1993, loss of the bases would be an undeniable blow to American capabilities.

The Bush Administration has devised a ten-year blueprint for the region, entitled "A Strategic Framework for the Asian Pacific Rim: Looking Forward to the 21st Century." It envisions American retention of access to Philippine bases only "over the mid-term."

The Joint Chiefs of Staff's latest net assessment is more pessimistic in its outlook and more emphatic in its prescription for change. US military forces, it says, should become "better suited" for operating over "vast distances" in view of the "relatively sparse base structure" that lies ahead.

"We for some years in the Pentagon have recognized that this was going to be a difficult negotiation," says Henry Rowen, the Assistant Secretary of Defense for International Security Affairs, who serves as the Pentagon's point man in the Philippine talks. Long ago, he says, "we began studying alternatives."

The review led to a secret Pentagon plan for the rapid withdrawal of some 40,000 US troops, Defense Department civilians, and their dependents and for the speedy relocation of aircraft, warships, repair facilities, and storage warehouses to Singapore, Guam, Tinian, Saipan, Japan, Hawaii, and Alaska, should such a dramatic move become necessary.

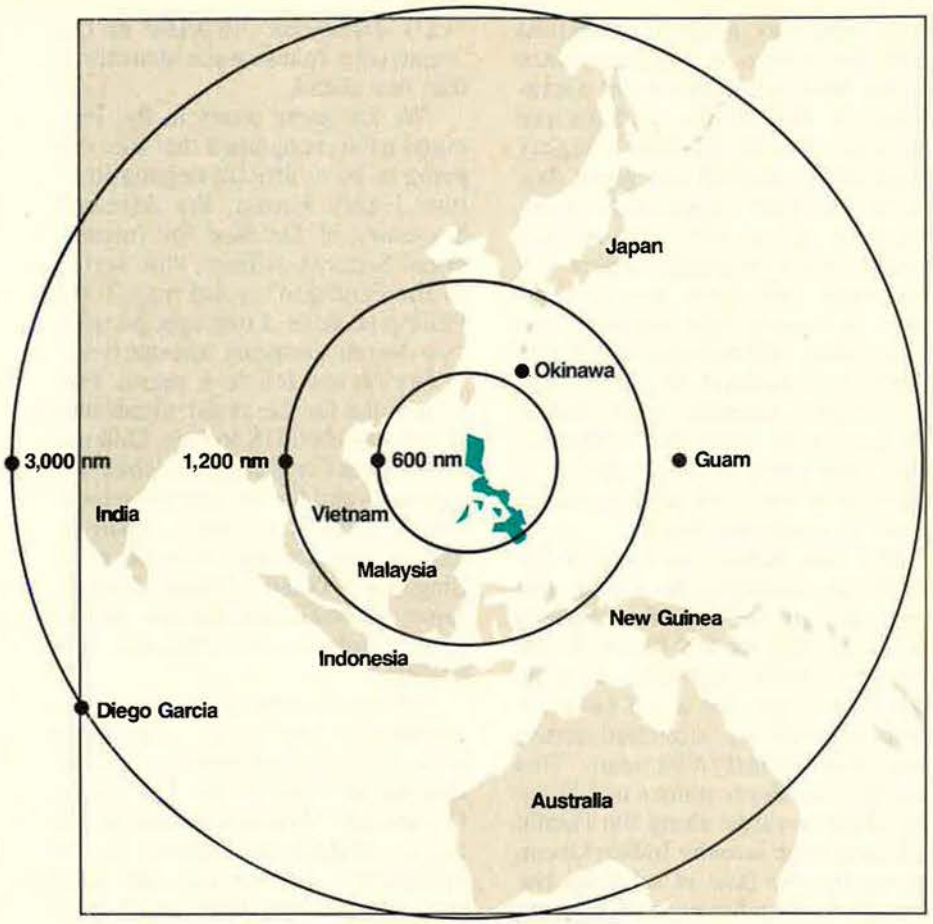
"We have a plan to leave the Philippines in one year," concedes Adm. Huntington Hardisty, Commander in Chief of the US Pacific Command. "These alternatives are not as strategically located as the Philippines, but we can still meet our commitments from these locations."

The cost of the fallback operation, according to a senior Pentagon aide deeply involved in its planning, does not exceed $4 billion. That is far below the $8 billion estimate for a facility on Saipan which was outlined in a classified report to Congress five years ago.

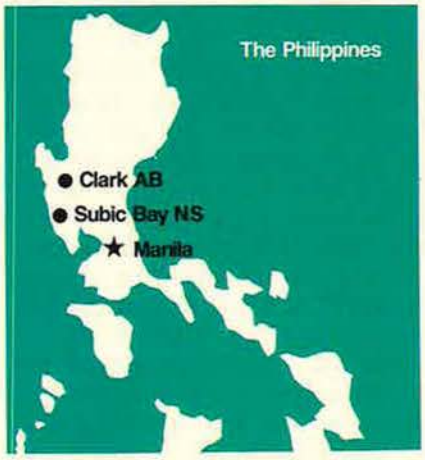
"No single potential replacement site could accommodate all of the functions now performed in the Philippines, and none would share the strategic Philippine location," says a declassified version of the Pentagon study completed this year. "Nonetheless, alternatives exist, even if expensive, time-consuming to develop, and operationally less effective."

Defining the Critical Requirements

What are the bedrock military requirements? As Pentagon planners see it, the US must come up with workable means to both deploy and sustain fighters in operations over the Strait of Malacca and other Indonesian chokepoints used by supertankers ferrying oil to US east Asian allies and trading partners. Open, unimpeded transit points are



There are no ideal substitutes for the Philippine bases. Guam, for example, is more than twice as far as Clark AB from the Vietnam coast. Bases in Malaysia would be a long way from Korea and Japan. Distance translates into both time and increased demand for aerial refueling.



needed as well for the twenty-six cargo flights each month that ferry supplies to Diego Garcia, the isolated Indian Ocean island that underpins Navy operations protecting Persian Gulf oil fields.

Also critical are aircraft maintenance facilities and bases of operations for tactical airlift aircraft now based at Clark. Ship-replenishment operations are crucial, as is the presence of large dry docks for ship overhauls, according to Pentagon officials. The massive naval magazine at Subic also would have to be moved to a site that would permit entry of nuclear weapons.

If US forces were evicted from the Philippines, training would be sharply curtailed in east Asia, forcing the US to make wider use of simulators and scaled-down exercises in the region. Many air combat training operations would be transferred back to the United States.

The choice of alternatives has been tightly constrained, however. Asian allies, although eager for continued US presence in the region to preserve stability, have been reluctant to offer their facilities, even when pressured. For example, a RAND Corp. study, released just last year, had envisioned basing opportunities in Malaysia, Thailand, Indonesia, and Brunei. Now, Pentagon officials say, US negotiations with all of these nations have gone sour.

Current US plans are focusing on a relative handful of sites, foreign and domestic.

• *Singapore.* By far the most cooperative nation has been Singapore, an island state trying to capture the US's security shield to enhance its prominence as southeast Asia's alternative financial hub once China takes control of Hong Kong in 1997.

The Pentagon has been working to obtain access to New Zealand's former facilities in Singapore, both at Paya Labar airfield and at a pier in the bustling commercial port. The runway at Paya Labar would serve as a refueling stop for cargo flights to Diego Garcia, as well as an austere, temporary base for F-15 and F-16 fighters and Navy P-3 Orion antisubmarine warfare planes deployed from other bases.

Ship resupply would take place at a single pier. Repairs would be carried out at Singapore's dry docks on a commercial basis.

Singapore, however, has insisted on use of the installations only on a "rotating basis," meaning that no permanent US military presence would be permitted. Permanent housing might be made available for no more than 200 service personnel and dependents.

• *Guam and Micronesia.* Pentagon officials foresee expanded operations on the small Pacific islands of Guam, Tinian, and Saipan to provide intermediate refueling facilities and bases for fighters, transports, and warships.

The withdrawal of the last fourteen B-52s from Andersen AFB on Guam in the next few months clears the way for stationing some of the combat aircraft now based at Clark AB. Limited ramp space and housing, however, would require $1 billion in new military construction, according to the RAND study. Guam already serves as a refueling stop for C-141s and C-5s bound for Diego Garcia.

Naval Air Station Agana in the middle of the 209-square-mile volcanic island offers opportunities for expansion, although local officials want US military operations to be consolidated even further at Andersen AFB to permit civilian use of the naval air station.

Because Guam is a US territory, Pentagon officials foresee using it as the east Asian naval magazine to store conventional and nuclear weapons without the political challenges that would arise on foreign territory.

The expansion and dredging of Guam's deep-water port, though it would cost hundreds of millions of dollars, could provide alternative basing for some warships now berthed at Subic. The port's waters already are home to the sub-tender USS *Proteus,* an ammunition delivery ship, three combat stores ships, and a maritime prepositioned ship.

The Guam option is not without problems, however. Its 130,000 residents, enjoying a bustling economy thanks to Japanese tourist development, seek greater autonomy and economic independence. Local authorities are pressing for the return of 3,500 acres of land deemed "surplus" by the Pentagon a dozen years ago.

Should problems develop, limited operations could be staged from US-controlled territories elsewhere in Micronesia. The US government has a renewable fifty-year lease on 18,000 acres of land at Tinian and Saipan. The island of Palau, which has recently become a state "freely associated" with the United States, offers a harbor that could accommodate a carrier battle group and an airfield capable of handling high-performance aircraft. Operations would be constrained, however, by lack of amenities and space for military dependents, making the islands suitable only for temporary, unaccompanied duty.

• *Japan.* Braced for eventually losing Subic, the US Navy already has quietly moved additional US warships to home ports in Japan to offset potential losses in combat capability along the Pacific Rim.

The US Navy fleet based at Yokosuka, on Tokyo Bay, is now being upgraded, and ships are being added whenever possible. The *Ticonderoga*-class, AEGIS guided missile cruiser USS *Bunker Hill* is being joined by its sister ship, the USS *Mobile Bay*. The forty-five-year-old carrier *Midway* is being replaced by the carrier *Independence,* with an aircraft complement of two dozen high-performance F-14s. At Sasebo, where five US warships are based, a San Diego-based amphibious assault ship is due to join the existing flotilla.

Four dry docks at Yokosuka, a 568-acre facility spared by US bombers in the final days of World War II, would serve as a site for ship repair work now carried out at Subic. Nearby commercial shipyards would play a part—particularly if Japan agrees to absorb a share of the cost. Japan already pays $2.4 billion of the $7 billion annual cost of maintaining 50,000 US soldiers, sailors, airmen, and Marines based in Japan.

Misawa AB, located a few miles from Soviet territory and 360 miles from the USSR's sprawling naval base at Vladivostok, is expected to take on additional missions if the US aircraft leave the Philippines. The Japanese government provides a variety of modern facilities to aircrews and their families. Japanese taxpayers have built high-rise housing for US personnel and their families and hardened, $2.5 million shelters for the forty-eight F-16s based at the facility.

• *Alaska and Hawaii.* Beyond overseas redeployments, the Pentagon plans to pull back some Asia-based operations to Hawaii and Alaska, two Pacific states of great strategic value.

Ground-combat training by Okinawa-based Marines deployed to the Philippines would shift to other Pacific islands under US control and to Hawaii, where 37,000 US troops are stationed, including the 1st Marine Expeditionary Brigade at Kaneohe Bay and the Army's 25th Light Infantry Division.

Ship-repair facilities at Pearl Harbor would be expanded to accommodate additional ships at a port where decommissioned warships are already mothballed.

For Asia-based Air Force squadrons that do not have time to rotate pilots to the Red Flag exercises and the combat range at Nellis AFB, Nev., Alaska's open skies may become an attractive alternative and come into wider use.

"There are other places in the world where there are ranges we can operate for simulated combat operations," notes Assistant Secretary Rowen. "Aircraft just have to fly in another direction and fly further to get to those ranges, but it can get done."

Poor weather conditions, however, are likely to limit the usefulness of Elmendorf AFB as a true alternative to Crow Valley Range in the Philippines. Of course, the weather and terrain of Alaska come nowhere close to approximating conditions found elsewhere in the Pacific.

Hoping to Avoid a Pullout

Though US officials are prepared to pull out on short notice, they hope to avert redeployment. For the ninety-two-year-old Philippine-US relationship to continue amicably, US officials insist, a "new relationship" must develop between Washington and Manila. Filipino politicians have outlined some of their demands.

For its part, Washington warns that Manila must end its focus on the $481 million a year in base payments and begin to take into account US trade concessions, possible debt relief, and the reassurance that US bases provide foreign investors. US officials indicate willingness to discuss "privatization" of Subic Bay and turning Crow Valley into an entirely Philippine-run operation. Additionally, they suggest, the US might be prepared to give up Clark AB in order to buy more time for Subic.

Whatever the outcome of the coming struggle over the bases, this much is clear: The US military presence in the Philippines will never be the same. Says one Pentagon official, "The old relationship has run its course." ■

Stewart M. Powell, national security correspondent for Hearst Newspapers in Washington, accompanied Defense Secretary Dick Cheney on a recent tour of the Pacific Rim that included stops in the Philippines, Guam, Japan, Hawaii, and Alaska. His most recent article for AIR FORCE *Magazine was "The State of START" in the June 1990 issue.*

Rather than offering specialized care at all locations, the military airlifts patients to specialized care centers.

Medevac

By Jeffrey P. Rhodes, Aeronautics Editor

Photos by Guy Aceto, Art Director

THE prime mission of the Air Force's aeromedical evacuation system is the general care and rapid movement of casualties in wartime. In peacetime, its main business is transporting service personnel or dependents from various points around the world to military medical centers where specialized treatment is available. It requires tight coordination of no fewer than six specialized groups.

While much about the system is standardized, it must be flexible enough to handle emergencies or respond to a rapid change in a patient's condition.

Medevac is different from other airlift missions. To begin with, as Lt. Col. John Bierie, an aircraft commander with the 375th Military Airlift Wing at Scott AFB, Ill., points out, you don't just "put patients out like cargo pallets on the ramp and leave them there until somebody comes along to pick them up."

The Air Evac System

The system allows patients to get the best care possible while maximizing use of military facilities. A specialized treatment capability also helps the military avoid reliance on high-cost civilian medical care. Military Airlift Command's worldwide budget for aeromedical airlift is $57 million, thirty percent of the MAC Surgeon General's medical budget.

Rather than maintaining hard-to-find medical specialists—in the care of burns, for example—and expensive equipment at numerous local facilities, the military transports patients to centralized hospitals in cases that require extremely complex care.

In 1975, the US completed consolidation of its worldwide aeromedical evacuation system under MAC. The system is divided into two operational components. One is intratheater, flown mainly by C-9A crews with backup from C-21 and C-12 pilots. The second is intertheater, flown by C-141 crews. A specialized part of the system is tactical evacuation by C-130 crews, which comes into play only in actual combat.

MAC conducts three main intratheater operations: in Europe, the Far East, and the continental US.

Above, Capt. Vic Lunsford, an air evac nurse, checks a patient's Form DD-602, the "ticket" for the flight. At right is a pivotal part of the air evac system: a C-9A, the military version of the McDonnell Douglas DC-9 Series 32.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Each operation revolves around a central hub. In Europe, five C-9As, the Air Force's dedicated "air ambulances," are based at Rhein-Main AB, West Germany, to provide evacuation service across the continent. In the Far East, three C-9As based at Yokota AB, Japan, are flown on round-robin routes between Guam and points on the Asian rim.

The largest intratheater operation is in the continental US. The 375th MAW and its collocated Reserve Associate unit, the 932d Aeromedical Airlift Group, operate twelve C-9s based at Scott AFB. These C-9 crews serve nearly 600 CONUS airfields.

"We routinely run six hardlines [scheduled routes] a day during the week, seven on Saturday, and five on Sunday," says Col. Ronald Sampson, the 375th MAW's director of operations. Most flights are at least eighty percent full.

Crews flying the longer-ranged C-141s ferry patients from Europe and the Far East to the US twenty-two times a month. C-141 crews (seventy percent of whom are Air Force Reservists) provide service to Hawaii, Alaska, Panama, Bermuda, the Azores, and Iceland. The C-141s can carry 103 litters each.

Planning the Move

Who gets moved on an aeromedical evacuation flight? In a domestic hospital situation, the process starts when a military physician decides a patient cannot receive proper care in his or her hospital. Says Army Lt. Col. James Culley, head of the Armed Services Medical Regulating Office (ASMRO), a joint services agency at Scott: "Basically, we match needs to available beds."

The ASMRO staff gets daily updates on the number of available beds in military hospitals with particular specialties, reviews a patient's case, and decides where patients will go. It is all done using an automated reporting system. Once a decision is made, ASMRO sends an electronic message to the receiving hospital that a patient is coming.

With the "where" determined, it falls to a Patient Airlift Center (PAC, located next door to ASMRO) to determine the "how" and "when" of moving a patient. "We have to be 'rigidly flexible,'" says Maj. Joseph Eckerman, the Air Force officer who is chief of PAC. "It is a very dynamic process, and a lot has to be taken into account to set up the best patient move."

PAC assigns priority to aircraft missions by determining how quickly the patients' medical problems must be treated. Routine patients (who account for most flights) must be moved within seventy-two hours, priority ones within twenty-four hours. A critical patient (one who is in imminent danger of losing life, limb, or eyesight) is transported as fast as possible. All types of patients are moved, including psychiatric and AIDS cases.

Every day, five to seven flights originate or end at Scott. Those terminating there are in the last days of two- or three-day missions during which the crew and some of the patients had to remain overnight at one of the regional medical centers. (There are one Army and five Air Force regional medical centers.) At least one mission a day (except Fridays) is a one-day round trip.

These scheduled flights provide a framework used by PAC's flight clinical coordinators to plan the next day's flights. The mission's origin and terminus are known, but the number of intermediate stops depends solely on the patients. Most flights make at least seven stops and are monitored closely by the PAC for delays or breakdowns.

"We build the missions around the requirements," says Major Eckerman. "We need to know what effect the flight will have on the patient's health, what special equipment [such as incubators or ventilators] is needed, whether the patients will be litter or ambulatory, and even the basics: Does a hospital have a runway nearby? What we do is mesh the clinical with the operational."

At each stop on an air evac mission, a nurse from the host medical facility reviews each patient's history with the medical crew director (also a nurse) aboard the C-9 (above), so that the patient's condition can be monitored for any changes during the flight. Above right, a Navy patient has been unloaded from the C-9 and into a waiting ambulance at NAS Norfolk, Va.

From Here to There

The next step is getting to the plane. At the Air Force's regional medical centers, an aeromedical staging flight (ASF) provides care, transportation, and lodging. The night before a patient enters the air evac system, he or she is transferred to the ASF, usually a separate wing in a hospital. Patients in the system who have to remain overnight during the course of an evacuation also stay at an ASF.

"A vast majority of the patients are here for food and rest," says Lt. Col. Suanne Smith, the commander of the 1st ASF at Scott. "But we are equipped to handle most everything and can take care of anybody. If we can't, the hospital proper is right up the hall."

Not all hospitals have ASFs, though, and in that case, patients are brought directly to the airplane. Patients from several hospitals always assemble at one place to reduce the required number of stops. For instance, a C-9 stopping at Charleston AFB, S. C., often picks up patients from the Myrtle Beach AFB, S. C., hospital ninety miles away.

The system is stressful for the patients. PAC now tries to eliminate as many overnight stays as possible, usually by scheduling direct plane-to-plane transfers. Most doctors also want to minimize the patient's travel time.

A patient is unloaded from an ambulance bus into the C-9 via the plane's specially designed, hydraulically operated, folding ramp. The litter is being carried by medical technicians, although it is not unusual to see members of the flight crew lift a litter. The air evac system carries all types of patients, ranging from premature babies to AIDS cases to cardiac care patients.

The next step (one of the most important) in the air evac system is the airlift. While the patients board the aircraft, the medical crew director, a nurse, gets details on each patient's condition from a nurse with the originating hospital. Notes are made on the patient's "ticket," called a DD-602 form, which, like a medical chart, is a legal document.

The crew on all evac flights consists of the medical crew (registered nurses and medical technicians) and the standard flight crew for the particular aircraft. "We don't ask them to fly the airplane, and they don't ask us to start IV lines or give shots, and it works out pretty well," says Lt. Col. Biagio Cannistraci, chief of current operations for the 375th MAW.

Urgent missions put the entire system to a test. In a severe burn case, the faster C-21 is used to ferry the burn team from Brooke Army Medical Center at Fort Sam Houston, Tex., to the patient's location. This eliminates an intermediate stop

At the regional medical centers, an Aeromedical Staging Flight serves as an en route hospital or a place for patients to rest and eat. The ASF's medical technicians drive the ambulance buses that take patients to and from the C-9s. At left, a typical morning scene at Scott AFB, Ill.: the med tech waits for the OK to unload the bus and start loading patients.

Medevac missions can last one, two, or three days, but they all terminate at Scott AFB. Left: At the end of a long day, Lt. Col. Biagio Cannistraci, the 375th MAW's chief of current operations, prepares the C-9 for landing. A view like the one below, from the cockpit window, is one benefit of these long flights.

that a C-9 would have to make and also saves money.

Meanwhile, the C-9 crew standing alert at Scott is called up and is off inside an hour. By the time the C-9 arrives, the burn team doctors have stabilized the patient's condition and prepared the patient for transport. The C-9 crew then transports everybody to the burn center.

Getting the Job Done

The C-9A Nightingale, a modified version of the McDonnell Douglas DC-9 Series 32 commercial airliner, can carry forty litter patients, forty ambulatory patients and four litter patients, or any combination. The airplane's overhead panels fold down to become the litter stanchions. The seats are easily removed and are stored in the plane's cargo hold.

Forward, the C-9s have a special hydraulically operated fold-down ramp for loading litter patients, a medical supply work area and sink, and a desk for the charge nurse. The planes also have a special care area aft of the cockpit.

"We are limited somewhat in what we can do by the aircraft, but the practice is state of the art," says Lt. Col. Elaine Berreth, the 57th Aeromedical Evacuation Squadron's chief nurse. "We are not a flying intensive care unit. The majority of the patients are in a stable condition before we move them."

The evac nurses, all RNs, undergo a six-week course at Brooks AFB, Tex., to learn the peculiarities of administering health care at an altitude of 20,000 feet. Active-duty nurses stay on flight status for three-year tours, going back to a hospital to keep their skills sharp. Reservists don't have that problem; most either teach or work full-time in a hospital.

Medical technicians keep track of baggage, serve meals, and, on the C-9s, give the standard airline safety briefing (except they do it from the back of the plane, because seats on MAC transports face rearward for safety reasons). When the situation dictates, however, they also are qualified to start intravenous lines and hook up patient ventilators. Med techs are not on a restricted tour, and some have been flying for nearly a decade.

To keep clinical skills up-to-date, med techs rotate through a hospital once every three years. Periodically, they will work for a month in the Special Equipment section, maintaining such health-care equipment as oxygen regulators and cardiac monitors.

Flight crews also are trained to give top consideration to the patient's welfare. New C-9 pilots must accumulate 100 hours of flight time before being permitted to land a plane carrying patients. "We preach the conservative approach," says

Lt. Col. Frederick Padgett, commander of the 11th Aeromedical Airlift Squadron. "We want pilots to know their limits and the limits of the aircraft."

The movement of patients is so critical that the C-9s carry a flight mechanic with them. With a small supply of parts on board (even a spare main tire), the flight mechanic is able to fix most minor maintenance problems that crop up.

On the C-9, "front-end" and "back-end" crews work together closely. It is common to see a pilot at

work opening the plane's cargo ramp or a flight mechanic loading litters. Part of this cooperation comes from an annual training session during which the front-end and back-end crews trade places and work through situations from each other's perspective. It is a valuable training tool.

Flight mechanics, all volunteers, are qualified as C-9 crew chiefs. The aircraft also have regular crew chiefs on the ground. Most C-9 missions return to Scott by 10:00 p.m. The maintainers have to turn the aircraft by 4:00 a.m. so that it can depart at 7:00 a.m. In spite of short turnaround time, the wing's mission reliability rate is 97.6 percent.

"Some of the airlines have 60,000 hours on their DC-9s," says Col. Dick Calta, the 375th MAW's chief of maintenance. "We gain from their problems, as the things they are seeing on aircraft the same age as ours, we won't see for several years. We get their service bulletins, and that helps us a lot."

"The integration we have with the active-duty folks may be a model for all [Reserve] Associate wings," says Lt. Col. Linda Carneal, the Air Reserve technician nursing administrator for the 932d AAG's 73d AES. Reservists are fully integrated into all phases of the 375th MAW's operations.

Reservists also bring unequaled experience to the system. Many nurses and medical technicians have performed combat casualty evacuation; active-duty troops have not. One Reserve pilot who flies for the airlines has almost 20,000 hours of DC-9/C-9 time. Says Col. David Stanley, 932d AAG commander. "He's our chief of stan/eval [standardization/evaluation]. There isn't a lot he hasn't seen."

The 375th MAW's twelve assigned C-9As have a 97.6 percent mission reliability rate and a daily utilization rate of about ninety percent. One of the reasons is the wing's maintenance complex. The maintainers, active-duty and Air Force Reserve personnel and civilians, are an essential part of the mission. Above, Sgt. David Smedegard, Mike Trezek, and SrA. Scott Lucchese check a C-9's nose gear.

Wartime Mission Changes

In wartime, such experience would be sorely needed. "A classic, large-theater war situation, having to move several thousand people a day, would put a horrendous load on our system," says Lt. Col. (Dr.) Kenneth Glifort, the 375th MAW's assistant deputy commander for aeromedical evacuation.

In future large-scale combat operations, the Civil Reserve Air Fleet (CRAF) would be crucial. A number of 767 and MD-80 airliners in the CRAF fleet will be dedicated to casualty evacuation. Now being tested, the CRAF air evac fleet is expected to be operational in 1991.

Both the 375th MAW and the 932d AAG would deploy with the C-9s to a forward location in a wartime theater. With C-9s nearer to the fighting, some C-130s would be freed to carry war materiel. The 767s would augment strategic evacuation of casualties, thus freeing C-141s for the war effort. The MD-80s would, in turn, replace the C-9s on the domestic system.

Reservists would fly almost ninety-five percent of the wartime evac missions; active-duty pilots would be pressed to fly C-130s, C-141s, C-5s, and C-17s. The CRAF fleet would be crewed by airline pilots and civilian flight attendants for support, including directing emergency access. Military medical crews would tend the patients.

The problem would be not only sheer numbers of casualties, but also the need for different medical care. In peacetime, says Colonel Glifort, the system deals with "typical" medical and surgical cases—cardiac care, obstetrics/gynecology, pediatric care, etc. In wartime, there are far more trauma cases and patients in unstable condition. Forty medical specialties are reduced to eight basic diagnostic categories.

The traditional method of moving combat casualties starts with buddy care, whereby one soldier helps another. Second-echelon care takes place at an aid station where the injured person first comes in contact with medical professionals. Third-echelon care is given at a medical treatment facility, where surgery is possible. Fourth-echelon care entails transport by C-130 or C-9 to a central collection point. Finally, C-141s move the wounded to the US for treatment.

In Just Cause, though, casualties needing lifesaving surgery were operated on immediately, in-country. The rest of the 257 injured servicemen were shipped directly to the US. "We couldn't rely on access to the military hospital in Panama," notes Colonel Glifort. "We were directed to get casualties out ASAP, and the system worked well."

Proximity was a major factor in changing the air evacuation procedure. Even so, success in Panama may lead to the elimination of the forward hospital phase in future conflicts.

Officials reason that, if casualties are stable enough to move, why not move them to better care in the US right away? This would save time and greatly reduce the need to preposition or replenish medical supplies in combat areas. ■

Gallery of US Navy, Marine Corps, and Army Aircraft

US Navy and Marine Corps

By Kenneth Munson, Paul Jackson, and Bill Gunston

Patrol and Antisubmarine Aircraft

P-3B/C and TP-3A Orion

In continuous Navy service, with progressive improvements, since the first P-3A was delivered in August 1962, the Orion won a 1958 competition for an off-the-shelf antisubmarine and maritime patrol successor to the P-2 Neptune. Based on Lockheed's Model L-188 Electra four-turboprop airliner, an aerodynamic prototype flew for the first time in August 1958, followed in November 1959 by a preproduction YP-3A (originally YP3V-1) with a full maritime avionics suite. Production of the initial **P-3A** model with 4,500 ehp Allison T56-A-10W turboprops totaled 157; with the emergence of later models the P-3A was transferred in 1978 to the USN Reserve, from which the last 30 examples were retired last year, although about a dozen **TP-3As** remain in service as trainers. More powerful T56-A-14s and provision for AGM-12 Bullpup missiles characterized the **P-3B;** Navy deliveries of this model, totaling 124, began in 1965, and nearly all of these are still in service with USN Reserve units.

Major variant of this long-serving patroller, however, has been the **P-3C,** first flown on September 18, 1968, six months after placement of the first production contract. Retaining the P-3B power plant, the C was notable chiefly for its so-called "A-NEW" advanced integrated avionics, built around a Univac AN/ASQ-114 digital computer and designed specifically for the ASW role. This system did away with routine log-keeping by the crew, permitting centralized retrieval, display, and transmission of all incoming tactical data. The first P-3C squadron became operational in July 1970, USN deliveries (totaling 267) ending in April 1990. Some 25 active USN shore squadrons and 13 in the Reserve currently operate P-3s in the ASW role.

The P-3C has been the subject of a succession of avionics and other upgrades during its 20-year career. After one YP-3C and 117 initial production P-3Cs the first upgrade, begun in the early 1970s, was Update I, which from January 1975 introduced on aircraft 118–148 Omega navigation, more sensitive acoustic processing, AN/ASA-66 tactical displays for the two sonar operators, more versatile CMS-2 computer language, and a sevenfold increase (to 393K) in computer memory. In 1977, Update II added to the next 44 P-3Cs an AN/AAS-36 FLIR system AN/ARS-3 sonobuoy reference system, and Harpoon missile capability. Update II.5, in 1981, introduced new nav/com equipment for aircraft 193–216. Update III, which received go-ahead in 1978, embodied a major upgrade of ASW avionics; it was installed by Lockheed in the last 50 new-build Navy Orions delivered from June 1984 and retrofitted to earlier in-service P-3Cs from 1987. Main ingredients of Update III are a new IBM Proteus acoustic processor, a new sonobuoy receiver to replace the earlier AN/AQA-7 DIFAR (directional acoustic frequency analysis and recording), an improved APU, and a modified environmental control system to improve avionics cooling and crew comfort. Most P-3Cs now in service are to Update III standard, and an Update IV program, headed by Boeing Aerospace and Electronics, is scheduled to complete FSED by 1992. This includes a Texas Instruments AN/APS-137(V) radar, new Resdel acoustic sensors, a Magnavox improved acoustic processing system, General Instrument AN/ALR-66(V)5 passive ESM in span-extending wingtip pods, Honeywell AN/AQH-4(V)2 data recorders, and a satellite communications system. Update IV is planned for retrofit of some 80 Update II and III P-3Cs; a prototype is due to be delivered to the Navy this year. *(Data for P-3C/Update III.)*

P-3C Orion

P-7A LRAACA

S-3A Viking

Contractor: LASG Burbank Division of Lockheed Corporation.

Power Plant: four Allison T56-A-14 turboprops; each 4,910 ehp.

Accommodation: normal crew of 10, including five in tactical compartment in main cabin.

Dimensions: span 99 ft 8 in, length 116 ft 10 in, height 33 ft 8½ in.

Weights: empty 61,491 lb, max expendable load 20,000 lb, normal gross 135,000 lb.

Performance: econ cruising speed at 25,000 ft at 110,000 lb gross weight 378 mph, patrol speed at 1,500 ft at same weight 237 mph, service ceiling 28,300 ft, mission radius (3 h on station at 1,500 ft) 1,550 miles.

Armament: one 2,000 lb or three 1,000 lb mines, or up to eight depth bombs or torpedoes, or depth bomb/torpedo combinations (including nuclear depth bombs) in internal weapons bay. Ten underwing pylons for torpedoes, mines, rockets, or other stores. Some P-3Cs equipped to carry AGM-84 Harpoon missiles.

P-7A

The P-7A has been selected as the US Navy's next land-based maritime patroller, to supplement and eventually replace the P-3 Orion. Original proposals to fill this requirement with a new Orion variant, the P-3G, were frustrated when funding was deleted from the FY 1987 defense budget request. Instead, the Navy launched its LRAACA (Long-Range Air ASW Capable Aircraft) competition, to which Boeing responded with a modified version of the 757, McDonnell Douglas with one based on the MD-87, and Lockheed with a stretched and further upgraded derivative of the P-3G. Selection of the Lockheed design, as the P-7A, was made in October 1988, and full-scale development was initiated with FY 1989 funding. The GE38 turboprop chosen for the P-7A is due to fly in a P-3 test-bed this summer, but if the P-7A survives a mid-1990 Pentagon review (and design problems have escalated both the cost and the development time frame) a prototype is not likely to make its first flight until at least the end of 1992. Deliveries of production P-7As would then follow in 1996–97. The Navy has a requirement for up to 125 P-7As, and West Germany has proposed to buy 12—provided that the USN program goes ahead—to replace its Dassault-Breguet Atlantics. Originally expected to have considerable airframe commonality with the P-3C, the P-7A has gradually become virtually an all-new design, with a longer fuselage, greater wingspan and tail area, and a different power plant, all contributing to a payload capacity and patrol range greater than that of the P-3C but inevitably adding to development time and cost. It will have the Update IV mission avionics suite of the P-3C, developed and installed by Boeing Aerospace and Electronics, a six-tube EFIS flight deck, and a Litton LTN-92 ring-laser gyro INS. The operational compartment will have seven console positions along the port side of the cabin: two facing forward, three facing the wall, and two facing aft. Two of these positions are to allow for future systems growth; the other five will be for nav/com, tactical coordinator (TACCO), and one nonacoustic and two acoustic sensor operators.

Contractor: LASG Burbank Division of Lockheed Corporation.

Power Plant: four General Electric T407-GE-400 (GE38) turboprops; each 5,150 shp.

Accommodation: two- or three-man flight crew, plus five-person tactical team (see text) and two observers.

Dimensions: span 106 ft 7½ in, length 112 ft 8½ in, height 32 ft 8½ in.

Weights: empty 73,900 lb, max gross 171,350 lb.

Performance: radius of action 2,145 miles (4 h on station); time on station at 1,842 miles 5 h 50 min.

Armament: 16 ft 8 in internal weapons bay for 38,385 lb of mines, depth bombs, torpedoes, etc; provision for up to five AGM-84 Harpoon antiship missiles under each wing.

S-3A/B Viking

Navy RFPs for an aircraft to replace its Grumman S-2 Trackers in the carrier-based ASW role were issued in January 1968, a contract to develop the S-3 being awarded in August of the following year. Lockheed was prime contractor, with LTV (Vought) being selected to manufacture the wings, tail unit, landing gear, and engine pods, and Sperry Univac the central digital computer. First flight was made on January 21, 1972, a production go-ahead was given three months later, and between 1972 and 1978 a total of 187 **S-3As** was produced for the Navy. Initial deliveries were made to VS-41 at NAS North Island, Calif., in February 1974, and the Viking's first operational deployment, with VS-21 in USS *John F. Kennedy,* followed in July 1975. Contracts in 1980 and 1981 initiated a weapon systems improvement program

(WSIP) for the S-3A, under which it was planned to upgrade up to 160 of these aircraft and give them the new designation **S-3B.** The main ingredients of this program are to upgrade the AN/AYK-10 central air data computer to AYK-10A(V) standard; replace the Sanders AN/OL-82A acoustic processor with an AN/OL-320/AYS, integrating with the IBM AN/UYS-1 processor; replace the Texas Instruments AN/APS-116 radar with an AN/APS-137(V)1 system incorporating inverse synthetic aperture capability; replace the AN/ARR-76 acoustic system communications link with a Hazeltine AN/ARR-78; modify the Goodyear AN/ALE-39 chaff/flare dispensing system; and add provision for the carriage of McDonnell Douglas Harpoon air-to-surface missiles. The first of two FSED S-3Bs flew on September 13, 1984, and funding has so far been approved for 48 production conversion kits. Installation of these is taking place at NAS Cecil Field, Fla. First fleet delivery of an S-3B was made to VS-27 in December 1987. The possibility of restarting the S-3 production line has not yet been entirely rejected. *(Data for S-3A.)*

Contractor: LASG Burbank Division of Lockheed Corporation.

Power Plant: two General Electric TF34-GE-2 turbofans; each 9,275 lb st.

Accommodation: crew of four (pilot, copilot, TACCO, and SENSO).

Dimensions: span 68 ft 8 in, length 53 ft 4 in, height 22 ft 9 in.

Weights: empty 26,650 lb, normal gross for ASW 42,500 lb.

Performance: max cruising speed 426 mph, loiter speed 184 mph, service ceiling over 35,000 ft, combat range more than 2,300 miles.

Armament: internal split weapons bays for bombs, depth bombs, mines, or torpedoes. Two underwing pylons for rocket pods, bombs, mines, flare launchers, or auxiliary fuel tanks.

Fighters

F-4S Phantom II

Although conversion from the F-4 to the F/A-18 Hornet is well advanced, some 50–60 examples of this final US Phantom variant were still in service with Marine fighter/attack squadrons (VFMAs) in 1990. The F-4S, of which 265 were produced, was modified by the Naval Air Rework Facility from the earlier F-4J under a service life extension program carried out in the late 1970s and early 1980s. The principal elements of this were new, slatted wing leading-edges, inboard leading-edge flaps, new outer wing panels, general structural strengthening, and an improved AN/AWG-10A digital weapon control system. A number of earlier Navy F-4N Phantoms have been converted to QF-4N target drones. *(Data for F-4S.)*

Contractor: McDonnell Aircraft Company Division of McDonnell Douglas Corporation.

Power Plant: two General Electric J79-GE-10 turbojets; each 17,900 lb st with afterburning.

Accommodation: pilot and weapon systems operator in tandem.

Dimensions: span 38 ft 7½ in (folded 27 ft 7 in), length 63 ft 0 in, height 16 ft 5½ in.

Weights (approx): empty 32,000 lb, gross 62,000 lb.

Performance: max speed at 40,000 ft Mach 2.0 class (over 1,320 mph), service ceiling over 54,000 ft, combat radius approx 500–750 miles according to mission.

Armament: one 20 mm M61A1 six-barrel gun; provision for up to four AIM-7E Sparrow, AGM-88A HARM, or AIM-9L Sidewinder missiles on four underfuselage and four underwing mountings, or up to 16,000 lb of other external stores.

F-14A/A Plus/D Tomcat

Development of the swingwing Tomcat began in January 1969 when Grumman's design, in response to a December 1967 RFP, was selected as winner of the US Navy's VFX competition for a new all-weather multirole fighter for fleet air defense, interdiction, and strike. The first of 12 development aircraft was flown on December 21, 1970, and deliveries of production **F-14A**s started in May 1972, initial operational capability (IOC) being achieved in July 1974 and fleet deployment, with VF-1 and VF-2 in USS *Enterprise,* two months later. When production of the F-14A ended in April 1987, a total of 545 of this version had been built and delivered to the Navy. They serve today with some two dozen USN squadrons, in 12 aircraft carriers, and ashore at the Naval Air Stations of Dallas, Tex., Miramar, Calif., and Oceana, Va. In 1980–81, to provide an interim reconnaissance capability pending the arrival of a purpose-built aircraft for this role, 49 F-14As (sometimes referred to unofficially as RF-14As) were equipped to carry an underbelly TARPS (tactical air reconnaissance pod system) containing a two-position (vertical and forward oblique) KS-87B frame camera, a KA-99 low-altitude panoramic camera, and an AN/AAD-5 infrared linescan camera. The TARPS

F-14A Tomcat

F/A-18 Hornet

Tomcat's first deployment was with VF-84 (USS *Nimitz*) in May 1981.

A two-pronged upgrade program for the F-14 was launched in the mid-1980s, aiming ultimately to fit improved performance engines and to replace most major items of the F-14A's analog avionics suite with digital systems. Somewhat affected by subsequent budget constraints, this has yielded two new variants known as the F-14A Plus and the F-14D. Of these, the **A Plus** features the engine refit only, retaining the same avionics as the F-14A. A prototype, converted from the original F-14B, flew for the first time on September 29, 1986, followed on November 14, 1987, by the first of 38 new-build F-14A Plus aircraft, deliveries of which, to VF-101 at NAS Oceana, Va., began in April 1988. In addition to these, 32 more A Plus Tomcats are to be acquired by converting existing F-14As. Original plans to acquire 127 new-build F-14Ds have been severely curtailed (to 37), but up to 400 D standard aircraft are planned for acquisition by conversion of F-14As, starting with six in FY 1990 with a further 12 planned for FY 1991.

In the **F-14D,** some 60 percent of the A's avionics will be replaced by more modern and effective digital equipment. The Hughes AN/AWG-9 weapon control system, for aiming and firing the Tomcat's Phoenix air-to-air missiles, will be replaced by an AN/APG-71 radar with monopulse angle tracking; digital scan control, target identification, and raid assessment; and improved ECCM. Other improvements include a digital INS, new computer and stores management systems and displays, and NACES ejection seats. The first F-14Ds should enter service in 1992. Grumman has also proposed, as a cost-effective alternative to the Air Force's ATF, an advanced "Tomcat 21" with enhanced aerodynamics (including stealth characteristics), upgraded F110-GE-429 engines, increased fuel load, and more advanced computer hardware and software. *(Data for F-14A/A Plus.)*

Contractor: Grumman Aircraft Systems Division.

Power Plant: two Pratt & Whitney TF30-P-412A or -414A turbofans in F-14A; each 20,900 lb st with afterburning. Replaced in F-14A Plus and F-14D by two General Electric F110-GE-400 turbofans; each 23,100 lb st with afterburning.

Accommodation: pilot and naval flight officer in tandem.

Dimensions: span 64 ft 1½ in (38 ft 2½ in swept), length 62 ft 8 in, height 16 ft 0 in.

Weights: empty 40,104 lb, gross (clean) 58,715 lb, (max) 74,349 lb.

Performance: max speed (low level) 912 mph, (at altitude) 1,544 mph, service ceiling above 50,000 ft, max range (with external fuel) 2,000 miles.

Armament: four Sparrow or Phoenix air-to-air missiles semirecessed under fuselage. Pylon under each inboard (fixed) wing section for additional Phoenix/Sparrows, and/or Sidewinders, or various combinations of missiles and bombs. One M61A1 20 mm gun in forward fuselage (port side).

F/A-18A/B/C/D Hornet

Given their reputations and service records, both the A-7 Corsair and the F-4 Phantom were bound to be hard acts to follow, and designing a single aircraft type to replace them both must have seemed a daunting task. McDonnell Douglas, with principal subcontractor Northrop, could not have done better than base its winning NACF (Navy air combat fighter) design on the YF-17 which had been such a strong contender in the USAF lightweight fighter competition. Selected in May 1975, the McAir/Northrop design received an FSED contract the following January, and the first of 11 development aircraft (nine single-seat and two two-seaters) made its maiden flight on November 18, 1978. Deliveries of a "pilot production" batch of 12 F/A-18s began in May 1980, the first recipients being the US Marine Corps's VMFA-314 squadron at MCAS El Toro, Calif., which achieved IOC with the Hornet in early 1983. The Navy's first Hornet development squadron, VFA-125 at NAS Lemoore, Calif., began flying the F/A-18 from November 1980, and the first seagoing squadron deployment of Hornets was with VFA-25 and VFA-113, in USS *Constellation,* in February 1985. Two years later the Hornet became the new mount of the celebrated "Blue Angels" USN demonstration team. Initial production models were the **F/A-18A** (single-seat) and **F/A-18B** (two-seat), of which, excluding prototypes, 410 were produced by 1987. Navy F/A-18s, replacing F-4 Phantoms in the fleet escort fighter/interdictor roles, carry a primary armament of Sparrow air-to-air missiles, while those of the USMC, intended as A-7 attack aircraft replacements, have a FLIR and laser tracker equipment instead of the Sparrow armament. In April 1986 two USN squadrons (VFA-131 and -132) and two from the USMC (VMFA-314 and -323), operating from USS *Coral Sea,* took part in the first combat deployment of Hornets when they attacked targets in Libya.

Upgraded versions now in service are the **F/A-18C** and two-seat **F/A-18D,** deliveries of which began in the fall of 1987. A combined total of 758 C and D models is planned, of which 390 (294 Cs and 96 Ds) had been funded through FY 1990, with continued procurement planned to maintain a rate of 66 per year. The F/A-18C upgrade includes an AN/ALQ-165 airborne self-protection jammer and capability for AMRAAM and IIR (imaging infrared) Maverick missiles. In addition, all Cs and Ds delivered from November 1989 have **night attack** capability, which includes a Hughes AN/AAR-50 thermal imaging navigation system (TINS), a Ford AN/AAS-38 attack FLIR, new Kaiser HUD, GEC Avionics night vision goggles, Honeywell digital moving map, and new Smiths cockpit displays. Up to four Mavericks can be carried underwing, or six AMRAAMs (four underwing and two under the fuselage). The two-seat F/A-18D will be employed only as a combat trainer by US Navy squadrons, but is intended to equip six Marine squadrons by the mid-1990s as an attack/reconnaissance replacement for their A-6E Intruders (which will be transferred to the Navy), RF-4B Phantoms, and OA-4M Skyhawks. *(Data for F/A-18C.)*

Contractor: McDonnell Aircraft Company Division of McDonnell Douglas Corporation.

Power Plant: two General Electric F404-GE-400 turbofans; each approx 16,000 lb st with afterburning.

Accommodation: pilot only.

Dimensions: span 37 ft 6 in, (folded) 27 ft 6 in, length 56 ft 0 in, height 15 ft 3½ in.

Weights: empty 23,050 lb, gross (fighter) 36,710 lb, (attack) 49,224 lb.

Performance: max speed more than Mach 1.8, combat ceiling 50,000 ft, combat radius (fighter) more than 460 miles, (attack) 662 miles.

Armament: nine external weapon stations (one at each wingtip, two under each wing, one on each nacelle, and one on fuselage centerline) for wide mix of missiles, bombs, laser or FLIR pods, or drop tanks. M61A1 six-barrel 20 mm gun in nose.

X-31A

Two prototypes of the X-31A, the first of which flew this spring, are being built under an EFM (enhanced fighter maneuverability) technology test-bed program funded by DARPA (via Naval Air Systems Command) and the West German Defense Ministry. First "X" series aircraft to be developed jointly with another country, the X-31A is designed to break the so-called "stall barrier" and allow future fighters to undertake controlled, agile maneuvering, during close-in combat, beyond normal stall angles of attack. It has a cranked-delta wing, all-moving canards for pitch control, a German-developed paddle-type thrust-vectoring system, and fly-by-wire movement of all main control surfaces (flaperons, canards, and rudder). The second X-31A was due to fly by late summer, and the two aircraft will undertake a 400-hour, 27-month trials program, beginning at Edwards AFB and transferring early next year to the NATC at NAS Patuxent River, Md.

Contractors: North American Aircraft Division of Rockwell International Corporation; and Deutsche Aerospace-MBB (West Germany).

Power Plant: one General Electric F404-GE-400 turbofan; 16,000 lb st with afterburning.

Accommodation: pilot only.

Dimensions: span 23 ft 10 in, length 43 ft 4 in, height 14 ft 7 in.

Weights: empty 11,410 lb, gross 15,935 lb.

Performance: max speed at 30,000 ft nearly 900 mph, service ceiling 40,000 ft.

Armament: none.

Attack and Observation Aircraft

A-4E/F/M and OA-4M Skyhawk

Pound-for-pound one of the most effective and versatile attack aircraft yet produced, the Skyhawk design is now an incredible 38 years old, yet many non-US export models are still highly regarded and undergoing modern avionics and weapons upgrades to maintain their viability through the 1990s. The **A-4E** (first flight July 1961) was the first variant to change from the 7,700 lb thrust Wright J65 turbojet of early Skyhawks to an 8,500 lb st Pratt & Whitney J52, which allowed the warload/range trade-off to be greatly improved by increasing the wing/fuselage weapon stations from three to five. Of over 450 A-4Es built for the Navy, some 50–60 remain in service, together with a slightly smaller number of the A-4F, which had an uprated J52-P-8 of 9,300 lb thrust and entered service in 1967. The **A-4F** introduced wing lift spoilers that enabled the landing run to be reduced by about 1,000 ft, nosewheel steering, a zero/zero seat, and a "saddleback" fairing behind the cockpit to house additional avionics.

The **A-4M,** delivered from 1970 and produced specifically for the Marine Corps, was a further development of the A-4F. Changes, claimed to increase combat effectiveness by 30 percent, earned it the name Skyhawk II. Engine thrust was increased by a further 1,900 lb; ammunition for the 20 mm guns was doubled from 100 rounds each to 200; an enlarged windshield and canopy, and undertail brake-chute, were standard; a new, square-topped fin was an instant recognition feature; and in-service improvements included enhanced ECM and the Hughes angle rate bombing set. Of 158 A-4Ms built for the Marines, about 140 remain in service, the last front-line unit transferring to the Reserve earlier this year. The **OA-4M,** which first flew in July 1978, was a two-seat FAC (forward air control) variant, also for the Marines, converted from TA-4F trainers by the Naval Air Rework Facility at Pensacola, Fla., with avionics and weapons capability to A-4M standard. The OA-4M entered USMC service in 1979 with H&MS-32 at MCAS Cherry Point, N. C. About 25 were procured, all or most of which were still in service in early 1990. *(Data for A-4M.)*

Contractor: Douglas Aircraft Company Division of McDonnell Douglas Corporation.
Power Plant: one Pratt & Whitney J52-P-408 non-afterburning turbojet; 11,200 lb st.
Accommodation: pilot only.
Dimensions: span 27 ft 6 in, length (excl probe) 40 ft 4 in, height 15 ft 0 in.
Weights: empty 10,800 lb, gross 24,500 lb.
Performance: max speed at S/L (clean) 670 mph, (with 4,000 lb weapon load) 646 mph, initial climb rate 10,300 ft/min, ferry range 2,000 miles.
Armament: one underfuselage and four underwing stations for numerous combinations of bombs, air-to-surface or air-to-air rockets or missiles, gun pods, or other stores. One 20 mm cannon in each wingroot.

A-6E Intruder

First flown (as the A2F-1) in April 1960, the A-6 has already enjoyed a career approaching 30 years as the airplane flown by the medium attack wings of the Navy and Marine Corps. For almost 20 of those years the model in service has been the A-6E, with completely new solid-state avionics, including the Norden APQ-148 multimode radar, IBM computer, and Kaiser cockpit display. Upgrading over those 20 years has been unceasing, current aircraft having the TRAM (target recognition and attack multisensor) package, including a precision-aimed chin turret housing a FLIR (forward-looking infrared) and laser, improved inertial navigation, and upgraded communications. Since 1981, newly built A-6Es and converted examples have been able to carry and launch up to four Harpoon antiship missiles. Grumman produced 240 aircraft by converting A-6As, followed by 205 new airframes of which 200 had been delivered by mid-1990. In 1988 the future looked bright. The prototype of the next-generation A-6F Intruder II, with all-digital avionics, airframe improvements, and GE F404 engines, was about to fly, and Boeing was about to refit 102 (possibly many more) A-6Es with new fatigue-free graphite/epoxy wings. Since then the A-6F has been canceled, the new wings (for the last 21 aircraft only) have just about completed flight testing, and the Navy has canceled the A-6G, which would at least have incorporated the A-6F's digital avionics.

All that is left—apart from a very long wait for a quite different aircraft, the A-12A—is a program to upgrade existing A-6Es. This SWIP (systems and weapons integration program) will equip some 342 aircraft with mainly digital avionics and displays, including a new radar and GEC Avionics wide-angle HUD and NANS (night attack navigation system), better self-defense systems (including AMRAAM missiles and additional chaff/flare dispensers), and various airframe improvements. The engine will be the J52-P-409 (PW1212), with faster acceleration (giving better performance on bolters and go-arounds) and increased thrust (see data).

A-6E Intruder

AV-8B Harrier II

Contractor: Grumman Aircraft Systems Division.
Power Plant: two Pratt & Whitney J52-P-408 turbojets, each 9,300 lb st; to be replaced by P-409s, each 12,000 lb.
Accommodation: pilot and bombardier/navigator side-by-side.
Dimensions: span (wings spread) 53 ft 0 in, (folded) 25 ft 4 in, length 54 ft 9 in, height 16 ft 2 in.
Weights: empty 26,746 lb, max gross (catapult launch) 58,600 lb, (field takeoff) 60,400 lb.
Performance: max speed (clean, sea level) 644 mph, service ceiling 42,400 ft, range with max military load 1,011 miles.
Armament: five attachment points for up to 18,000 lb of external stores, a typical load being 28 bombs of 500 lb plus two AIM-9 Sidewinder AAMs for self-defense. See text regarding Harpoon missiles; many other weapons (such as HARM, SLAM, and Skipper) have been test fired.

A-7B/E Corsair II

In one of the fastest development programs on record, LTV met the VAX attack requirement with the A-7A, derived from the F-8 Crusader fighter, flying the prototype in September 1965, 18 months after receiving the contract, and getting it into action in southeast Asia 18 months later. Altogether 1,545 were built in numerous versions. These included 196 **A-7Bs**, powered by the 12,200 lb Pratt & Whitney TF30-P-8 and fitted with two 20 mm guns. A very small number are still flying, most having been stricken from the active list or rebuilt (see TA-7C).

First flown on November 25, 1969, the **A-7E** corrected all the shortcomings of earlier versions, including a tricky engine (especially when ingesting catapult steam), lack of power, and (despite good bombing accuracies) obsolescent navigation and weapon-delivery systems. The E transformed the Corsair II; of 551 built, more than half are still equipping light attack wings of the Navy and will serve for many years with the Navy Reserve squadrons. They have 1,500 gallons of internal fuel and can take on fuel in flight via a retractable probe. The capacious cockpit is protected by boron carbide armor (the one-piece birdproof windshield of the latest A-7D may be a future modification). The seat is the McDonnell Douglas Escapac 1G3, the zero-altitude performance of which saved the life of the leader of the strike against Syrian/Druse positions on December 4, 1983. The A-7E saw intensive action in Vietnam and, without much publicity, also played an important role in the invasion of Grenada in 1983 and the strike against Libya in 1986. The A-7Es that attacked Libya used the HARM (high-speed antiradiation missile) for the first time in anger.

Avionics carried by the A-7E include the APQ-126 forward-looking radar, a Doppler radar, inertial navigation set, ADF, Tacan, and projected map display, giving pilots their latitude and longitude to the nearest foot throughout the mission. Defensive avionics include the ALR-45/50 internal homing and warning systems, ALQ-126 active ECM installation, and chaff/flare dispensers. A total of 221 have been equipped with a Texas Instruments FLIR (forward-looking infrared) pod carried under the starboard wing and a GEC Avionics raster HUD to give excellent night attack capability. Even though the A-7E was meant to be replaced swiftly by the F/A-18, the Corsair II's long range and outstanding weapons delivery capability will keep two A-7E squadrons in each carrier air wing until at least 1991, and the type is expected still to be in service beyond 2000. *(Data for A-7E.)*

Contractor: LTV Corporation, Aircraft Products Group.
Power Plant: one Allison TF41-A-2 turbofan, derived from RR Spey; 15,000 lb st.
Accommodation: pilot only.
Dimensions: span 38 ft 9 in, length 46 ft 1 in, height 16 ft 1 in.
Weights: empty 19,127 lb, max gross 42,000 lb.
Performance: max speed with 12 Mk 82 bombs 646 mph, tactical radius with typical bomb load 700 miles.
Armament: one 20 mm M61 cannon with 1,000 rounds; up to 20,000 lb of external weapons (enormous variety of types).

A-12A

Subject of a recent Pentagon review, which confirmed that the requirement for it was still valid, the two-seat A-12A carrier-borne strike aircraft is a joint General Dynamics/McDonnell Douglas program for a mid-1990s A-6E replacement. It was originally known as the ATA (advanced tactical aircraft). Highly classified still, the twin-turbofan, subsonic A-12A will embody low-observables (stealth) airframe technology, but is said to use derivative rather than new technology in its engines (based on the GE F404), radar, and other systems. These will include a Norden/Texas Instruments multifunction radar and Westinghouse FLIR, and the A-12A will also have an in-flight refueling capability. Initial Navy plans, announced in 1986, were to acquire up to 858 of the new aircraft, 106 of them by FY 1994, but this number has been reduced to 620. More details of the A-12A are expected to be released this fall, when the prototype is due to be rolled out and make its first flight.

AV-8B and TAV-8B Harrier II

Experience with the AV-8A Harrier STOVL (short take-off/vertical landing) aircraft from January 1971 led the Marine Corps to order development of a redesigned Harrier II. Produced as a joint US/UK aircraft, this retains a long-life version of the original engine, but has a long-span wing made of graphite composites, with a super-critical profile and large flaps. This gives much-enhanced lift and adds 50 percent to the internal fuel capacity. Lift is also increased by improved engine inlets and nozzles, drooped ailerons, and lift-increasing strakes under the fuselage or gun pods. The forward fuselage is redesigned with a more capacious cockpit, much better all-round view, and the Hughes ARBS (angle rate bombing set) for enhanced bombing accuracy. Other changes include a carbonfibre front fuselage and horizontal stabilizer, inboard outrigger landing gears, UPC/Stencel zero/zero seat, and greatly upgraded avionics and weapons capability. If necessary, a retractable in-flight refueling probe can be attached above the port engine inlet duct.

The Marine Corps has a requirement for 304 single-seat Harrier IIs and 24 TAV-8B dual-control trainers. The first pilot-production AV-8B flew on August 29, 1983, and deliveries began on January 12, 1984. The first operational squadron, VMA-331, was commissioned at MCAS Cherry Point, N. C., on January 30, 1985. The first TAV-8B, with a completely redesigned forward fuselage and taller vertical tail, first flew on October 21, 1986. Until this entered service, pilots had to convert on the unrepresentative TAV-8A, but the first class to be trained on the TAV-8B graduated in 1988. The prototype of a **night attack** version of the AV-8B flew on June 26, 1987, and deliveries of this model began on September 15, 1989. At that time 156 AV-8Bs remained to be delivered, and it was stated that all would have night attack capability. Above the nose is a GEC Sensors FLIR, presenting clear night pictures on color HDDs and a wide-angle HUD. The pilot wears NVGs, and the cockpit also contains a digital moving-map display. Aircraft delivered from May 1990 have the Dash-408 engine *(see data, which apply to the AV-8B).*

Contractors: McDonnell Douglas Corporation; British Aerospace.
Power plant: one Rolls-Royce F402-RR-406A (Pegasus) vectored-thrust turbofan (to 1990), 21,450 lb st, (1990 onwards) F402-RR-408, 23,800 lb st.
Accommodation: pilot only.
Dimensions: span 30 ft 4 in, length 46 ft 4 in (TAV-8B, 50 ft 3 in), height 11 ft 8 in.
Weights: empty 12,525 lb, max gross 31,000 lb.
Performance: max speed at sea level 661 mph, operational radius with seven Snakeye bombs 553 miles, deck-launched intercept radius 722 miles.
Armament: one 25 mm GE GAU-12/U with 300 rounds; six wing pylons stressed to 2,000 lb each (inboard and center) or 620 lb (outboard) for very wide range of weapons, pods, dispensers, sensors, or tanks, to normal maximum load of 9,200 lb.

OV-10A/D Bronco

The Bronco was developed in the early 1960s to a Marine Corps LARA (light armed reconnaissance aircraft) requirement, Rockwell (North American) producing 157 **OV-10As** for USAF and 114 for the USMC, deliveries from original production ending in 1969. Eighteen enhanced **OV-10Ds** (the B and C having been export models) were modified from As under a 1974 contract to provide the Marines with a NOS (night observation system) version having 45 percent more powerful T76 engines, increased fuel capacity, a chin-mounted Texas Instruments AN/AAS-37 FLIR turret with integral laser rangefinder/designator, and a reconfigured cockpit. Plans to fit a belly-mounted XM197 20 mm gun turret, boresighted to the FLIR, were canceled on cost grounds. Deliveries of the original 18 OV-10Ds were completed by 1980, but the conversion effort is being continued by Rockwell under a further (1988) contract that will upgrade the USMC's remaining 42 OV-10As to D standard. Deliveries of the first 15 of this new batch of OV-10Ds are due to be completed in early 1991. Rockwell is also supplying the Navy with 14 service life extension program kits to convert earlier OV-10Ds to the same D (SLEP) standard. *(Data for OV-10D.)*

Contractor: North American Aircraft Division of Rockwell International Corporation.
Power Plant: two Garrett T76-G-420/421 turboprops; each 1,040 ehp.
Accommodation: crew of two in tandem.
Dimensions: span 40 ft 0 in, length 44 ft 0 in, height 15 ft 2 in.
Weights: empty 6,893 lb, gross 9,908 lb (normal), 14,444 lb (max).
Performance: max speed at S/L (clean) 288 mph, service ceiling at normal gross weight 30,000 ft, combat radius with max weapon load 228 miles.
Armament: five fuselage stations (one on centerline and two on each sponson) for combined load of 3,600 lb, plus two 600 lb capacity underwing stations, for bombs, rockets, gun pods, flares, or other stores. Two internal 7.62 mm guns in each fuselage sponson.

Reconnaissance and Special-duty Aircraft

ATSA

The FY 1991 budget request included $1.5 million to initiate development of a new advanced tactical support aircraft (ATSA) for the late 1990s, to replace the present mixed fleet of E-2C Hawkeyes, EA-6B Prowlers, and ES-3A Vikings. One possibility being studied is to base the ATSA on the S-3 airframe.

DC-130A Hercules

The DC (D indicating modification as a drone or missile launch and control aircraft) is one of the few variants of the original C-130A Hercules production model to remain in service, both USAF and the US Navy still having some in their inventories. They are modified to carry four drones/RPVs on underwing pylons—usually members of the Teledyne Ryan BQM-34 family. The three Navy-owned DC-130As are operated for the service by Flight Systems Inc.

Contractor: LASC Georgia division of Lockheed Corporation.
Power Plant: four Allison T56-A-9 turboprops; each 3,750 ehp.
Accommodation: total crew (including drone operators/controllers) of seven or eight.
Dimensions: span 132 ft 7 in, length 100 ft 2 in, height 38 ft 0 in.
Weights: empty 62,800 lb, gross 124,200 lb.
Performance: max cruising speed 360 mph, service ceiling 40,000 ft, range (with max fuel and 29,200 lb payload at 335 mph) 2,900 miles.
Armament: none.

E-2B/C and TE-2C Hawkeye

Though developed as a highly specialized carrier-based AEW (airborne early warning) aircraft, with an airframe design greatly influenced by the need to fold into a space compatible with a carrier, the Hawkeye has also been sold to four air forces that have land bases only. This is because it fills a unique slot in the spectrum of combat aircraft, infinitely more capable than smaller surveillance platforms yet a fraction of the price of an E-3 AWACS. The prototype flew on October 21, 1960, introducing the concept of a giant (24-ft diameter) rotodome revolving on a pylon high above the fuselage to enable its antenna groups to sweep round all points of the compass. Incoming data are displayed in the ATDS (airborne tactical data system) compartment in the center fuselage to the Combat Information Center Officer, Air Control Officer, and Radar Operator. At the operating altitude of about 30,000 ft the radar can see targets up to 300 miles distant. Electronic emitters, such as hostile radars, can be detected over distances up to 600 miles by the Litton ALR-73 PDS (passive detection system), which has receiver antennas in the nose and tailcone and looking out sideways from the outer vertical stabilizers.

The tail has four vertical stabilizers in order to keep the height within the severe limit imposed by carrier hangars and workshops. They are made of glassfibre to reduce their interference with the main radar. The height limit also requires that the rotodome should be lowered by a hydraulic jack when aboard ship, reducing overall height to 16 ft 5 in. All leading edges have pneumatically inflated deicers. Of course, the outer wings fold, skewed hinges turning each wing to lie upper surface outwards, locked by a jury strut to the tail.

The **E-2A** (62 built) had 4,050 shp T56 engines and the APS-96 radar. Subsequent models received more powerful engines and, via the APS-125 and -138, the current GE APS-139 radar system with an advanced radar processing system. It can automatically track more than 2,000 targets and control more than 40 airborne intercepts. The first **E-2C** flew in 1971, but the Hawkeye has developed greatly since then. Of 137 on Navy order by FY 1990, about 115 had been delivered by mid-1990, with six being funded each year. Universally regarded as a force multiplier, the Hawkeye equips 17 Navy squadrons and also serves the US Coast Guard and the air forces of Israel, Egypt, Japan, and Singapore. A few **E-2Bs** (updated E-2As) remain in service, plus two **TE-2C** training aircraft. *(Data for E-2C.)*

Contractor: Grumman Aircraft Systems Division.
Power Plant: two Allison T56-A-427 turboprops; each 5,250 shp.
Accommodation: two pilots, plus three tactical officers.
Dimensions: span 80 ft 7 in, (folded) 29 ft 4 in, length 57 ft 6¾ in, height (rotodome raised) 18 ft 4 in.
Weights: empty 38,063 lb, max gross 51,933 lb.
Performance: max cruising speed 358 mph, service ceiling 30,800 ft, time on station 200 miles from base 3 to 4 h, endurance 6 h 6 min.

E-6A TACAMO II

Now beginning to take over from the EC-130Q version of the Lockheed Hercules in the TACAMO (TAke Charge And Move Out) role, the E-6A was developed to provide a survivable airborne communications link between the national command authorities (NCA) and the US Navy's fleet of Trident nuclear submarines (SSBNs). It retains, at least initially, the airborne VLF communications system used in the EC-130Q, and utilizes a nuclear/EMP hardened airframe having approximately 75 percent commonality with USAF's E-3 Sentry AWACS aircraft, minus the latter's dorsal rotodome and its support structure. The E-6A has more anticorrosion treatment than the E-3, a large forward freight door in the windowless main fuselage, wingtip ESM/Satcom pods, and CFM56 turbofans similar to those now powering USAF's reengined KC-135Rs. In operational use the AN/ALR-66(V)4 ESM (electronic support measures) systems in each wingtip pod provide threat information (detection, identification, bearing, and range). This can be relayed upward to other airborne command posts such as the Presidential E-4 or communications satellites, or downward to VLF ground stations and the SSBN fleet, using two trailing wire antennas (TWAs): one 26,000 ft long (LTWA) reeled out from an underfuselage hatch and a shorter 4,000-ft antenna (STWA) winched out from the tailcone to act as a dipole. To be effective operationally, the LTWA must be kept at least 70 percent vertical; this is achieved by weighting the end with a 90 lb drogue while the E-6A flies in a tight orbit. Prototype flight testing with full on-board avionics started in June 1987, and the first two production E-6As were handed over to VQ-3 in August 1989. Thirteen more have been funded, and the total will eventually be increased to 16 by refurbishing the prototype. Eight will serve in the Pacific area with VQ-3 at NAS Barber's Point, Hawaii, and eight in the Atlantic with VQ-4 at NAS Patuxent River, Md., supplementing and eventually replacing EC-130Qs. The main operating base for the E-6As will shift to Tinker AFB, Okla., in mid-1992.

Contractor: Boeing Aerospace and Electronics.
Power Plant: four CFM International F108-CF-100 turbofans; each 24,000 lb st.
Accommodation: flight crew of four, plus mission crew of five including an airborne communications officer (ACO).
Dimensions: span 148 ft 2 in, length 152 ft 11 in, height 42 ft 5 in.
Weights: operating empty 172,795 lb, gross 342,000 lb.
Performance: cruising speed at 40,000 ft 523 mph, dash speed 610 mph, patrol altitude 25,000–30,000 ft, mission range (unrefueled) 7,307 miles.
Armament: none.

EA/ERA/RA-3B Skywarrior

Original Skywarrior production included 30 twelve-camera day/night reconnaissance **RA-3Bs** and 25 **EA-3Bs** for elint duties, the latter having internal infrared sensors, underwing jammer pods, and side-looking airborne radar (SLAR) in a canoe-shaped underfuselage radome. Two of the former and 13 of the latter remain in service in 1990. About 10 of the RA-3Bs were converted to a combined electronic/photographic surveillance configuration and redesignated **ERA-3B;** eight of these remain. Most surveillance Skywarriors are now used mainly for EW training with carrier and battleship battle groups. *(Data for EA-3B.)*

Contractor: Douglas Aircraft Company Division of McDonnell Douglas Corporation.
Power Plant: two Pratt & Whitney J57-P-10 turbojets; each 10,500 lb st.
Accommodation: crew of three plus four equipment operators.
Dimensions: span 72 ft 6 in (folded 49 ft 5 in), length 74 ft 8½ in, height 22 ft 9½ in (15 ft 11 in with tail folded down).
Weights: empty 39,620 lb, gross 73,000 lb.
Performance: max speed at S/L 640 mph, service ceiling 40,400 ft, combat radius 1,416 miles.

EA-6A Intruder and NA/NEA-6A

The **EA-6A** was the original EW (electronic warfare) version of the Grumman A-6 Intruder. It was an interim solution pending the complex development of the dedicated EA-6B Prowler. Thus, it even retained partial attack capability, though some of the navigation/bombing subsystems were deleted. The receiver antennas for the ECM system were grouped in a large fairing on top of the vertical stabilizer, and the active jammers were housed in up to five self-powered pods hung on the wing and fuselage pylons. Three YA-6A and four A-6A Intruders were converted, and 21 EA-6As were built as such. Three YA-6As and three A-6As used for various test purposes were designated **NA-6A,** and BuNo 149935 was for many years assigned to permanent electronic testing as the **NEA-6A.** All retained a two-man crew. Deliveries took place in 1965–69, and many are still active in secondary roles. *(Data generally as for A-6E, except as follows.)*

Power Plant: two Pratt & Whitney J52-P-8A or -8B turbojets; each 9,300 lb st.
Weights: max gross 56,500 lb.

EA-6B Prowler

These historic aircraft were the first to be designed from the start for the electronic warfare and active jamming mission. All attack capability was deleted, and the forward fuselage was extended by 40 in to accommodate two additional crew (see data below). The main group of receiver antennas is housed in a large fairing on top of the tail to give all-round coverage on many wavelengths used by all kinds of hostile emitters. The received information is processed by a powerful AYK-14 central computer. The signals are displayed in the cockpit, recorded and (automatically, plus monitoring and, if necessary, crew assistance) compared with threat libraries, ranked in order of threat, and jammed. The processing system automatically adjusts the radiated jamming power to match the threat, to make best use of energy, and aims the jamming toward the threat. The jammers are contained in up to five streamlined pods hung on the fuselage and wing pylons. Each pod is self-powered by a windmill generator on the nose. Current EA-6Bs have ICAP-2 capability, each pod being able to generate signals in any of seven frequency bands and to jam in any two simultaneously.

In 1983 development began on ADVCAP (advanced capability), managed by Litton assisted by TI and ITT. This dramatically upgrades the receiving and processing part of the Prowler's TJS (tactical jamming system). The antenna pod on the vertical tail will be noticeably larger, and an extra antenna group is added beneath the rear fuselage. This new version will have its own direct antiradar capability by launching HARM missiles from the inboard pylons, extra pylons being added under the outer wings to preserve the capability of five jamming pods (though usually some pylons carry tanks). The ADVCAP prototype was in the flight test stage in 1990, and up to 100 aircraft with front-line squadrons are expected to be modified from late 1991. The first EA-6B flew on May 25, 1968, and it rapidly became a vital part of each Navy carrier air wing, serving aboard every carrier (and at two shore stations) in 14 VAQ squadrons. Additional aircraft serve with one Marine Corps unit (VMAQ-2) and, since 1990, the Navy Reserve.

Deliveries total 139 of a funded 149, output tapering off from a recent level of 12 per year. The latest of many updates is the Sanders ALQ-149, a comprehensive system for detecting and jamming hostile communications. Grumman is also flying a VIP (vehicle improvement program) Prowler with more powerful J52 engines and numerous airframe improvements.

Contractor: Grumman Aircraft Systems Division.
Power Plant: two Pratt & Whitney J52-P-408 turbojets; each 11,200 lb st.
Accommodation: crew of four (pilot and three ECM officers) on Martin-Baker GRUEA-7 seats.
Dimensions: span 53 ft 0 in, (folded) 25 ft 10 in, length 59 ft 10 in, height 16 ft 3 in.
Weights: empty 32,162 lb, max gross 65,000 lb.

Performance: max speed at S/L with five pods 610 mph, service ceiling 38,000 ft, range with five pods 1,100 miles.
Armament: none originally, but AGM-88 HARM being added (see text).

EA-7L Corsair II

One of the least-publicized Navy aircraft, the EA-7L is a TA-7C trainer converted as a dedicated EW (electronic warfare) platform. Six aircraft were thus rebuilt, equipping squadron VAQ-34, which was formed at NAS Point Mugu, Calif., on March 1, 1983. The conversion adds the capability of carrying any of five different emitter pods or an active emitting drone aircraft to simulate hostile radars, communications, aircraft, or cruise missiles. They have been reengined with the TF41 (see TA-7C entry). *(Data generally as for TA-7C.)*

EC-24A

Delivered to the USN in August 1987 and based at Tulsa, Okla., the EC-24A is one of a diverse and growing assortment of aircraft assigned to FEWSG (fleet electronic warfare support group) activities, with accommodation and range that enable it to self-deploy to anywhere in the world. Converted from a DC-8-54F Jet Trader commercial freighter, it carries dual AN/ALT-40 radar jammers with steerable antennas, dual AN/ASQ-19* communications transceiver/jammers, two AN/ALE-43 chaff dispensers, dual AN/ALR-75 systems for signal identification, 12 radio transceivers (six UHF, two VHF, and four HF), and can be identified by two canoe-shaped radomes under the fuselage.
Contractor: Electrospace Systems Inc.
Power Plant: four Pratt & Whitney JT3D-3 turbofans; each 18,000 lb st.
Accommodation (typical): flight crew of three, plus seven systems operators (including mission commander). Capacity also for up to 3,000 lb of cargo and seats for 20 maintenance personnel or additional crew members.
Dimensions: span 142 ft 5 in, length 150 ft 6 in, height 42 ft 4 in.
Weights: gross 315,000 lb.
Performance: max cruising speed at 30,000 ft approx 545 mph, max unrefueled range approx 5,525 miles, max endurance 11 hours.

EC-130G/Q Hercules

These conversions of the C-130 were the first aircraft ever to be assigned the task of serving as relay platforms in communicating with submerged submarines. In a program called TACAMO (TAke Charge And Move Out), their duty is to relay vital messages (for example from the President) to Poseidon and Trident boats waiting on station. The submarine is linked with a very small antenna floating on the sea surface, and the aircraft carries HF and VLF relay equipment with SIMOP (simultaneous operation) capability. The key radiating element in the VLF link is a pair of trailing wire antennas which, weighted at their free ends, hang down almost to ground level as the EC-130 orbits in continuous circles. The radiative portions of wire are vertical, the shorter of the two wires being the feeder and the longer the radiator. Following experience with four **EC-130G** aircraft, the Navy purchased 18 **EC-130Q**s with improved equipment and crew accommodation. The Q has been described as "the only airborne, survivable communications link with submarine forces, providing SIMOP capability in a collocated environment." All these aircraft are expected to be replaced by the Boeing E-6A. Training variants are designated **TC-130G/Q**. *(Data generally as for KC-130.)*

EP-3E, RP-3A/D, and WP-3D Orion

Ten P-3As and two P-3Bs were modified in the late 1960s to EP-3A and EP-3B elint configuration, replacing EC-121s in this role. All 12 were subsequently upgraded to **EP-3E** standard, serving with Navy squadrons VQ-1 and VQ-2 from the early 1970s. They were characterized by absence of a MAD tail "sting" (replaced by a conventional tailcone), had prominent radome fairings above and below the fuselage, and underwent wing and landing gear strengthening. Specialized equipment included a Hughes AN/AAR-37 IR receiver, Raytheon AN/ALQ-76 and Magnavox AN/ALQ-108 jammers, a Loral AN/ALQ-78 passive ECM receiver, UTC AN/ALQ-110 radar signal collector, and a Sanders AN/ALQ-132 infrared countermeasures system. The conversion program was conducted by the US Naval Avionics Facility at Indianapolis, Ind. Twelve replacements, designated **EP-3E-II**, are currently being provided by transferring these systems to early production P-3C airframes. Five other P-3As were converted to **RP-3A** for oceanography research and miscellaneous test or evaluation programs, while the **RP-3D** designation was given to a single P-3C equipped under the US Naval Oceanographic Office's Project Magnet and used by squadron VXN-8 to map the Earth's magnetic field. Four P-3As were converted in the early 1970s as **WP-3A** weather reconnaissance replacements for the WC-121; two others were reconfigured in 1976 as **WP-3D** airborne research centers for the National Oceanic and Atmospheric Administration. *(Data for EP-3E-II generally as for P-3C, except as follows.)*
Accommodation: duty and relief flight crew, plus 15 electronic warfare equipment operators.
Weights: gross, approx 142,000 lb.

EC-24A

RF-4B Phantom II (Ivo Sturzenegger)

ES-3A Viking

A distinctive dorsal avionics fairing and no fewer than 60 underfuselage and underwing antennas characterize this elint conversion of the S-3A, currently under development to replace most of the elderly EA-3B Skywarriors. Nine conversion kits have been ordered so far, and an aerodynamic prototype, without mission avionics, flew for the first time in September 1989. The ES-3A will retain the AN/APS-137(V)1 synthetic aperture radar and AN/ALR-76 electronic support measures system of the S-3A, but will replace some 3,000 lb of ASW installation with over 5,000 lb of new ESM, broadly similar to those of the EP-3E Orion, plus Omega navigation, GPS, and three AN/AYK-14 digital computers. A second ES-3A, equipped with mission avionics, was due to fly by the summer of this year, and evaluation by the Naval Air Test Center and USN squadron VX-1 should be completed by the spring of 1991. This and the next seven aircraft are planned, subject to funding, to be joined by a second batch of eight ES-3As, permitting the equipping from 1992 of two new squadrons: VQ-5 and VQ-6, based, respectively, at NAS Agana, Guam, and NAS Rota, Spain, in support of the Pacific and Atlantic/Mediterranean fleets. They will form the airborne component of the Battle Group Passive Horizon Extension System, being deployed in detachments of two ES-3As to a carrier, to extend the group's threat detection/identification range. Each ES-3A will carry a four-man crew of pilot, EW combat coordinator, and two EW systems operators. *(Data generally as for S-3A/B, except performance slightly reduced due to external antenna drag.)*

F/A-18D(RC) Hornet

A reconnaissance version of the Hornet, with the nose gun removed and replaced by a two-window, twin-sensor pack, was the subject of a USN study started in the fall of 1982, and a prototype was flown for the first time on August 15, 1984. This aircraft was fitted with a Fairchild Weston KA-99 low-altitude panoramic camera and a Honeywell AN/AAD-5 infrared linescan imager, similar to those installed in the TARPS pod of some F-14A Tomcats. A more recent version is the F/A-18D(RC), which is being developed for the USMC to carry an all-weather ATARS (advanced tactical airborne reconnaissance system) underfuselage pod that will contain a Loral AN/UPD-8 side-looking synthetic aperture radar to supplement the nose-mounted optical and IR sensors. The pod has already been flight tested on an RF-4B. *(Data generally as for F/A-18.)*

HV-22A Osprey

Second version of the now-endangered V-22 required by the US Navy was the HV-22A, envisaged as an HH-3 replacement in the roles of CSAR (combat search and rescue), special warfare, and fleet logistics support. With a five-man crew, it would be able to put down or pick up casualties or SOF teams 530 miles from base, even in "hot and high" environments, or to provide carrier and vertical on-board delivery at ranges up to 1,150 miles. Navy requirement was for 50 of this model. *(Data as for MV-22A.)*

RF-4B Phantom II

From the original 46 built in the late 1960s, about two dozen examples of this photoreconnaissance version of the Phantom were still in service early this year with VMFP-3, the US Marine Corps's only tactical reconnaissance squadron. They will eventually be replaced by F/A-18D(RC) Hornets. The RF-4B has 17,000 lb thrust (with afterburning) J79-GE-8 turbojets, and forward/oblique cameras in the nose and fuselage instead of the F-4B's gun.

YEZ-2A

The YEZ-2A is the operational development model of a large, nonrigid airship being developed under a 1987 Navy contract for an AEW (airborne early warning) airship carrying a surveillance system to warn surface ships of threats, including long-range, sea-skimming cruise missiles, that would be beyond the range of shipboard radars. Other roles include surveillance, targeting, and communications. Designed and built by Airship Industries of the UK, the Sentinel 5000 will carry a Westinghouse surveillance radar and have a CODAG (combined diesel and gas-turbine) propulsion system consisting of two diesel cruise engines with vectoring ducts, plus a turboprop to boost power for higher dash speeds. The crew will occupy a multideck, pressurized control car with full rest and refreshment facilities. Some program slippage has deferred the probable first flight date until late 1993, but a half-linear-scale Sentinel 1000 test vehicle was due to begin flight trials recently.
Contractors: Airship Industries Ltd (UK); Westinghouse Electric Corporation.
Power Plant: two CRM diesel engines (each 1,870 hp) and one General Electric CT7-9 turboprop (1,870 shp).
Accommodation: crew of 10–15.
Dimensions: (envelope) length 425 ft 0 in, max diameter 105 ft 0 in, volume 2,502,540 cu ft; (car) length 79 ft 4 in.
Weights: envelope 18,300 lb.
Performance (estimated): max speed (3 engines) 103 mph, pressure ceiling 14,000 ft, max unrefueled endurance at 5,000 ft and 46 mph more than 60 hours, mission capability with refueling 30 days.

Transports and Tankers

C-2A Greyhound

Following the pioneer C-1 Trader, the first airplane designed as a COD (carrier on-board delivery) transport, the C-2A has been the Navy's standard COD aircraft since 1964, staving off competiton from later rivals. Derived from the E-2 Hawkeye, the C-2A has a new fuselage of greater diameter (though still somewhat constricted, with a max width of 7 ft 4 in and max height of 5 ft 5 in). Pressurized accommodation is provided for up to 28 passengers (or, in theory, 39 troops), or 12 litters and medical attendants. The floor is stressed for cargo and could be equipped for the 463L pallet system, bulky loads being winched or driven in via the full-width rear ramp door. Maximum cargo payload is 10,000 lb, or 15,000 lb for operations from airfields only. Of course, the C-2A is stressed for catapult launch and arrested landing and can fold for compatibility with carrier elevators and hangars.

Grumman delivered 19 in the original batch, all being retired by the end of 1987. From 1985 Grumman delivered a further series of 39 aircraft, multiyear funded in 1983. These aircraft have uprated engines, a new APU for increased self-sufficiency, upgraded avionics, improved passenger comfort, and enhanced anticorrosion protection.
Contractor: Grumman Aircraft Systems Division.
Power Plant: two Allison T56-A-425 turboprops; each 4,910 ehp.
Accommodation: crew of pilot, copilot, and loadmaster; payload, see text.
Dimensions: span 80 ft 7 in, length 56 ft 10 in, height 15 ft 10½ in.
Weights: empty 36,346 lb, max gross 57,500 lb.
Performance: max cruising speed 299 mph, range with 10,000 lb cargo over 1,200 miles.
Armament: none.

C-9B Skytrain II

Forty-one military DC-9s were built for the US Air Force (21 C-9A Nightingales and three VC-9Cs) and US Navy (17 C-9Bs), the Navy aircraft being convertible passenger/cargo transports based on the commercial Series 32CF. They entered service in 1973. The cabin can seat up to 107 passengers or accommodate eight standard military pallets loaded via an 11 ft 4 in × 6 ft 9 in cargo door at the front on the port side. A typical combi load comprises three pallets and 45 passengers. Fifteen

C-9Bs remain in service, augmented by 14 more recently acquired DC-9 Series 30 standard transports. Some still serve with the Marine Corps, the remainder being distributed among 11 Naval Reserve units. *(Data for C-9B.)*

Contractor: Douglas Aircraft Company Division of McDonnell Douglas Corporation.

Power Plant: four Pratt & Whitney JT8D-9 turbofans; each 14,500 lb st.

Accommodation: flight crew of three, plus two cabin attendants. See text for other details.

Dimensions: span 93 ft 5 in, length 119 ft 3½ in, height 27 ft 6 in.

Weights: empty (passenger) 65,283 lb, (cargo) 59,706 lb, gross 110,000 lb.

Performance: max cruising speed 576 mph, military field length 7,410 ft, range with 10,000 lb payload 2,923 miles.

C-20D Gulfstream

Like the Army, the US Navy has a pair of Gulfstream III twin-turbofan executive jets for use as VIP transports. Designation of the Navy aircraft is C-20D. *(Data as for Army C-20E.)*

C-130F and LC-130F/R Hercules

The **C-130F** was the original version of the C-130 to be purchased by the Navy, as the GV-1U, in 1961. Seven remain in service: four with VR-22 at Rota, Spain, and three with VRC-50, based at Kubi Point, the Philippines. They are equivalent to the C-130B. The generally similar **LC-130F** has retractable skis, coated with Teflon to reduce adhesion to ice. Engines are 4,910 ehp T56-A-15, and attachments are provided for four JATO rockets on each side. The four aircraft have had eventful careers in Antarctica. The current Antarctica transport is the **LC-130R,** based generally on the C-130H, with greater fuel capacity and various other upgrades. The Navy received one as a Lockheed 382C-9D, three Model 382C-26Ds procured via USAF, and two Model 382C-65Ds operated by the Navy for the National Science Foundation. These aircraft have had fantastic histories flying with VXE-6 (previously VX-6) with home base at Christchurch, New Zealand. *(Data generally as for KC-130.)*

C-131F/G/H Samaritan

The Navy's original fleet of Convairliners consisted of 36 Convair 340s, then designated R4Y-1; these became **C-131F** in the 1962 adoption of triservice designations, including a small number in VC-131F VIP configuration. The standard C-131F carried 44 passengers and a crew of three. The **C-131G** corresponded to the Convair 440, and was likewise powered by two 2,500 hp Pratt & Whitney R-2800-52W radial piston engines; as an alternative to passengers, 21 casualty litters or cargo could be carried, and at least one Samaritan became an **EC-131G** ECM trainer. Final Navy version was the **C-131H,** equivalent to the turboprop Convair 580. The few Samaritans still in service form a mixed fleet (with C-9Bs) operated by the USN Reserve Tactical Support Wing. *(Data for civil Convair 580.)*

Contractor: Convair Division of General Dynamics Corporation.

Power Plant: two Allison 501-D13H turboprops; each 3,750 shp.

Accommodation: see text.

Dimensions: span 105 ft 4 in, length 81 ft 6 in, height 29 ft 2 in.

Weights: empty 30,275 lb, gross 54,600 lb.

Performance: cruising speed at 20,000 ft 342 mph, range with 5,000 lb payload (incl reserves) 1,605 miles.

CT-39E/G Sabreliner

Although few, if any, of the Navy's original 42 T-39D Sabreliners are still in service today, two other variants of this small business jet still perform useful duties as tactical support transports. The **CT-39E** (seven ordered, of which six are still in service with VRC-30 at NAS North Island, Calif.) corresponds to the commercial Sabreliner Model 40. A fuselage longer by 3 ft 2 in, with five cabin windows per side (instead of three), characterizes the **CT-39G,** which also features engine thrust reversers. The Navy had 13 of these (12 still in service, with VR-24, VRC-40 and -50, and the Headquarters Flights of USMC and Naval Air Training Command).

Contractor: North American Aircraft Division of Rockwell International Corporation.

Power Plant: two Pratt & Whitney JT12A-8 turbojets; each 3,300 lb st.

Accommodation: crew of two; up to nine (-39E) or ten (-39G) passengers.

Dimensions: span 44 ft 5¼ in, length 43 ft 9 in (-39E), 46 ft 11 in (-39G), height 16 ft 0 in.

Weights: empty 9,895 lb (-39E), 10,486 lb (-39G), gross 18,340 lb (-39E), 19,615 lb (-39G).

Performance: max cruising speed (both) 563 mph, service ceiling (both) 45,000 ft, range (-39E) over 2,100 miles, (-39G) over 2,000 miles.

C-2A Greyhound (Ivo Sturzenegger)

LC-130F Hercules (Paul Jackson)

KA-6D Intruder (Ivo Sturzenegger)

KA-6D Intruder

First flown on May 23, 1966, the KA-6D is the standard inflight-refueling tanker of the Navy carrier air wings, replacing tanker versions of the A-3 Skywarrior. All are conversions, Grumman St Augustine division having rebuilt 78 A-6A and seven A-6E aircraft. The main features are the hose-reel installation in the rear fuselage and the addition of Tacan and other avionic items. The KA-6D was originally left with the capability of flying day bomber missions, but the latest configuration deletes all weapons capability and enables the tanker to carry five 400-gal drop tanks. Approximately 65 remain in front-line service. The KA-6D can transfer more than 21,000 lb of fuel immediately after takeoff, or 15,000 lb at a distance of 288 miles from the carrier. *(Data generally as for A-6E.)*

KC-130F/R/T Hercules

First flown (as the GV-1) in January 1960, the **KC-130F** was bought by the Marine Corps as a multirole tanker/transport. Based on the C-130B, with 4,050 ehp T56-A-7 engines, it was fitted with tanks with a capacity of 3,600 gallons of fuel in the main cargo compartment, and with two quickly installable or removable hose-reel units under the outer wings for refueling two aircraft simultaneously. All Marine Corps tankers can refuel anything from jets to probe-equipped helicopters. The F version, 46 of which were purchased, could transfer 31,000 lb of fuel at a distance of 1,000 miles from its base. In 1975 squadron VMGR-352, which had by that date transferred nearly 5,000,000 gallons of fuel (mainly on transpacific deployments), was picked to introduce the extended-range **KC-130R,** based on the C-130H. This has more powerful engines (see data) and pylon-mounted external tanks. A total of 14 were supplied. The latest tanker version, the **KC-130T,** is similar to the R but has upgraded avionics including INS, Omega, and Tacan, a solid-state APS-133 color radar, flush antennas, and orthopedically designed crew seats. VMGR-234 received 14 and VMGR-452 four. *(Data for KC-130T.)*

Fourth prototype V-22 Osprey

Contractor: LASC Georgia division of Lockheed Corporation.

Power Plant: four Allison T56-A-423 turboprops; each 4,910 ehp.

Accommodation: normal crew of four to seven.

Dimensions: span 132 ft 7 in, length 97 ft 9 in, height 38 ft 3 in.

Weights: empty about 77,500 lb, max gross 175,000 lb.

Performance: max cruising speed 374 mph, max fuel offload 70,000 lb (10,769 gal) or 46,000 lb (7,077 gal) at a distance from takeoff of 1,150 miles.

Armament: none.

KS/US-3A Viking

In 1982 three S-3As were converted as **US-3A** COD (carrier on-board delivery) transports, and another to **KS-3A** tanker configuration with extra fuel tanks in the cabin and bomb bay. However, after flight-testing, the KS-3A was also converted, in the following year, to a US-3A. These aircraft remain in service, but no further examples have been completed. *(Data generally as for S-3A.)*

MV/SV-22A Osprey

Although no FY 1991 funding was provided for Bell/Boeing's multirole V-22 tilt-rotor, the fully funded FSED (full-scale engineering development) phase provides for six flying prototypes. Four of these had flown by early this year, the first of them doing so on March 19, 1989. If ongoing lobbying succeeds in restoring a future for the Osprey program, the Marine Corps's **MV-22A** variant will resume its place as the most urgently sought version, the requirement for 552 being a key element of the USMC's stated objective of achieving an all-STOVL (short takeoff/vertical landing) force by year 2000. The MV-22A is required to be able to carry 24 combat-equipped troops, on crash-resistant foldaway seats, over a combat radius of 495 miles after vertical takeoff, or to provide VTOL with 8,300 lb of internal tiedown cargo over a 250 mile radius. Optimized for amphibious assault and support missions, it has a hydraulic ramp/door in the upswept rear fuselage and one or two external cargo hooks for a single load of 10,000 lb or combined load of 15,000 lb. With nacelles horizontal and propeller blades folded, the entire wing pivots to a fore-and-aft position for shipboard stowage. The **SV-22A** is a proposed USN antisubmarine version, equipped with AN/APS-137 detection radar. *(Data for MV-22A.)*

Contractors: Bell Helicopter Textron Inc; Boeing Helicopters.

Power Plant: two Allison T406-AD-400 turboshafts; each 6,150 shp.

Accommodation: flight crew of three; see text for main cabin capacity.

Dimensions: span (excluding nacelles) 46 ft 0 in, fuselage length 57 ft 4 in, height (nacelles vertical) 20 ft 10 in.

Weights: empty 31,886 lb, normal gross 47,500 lb for vertical takeoff, 55,000 lb for forward (short) takeoff.

Performance: max cruising speed (airplane mode) at optimum altitude 345 mph, service ceiling 26,000 ft, max unrefueled self-deployment range 2,418 miles.

U-3A/B

About half a dozen of these five-seat business twins are still in service 30 or more years since acquisition, for general communications work. The **U-3A** corresponded to the original Cessna 310 of the late 1950s, with upright vertical tail, whereas the **U-3B** was similar to the swept-fin Cessna 310D of 1960, with a slightly longer nose and additional cabin windows. *(Data for U-3A.)*

Contractor: Cessna Aircraft Company.

Power Plant: two Continental IO-470-B piston engines; each 240 hp.

Accommodation: five people, including pilot(s).

Dimensions: span 36 ft 11 in, length 29 ft 6 in, height 9 ft 11 in.

Weights: empty 3,125 lb, gross 4,990 lb.

Performance: max cruising speed at 6,500 ft 237 mph, service ceiling 19,900 ft, range 777 miles.

U-11A Aztec

The 20 Piper PA-23-250 Aztec Bs bought by the US Navy in February 1960 (at that time designated UO-1) were basically off-the-shelf civil examples, differing only in having propeller anti-icing, an oxygen system, and additional radio. Used mainly for communications and liaison duties, about seven remain in service.

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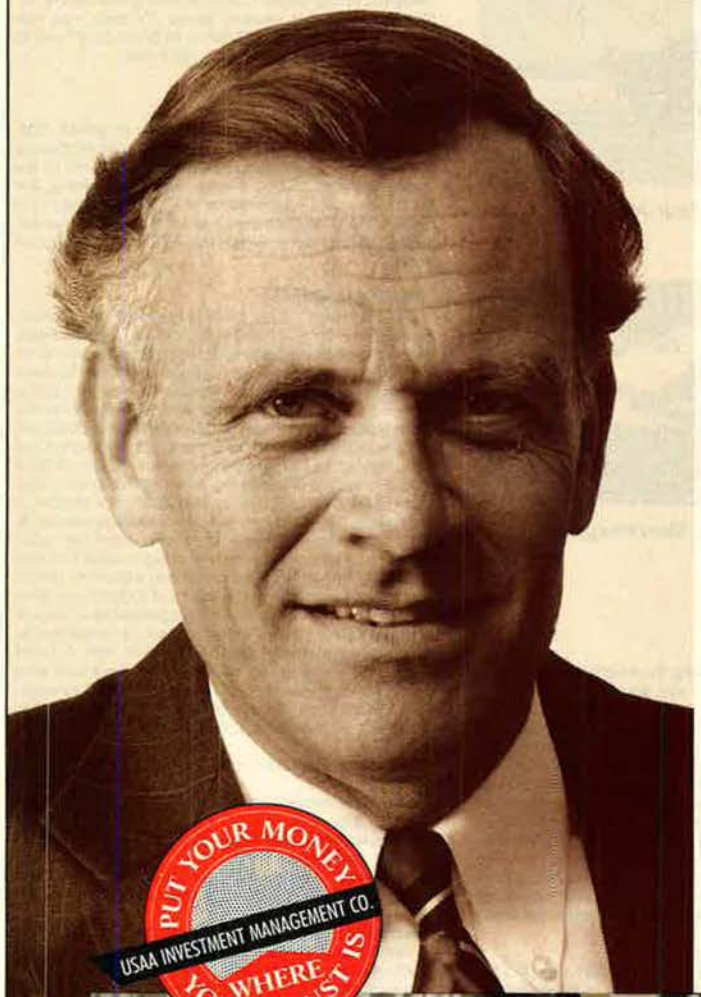

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Contractor: Piper Aircraft Corporation.
Power Plant: two Textron Lycoming O-540-A1A piston engines; each 250 hp.
Accommodation: six people, including pilot(s).
Dimensions: span 37 ft 1¾ in, length 30 ft 2⅝ in, height 10 ft 3 in.
Weights: empty 2,900 lb, gross 4,800 lb.
Performance: max cruising speed at 7,000 ft 205 mph, service ceiling 22,500 ft, range 1,200 miles.

UC-12B/F

Military variants of the T-tailed Beechcraft Super King Air are deployed worldwide by all three US military services, whose total orders now exceed 300 of these twin-turboprop general-purpose transports. Major operator is the US Army, in several C-12 and RC-12 models (which see), with USAF and USN receiving 76 and 78, respectively. Navy Department procurement began with 66 **UC-12B**s (49 for the USN and 17 for the Marine Corps), deliveries of which were completed by the spring of 1982. Now serving principally at Reserve bases, the UC-12B has PT6A-41 engines, a 4 ft 4 in square cargo door aft of the wing (port side), and high-flotation landing gear; it is otherwise similar to the civil Model A200C Super King Air. The later **UC-12F** (12 delivered from 1986) corresponds to the civil Model B200C, with PT6A-42s of the same power rating and hydraulic (instead of electric) gear actuation. *(Data for UC-12F.)*
Contractor: Beech Aircraft Corporation.
Power Plant: two Pratt & Whitney Canada PT6A-42 turboprops; each 850 shp.
Accommodation: crew of two plus up to eight passengers or equivalent cargo.
Dimensions: span 54 ft 6 in, length 43 ft 9 in, height 15 ft 0 in.
Weights: empty 8,060 lb, gross 12,500 lb.
Performance: max cruising speed at 25,000 ft 333 mph, service ceiling over 35,000 ft, range at 27,000 ft at econ cruising speed of 325 mph 2,142 miles.

UP/VP-3A Orion

About five **VP-3A**s, converted from former WP-3A weather reconnaissance variants of the Orion, remain in service as Navy VIP transports. The more numerous **UP-3A**s, some 38 of which were produced for more mundane transport duties, were converted by the Navy from retired P-3As by removing the ASW systems and installing seats in the cabin. Many of these, however, are now in storage.

VA-3B Skywarrior

Six Skywarriors were converted into Navy staff transports, one from an EA-3B and five from TA-3B crew trainers. The latter, designed originally to accommodate six bombardier/navigator students as well as a two-man flight crew, can be identified by their three windows in each side of the fuselage. *(Data generally as for EA-3B.)*

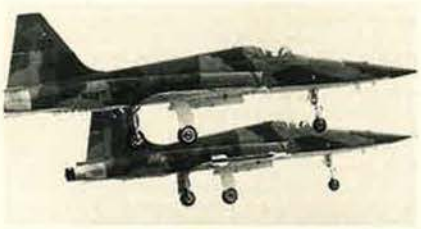
Trainers

F-5E/F Tiger II

Utterly unlike anything else in the Navy, the agile **F-5E** lightweight fighter and its tandem dual-control partner, the **F-5F**, were acquired to supplement A-4 and TA-4 aircraft in the Aggressor role at Top Gun establishments, notably NAS Miramar, Calif. A total of 18 Es and six Fs were supplied. They were painted in a variety of Warsaw Pact and Middle East camouflage schemes, and some are actually assigned to the Marines. They have proved excellent in their assigned role and from the start were popular with pilots and line crews. With the delivery of the F-16Ns they have been retired from the Top Gun schools but are still active, mainly at the growing establishment at NAS Fallon, Nev.
Contractor: Northrop Corporation.
Power Plant: two General Electric J85-GE-21B turbojets; each 5,000 lb st with afterburning.
Accommodation: (E) pilot only, (F) instructor and pupil.
Dimensions: span 26 ft 8 in, length (E) 47 ft 5 in, (F) 51 ft 4 in, height (E) 13 ft 4 in, (F) 13 ft 2 in.
Weights: empty (E) 9,723 lb, (F) 10,576 lb, max gross (E) 24,722 lb, (F) 25,152 lb.
Performance: max speed at 36,000 ft (E) Mach 1.64 (about 1,085 mph), service ceiling 51,800 ft, combat radius (E with two Sidewinders only, max fuel, 5 min in afterburner) 656 miles.
Armament: two AIM-9 Sidewinder missiles (not normally carried in Aggressor missions) and two M39A2 20 mm guns (F, one gun).

F/TF-16N Fighting Falcon

Probably the most agile fighters in the Western world, these versions of the F-16 were selected in 1985 as the Navy's SAA (supersonic adversary aircraft). In 1987–88 a total of 26 were supplied, 22 being based on the Block 30 F-16C and the other four being two-seat dual-control



F-5E Tiger IIs

T-2C Buckeye (Paul Jackson)

T-45A Goshawk

trainers based on the F-16D. Noted for its ability to hold 9g in a sustained turn, the Navy F-16 is even more agile than other versions because it is lighter (for example, the gun and wing pylons are removed, and the radar is the APG-66, slightly lighter than the APG-68) and at the same time has the most powerful engine (see data). The only stores normally carried are wingtip launch rails for practice AIM-9 missiles, the air combat maneuvering instrumentation pod, and external tanks. To meet the increased frequency of violent maneuvers and the rapidity with which fatigue damage could otherwise accrue, these aircraft have titanium substituted for aluminum in lower wing fittings and the lower wing skin holes cold-worked during manufacture.

The Navy Falcons are painted in normal low-visibility grey, not in "adversary camouflage." They serve with the fighter weapons school (eight) and VF-126 (six) at NAS Miramar, Calif., and VF-45 (12) at NAS Key West, Fla.
Contractor: General Dynamics Corporation.
Power Plant: one General Electric F110-GE-100 turbofan; 27,600 lb st with afterburning.
Accommodation: (F) pilot only, (TF) instructor and pupil.
Dimensions: span over missiles 32 ft 10 in, length (both) 49 ft 4 in, height 16 ft 8½ in.
Weights: empty (F) 18,815 lb, max gross (F, no tanks) 25,071 lb.
Performance: max speed over Mach 2 (1,320 mph), service ceiling over 55,000 ft, combat radius (typical) over 575 miles.
Armament: normally confined to two AIM-9 training Sidewinder AAMs.

T-2B/C Buckeye

As the T2J, this was the first aircraft specifically designed from the start as a jet trainer for the Navy. The original J34-powered version had a single engine, but the **T-2B** switched to twin Pratt & Whitney J60 engines of 3,000 lb thrust each, giving greatly enhanced performance and twin-engine safety. Features include tandem seating with the instructor raised well above the level of the pupil in order to give a good forward view, zero/zero ejection seats, full carrier equipment for catapult launch and arrested landing, and the ability to carry a wide range of external stores on underwing pylons, including target-towing gear. When a gun pod is carried, the instructor can check the pupil's aim by means of a closed-circuit TV monitor looking through the sight. The tip tanks, which hold only about one-seventh of the fuel, are permanently installed. North American (now Rockwell) delivered 97 T-2Bs, many of which are still in use, followed by 231 **T-2C**s with the J85 engine. Funding ceased in FY 1974, and no replacement will be available until the delayed T-45A enters service. *(Data apply to T-2C.)*
Contractor: North American Aircraft Division of Rockwell International Corporation.
Power Plant: two General Electric J85-GE-4 turbojets; each 2,950 lb st.
Accommodation: pupil and instructor.
Dimensions: span 38 ft 2 in, length 38 ft 8 in, height 14 ft 9½ in.
Weights: empty 8,115 lb, max gross 13,180 lb.
Performance: max speed at 25,000 ft 521 mph, service ceiling 44,400 ft, range 910 miles.
Armament: provision for a wide range of practice bombs, rocket launchers, or gun pods.

T-34B/C Mentor

The original piston-engined Mentor tandem-seat trainer was flown in December 1948. The later **T-34B** became the standard primary pilot trainer of the Navy, 423 being acquired, of which a dozen or so are still retained for student pregrading. By the 1970s the Navy was seeking ways of procuring an upgraded primary trainer with turboprop propulsion, and it initiated a program to see if the T-34 could be improved to meet the requirement. The first of two prototype **YT-34C**s was flown on September 21, 1973. The airframe was strengthened to permit operation at higher weights and higher indicated airspeeds, while the selected engine was provided with a torque limiter to restrict power to only 56 percent of the maximum, giving constant output at all airfield elevations and temperatures and very long engine life. The design fatigue-free life of the structure is 16,000 hours. Between 1977 and 1984 Navy procurement of **T-34C** Turbo-Mentors amounted to 334, not including the prototypes, augmented during the past year by a further 19 as attrition replacements. Student training began in January 1978; since then Navy T-34Cs have flown over a million hours, and the type is likely to remain in intensive use until year 2000. *(Data for T-34C.)*
Contractor: Beech Aircraft Corporation.
Power Plant: one Pratt & Whitney Canada PT6A-25 turboprop; 715 shp, torque limited to 400 shp.
Accommodation: instructor and pupil in tandem.
Dimensions: span 33 ft 4 in, length 28 ft 8½ in, height 9 ft 7 in.
Weights: empty 2,960 lb, max gross 4,300 lb.
Performance: max cruising speed 246 mph, service ceiling over 30,000 ft (but unpressurized), max range at 20,000 ft 814 miles.
Armament: none (except in export versions).

T-38A Talon

Although produced predominantly for USAF (more than 1,000 of the 1,189 built), the T-38A was also acquired by the US Navy, which received 18 of these tandem-seat supersonic trainers over a period of several years. Bearing the Northrop model number N-156T, the T-38A (first flight April 1959) was essentially a simplified, two-seat version of the company's N-156F "Freedom Fighter" design (later to become the F-5), having lower-powered engines and no armament. More than half of the Navy's T-38As were eventually converted to DT-38A drone director configuration, but a few are still used by the "Aggressor" squadrons for training.
Contractor: Northrop Corporation.
Power Plant: two General Electric J85-GE-5A turbojets; each 3,850 lb st with afterburning.
Accommodation: instructor and pupil in tandem.
Dimensions: span 25 ft 3 in, length 46 ft 4½ in, height 12 ft 10 in.
Weights: empty 7,410 lb, gross 11,761 lb.
Performance: max speed at 36,000 ft 805 mph, service ceiling 45,000 ft, normal range 860 miles.

T-44A King Air

The Beech King Air was selected in 1976 to fill the Navy's VTAM(X) requirement for a twin-turboprop instrument trainer for pilots of multiengined aircraft. Combining features of the civil C90 and E90 King Airs, its standard commercial avionics were augmented by Tacan, UHF radio, and UHF/DF equipment. Procurement totaled 61, all being delivered by mid-1980 to replace TS-2A Trackers with squadrons VT-21 and VT-28. Student training began in July 1977, and some 56 T-44As are still in service with Naval Air Training Command.
Contractor: Beech Aircraft Corporation.
Power Plant: two Pratt & Whitney Canada PT6A-34B turboprops; each flat rated to 550 ehp.
Accommodation: one instructor, two students, and two observers.
Dimensions: span 50 ft 3 in, length 35 ft 6 in, height 14 ft 3 in.
Weights: empty approx 5,800 lb, gross 9,650 lb.
Performance: cruising speed at 15,000 ft 276 mph, service ceiling 29,500 ft, max range 1,456 miles.

T-45A Goshawk

Destined to become the US Navy's standard "undergraduate" jet pilot trainer of the 1990s, generally replacing both the T-2C Buckeye and TA-4J Skyhawk, the T-45A

aircraft is part of an overall package called T45TS (T-45 Training System) that also includes flight simulators, computer-assisted training aids, training manuals and integration, and full contractor-operated logistics support during its service life. Original plans for 54 land-based T-45As and 253 carrier-capable T-45Bs were dropped in FY 1984 in favor of an "all-wet" fleet of 300 Goshawks, this variant therefore assuming the T-45A designation. Derived from the British Aerospace Hawk, the T-45A has new landing gear, a deck hook and catapult launch bar, twin airbrakes, strengthened airframe, and customer-specified avionics and cockpit displays, to meet USN requirements. Because these changes increase weight, it also has a more powerful Adour engine than other BAe Hawks, which presumably will reduce the original estimate of 48 million gallons of fuel saved per year once the T-45A is in full service. The aircraft is also to be fitted with full-span leading-edge slats, for use in the landing regime only, to improve slow-speed handling and stability. The first 12 Goshawks should enter service at NAS Kingsville, Tex., in late 1990 or early 1991. Subsequently, the Naval Air Stations at Chase Field, Tex., and Merician, Miss., are slated to operate the T-45 system.

Contractors: McDonnell Douglas Corporation; British Aerospace plc.

Power Plant: one Rolls-Royce Turbomeca F405-RR-401 (naval zed Adour Mk 871) nonafterburning turbofan; 5,840 lb st.

Accommodation: instructor and pupil in tandem.

Dimensions: span 30 ft 9¾ in, length 39 ft 3⅛ in, height 13 ft 5 in.

Weights: empty 9,399 lb, gross 12,758 lb.

Performance: max speed at 8,000 ft 620 mph, service ceiling 42,250 ft, ferry range (internal fuel) 1,150 miles.

Armament: two underwing pylons for practice bombs, rocket pods, or drop tanks.

T-47A Citation

Initially on a five-year basis, with the option to extend to eight years, the US Navy acquired 15 modified Cessna Citation S/IIs in 1985 to replace the T-39 Sabreliners hitherto used as trainers in the use of air-to-air, air-to-surface, intercept, and other radar equipment. They differ from the standard S/II business jet in having shorter-span wings, a more bulbous nose housing an Emerson AN/APQ-159 radar, and JT15D-5 (instead of Dash 4B) engines. The first T-47A flew on February 15, 1984, and by the end of its first two years of service the type was achieving a mission completion rate of better than 95 percent.

Contractor: Cessna Aircraft Company.

Power Plant: two Pratt & Whitney Canada JT15D-5 turbofans; each 2,900 lb st.

Accommodation: civilian pilot, Navy instructor, and three students.

Dimensions: span 46 ft 6 in, length 47 ft 10¾ in, height 14 ft 9¾ in.

Weights: empty 9,035 lb, gross 15,000 lb.

Performance: max speed at 40,000 ft approx 485 mph, service ceiling 43,000 ft, range approx 2,000 miles.

TA-4F/J Skyhawk

Only about two dozen examples of the **TA-4F** are still in service, of the 240 originally procured in the second half of the 1960s. These dual-control, combat-capable operational trainers—the first production tandem-seat Skyhawks—were based on the A-4F, but with a fuselage longer by 2 ft 4 in to accommodate the second cockpit, reduced fuel load, Escapac crew seats, and some avionics deleted. Still very much in service, however, is the **TA-4J**, of which nearly 300 (from the original 293, augmented by large numbers of others converted from TA-4F) remain with the Navy and Marines as standard advanced trainers and will do so until replaced during this decade by the T-45A Goshawk. Essentially a simplified TA-4F, minus the nav/attack weapon delivery system, in-flight refueling, and a few lesser installations (although provisions for these are retained), the TA-4J flew for the first time in May 1969, deliveries beginning later that year to VT-21 and VT-22 at NAS Kingsville, Tex.

Contractor: Douglas Aircraft Company Division of McDonnell Douglas Corporation.

Power Plant (both): one Pratt & Whitney J52-P-6 turbojet; 8,500 lb st.

Accommodation (both): instructor and pupil in tandem.

Dimensions (both): span 27 ft 6 in, length (excluding probe) 42 ft 7¼ in, height 15 ft 3 in.

Weights (TA-4F): empty 10,602 lb, gross (shipboard) 24,500 lb, (land) 27,420 lb.

Performance (TA-4F): max speed 675 mph, service ceiling approx 49,000 ft, typical range (clean) 920 miles.

Armament (TA-4J): one 20 mm cannon in wingroot.

TA-7C Corsair II

Faced with the obvious prospect of substantial numbers of A-7A and A-7B Corsair IIs withdrawn from Navy service upon replacement by the A-7E, Vought investigated the prospects for rebuilding some for other purposes. The company itself rebuilt one aircraft, an A-7E, as the V-519, later designated the YA-7H, a tandem-seat operational trainer. The Navy decided to have 81 aircraft thus rebuilt (40 A-7As and 41 A-7Bs), but actually converted only 60, and they were originally 24 A-7Bs and 36 A-7Cs. The rebuild involved splicing a 16-in plug into the forward fuselage to provide for the additional cockpit, the two cockpits being stepped to give both crew members a good view ahead. An 18 in plug was added to the fuselage in line with the trailing edge, and the upper line of the high rear cockpit was carried back in a large fairing across the wing. The original seats were Escapacs, fitted with strong breakers to punch through the canopies, which, unlike the single-seater, hinge open to the right. Full armament and operational equipment was retained, and a braking parachute was added above the jetpipe. The first TA-7C flew on December 8, 1976. Deliveries took place starting in 1978 to VA-122 and VA-174, the East and West Coast Fleet Replenishment Squadrons.

On January 22, 1985, redelivery began of 49 aircraft upgraded with the TF41 engine (replacing the TF30), Stencel seats, automatic maneuvering flaps, and an engine monitoring system. These had all been redelivered by August 1987, and it was then intended that a proportion should be fitted with a FLIR pod hung under the starboard wing as in some A-7Es. Six other TA-7Cs were converted into EA-7Ls (which see).

Contractor: LTV Corporation, Aircraft Products Group.

Power Plant: one Allison TF41-A-2 nonafterburning turbofan; 15,000 lb st.

Accommodation: crew of two, normally instructor and pupil.

Dimensions: span 38 ft 9 in, length 49 ft 0 in, height 16 ft 1 in.

Weights: empty about 19,420 lb; max gross 42,000 lb.

Performance and armament: generally similar to A-7E.

TC-4C Academe

Ordered at the end of 1966, when the design still belonged to Grumman, the Academe is a special variant of the twin-turboprop G159 Gulfstream I adapted for service as a bombardier/navigator trainer for crews of the A-6 Intruder. Main external difference from the standard business jet is an extended nose, with a radome containing the same radar as the A-6. Navy units have included VA-42 (Oceana, Va.) and VA-128 (Whidbey Island, Wash.); Marine units were VMAT(AW)-202 and -212. Nine TC-4Cs were acquired, of which eight are still in service: six with the USN and two with the Marines.

Contractor: Gulfstream Aerospace Corporation (originally Grumman Aircraft Corporation).

Power Plant: two Rolls-Royce Dart Mk 529-8X turboprops; each 2,185 ehp.

Accommodation: flight crew of two; up to six students and an instructor.

Dimensions: span 78 ft 6 in, length 67 ft 11 in, height 22 ft 9 in.

Weights: empty 21,900 lb, gross 36,000 lb.

Performance: max cruising speed at 25,000 ft 348 mph, service ceiling 33,600 ft, max range (with reserves) 2,540 miles.

Armament: none.

AH-1W SuperCobra (Ivo Sturzenegger)

CH-46E Sea Knight (Ivo Sturzenegger)

Helicopters

AH-1J/T SeaCobra and AH-1W SuperCobra

Twin-engine versions of the Cobra are in service with the Marine Corps's light attack helicopter squadrons, which have mixed complements of Bell UH-1N Hueys and one of three varieties of Cobra. First of these, the **AH-1J**, continues to serve the USMC Reserve at Atlanta, Ga. (HMA-773), and Camp Pendleton, Calif. (HMA-775), having staged its first combat mission in Vietnam on February 22, 1971. Production totaled 67 for the US, all armed with a three-barreled General Electric M197 20 mm cannon and with wing pylon attachments for four LAU-61 or -68 rocket pods, SUU-11A Minigun pods, or similar ordnance up to 2,200 lb maximum.

In the **AH-1T** improved SeaCobra (62 built), dynamic components from the Bell 214 helicopter and a change to a higher-rated version of Pratt & Whitney Canada T400 Twin-Pac turboshaft bestow significant performance advantages in agility and a more than doubled payload. Most were retrofitted to carry the TOW antiarmor missile system. Stretched by 3 ft 7 in to carry additional fuel, the AH-1T serves with HML/A-269 at New River, N. C., and HMT-303 at Camp Pendleton, but the 39 remaining helicopters are being converted to AH-1W standard, deliveries having begun January 26, 1989, and reached 17 by February 1990.

With yet further power, provided by General Electric T700s, the **AH-1W** SuperCobra is the current production model, having expanded weapons capability including Hellfire and Sidearm missiles. Deliveries of 78 began on March 27, 1986, and are due to be completed in June 1991. Already equipped are HML/A-169, -267, -367, and -369 at Camp Pendleton and HML/A-167 at New River, providing detachments of between four and six Cobras to LPH and newer LHA assault vessels for antiarmor, troop-carrier escort, armed reconnaissance, multiple weapon fire-support, and target acquisition missions. Night capability for the helicopter's M65 TOW sight, consisting of FLIR and a laser-ranger, is being developed jointly by the USMC and Israel, based on Tamam equipment. Retrofit is in prospect of a Doppler navigation system and an enhanced electronic warfare system, but Bell is also offering a four-blade modification, based on its Model 680 bearingless main rotor project. The prototype AH-1 (called four-blade Whiskey, or 4BW), which will be demonstrated to the USMC this year, offers a 2,050 lb increase in gross weight, 23 mph of extra speed, a digital flight-control system, and night targeting sights. *(Data for AH-1W.)*

Contractor: Bell Helicopter Textron.

Power Plant: two General Electric T700-GE-401 turboshafts; each 1,690 shp.

Accommodation: pilot and gunner.

Dimensions: rotor diameter 48 ft 0 in, fuselage length 45 ft 6 in, height 14 ft 2 in.

Weights: empty 10,200 lb, gross 14,750 lb.

Performance: max speed 175 mph, service ceiling over 14,000 ft, max range 395 miles.

Armament: turreted M197 20 mm cannon; up to eight TOW/Hellfire ATMs, two Sidewinder AAMs, or two Sidearm ARMs; or four rocket/gun pods.

CH-46D/E Sea Knight

Standard utility transport helicopter of the Marine Corps, the Sea Knight may take on a further lease of life following the V-22 Osprey's apparent demise. A few HH-46A base rescue/SAR conversions remain from the early production CH/UH-46A, as do CH/UH/HH-46Ds with uprated, -10 versions of the GE T58 turboshaft. Final production was of the CH-46F, with improved avionics and other equipment, manufacture ending in 1971 with the 624th CH-46. Of these, 273 D and F models were updated at MCAS Cherry Point, N. C., from 1977 as **CH-46Es**, with T58-GE-16 turboshafts delivering one-third more power, crash-resistant crew seats and fuel system, and improved rescue equipment. New glassfibre rotors have also been added to the CH-46E fleet.

To keep the remaining **HH-46As**, unmodified **CH-46Ds**, and the CH-46E in operation beyond the turn of the century, contracts were awarded to Boeing during the 1980s for SR&M (safety, reliability, and maintainability) modifications. These included revision of the hydraulic control system, flight controls, electrics, rotor drive, airframe, and landing gear in 357 helicopters. All have been updated at Cherry Point with Boeing-supplied kits of parts, the first redelivery taking place in July 1985. Beginning in 1990, the HEFS (Helicopter Emergency Flotation System) will be installed in all CH-46s, while 171 CH-46Es are to receive modifications to increase fuel capacity, and others are to gain Doppler navigation systems. Relaunched production of a "CH-46X" with updated avionics is one proposed alternative to the Osprey.

Fifteen Marine medium helicopter squadrons operate CH-46Es from Kaneohe Bay, Hawaii, New River, N. C., Tustin, Calif., and Futenma, Japan, and two more of the Reserve fly from Tustin and Norfolk, Va. Deployments are made regularly on LPH and LHA vessels. HMT-204 and

-301 are training squadrons, while smaller-scale Navy use includes HC-6 and -8 at Norfolk, Va., and HC-5 at Agana, Guam. *(Data for CH-46E.)*

Contractor: Boeing Helicopters.

Power Plant: two General Electric T58-GE-16 turboshafts; each 1,870 shp.

Accommodation: flight crew of two and 17 troops, 15 litters, or 10,000 lb of cargo.

Dimensions: rotor diameter (each) 51 ft 0 in, fuselage length 44 ft 10 in, height 16 ft 8½ in.

Weights: empty 13,112 lb, gross 23,000 lb.

Performance: max speed 165 mph, service ceiling 14,000 ft, max range (4,500 lb payload) 238 miles.

CH-53A/D Sea Stallion

Delivered to the Marine Corps from September 1966, early **CH-53A** Sea Stallions proved their worth soon after in Vietnam, operating in the heavy assault role during all weathers. The helicopter employs the dynamic components of the Army's CH-54 Tarhe, married to a watertight hull (for emergency sea landings) fitted with clamshell rear doors. Maneuvering of heavy cargo is assisted by hydraulic winches and a floor roller track, typical loads including pallets, vehicles, and a 105 mm howitzer and carriage. For stowage aboard LPH (and now LHA) assault carriers, the CH-53 has a folding tail and main rotors. Power plants are two General Electric T64-GE-6 or -12 turboshafts delivering up to 3,435 shp. From 1969, the 139 CH-53As were followed by 126 **CH-53D**s with an enlarged cabin for 55 instead of 38 troops and uprated T64-GE-412/413 engines. Deliveries of the CH-53D ended in January 1972, the A and D variants remaining in service with heavy helicopter squadrons HMH-361 and -462 at Tustin, Calif.; HMH-362 and -461 at New River, N. C.; HMH-363 at Futenma, Japan; and HMH-463 at Kaneohe Bay, Hawaii, plus Reserve HMH-772 at Willow Grove, Pa., and detachments. HMT-301 and -302 provide training at Tustin. *(Data for CH-53D.)*

Contractor: Sikorsky Aircraft Division of United Technologies Corporation.

Power Plant: two General Electric T64-GE-412/413 turboshafts; each 3,695/3,925 shp.

Accommodation: three flight crew and up to 55 equipped troops or 24 litters.

Dimensions: rotor diameter 72 ft 3 in, fuselage length 67 ft 2¼ in, height 24 ft 10½ in.

Weights: empty 23,000 lb, gross 42,000 lb.

Performance: max speed 196 mph, service ceiling 18,000 ft, max range (with reserves) 250 miles.

CH-53E Super Stallion

The free world's largest and most powerful helicopter is a three-engined Stallion variant with a longer fuselage, revised transmission, and doubled lifting capacity. As a result, its principal Marine Corps role is cargo transport (rather than troop airlift) and recovery of downed aircraft. The Navy employs the helicopter for vertical replenishment of ships at sea and airlifting unserviceable aircraft incapable of leaving carriers under their own power. Maximum payload is 36,000 lb underslung. Orders currently total 124 of the 191 required, of which 120 (including 15 USN) had been delivered by early 1990.

Several upgrades are in prospect, including the HNVS (Helicopter Night Vision System) for low-level night/adverse weather operations. This comprises a Martin Marietta pilot's NVS, Honeywell integrated helmet and display sighting system, and Northrop-developed equipment from the Bell AH-1S surrogate trainer system. Also planned are Omega navigation, composite tail rotor blades, ground proximity warning, improved cargo handling equipment, missile warning, chaff/flare dispensers, and an inerting (nitrogen-based) fuel system. Sidewinder AAMs may be fitted for self-defense. Operational use of the CH-53E began in 1983 with HC-4 at Sigonella, Sicily. Other operators include HC-1 at North Island, Calif., HC-2 at Norfolk, Va., and VC-5 at Kubi Point, the Philippines; and Marines' HMH-464, -465, -466, plus HMT-301 and -302 for training. Eventually, six USMC squadrons will have CH-53Es.

Contractor: Sikorsky Aircraft Division of United Technologies Corporation.

Power Plant: three General Electric T64-GE-416 turboshafts; each 4,380 shp.

Accommodation: flight crew of three, up to 55 equipped troops or 24 litters, or 32,000 lb of cargo.

Dimensions: rotor diameter 79 ft 0 in, fuselage length 73 ft 4 in, height 29 ft 5 in.

Weights: empty 33,228 lb, gross 73,500 lb.

Performance: max speed 196 mph, service ceiling 18,500 ft, max ferry range 1,290 miles.

HH-3A and VH-3A/D Sea King

The **HH-3A** combat rescue version of Sea King concerned 12 helicopters converted for use in Vietnam with -8F versions of the T58 power plant, 7.62 mm machine-gun barbettes in the rear of each sponson, crew armor, and provision for long-range tanks. The last operator, disbanded this summer, was Naval Reserve squadron HC-9 at North Island, Calif.

CH-53D Sea Stallion (Ivo Sturzenegger)

CH-53E Super Stallion

Two VIP transport Sea King variants are in use, with appropriate color schemes and interior fittings. Principal operator is Marine Corps squadron HMX-1 at Quantico, Va., to which 11 **VH-3D**s were delivered for its Executive Flight Detachment. Survivors of the unit's previous eight **VH-3A**s operate with HC-6 at Norfolk, Va.

RH-53D Sea Stallion and MH-53E Sea Dragon

Navy use of the Sea Stallion for MCM (mine countermeasures) missions began when HM-12 was issued with 15 RH-53A conversions of USMC helicopters. Thirty purpose-built **RH-53D**s followed in September 1973, these having provision for aerial refueling and two 0.5 in machine-guns on flexible mountings. T64-GE-415 power plants of 4,380 shp were retrofitted. Current operators are HM-14 and -18 at Norfolk, Va., and Reserves' HM-19 at Alameda, Calif.

The **MH-53E** is an adaptation of the higher-powered CH-53E Super Stallion, which has enlarged sponsons carrying nearly 1,000 gallons of additional fuel; improved hydraulic and electrical systems; and minefield, navigational, and AFC systems, including automatic tow couplers and automatic approach to/depart from hover features. Operational equipment towed by the helicopter comprises mechanical, acoustic, and magnetic hydrofoil sweeping gear weighing up to 26,000 lb. Deliveries totaled 25 (from 32 required) at the start of 1990. HM-12 at Norfolk, Va., assigns helicopters to the Atlantic Fleet and HM-15 at Alameda, Calif., to its Pacific counterpart. *(Data for MH-53E as for CH-53E, except empty weight 36,336 lb.)*

SH-2F Seasprite and SH-2G Super Seasprite

Extensive modifications are keeping the Seasprite operational until we'l into the next century, having begun in 1967 when all utility UH-2A/2Bs were converted to twin-engine (General Electric T58) UH-2Cs or HH-2C/Ds. Twenty became ASW SH-2Ds aboard USN destroyers. Addition of more comprehensive antisubmarine and surveillance equipment to meet the LAMPS I requirement resulted in further reworking of the Seasprite fleet to **SH-2F** standard with stronger landing gear, uprated engines, and an improved rotor system.

Conversions to SH-2F have totaled 104, including 16 of the SH-2Ds, while new production added 54, all of which had been received by the end of 1989. LAMPS I helicopters have accumulated 685,000 hours of operations from *Iowa*-class battleships; *Belknap*- and *Ticonderoga*-class cruisers, plus USS *Truxtun; Kidd*- and *Spruance*-class destroyers; and *Knox*- and *Perry*-class frigates. Operating squadrons are HSL-30, -32, -34, and -36 for the Atlantic Fleet; HSL-31, -33, -35, and -37 for the Pacific; and HSL-74, -84, and -94 of the USN Air Reserve. The last mentioned were assigned the first of 24 SH-2Fs in 1984. Fifteen SH-2Fs operating in the Persian Gulf during the latter stages of the Iran-Iraq war were fitted with additional survival aids including IR jammers, chaff/flare dispensers, and missile-warning equipment. Eight of these also had FLIR beneath the nose.

It is planned to obtain 103 **SH-2G** Super Seasprites, a prototype conversion of which flew on December 28, 1989. Six new-build SH-2Gs are on order, but most or all of the remainder will be conversions from SH-2F. The SH-2G benefits considerably from installation of two T700 turboshafts, providing both fuel economy and additional power, and composite main rotor blades. Avionics improvements include a MIL-STD-1553B databus, a multifunction raster display, AN/ASN-150 tactical navigation display, and a 99-channel sonobuoy receiver. Operational equipment of the basic SH-2G, of which 42 will go to the Reserve, includes Canadian Marconi LN-66HP surveillance radar, Texas Instruments AN/ASQ-81 MAD, an acoustic processor, data link, sonobuoy accommodation, 4,000 lb cargo hook, 600 lb rescue hoist, and provision for two torpedoes. The remaining 61 helicopters, provisionally designated **SH-2G+**, will be augmented by FLIR, IR jammers, missile warning equipment, and secure radio. Dipping sonar is under consideration, but has not been funded. *(Data for SH-2G.)*

Contractor: Kaman Aerospace Corporation.

Power Plant: two General Electric T700-GE-401 turboshafts; each 1,723 shp.

Accommodation: pilot, tactical coordinator, and sensor operator.

Dimensions: rotor diameter 44 ft 4 in, fuselage length 40 ft 0 in, height 15 ft 0½ in.

Weights: empty 7,600 lb, gross 13,500 lb.

Performance: max speed 159 mph, service ceiling 23,900 ft, max range (two external tanks) 500 miles.

Armament: two Mk 46/50 torpedoes or AGM-119B Penguin antiship missiles. Optionally, two pintle-mounted 7.62 mm machine-guns.

SH-3G/H Sea King

Replacement of the Sea King in ASW roles aboard aircraft carriers is now under way, but the helicopter will continue to play a vital role in defense of the fleet for many more years—as evidenced by the recent acquisition of two surplus USAF Sea Kings and their conversion to antisubmarine configuration. The original SH-3A (245 built) has disappeared from the inventory, as have all but a handful of the 72 SH-3Ds with their twin 1,400 shp T58-GE-10 power plants, improved sonar, and extra 140 gallons of fuel capacity, which until recently served with the Naval Air Reserve. Current versions are conversions of A and D airframes.

ASW systems are removed in the **SH-3G** utility version, produced by converting 103 SH-3As and two SH-3Ds for plane-guard and light transport duties aboard attack carriers. The interior holds 15 canvas seats and long-range fuel tanks. Some SH-3Gs were returned to ASW as H versions when the specialized ASW carriers were retired and their assets transferred to all-purpose vessels. Survivors serve with multitype squadrons HC-1, HC-2, VC-5, and VC-8, plus training unit HS-1 at Jacksonville, Fla.

The antisubmarine **SH-3H,** of which 145 were remanufactured (including 12 by Agusta in Italy), was first announced in 1971 with the aim of increasing fleet helicopter capability against submarines and low-flying missiles. It also undertakes the former SH-3G roles of "Pedro" and general-purpose communications. Revised equipment includes AQS-13B lightweight sonar, active and passive sonobuoys, ESM sensors, H-240 chaff dispenser, ASQ-81 towed MAD, and Canadian Marconi LN-66HP surveillance radar in a belly radome. The radar and ESM were later removed as a weight-saving measure, allowing the fit of an improved tactical navigation system and sonar processing equipment without exceeding the 21,000 lb gross weight limitation. Structural and dynamic components have been upgraded in parallel with operational equipment. Atlantic Fleet carriers are served by HS-1, -3, -5, -7, -9, -11, -15, and -17 at Jacksonville, Fla.; and the Pacific Fleet by HS-2, -4, -6, -8, -12, and -14 at North Island, Calif. HS-75 and -85 are Reserve squadrons at Willow Grove, Pa., and Alameda, Calif., recently converted from SH-3Ds. *(Data for SH-3H.)*

Contractor: Sikorsky Aircraft Division of United Technologies Corporation.

Power Plant: two General Electric T58-GE-10 turboshafts; each 1,400 shp.

Accommodation: flight crew of two and two systems operators.

Dimensions: rotor diameter 62 ft 0 in, fuselage length 54 ft 9 in, height 16 ft 10 in.

Weights: empty 12,350 lb, gross 21,000 lb.

Performance: max speed 166 mph, service ceiling 14,700 ft, max range 625 miles.

SH-60B/F and HH-60H Seahawk

Assigned for several years to small and medium-size Navy warships, the Seahawk is now being taken aboard aircraft carriers to replace Sea Kings. Produced to meet the LAMPS III (Light Airborne Multipurpose System 3) requirement, in which commonality with the Army's chosen utility helicopter was a prerequisite, the initial **SH-60B** Seahawk version entered production in 1983 and has been operationally deployed since 1984. Role equipment added to the basic H-60 includes chin-mounted pods for ESM equipment, underfuselage Texas Instruments AN/APS-124 search radar, pylons for two torpedoes or additional fuel tanks, Texas Instruments AN/ASQ-81 towed MAD to starboard, a sensor operator's position in the cabin, a 25-round sonobuoy launcher to

port, an IBM AN/UYS-1 acoustic processor, folding main rotors, a rescue hoist, folding tailboom, modified undercarriage, deck haul-down equipment, and emergency buoyancy features.

The USN has a requirement for 208 SH-60Bs, of which 137 had been received by early 1990. These are due to form 95 ship's flights—replacing Kaman Seasprites (LAMPS I) in some cases—aboard *Perry*-class frigates, *Spruance*-class destroyers, and *Ticonderoga*-class guided missile destroyers. They provide all-weather capability for detection, classification, localization, and interdiction of surface vessels and submarines and are able to communicate with their parent vessel by data link. Secondary missions include SAR, vertical replenishment, medevac, fleet support, and radio relay. Operating squadrons are HSL-40, -42, -44, -46, and -48 at Mayport, Fla., for Atlantic Fleet vessels and HSL-41, -43, -45, -47, and -49 at North Island, Calif., on the Pacific seaboard.

For the closing stages of the Gulf War, 25 SH-60Bs received a special fit of IR jammers, chaff/flare dispensers, missile warning equipment, and a 7.62 mm machine-gun in the cabin doorway. Seven of these were equipped additionally with FLIR. From May 1990, new-build SH-60Bs have provision for NFT Penguin antiship missiles, the Mk 50 advanced lightweight torpedo, an upgraded sonobuoy receiver, GPS, and other avionics improvements. Some earlier helicopters will be retrofitted to provide the Navy with a total of 115 Penguin-capable Seahawks.

In March 1985, Sikorsky was contracted to develop the **SH-60F Ocean Hawk**, or "CV-Helo" version, to replace SH-3H Sea Kings in the provision of antisubmarine protection within the immediate area of a carrier battle group. All LAMPS III sensors, avionics, and sonobuoy launchers are removed, being replaced by Allied Signal AN/AQS-13F dipping sonar and an additional weapon pylon on the port side of the fuselage, to which may be added a third auxiliary fuel tank. Four crew members are carried. Possible later additions include search radar, FLIR, night vision systems, sonobuoy data link, passive ESM, and MAD in conjunction with a gross weight increase to 23,500 lb. Immediate requirements are for 76 SH-60Fs from 175 eventually planned. Deliveries began in 1989 to HS-10 at North Island, Calif., first operational squadron being HS-2 at the same base. First seaborne deployment, in USS *Nimitz*, is due next year.

The **HH-60H** is a strike-rescue/special warfare support helicopter developed from the SH-60F under a September 1986 contract. It has the same -401C version of T700 turboshaft as later production versions of Sea/Ocean Hawk, but sonar and other ASW equipment is replaced by defensive aids including radar warning receivers, IR jammers, and chaff dispensers. Provision is made for pilot's night vision goggles, IR suppressors effective at the hover, and M60D machine-guns, and for operation from *Perry*-, *Spruance*-, and *Ticonderoga*-class vessels. In its strike-rescue role, the HH-60H is able to recover the four-man crew of a shot-down aircraft up to 288 miles from the helicopter's launch point. Supporting special forces, it can airdrop eight SEALS from 3,000 ft at 230 miles' radius. All 18 are assigned to the Reserves, HCS-5 at Point Mugu, Calif., gaining its first on August 5, 1989; HCS-4 at Norfolk, Va., followed in January 1990. *(Data for SH-60B.)*

Contractor: Sikorsky Aircraft Division of United Technologies Corporation.
Power Plant: two General Electric T700-GE-401C turboshafts; each 1,900 shp.
Accommodation: pilot, tactical officer, and sensor operator.
Dimensions: rotor diameter 53 ft 8 in, fuselage length 50 ft 0¾ in, height 17 ft 0 in.
Weights: empty 13,648 lb, gross 20,244 lb.
Performance: max speed 145 mph, service ceiling 19,000 ft, endurance (SH-60F) 4 hours.
Armament: two Mk 46/50 torpedoes or AGM-119B Penguin missiles. (Two pintle-mounted machine-guns in HH-60H.)

TH-57B/C SeaRanger

Based on the commercial Bell 206 JetRanger, the SeaRanger has been standard USN helicopter pilot trainer since 1968. The original batch of 40 TH-57As, now retired, were off-the-shelf Model 206A JetRanger IIs with Allison 250-C18 engines, and were used by HT-8 for primary training only. The later **TH-57B** and -57C are new-production helicopters, related to the Bell 206B JetRanger III, with uprated 250-C20J engines and Navy-specified avionics. The TH-57B, of which 51 were built for the primary stage of instruction, has a basic VFR panel only and lacks a stability augmentation system (SAS). The **TH-57C** (89 built), however, is configured for advanced instrument training, with a SFENA three-axis SAS and full IFR avionics that include VOR, Tacan, ADF, HSI, and CDI. Among other features of the C are a rotor brake, jettisonable doors, and a 150 lb capacity external cargo hook. All 140 TH-57B/Cs are shared by two squadrons within Training Air Wing Five (HT-8 and HT-18) at Whiting Field, Fla., where they are used to instruct more than 600 Navy, Marine Corps, Coast Guard, and foreign pilots per year. *(Data for TH-57C.)*

HH-60H Seahawk

Contractor: Bell Helicopter Textron.
Power Plant: one Allison 250-C20J turboshaft; 420 shp.
Accommodation: instructor (on left) and pupil; three rear seats for student "familiarization rides."
Dimensions: rotor diameter 33 ft 4 in, fuselage length 31 ft 2 in, height 9 ft 6½ in.
Weights: empty 1,852 lb, gross 3,200 lb (3,350 lb with external load).
Performance: max cruising speed 131 mph, max range 527 miles.

UH/VH-1N Iroquois

Much preferred for overwater operations because of its twin-engine reliability, the **UH-1N** is based on the Bell 212 originally sponsored by Canada with a PT6T (T400) Turbo Twin-Pac installation. This is, itself, a UH-1H airframe with 220 cu ft of interior space and the ability to carry 3,383 lb of cargo. Deliveries began to the Navy and Marine Corps in 1971, and 210 were received, including eight **VH-1Ns**—the latter mainly for VXE-1 in VVIP configuration. The majority are in USMC service, notably with light helicopter squadrons HML-767 at New Orleans, La., and HML-771 and -776 at South Weymouth, Mass., plus HMT-303 at Camp Pendleton, Calif., for training. Each of the six AH-1 Cobra squadrons also has a few UH-1Ns assigned, some four of these helicopters regularly deploying aboard LPH and LHA assault carriers for light transport tasks. Others are allocated to carrier flights and base flights, while the USN has two partly equipped squadrons: HC-16 at Norfolk, Va., for training base rescue flights and VXE-6 at Point Mugu, Calif., which is assigned to Antarctic operations.

Contractor: Bell Helicopter Textron.
Power Plant: Pratt & Whitney Canada T400 Turbo Twin-Pac; combined 1,250 shp (individual 900 shp).
Accommodation: pilot and 14 troops (VH-1N: two crew and seven passengers).
Dimensions: rotor diameter 28 ft 2¼ in, fuselage length 42 ft 4¾ in, height 14 ft 4¾ in.
Weights: empty 5,550 lb, gross 10,500 lb.
Performance: max speed 126 mph, service ceiling 15,000 ft, max range 248 miles.

VH-60A Black Hawk

Transport of the President and other VVIPs by helicopter is entrusted to the Executive Flight Detachment of Marine Corps squadron HMX-1 at Quantico, Va. Beginning on November 30, 1988, the unit was augmented by the first of nine VH-60As. Though based on the Army's Black Hawk, these special mission helicopters have a Seahawk-type flight-control system and ASI, soundproofing, radio operator's station, EMP hardening, additional avionics, and special interior fittings. *(Data similar to those for SH-60.)*

US Army

By Paul Jackson

Reconnaissance and Special-Duty Aircraft

OV-1B/C/D and RV-1D Mohawk

Out of production since the early 1970s, the Mohawk has been upgraded in subsequent years to provide the Army with radar, IR, photo, and electronic intelligence in all weather. Early variants were the photographic OV-1A with Fairchild KA-30 and KA-60 cameras (73 built); side-looking airborne radar **OV-1B**, having Motorola AN/APS-94D/E SLAR in an external, starboard side "canoe" plus cameras (101 built); and IR sensor **OV-1C** with AN/UAS-4 underfuselage linescan and Fairchild cameras (133 built). These variants served in Vietnam, also carrying light weapons underwing and suffering 28 losses to enemy fire.

Attributes of all three earlier versions are combined in the **OV-1D.** This has the KS-113A photo-survey system comprising KA-60C and KA-76 panoramic cameras and may also carry either ECM-resistant APS-94F SLAR in a rapidly removable "canoe" or an AN/AAS-24 IR detection system in the lower fuselage. A mission equipment payload of up to 2,129 lb may be carried, but the OV-1D is no longer tasked with armament. Wing pylons normally mount two 100 gal fuel tanks and a Sanders AN/ALQ-147 "Hot Brick" kerosene-powered IR jamming pod.

Only 37 new OV-1Ds were built, but another 78 OV-1B/Cs were converted to this standard, the fleet now having been reduced to about 95. The aircraft's AN/UPD-7 airborne radar surveillance system allows transmission of information via data link to a ground station, where it is converted to a film image for near-real-time analysis. UPD-7 can also interface with the Ground Station Module of Joint STARS. A program of reliability/maintainability modifications is in hand for the radar system while, beginning in 1988, certain RV-1s have received structural modifications to extend airframe lives from 7,000 to 12,000 hours. In parallel, Mohawks are receiving new communications and navigation equipment.

Addition of the "Quick Look I" elint package in OV-1Cs gave rise to the RV-1C, while the definitive "Quick Look II" is fitted to the **RV-1D.** Tasked with locating opposing radar sites, the RV-1 variants may be distinguished by their rectangular sensor pods on outboard underwing pylons. Up to 36 RV-1s were converted, all of which will be replaced by Beech RC-12Ks beginning in 1991. RV-1 equipment includes AN/ALQ-133 jammers, an AN/MSA-34 antenna group, and an AN/USQ-161 digital data set.

Mohawks serve in seven Military Intelligence Battalions (Aerial Exploitation). Two of these are in Forces Command at Hunter AAF, Ga., and Robert Grey AAF, Fort Hood, Ala.; two in the Army National Guard at Hunter AAF, Ga., and Salem, Ore.; one in Korea (3d MIB); and two in Germany (1st MIB at Wiesbaden and 2d MIB at Stuttgart). Typical MIB composition is eight OV-1Ds, seven RV-1Ds, and six Beech RC-12s. Other units retain a few OV-1Bs and Cs. *(Data for OV-1D.)*

Contractor: Grumman Aircraft Systems Division.
Power Plant: two Textron Lycoming T53-L-701 turboprops; each 1,400 shp.
Accommodation: pilot and systems operator on Martin-Baker J5 ejection seats.
Dimensions: span 48 ft 0 in, length 41 ft 9 in, height 13 ft 0 in.
Weights: basic 12,054 lb, gross 18,109 lb.
Performance: cruising speed 253 mph, service ceiling 25,000 ft, max range 945 miles.

RC-12D/H/K Guardrail

As with the U-21 transport before it, the C-12 forms the basis of current Army intelligence-gathering aircraft. Three RC-12 versions are operational or about to enter service, although they were preceded by a trio of Guardrail-equipped RU-21Js, ordered in FY 1971 for the Cefly Lancer program. Equivalent to civilian Super King Air 200s, the RU-21Js have since been converted to transports and redesignated C-12L. The **RC-12D** Improved Guardrail V became operational in 1985 for battlefield surveillance duties in Europe. The aircraft provides a platform for the AN/USD-9(V)2 remotely controlled communications intercept and direction-finding system, which operates in the 20–75, 100–150, and 350–450 MHz bands and is able to report directly to tactical commanders at corps level and below. It is fitted with an aircraft survivability equipment suite, a Carousel IV-E inertial platform with Tacan, and mission equipment including a data link, AN/ARW-83(V)5 airborne data relay, and ESM antennas in the wingtip pods. Prominent vertical "winebottle" antennas are located above and below the wing, while another protrudes from the rear fuselage. Dielectric panels cover other sensors in the tail and an undernose pod. Data processing is by an AN/TSQ-105(V)4 system, which senses and analyzes radio and radar signals, comparing them with a "threat library" and classifying accordingly. Direction and range parameters are included.

With ESL Inc as prime system contractor, Beech has converted 13 C-12D airframes to RC-12D standard, 12 of them based in Europe with the 1st and 2d Military Intelligence Battalions at Wiesbaden and Stuttgart, West Germany, the other at Hq. FORSCOM, Fort McPherson, Ga. A further six conversions were completed in 1988 as basically similar Improved Guardrail V **RC-12Hs**, with gross weight increased from 14,200 to 15,000 lb. All are with the 3d MIB in South Korea. Currently under conver-

sion for deployment in 1991 are nine **RC-12K** Guardrail Common Sensor aircraft, ordered in October 1985, with 1,280 shp PT6A-67 turboprops and 16,000 lb gross weight. *(Data for RC-12D.)*
Contractor: Beech Aircraft Corporation.
Power Plant: two Pratt & Whitney Canada PT6A-41 turboprops; each 850 shp.
Accommodation: two flight crew; eight passengers optional.
Dimensions: span 55 ft 6 in, length 43 ft 10 in, height 15 ft 5 in.
Weights: basic 8,143 lb, gross 14,200 lb.
Performance: cruising speed 300 mph, service ceiling 31,000 ft, endurance 5 h 45 min.

RG-8A

The unusual "Reconnaissance Glider" designation RG-8A refers to a special version of the Schweizer SGM 2-37 motorized sailplane known as the SA 2-37A, developed for law-enforcement agencies, border surveillance, and other military applications. The RG-8A is optimized for discreet observation, having been modified with long exhaust mufflers for its uprated power plant and a three-blade "quiet" propeller. Only some 52 hp of the available power is required to loiter at 2,000–3,000 ft, at which heights the RG-8 is reported to be inaudible from the ground. Other changes from the civilian variant include increased-span wings with modified leading edges and additional fuel capacity. A 65 cu ft payload bay to the rear of the cockpit can accommodate various sensors. Following a prototype first flight in 1986, two RG-8As funded in FY 1985 have been supplied for US Army and USAF trials. Another (from FY 1986) is on loan to the Coast Guard, based in Miami for drug-interdiction duties, carrying FLIR and secure communications equipment.
Contractor: Schweizer Aircraft Corporation.
Power Plant: one Textron Lycoming IO-540-W3A5D piston engine; 235 hp.
Accommodation: crew of two.
Dimensions: span 61 ft 6 in, length 27 ft 9 in, height 7 ft 9 in.
Weights: basic 2,025 lb, gross 3,500 lb.
Performance: cruising speed at 5,000 ft 159 mph, service ceiling 18,000 ft, endurance 8 h 0 min.

RU-21A/B/C/D/H Ute

Several electronic versions of the U-21 transport remain in service, although replacement of some is gradually under way by the RC-12 derivative. First to appear, and still in service, were the **RU-21B** and **RU-21C,** which introduced 620 shp PT6A-29 turboprop engines and a 10,900 lb gross weight. Only three B and two C versions were produced, both having a prominent external aerial array (which differed slightly between the models) for sigint and electronic warfare missions. Similarly tasked were seven **RU-21A** conversions from U-21A, which grossed at 10,200 lb; three EU-21As (no longer in service); and 16 new-build **RU-21D**s ordered in FY 1970 which reverted to 550 shp PT6A-20 power plants, with a consequent gross weight limit of 9,650 lb. There were also 18 conversions to RU-12D, a few of which remain, but most were later uprated as RU-21Es with Guardrail equipment. The surviving 21 were then modified to **RU-21H** configuration with some structural strengthening, improved electronic equipment, and revised wingtips and landing gear doors. RU-21Hs employ the Guardrail V Sigint package described in the RC-12 entry, above. RU-21A/B/Cs are concentrated at Orlando, Fla., with the 138th Aviation Company (EW), Army Reserve, operating the AN/TLQ-11 Cefrim Leader system with RU-21As for transmitter location, RU-21Bs supplying command and control, and RU-21Cs providing jamming. Other RU-21s serve with Army National Guard units in Hawaii, Washington, and elsewhere, some having been assigned as light transports. *(Data for RU-21H.)*
Contractor: Beech Aircraft Corporation.
Power Plant: two Pratt & Whitney Canada T74-PC-700 turboprops; each 550 shp.
Accommodation: two pilots and two equipment operators.
Dimensions: span 50 ft 11 in, length 35 ft 10 in, height 14 ft 2 in.
Weights: basic 6,814 lb, gross 10,200 lb.
Performance: cruising speed 236 mph, service ceiling 26,000 ft, endurance 4 h 15 min.

Transports

C-7A/B Caribou

The Army received 56 C-7A and 103 C-7B STOL transports in 1961–64, but transferred 134 of the surviving machines to USAF on January 1, 1967. During the early 1980s, at least 14 were returned to their original owner in the form of the Army National Guard, by which they are used at several locations for logistic support, carrying up to 6,720 lb of cargo. Replacement by Shorts C-23Bs is imminent.
Contractor: de Havilland (now Boeing) Canada.
Power Plant: two Pratt & Whitney R-2000-D5 Twin Wasp radial piston engines; each 1,450 hp.
Accommodation: two crew and 32 fully equipped troops.
Dimensions: span 95 ft 7½ in, length 72 ft 7 in, height 31 ft 9 in.
Weights: basic 18,260 lb, gross 28,500 lb.
Performance: cruising speed 182 mph, service ceiling 24,800 ft, range 242 miles.

C-12C/D/F/L Huron

Closely related to some of the later U-21 variants (which see) the C-12 (civilian equivalent, Super King Air 200) is used as an executive and light cargo (2,000 lb) transport, specialist RC-12 conversions being described separately. First in the inventory were three FY 1971 Guardrail-configured RU-21Js which have since been converted for transport on behalf of ERADCOM at Warrenton, Va., and were recently given the more appropriate designation **C-12L.** Sixty C-12As were supplied with 750 shp Pratt & Whitney Canada PT6A-38 turboprops and subsequently converted to **C-12C**s with PT6A-41s, joining 14 new-built to this standard. They are used by several headquarters, including some overseas, at least seven having been loaned to the Customs Service. Of 46 cargo-door-equipped **C-12D**s procured in FYs 1978–84, 19 have been converted to RC-12D/Hs and a further three specially modified. Span over tiptanks is 55 ft 6 in. The Army bought 18 **C-12F**s in FYs 1985–86, features including 850 shp PT6A-42 engines and a cargo door. *(Data for C-12C.)*
Contractor: Beech Aircraft Corporation.
Power Plant: two Pratt & Whitney Canada PT6A-41 turboprops; each 850 shp.
Accommodation: two pilots and eight passengers.
Dimensions: span 54 ft 6 in, length 43 ft 10 in, height 15 ft 5 in.
Weights: basic 8,084 lb, gross 12,500 lb.
Performance: cruising speed 300 mph, service ceiling 35,000 ft, max range 2,273 miles.

C-20E Gulfstream III

Two late-production Gulfstream III executive jets were funded in FY 1987 and delivered the following year to Andrews AFB, Md., for VIP transport duties. (A turboprop Gulfstream I was purchased secondhand in FY 1986 for Hq. WESTCOM at Wheeler AFB, Hawaii, and a Gulfstream II is understood also to have been acquired.)
Contractor: Gulfstream Aerospace Corporation.
Power Plant: two Rolls-Royce Spey Mk 511-8 turbofans; each 11,400 lb st.
Accommodation: two or three crew and up to 19 passengers.
Dimensions: span 77 ft 10 in, length 83 ft 1 in, height 24 ft 4½ in.
Weights: basic 38,000 lb, gross 69,700 lb.
Performance: cruising speed 576 mph, service ceiling 45,000 ft, range (with 8 passengers) 4,200 miles.

C-23B and Shorts 330

In FY 1985, the Army obtained on lease four **Shorts 330** commuterliners from civilian sources for light transport support of the Pacific Missile Test Center at Kwajalein Atoll, Marshall Islands. A further two were added late in 1987. The **C-23** is a military version of the Shorts 330, first ordered by USAF and equipped with a rear-loading ramp. In October 1988, the Army announced plans to order ten C-23Bs to replace C-7 Caribous in the role of transporting aviation spares and components between Army National Guard bases and Aviation Classification Repair Activity Depots (AVCRAD). The first six C-23Bs were funded in FY 1990. Changes from the USAF C-23A variant include strengthened wings and landing gear, modernized flight-deck instrumentation, an air-opening facility for the freight ramp, greater payload (7,280 lb), and uprated engines fitted with the five-blade propellers of the Shorts 360. *(Data for C-23A.)*
Contractor: Short Brothers PLC (UK).
Power Plant: two Pratt & Whitney Canada PT6A-65A turboprops; each 1,100 shp.
Accommodation: two pilots and one flight mechanic.
Dimensions: span 74 ft 8 in, length 58 ft 0½ in, height 16 ft 3 in.
Weights: basic 14,500 lb, gross 25,600 lb.
Performance: cruising speed 218 mph, max range 225 miles.

C-26B

The Fairchild Metro III was first ordered by the Air National Guard under the designation C-26A. During 1989 two similar C-26Bs were purchased for the Army National Guard (and one for the ANG). They differ only slightly in having TPE331-12 turboprops each delivering 19 more shp than the -11s of C-26As. Interiors will be able to accommodate passengers or cargo.
Contractor: Fairchild Aircraft Corporation.
Power Plant: two Garrett TPE331-12 turboprops; each 1,119 shp.
Accommodation: two crew and up to 20 passengers.
Dimensions: span 57 ft 0 in, length 59 ft 4¼ in, height 16 ft 8 in.
Weights: basic 9,180 lb, gross 16,000 lb.
Performance: cruising speed 320 mph, service ceiling 27,500 ft, max range 1,324 miles.

C-212 Aviocar

According to unconfirmed reports, up to 20 CASA Aviocar light twin transports are used by the Army for trials of unspecified equipment and gathering of intelligence.
Contractor: Construcciones Aeronauticas SA (Spain).
Power Plant: two Garrett TPE331-10R-513C turboprops; each 900 shp.
Accommodation: two crew and up to 25 passengers.
Dimensions: span 66 ft 6½ in, length 52 ft 11¾ in, height 21 ft 7¾ in.
Weights: basic 8,333 lb, gross 17,637 lb.
Performance: cruising speed 220 mph, service ceiling 26,000 ft, max range 519 miles.

F27 Friendship

Since 1985, the "Golden Knights" parachute demonstration team of the US Army has used a pair of Fokker F27 Mk 400Ms for logistic support and as jump platforms. The 400M variant of the civilian transport has a parachuting door on each side of the fuselage, in addition to a cargo door, and capacity for 13,383 lb of freight.
Contractor: Fokker Aircraft BV (Netherlands).
Power Plant: two Rolls-Royce Dart Mk 536-7R turboprops; each 2,140 shp.
Accommodation: two pilots and up to 46 paratroops.
Dimensions: span 95 ft 2 in, length 77 ft 3½ in, height 27 ft 11 in.
Weights: basic 24,720 lb, gross 45,900 lb.
Performance: cruising speed 298 mph, service ceiling 29,500 ft, max range 2,727 miles.

U-3A/B

A few militarized versions of the Cessna 310 were transferred from USAF to Army aviation, comprising L-27As (Model 310As) purchased in FYs 1957–58 and L-27Bs (310Es) from FY 1960; they were redesignated U-3A/B in 1962. The aircraft's nickname, "Blue Canoe," has not been officially recognized. The remaining aircraft are used for liaison by some units of the Army National Guard, augmented by four ex-civilian Cessna 310s obtained in FYs 1983–85. *(Data for U-3B.)*
Contractor: Cessna Aircraft Company.
Power Plant: two Continental IO-470-D piston engines; each 260 hp.
Accommodation: pilot and four passengers.
Dimensions: span 36 ft 0 in, length 29 ft 6 in, height 9 ft 11¼ in.
Weights: basic 3,040 lb, gross 4,830 lb.
Performance: cruising speed 220 mph, service ceiling 21,300 ft, max range 1,340 miles.

U-8F Seminole

Early models of the U-8 (L-23 until 1962) were based on the Twin-Bonanza and used for liaison and radar reconnaissance. These have now been withdrawn. In January 1959, the L-23F/U-8F was first flown, being a military parallel of the larger Queen Air 65, carrying 700 lb more freight on the power of two 340 hp IGSO-480 piston engines. Procurement totaled 79 in FYs 1958–65, while between 1980 and 1985 a further nine or more Beech 65s were acquired from civilian sources, together with two Beech 80 Queen Airs. Over 50 remaining U-8Fs have been modified by Excalibur Aviation of San Antonio, Tex., to Queenaire 800 standard with uprated power plants and propellers, plus associated engine mountings, exhaust system, and low-drag nacelles. They have been issued to numerous Army National Guard units for communications and light transport duties. *(Data for Queenaire 800.)*
Contractor: Beech Aircraft Corporation.
Power Plant: two Textron Lycoming IO-720-A1B piston engines; each 400 hp.
Accommodation: pilot and up to five passengers.
Dimensions: span 45 ft 11 in, length 33 ft 4 in, height 14 ft 2 in.
Weights: basic 5,490 lb, gross 7,700 lb.
Performance: cruising speed 231 mph, service ceiling 19,700 ft, max range 1,523 miles.

U-21A/D/F/G/H Ute

Designation **U-21A** was assigned to initial FY 1966 procurement of a hybrid King Air variant comprising a Queen Air 65-80 unpressurized fuselage married to King Air 65-90 wings, tail surfaces, and landing gear, and powered by two 550 shp PT6A-20 turboprops. Deliveries totaled 124, including some conversions to RU/EU-21 (which see), usual internal layout being for two crew and ten passengers. These aircraft were immediately followed by 17 **U-21G**s which were essentially similar, apart from modernization of some features. In FY 1970, the Army bought five **U-21F**s—a King Air A100 derivative with 680 shp PT6A-28s and space for 13 passengers—which are operated for the Military District of Washing-

ton from Andrews AFB. Availability of RC-12s has allowed some RU-21s to be relegated to transport duties, resulting in appearance of a small number of **U-21Ds** (basically similar to the U-21A) and **U-21Hs** (620 shp power plants). Several units use U-21s for communications and light transport. *(Data for U-21A.)*

Contractor: Beech Aircraft Corporation.
Power Plant: two Pratt & Whitney Canada PT6A-20 turboprops; each 550 shp.
Accommodation: two pilots and up to ten passengers.
Dimensions: span 45 ft 11 in, length 35 ft 10 in, height 14 ft 2 in.
Weights: basic 5,383 lb, gross 9,500 lb.
Performance: cruising speed 242 mph, service ceiling 26,150 ft, max range 1,216 miles.

UV-18A Twin Otter

The DHC-6 was designed for STOL transport with Canada's wilderness airstrips in mind and was therefore an appropriate choice for the Alaska Army National Guard. Two were purchased in FY 1976, followed by further pairs in FY 1979 and FY 1982.

Contractor: de Havilland (now Boeing) Canada.
Power Plant: two Pratt & Whitney Canada PT6A-27 turboprops; each 620 shp.
Accommodation: two crew and up to 20 passengers.
Dimensions: span 65 ft 0 in, length 51 ft 9 in, height 19 ft 6 in.
Weights: basic 5,850 lb, gross 12,500 lb.
Performance: cruising speed 210 mph, service ceiling 26,700 ft, max range 806 miles.

Trainers

T-42A Cochise

This military version of the B55 Baron was the subject of FY 1955–66 Army orders for 65 aircraft, one further ex-civilian Baron being acquired in FY 1983. The Cochise was formerly used as an instrument trainer at the Fort Rucker, Ala., aviation school and is now assigned to several Army National Guard units for training and liaison.

Contractor: Beech Aircraft Corporation.
Power Plant: one Continental IO-470-L piston engine; 260 hp.
Accommodation: four persons, including pilot.
Dimensions: span 37 ft 9¾ in, length 27 ft 3 in, height 9 ft 7 in.
Weights: basic 3,075 lb, gross 5,100 lb.
Performance: cruising speed 225 mph, service ceiling 19,700 ft, max range 1,225 miles.

Helicopters

AH-1P/E/F, TH-1G/S, and TAH-1S Cobra

Now eclipsed in US Army Europe by the AH-64 Apache, the Cobra remains, numerically, the prime antiarmor/attack helicopter of American ground forces. Having proved its worth in Vietnam from 1967 onward, the original AH-1G has been progressively upgraded with more potent weaponry, target acquisition aids, and defensive equipment, and now serves front-line units in four basic variants. Having 85 percent commonality with the UH-1 Iroquois ("Huey") in its early form, the Bell 209 Cobra retained the H-1 designation despite its considerably thinner fuselage and tandem seating. Though not the first helicopter of this configuration, it was the first to enter quantity production.

Initial manufacture totaled 1,075 AH-1Gs, of which some remain in original configuration and as **TH-1G** trainers. The AH-1G is powered by a 1,100 shp Textron Lycoming T53-L-13 turboshaft engine and has four weapons pylons beneath the stub-wings and a 0.30-in Gatling-type machine-gun in an Emerson TAT-102 nose turret. The latter was later replaced by an M28 turret with provision for two guns, two M129 40 mm grenade launchers, or one of each. Stub-wings held M18E1 Minigun pods and/or up to 76 rockets of 2.75-in caliber. Modification of 92 AH-1Gs to carry Hughes TOW antiarmor missiles produced the AH-1Q, all of which were further reworked to later standards.

Combination of the TOW weaponry with an 1,800 shp T53-L-703 power plant restored the Cobra's agility under the designation AH-1S. Four standards of AH-1S have been produced, generating so much confusion that three were redesignated in March 1987 with redundant H-1 series suffix letters. **AH-1S** (previously known as Mod AH-1S) now applies only to the 92 AH-1Qs updated before 1979 and 87 AH-1Gs similarly treated in 1986–88. There are 15 **TH-1S** Night Stalker training helicopters which provide experience of the Martin Marietta FLIR-based night vision system and Honeywell integrated helmet and display sighting system of the AH-64 Apache.

AH-1F Huey Cobra

AH-64A Apache

New-production variants are the AH-1P (previously known as the "Production AH-1S"), AH-1E (ex "Up-Gun AH-1S"), and AH-1F (ex "Modernized AH-1S"). One hundred **AH-1Ps** were delivered in 1977–78, their most obvious external modification being the change to a cockpit canopy composed of flat, reinforced panels to reduce glinting and improve crew protection. Instrumentation and avionics were also upgraded to ease nap-of-the-earth flying, and (from the 67th) the rotor blades changed to Kaman-designed units in composite materials with tapered tips. The engine exhaust duct is turned upwards to reduce the IR signature. (This "toilet bowl" exhaust and the Kaman blades have been retrofitted to some AH-1Ss.) **AH-1E** covers the next 98 helicopters, built in 1978–79 and equipped with a universal 20 mm or 30 mm gun turret and an improved stores management system. (The long-barrel, 20 mm weapon is normally fitted.) The wing stores management system is improved, and there is automatic compensation for off-axis cannon-firing.

In the definitive **AH-1F**, comprising 149 helicopters, including 50 for the National Guard, Bell added a new fire-control system incorporating an AN/AAS-32 laser-ranger and tracker, pilot's HUD, air data sensor and ballistics computer, AN/ALQ-144 infrared jammer (to the rear of the rotor mast), AN/APR-39 radar warning receiver, an IR-suppressing exhaust, and secure communications. Between 1979 and 1982, 378 AH-1Gs were rebuilt as AH-1Fs and others as **TAH-1F** trainers. Upgrades applied to, or in prospect for, the Cobra fleet include C-Nite night sighting systems in some 50 AH-1Fs; ATAS for adding air-to-air Stinger SAMs; and C-Flex life-extension modifications. Approximately 700 Cobras remain in regular Army service, and a further 325 with the Army National Guard.

Contractor: Bell Helicopter Textron.
Power Plant: one Textron Lycoming T53-L-703 turboshaft; 1,800 shp.
Accommodation: pilot (rear) and gunner in tandem.
Dimensions: rotor diameter 44 ft 0 in, length of fuselage 44 ft 7 in, height 13 ft 6 in.
Weights: basic 6,598 lb, gross 10,000 lb.
Performance: cruising speed 219 mph, service ceiling 10,550 ft, endurance 3 h 0 min.
Armament: nose turret for 20 mm M197 or 30 mm cannon; M65 system of eight TOW antiarmor missiles and two pods of rockets (M158/M200/M260), grenades, or machine-guns.

AH-6F/G and MH-6F/H "Little Bird"

The failed 1980 bid to rescue the US hostages in Iran had its ramifications in all branches of the armed forces, and for the Army was the spur to formation of Task Force 160—officially known as the 160th Special Operations Aviation Regiment—based at Fort Campbell, Ky. TF-160 was established to operate night-capable helicopters that could be internally airlifted to an operational area by Lockheed MC-130 Hercules transports and made ready to fly within four minutes. Initially, the Army converted existing equipment in the form of the Hughes (now MDH) OH-6A Cayuse, 36 of these small helicopters emerging as EH-6B, MH-6B, and AH-6C versions for electronic surveillance, night interdiction, and attack duties, respectively. These have been replaced in operational use by new-built helicopters: three **EH-6Es**, 15 **MH-6Es** and 12 **AH-6Fs**, all based on the MDH 500MG Defender, fitted with an Allison 250-C20 turboshaft. Most have been re-engined with 250-C30 power plants for increased hot-and-high performance, making them equivalent to the civilian MDH 530 and amending their designations to **AH-6G** and **MH-6F**. Multifunction displays and other improvements are reported also to have been installed.

MH- versions have "Black Hole" IR-suppressing exhausts, are equipped with FLIR and NVG-compatible cockpit lighting, and may carry light armament comprising 0.30 in Miniguns and 2.75 in rockets. Alternatively, four external seats can be installed for airlifting troops. The AH- models dispense with FLIR and instead mount heavier armament, such as TOW antiarmor missiles. TF-160's combat debut was in the 1983 Grenada invasion, but it came to prominence when H-6s operating from USS *Jarrett* attacked the Iranian minelayer *Iran Ajr* in the Persian Gulf in September 1987. Its specially modified helicopters were also used in the Panama operation in December 1989. In a program code-named "Black Tiger," the "Night Stalkers" of TF-160 are now understood to be preparing to evaluate the NOTAR (no tail rotor) MD 520N as a potential follow-on. A NOTAR retrofit kit is also being considered. *(Data for AH-6G.)*

Contractor: McDonnell Douglas Helicopter Company.
Power Plant: one Allison 250-C30 turboshaft; 425 shp (derated).
Accommodation: pilot and gunner, plus up to four internal passengers; alternatively, four external passengers.
Dimensions: rotor diameter 27 ft 4 in, fuselage length 25 ft 0 in, height 8 ft 8 in.
Weights: (approximate) basic 2,000 lb, gross 3,550 lb.
Performance: (approximate) cruising speed 140 mph, service ceiling 16,000 ft, endurance 2 h 6 min.
Armament: combinations of TOW antiarmor or Stinger antihelicopter missiles, 2.75 in rocket pods and 0.3 in Miniguns.

AH-64A Apache

This product of the former Hughes company is now firmly established in service as the Army's primary attack helicopter and a partial replacement for the Bell AH-1 Cobra, notably in Europe, where one quarter of the force will eventually be based. Designed to meet the advanced attack helicopter (AAH) requirement, the Apache is optimized for rapid reaction, day and night, with laser-guided Hellfire antitank missiles, integral 30-mm cannon, and rocket pods. It is capable of withstanding 23-mm caliber fire in critical areas and underwent its combat debut in Panama during December 1989, serving with the 1st Battalion, 82d Airborne Division. For long-range reinforcement, the AH-64 can self-deploy from the US to Europe via Canada, Greenland, Iceland, and the UK or be airlifted inside a C-141B StarLifter (two) or C-5 Galaxy (six).

Apache production for the Army is due to end in 1993 with the 807th example, of which 550 had been delivered by early 1990. IOC was achieved in 1986, and by the end of 1989, 15 of the planned Apache battalions were operational, with seven more due to follow in the course of 1990. AH-64As are based in the US at Fort Hood and Fort Bragg and (from 1987) with Army National Guard battalions in North Carolina, South Carolina, Florida, and Utah. Seven battalions are currently in Europe, each with an established strength of 18 Apaches, 13 scouting OH-58Cs, and three support UH-60As. Training at the Fort Rucker complex is undertaken from Guthrie and Hanchey AHPs.

Primary sensors, mounted in the Apache's nose, are a Martin Marietta Orlando Aerospace target acquisition and designation sight and an AN/AAQ-11 pilot's night vision sensor (TADS/PNVS). Once acquired by TADS, targets can be tracked manually or automatically for attack by gun, rockets, or Hellfire missiles. The system includes a laser for designation. PNVS includes a FLIR, with imagery projected in a single monocle, to permit night/adverse-weather nap-of-the-earth flying.

In August 1989, MDH received a 51-month contract to convert four prototypes to **Longbow Apache** configuration, of which the prominent feature will be mast-mounted Martin Marietta/Westinghouse Longbow millimeter-wave radar, previously known as the airborne adverse weather weapon system (AAWWS). With this, the helicopter will achieve "fire and forget" capability with Hellfire. Other changes will include 1,857 shp T700-GE-701C turboshaft engines, double-capacity power distribution system, MIL-STD-1553B digital databus, and improved cooling. Longbow proof-of-principle testing was completed in April 1990, and if a go-ahead is given, full-scale development will begin this November. The

Army plans to convert 227 Apaches to this standard, with first deployment early in 1996.

Contractor: McDonnell Douglas Helicopter Company.

Power Plant: two General Electric T700-GE-701 turboshafts; each 1,696 shp.

Accommodation: pilot (rear) and gunner in tandem.

Dimensions: rotor diameter 48 ft 0 in, fuselage length (tail rotor turning) 48 ft 2 in, height 14 ft 1 in.

Weights: basic 10,505 lb, gross 17,400 lb.

Performance: cruising speed 184 mph, service ceiling 21,000 ft, endurance 2 h 15 min.

Armament: turreted 30-mm M230 Bushmaster Chain Gun; 16 Hellfire missiles or up to 76 2.75 in rockets in M200 or M260 pods of seven or 19.

CH-47C/D Chinook

The Army is well advanced in the conversion of its Chinook medium-lift helicopter fleet to a common CH-47D standard, having now returned all surviving CH-47As and CH-47Bs to Ridley Township, Pa., for remanufacture by Boeing. Production of these versions was originally 354 and 108, respectively, many of which performed valuable service in Vietnam as carriers of troops, cargo, fuel, and weapons, as well as recoverers of downed aircraft. Southeast Asia losses totaled 136, including 50 to small-arms fire. Currently passing through Boeing are the survivors of 270 **CH-47Cs**, powered by a pair of 3,750 shp T55-L-11A turboshafts and having a gross weight of 46,000 lb. In-service improvements to the "C" model have included glassfibre rotor blades fitted to 182 helicopters, a crash-resistant fuel system, and integral spar inspection system. Eleven CH-47Cs of the Pennsylvania Army National Guard are unusual in having been built by Meridionali in Italy to an embargoed Iranian order.

In 1982, deliveries began of Chinooks rebuilt to CH-47D configuration, current contracts calling for 472 to be thus upgraded, of which over 300 have been completed. IOC was achieved in February 1984, and all intended active Army recipients in the US and Europe had been equipped by the end of 1988, in which year the Army National Guard began receiving CH-47Ds. Deliveries to units in Korea followed in 1989. Battalion strength is normally 16 Chinooks. The CH-47D is able to lift a useful load of 22,783 lb and a maximum weight on the central hook of 26,000 lb. A typical cargo would comprise an M198 155-mm howitzer underslung, plus the 11-man gun crew and 32 rounds of ammunition in the cargo hold. Over short distances, it is the only Army helicopter capable of transporting a 24,750 lb D5 bulldozer. Employing all three underfuselage cargo hooks, the CH-47D can transport seven rubber fuel blivets, each holding 500 gallons.

Changes incorporated in the CH-47D include T55-L-712 engines, composite rotor blades, uprated transmission, a reconfigured flight deck to reduce crew work load, redundant and improved electrical systems, modular hydraulic systems, single-point pressure refueling, provision for night vision goggles, an advanced flight control system, and improved avionics. The rejuvenated Chinook fleet will continue to serve the Army until well into the next century. *(Data for CH-47D.)*

Contractor: Boeing Helicopters.

Power Plant: two Textron Lycoming T55-L-712 turboshafts; each 4,500 shp.

Accommodation: two pilots, two crew, and up to 55 troops or 24 litters.

Dimensions: rotor diameter 60 ft 0 in each, fuselage length 51 ft 0 in, height 18 ft 8 in.

Weights: basic 22,499 lb, gross 50,000 lb.

Performance: cruising speed 178 mph, service ceiling 22,100 ft, endurance 3 h 0 min.

Armament: (optional) M24 system of two 0.30 in machine-guns; and/or XM41 system of 0.30 in gun on rear cargo ramp.

CH-54A/B Tarhe

The Army's heavy-lift helicopter has now been eclipsed by the "D" version of Chinook, which has a useful load almost one ton greater. It nevertheless is able to look back on a history of missions that could have been performed by few other helicopters, such as recovery of 380 downed aircraft in Vietnam. The ungainly shape of the Sikorsky S-64 derives from a requirement for it to lift standard-size cargo pods, but much of its work is accomplished using the cargo hook. Following six preproduction YCH-54As ordered in FY 1964, the Army received 54 **CH-54As** and 21 Universal Pods, a final order in FY 1969 covering 37 **CH-54Bs**. The latter are most readily identifiable by their twin mainwheels, but other differences include uprated (4,800 shp) engines and gearboxes, improved rotor blades, and a modified flight control system, increasing gross weight to 47,000 lb and useful load to 25,800 lb, compared with the CH-54A's 21,200 lb. After their service overseas, Tarhes have operated with Army National Guard units in Alaska, Alabama, Georgia, Mississippi, Nevada, New York, and Pennsylvania. Approximately 70 remain airworthy. *(Data for CH-54A.)*

Contractor: Sikorsky Aircraft Division of United Technologies Corporation.

Power Plant: two Pratt & Whitney T73-P-1 turboshafts; each 4,500 shp.

Accommodation: four crew; pod for 67 troops or 48 litters.

Dimensions: rotor diameter 72 ft 0 in, fuselage length 70 ft 0 in, height 25 ft 5 in.

Weights: empty 20,800 lb, gross 42,000 lb.

Performance: cruising speed 109 mph, service ceiling 13,600 ft, endurance 2 h 30 min.

EH-1H/X Quick Fix I

Quick Fix is the code name of a series of tactical electronic jamming systems fitted to the UH-1 and UH-60 utility helicopters. Initial application of the ESL Inc Quick Fix IA, during 1980, was in the UH-1H. Redesignated as **EH-1H**, this had additional aerial arrays, plus self-defense equipment including an AN/APR-39(V)2 radar warning receiver, XM130 chaff/flare dispenser, and AN/ALQ-144 IR jammer. Some ten EH-1Hs were produced, later gaining Quick Fix IB equipment, together with hot-metal/plume-suppression measures. One equipment operator is carried by the EH-1H in addition to two flight crew. Mission equipment weight is 1,050 lb within the helicopter's gross of 8,800 lb, and endurance is 1 h 40 min.

The improved **EH-1X** Quick Fix II has the same equipment as the EH-60A Black Hawk, this differing from earlier standard in being able to locate communications transmitters as well as jam them. About 20 of this model have been converted from UH-1Hs, payload weight having increased to 1,557 lb. More than 20 of the EH-1 fleet serve with the Army National Guard. *(Data for EH-1X as for EH/UH-1H, except as follows.)*

Accommodation: two flight crew and one (EH-1H) or two (EH-1X) equipment operators.

Weight: gross 9,200 lb.

Performance: max speed 115 mph, endurance 1 h 30 min.

EH-60C Quick Fix II and MH-60A/K Black Hawk

Between 1987 and 1989, 66 UH-60A helicopters were retrofitted by Tracor Aerospace with 2,130 lb ESL Inc AN/ALQ-151 Quick Fix IIB systems for the location and monitoring of enemy communications in the 2–76 MHz band and appropriate jamming at up to 150 W. The **EH-60C** is able to operate at up to 10,000 ft in almost all weather conditions and communicate via a secure link with other Army aircraft and ground stations. Quick Fix aircraft are organic to divisions and armored cavalry regiments, assignment being two or three helicopters per unit. Recognition features are prominent dipole aerials on the rear fuselage, accompanied by external chaff/flare dispensers and a deployable whip antenna. Four crew are carried, and endurance is 2 h 0 min.

Due to fly this year, the **MH-60K** is a special operations aircraft (SOA) Black Hawk variant ordered from Sikorsky in January 1988. Requirements are for 23 MH-60Ks, of which 11 are on order for delivery from November 1991 onwards. IOC is planned in September 1992 with the 160th Special Operations Aviation Regiment's 3d Battalion at Savannah, Ga. TF-160, which is headquartered at Fort Campbell, Ky., currently operates 30 interim **MH-60A** Black Hawks with FLIR, Omega navigation equipment, and MFD instrument panels, and with a door-mounted 0.30 in machine-gun. The definitive MH-60K will have Hughes AN/AAQ-16 FLIR, Texas Instruments AN/APQ-174 terrain-following radar, uprated (1,857 shp T700-GE-701C) engines and gearbox, refueling probe, provision for additional cabin and external fuel tanks, folding tailplane, two 0.50 in pintle-mounted machine-guns, Stinger AAMs, wire-strike protection, Seahawk-type AFCS, and rescue hoist. Comprehensive protection aids include missile- and laser-warners, radio-frequency and IR jammers, and chaff/flare dispensers. *(Data for MH-60K similar to those for UH-60M, except as follows.)*

MH-47E Chinook

Accommodation: four crew plus up to 12 troops.

Weights: mission weight 24,500 lb.

Performance: cruising speed 140 mph, endurance 7 h 35 min (unrefueled).

LH (Light Helicopter)

In January 1991, either the Bell/McDonnell Douglas or the Boeing/Sikorsky team will be chosen to proceed with the Army's next-generation light helicopter, although the prize is smaller than envisaged in 1982, when the LHX program was begun with a target of 5,000 replacements for UH-1, AH-1, OH/AH-58, and OH-6 helicopters. Elimination of a UH-1 follow-on reduced the total to 2,096 of the new design (replacing 3,000 helicopters), but further cuts have eroded this figure to 1,822. The program dropped its "Experimental" suffix early in 1990. A request for proposals was issued in June 1988, and four months later the two consortia were awarded 23-month demonstration/validation contracts. A related project is the new LHTEC T800 turboshaft engine, which will power the successful LH design and probably be retrofitted in other types of helicopter.

Bell/MDH is concentrating its studies on an advanced, bearingless, four-blade rotor, the NOTAR antitorque system, and composite materials developed from the ACAP research program. Further support was provided by the ARTF project concerning a digital FBW system fitted to a Bell 249 Huey Cobra. Boeing/Sikorsky's LH has a five-blade main rotor, T-tail, and shrouded ("fenestron") antitorque rotor. Specified common aspects of both LH contenders include low-observability features, a pilot's night vision system with helmet-mounted display, internal weapons stowage, integrated cockpit, second-generation FLIR targeting, digital map display, "Have Quick" tactical communications, airborne target handoff system, GPS, laser- and radar-warning, and RF/IR jammers. Avionics are required to have maximum commonality with the Naval A-12 and USAF YF-22/YF-23 programs.

A prototype LH is due to fly in August 1993, and an initial order for 24 (possibly designated AH-66) will be placed in 1994, manufacture beginning in November of that year. First deliveries in March 1996 will lead to IOC eight months later. Yearly contracts will build up to 216, for which, beginning in FY 1998, each consortium member will be required to bid against its partner. If requirements are reduced below 157 per year, coproduction will probably continue. The multirole LH will allow reduction in the size of current operating units. Attack battalions of light divisions will reduce from 21 AH-1s and 13 OH-58s to 25 LHs; heavy division and corps attack battalions from 18 AH-64s and 13 OH-58s to 15 AH-64s and 10 LHs; and cavalry troops from four AH-1s and six OH-58s to eight LHs. The effect will be a 25 percent reduction in inventory allied to a 100 percent improvement in combat capability.

Contractor: to be announced.

Power Plant: two LHTEC T800 turboshafts; each 1,200 shp.

Accommodation: pilot and WSO in stepped cockpit, but single-pilot operable.

Dimensions: rotor diameter 41 ft 0 in, fuselage length 40 ft 0 in.

Weights: empty 7,500 lb, gross 11,200 lb.

Performance: cruising speed 196 mph, endurance 3 h 0 min.

Armament: turret-mounted gun; eight Hellfire antiarmor and two Stinger antihelicopter missiles (attack role); or four Hellfires and four Stingers (armed reconnaissance); or two Hellfires and eight Stingers (air combat).

MH-47E Chinook

Newest Chinook variant—rolled out last December—the MH-47E is a special forces helicopter based on the CH-47D. Intended as a larger counterpart of the MH-60K Black Hawk, the Boeing helicopter will be able to conduct a 5½ hour, deep-penetration mission over a 345-mile radius in adverse weather, day or night, over all terrain, with a 90 percent success probability. The MH-47E is required to have larger external fuel tanks, an in-flight refueling probe, and the capability to self-deploy to Europe; seating for 42 troops; and comprehensive self-defense capability in the form of weapons and ECM. Principal sensors are a Texas Instruments AN/APQ-174 radar with terrain-following provision down to 100 ft, and Hughes AN/AAQ-16 FLIR in a chin turret. Other features include an integrated avionics system with four-screen EFIS cockpit compatible with NVGs; two dual high-speed MIL-STD-1553 digital databuses; jam-resistant radios; automatic target handoff system; inertial, Doppler, GPS, and terrain-reference navigation systems; laser- and radar-warners; chaff/flare dispensers; RF jammers; and a 600 lb rescue hoist with 200 ft of usable cable. The longer nose of the civilian Chinook is fitted to allow possible later addition of a second radar, and there are plans to retrofit Stinger missiles for self-defense.

The Army requires 51 MH-47Es, all of which will be converted low-hour CH-47Cs taken from the total of 472 CH-47D conversions now funded. Rework of 17 MH-47s

is covered by current contracts, these to be delivered between January and September 1992 to the 160th Special Operations Aviation Regiment's 2d Battalion at Fort Campbell, Ky.; 3d Battalion at Savannah, Ga.; and 4th Battalion, Oklahoma Army National Guard. TF-160 presently operates 15 interim **MH-47D** Chinooks fitted with 29 ft 3½ in extending refueling probes, which allow them to be completely replenished from a KC-130 Hercules tanker in six minutes. The MH-47D also has FLIR and self-defense Miniguns. *(Data as for CH-47D, except as follows:)*

Power Plant: two Textron Lycoming T55-L-714 turboshafts; each 4,100 shp.
Dimensions: fuselage length 52 ft 1 in.
Weights: mission weight 54,000 lb.
Performance: cruising speed 159 mph, endurance 10 h 20 min.
Armament: two pintle-mounted 0.50 in. machine-guns.

OH-6A Cayuse

Partner to the AH-1 Cobra in Vietnam, the "Loach" is a light-combat/escort helicopter based on the civilian Hughes Model 500 and currently operated by the Army National Guard. Procurement began in 1965, and by August 1970 a total of 1,417 OH-6As had been supplied, with production peaking at 70 per month. Despite its speed and agility, the helicopter suffered 955 losses in southeast Asia between 1967 and 1973, of which 635 were due to ground fire. The 250 or so current survivors have recently been upgraded for continued service and mount the XM27E-1 weapons subsystem, comprising a General Electric M134 six-barrel 0.30 in Minigun and an XM70E-1 reflector sight, both on the port side. The alternative M129 40-mm grenade launcher is no longer used. Army National Guard Cayuse units are located in Alabama, Arizona, Colorado, the District of Columbia, Delaware, Maryland, Massachusetts, Mississippi, New Jersey, New York, Oklahoma, Pennsylvania, Rhode Island, Texas, Utah, Virginia, and elsewhere.

Contractor: McDonnell Douglas Helicopter Company.
Power Plant: one Allison T63-A-5A turboshaft; 253 shp.
Accommodation: pilot and observer/gunner; two passengers optional.
Dimensions: rotor diameter 26 ft 4 in, fuselage length 23 ft 0 in, height 8 ft 1½ in.
Weights: basic 1,163 lb, gross 2,400 lb.
Performance: cruising speed 139 mph, service ceiling 15,800 ft, endurance 3 h 45 min.
Armament: XM27E-1 system of 0.30 in Minigun.

OH-58A/C and AH-58D Kiowa

Deliveries of this military version of the JetRanger began in 1969, and 2,200 were supplied to the US Army in the scouting and liaison role, many serving in Vietnam, with provision for carrying an XM27E-1 armament system (0.30 in Minigun). Over 1,800 remain, including nearly 500 with the Army National Guard and 80 with the Army Reserve, although not all are in their original configuration. Under a contract placed in 1976, many Kiowas have been upgraded to OH-58C standard with features including infrared suppression measures, a new instrument panel, revised navigation equipment, and an observation sight above the port seat. A welcome boost to performance has been obtained by replacing the 317 shp Allison T63-A-700 turboshaft by an A-720 delivering 420 shp. Of 585 such conversions, 150 were undertaken in Europe for locally based units of the US Army. Bell AH-1 Cobra and AH-64 Apache battalions each include OH-58As or Cs. Further modifications to the tail rotor were effected from 1985 onward to improve control during nap-of-the-earth flying in search of targets for the Cobra attack helicopter force.

Seeking to obtain what it describes as its first true scout, under the Army Helicopter Improvement Program (AHIP), the US Army is converting 243 OH-58As to four-blade OH-58D standard, the initial deliveries to Europe (partly replacing OH-58Cs) having taken place in 1987. Fitted with IR jammers, laser warning equipment, chaff/flare dispensers, and crew night vision equipment, the OH-58D is most readily recognized by its mast-mounted sight. This contains a 12x TV camera, thermal imaging sensor, and laser-ranger/designator for day and night target acquisition and marking. Scouting OH-58Ds are able to designate for Hellfire-armed helicopters themselves unable to see the target—including types such as the Black Hawk that have none of their own sighting equipment. Position data can also be passed via the airborne target handoff system.

Work began in September 1987 on an armed OH-58D. Three months later, the first of 15 "Prime Chance" conversions for D Company of the 1st Battalion, 159th Aviation Regiment, at Fort Bragg, N. C., was preparing to deploy to the Persian Gulf operations against Iranian gunboats threatening international shipping. Modifications included weapons pylons attached to the ends of an aluminum tube running through the rear of the fuselage, air-to-air Stinger (ATAS) antiaircraft and Hellfire missiles, 0.50 in machine-guns and 2.75 in rocket pods, and a higher engine gas temperature to permit longer use of maximum power through a transmission rerated at 510 shp.

JUH-1N Iroquois (Ivo Sturzenegger)

UH-60A Black Hawk

The US Army has decided to arm, at the time of conversion and through a retrofit program, all 243 OH-58Ds being produced, assigning them the name of **Kiowa Warrior** early in 1990. Compared with the "Prime Chance" helicopters, future conversions will have a new engine diffuser providing 15 percent additional power, transmission rated at 575 shp, weapons stations added to the fuselage structure, structural improvements, and an integrated weapons control system. The two last-mentioned measures reduce weight by some 250 lb compared with "Prime Chance." Up to 81 of the 243 helicopters will be further modified for special duties with a "squatting" landing gear, folding main blades, and tilting vertical stabilizer to allow them to fly within 10 minutes of being taken from the hold of a C-130 Hercules transport aircraft. These Multipurpose Light Helicopters (MPLH) will also receive a cargo hook for loads of up to 2,000 lb and external attachments for six troop seats or four medevac litters. Initial Stinger-capable helicopters are to be delivered in January 1991 and are regarded as the first Kiowa Warriors. Currently being introduced are engine diffuser and transmission upgrades, plus provision for air-to-surface weapons. Max weight growth to 5,500 lb is envisaged.

OH-58Ds are based at Fort Eustis, Va., Fort Rucker, Ala. (for training), and with operational units in the CONUS, Korea, and Europe. Germany-based OH-58Ds have real-time video down-link which can be relayed via Guardrail-capable aircraft. Phase 1 additions, introduced on the production line in 1990, include doubled computer capacity to 88K, added weapons selection/aiming and multitarget acquisition/track displays, IR jammer, second RWR and laser-warning, video recorder, data transfer system, SINCGARS and Have Quick II radios, ANVIS display and symbology system, NBC mask, and EMP hardening. *(Data for OH-58D.)*

Contractor: Bell Helicopter Textron.
Power Plant: one Allison 250-C30R turboshaft; 650 shp.
Accommodation: pilot and observer/gunner.
Dimensions: rotor diameter 35 ft 0 in, fuselage length 33 ft 10 in, height 12 ft 9½ in.
Weights: basic 2,825 lb, gross 4,500 lb.
Performance: cruising speed 138 mph, service ceiling 12,000 ft, endurance 2 h 30 min.

UH-1C/H/M/V Iroquois

Supplanted in many first-line units by Black Hawks, the ubiquitous "Huey" has been assured of a continuing place in the Army's inventory by a reduction in LH requirements. Of some 5,400 UH-1Hs received since 1967, about 3,200 remain in service, together with modified variants and a few earlier models. The latter include **UH-1C**s powered by a 1,100 shp Lycoming T53-L-11 turboshaft and capable of carrying ten troops or external light armament. UH-1Cs fitted with the INFANT (Iroquois Night Fighter And Night Tracker) LLLTV-type equipment for night attack operations are designated **UH-1M.** With the **UH-1H,** Bell took the UH-1D's 12-seat cabin and added a 1,400 shp power plant, giving the ability to lift a 4,000 lb external load or fit a 300 lb rescue hoist. Like its predecessors, the UH-1H was widely used in Vietnam (where 2,591 of several UH-1 variants were lost), although the AH-1 Cobra removed some of the need for external armament. Nevertheless, the UH-1 may be fitted with a machine-gun in the cabin doorways. An unarmed version is the **UH-1V** medevac helicopter conversion of the UH-1H, of which some 220 were produced.

The UH-1H has been upgraded for its extended life. Changes have included an IR jammer, IR suppression measures, radar altimeter, radar-warning receiver, chaff/flare dispenser, crash-resistant fuel system, closed-circuit refueling, improved main driveshaft, and new radios. A further package of improvements in prospect includes Doppler, an improved gyro-magnetic compass, and NVG-compatible cockpit. In 1988, deliveries began of new composite-materials main rotor blades, which provide a 6 percent improvement in hovering capability and a 5–8 percent reduction of fuel consumption in forward flight. Reequipment is continuing of the UH-1H fleet, including the 1,260 in Army National Guard and 340 in Army Reserve service.

Contractor: Bell Helicopter Textron.
Power Plant: one Textron Lycoming T53-L-13 turboshaft; 1,400 shp.
Accommodation: two pilots and 11 troops, or six litters and attendant.
Dimensions: rotor diameter 48 ft 0 in, fuselage length 41 ft 10¾ in, height 14 ft 5½ in.
Weights: basic 5,132 lb, gross 9,500 lb.
Performance: cruising speed 138 mph, service ceiling 12,600 ft, endurance 2 h 45 min.
Armament: M23 subsystem of two 7.62-mm pintle-mounted machine-guns; or M56 mine-dispensing pods; or M59 subsystem of paired 7.62-mm and 0.50-in machine-guns.

UH-60A/L Black Hawk

With over 1,100 in service out of a target of 2,253 to be purchased by FY 2007, the Black Hawk is well on the road to its stated goal of replacing the UH-1 Iroquois in air assault, air cavalry, and aeromedical evacuation units of the Army. Though carrying the same 11-man squad as the Huey, a Black Hawk has more than twice the payload and better speed. It is the first utility/transport helicopter to increase division-level mobility, in that it can transport (for example) a 105-mm Howitzer, its six-man crew, and 30 rounds of ammunition in a single mission. Underslung load limit is 8,000 lb. Design aspects include armored or redundant components to resist small-arms fire, an impact-absorbing airframe to protect occupants in a crash, and maintainability features to ease servicing in the field. A compact design allows one Black Hawk to be airlifted by C-130 Hercules, two by C-141 StarLifter, and six by C-5 Galaxy.

Winner of the UTTAS (Utility Tactical Transport Aircraft System) competition in 1976, the Black Hawk entered production two years later and is currently deployed with the regular Army in the CONUS, Europe, and Korea; Army National Guard (60); and Army Reserve (45). Companies previously using 23 UH-1Hs now operate 15 Black Hawks. Armored cavalry regiments reporting directly to corps have, typically, 17 UH-60As operating alongside 26 AH-1s, 27 OH-58Cs, and three EH-60Cs; while divisional task forces use 15 UH-60As to support six UH-1Hs, six OH-58As, six OH-58Ds, and three EH-60Cs.

Beginning in 1989, the Corpus Christi Army Depot has been retrofitting new UH-60s with **Enhanced Black Hawk** modifications, including Omega navigation, satellite UHF, a specific threat radar-warning receiver, and provision to replace the M60 doorway-mounted machine-guns with M134 Miniguns. The first 15 were delivered to the US Army in Korea, achieving IOC in November 1989. From FY 1982 contracts onward, Black Hawks have been able to carry an ESSS (External Stores Support System), which allows up to 10,000 lb of external equipment to be carried, including Hellfire and other weapons, or fuel tanks for self-deployment. NVG-compatible cockpits were introduced in 1985 and have been retrofitted. Similarly, a HIRSS (Hover Infrared Suppression System) is now being installed to provide protection against heat-seeking missiles even when hovering.

In October 1989, production switched to the **UH-60L,** which replaces the T700-GE-700 turboshaft engines by -701Cs delivering almost 300 more shp, plus an improved gearbox. Sikorsky has also offered a further improved UH-60M which would feature a 1 ft fuselage stretch, advanced cockpit with integrated avionics, improved main rotor, two-piece windscreen, wire-strike protection, and self-defense measures, such as Stinger missiles. *(Data for UH-60A.)*

Contractor: Sikorsky Aircraft Division of United Technologies Corporation.
Power Plant: two General Electric T700-GE-700 turboshafts; each 1,560 shp.
Accommodation: three crew and up to 14 troops; or four litters and six walking wounded.
Dimensions: rotor diameter 53 ft 8 in, fuselage length 50 ft 0¾ in, height 16 ft 10 in.
Weights: basic 11,284 lb, gross 22,000 lb.
Performance: cruising speed 167 mph, service ceiling 19,000 ft, endurance 2 h 45 min.
Armament: M23 system of two 7.62-mm pintle-mounted machine-guns; M56 mine-dispensing pods; 16 Hellfire antiarmor missiles; or Stinger air-to-air missiles. ■

In the Toils of Congress

With Congress churning sixty percent of the budget a year, how is the Pentagon supposed to plan or manage?

In a white paper published April 5, Secretary of Defense Dick Cheney suggested that Congress "navigate the ocean" rather than "pick at the sand grains" in its relationship with the Pentagon.

"The Department of Defense is urged to act more like a business, but it is saddled with requirements that prevent businesslike operations and discourage private businesses from dealing with the Pentagon," Mr. Cheney said.

With up to sixty percent of the line items in the defense budget changed each year by Congress—the alterations sometimes being decided after the fiscal year has begun—"stability for individual programs is the exception rather than the rule," and the "most significant casualty is the ability to plan."

Mr. Cheney said his white paper was not intended "to indict Congress or to create consternation on Capitol Hill," but rather was an attempt to get Congress to do its part in making Pentagon management better. He proposed a number of changes.

• *Break the one-year syndrome.* Mr. Cheney asked Congress to adopt a real two-year budget cycle for defense. The Secretary urged lawmakers to "end the practice of reviewing all procurement programs every year. Instead, Congress should review programs as they go through major phases, such as from development to production."

Before 1959, the white paper said, Congress authorized weapons and forces without "revisiting the issue annually." This changed by increments. Yearly authorization reviews became a fixture of the process during the 1960s. After the formation of the House and Senate budget committees in 1974, yearly appropriations became "the preferred means of enacting policy."

The rate of line-item changes dropped sharply in 1989, the second year of the biennial budget experiment, but began rising again with the 1990 budget. The budget for any given program can be adjusted at more than fourteen points in the annual legislative process.

In 1989 alone, the paper said, there were more than fifty instances when defense money was earmarked restrictively, often mandating expenses that had little to do with genuine needs and funding for "what are clearly low-priority items."

Another frequent practice in pork-barrel politics "is the establishment of personnel or work load floors or requiring the continuance of specific functions at various installations. There are about a dozen such requirements in the 1989 defense bills, with even more extensive requirements in permanent law."

• *Reduce the reporting work load.* The number of pages of budget justification required grew from 12,000 in 1977 to 20,000 in 1990. It takes the equivalent of more than 500 full-time employees and more than $50 million a year to produce about 1,000 reports ordered by Congress. The time of 400 Pentagon employees is required "on a continuing basis" to respond to audits by the General Accounting Office, Congress's investigative arm.

In 1988, the Defense Department spent 245,000 hours replying to 18,000 congressional inquiries on acquisition issues alone. That does not include telephone inquiries —599,000 of them a year at last count.

• *Operate pilot programs.* At a press briefing, Deputy Secretary of Defense Donald Atwood said that the most important item in the legislative package accompanying the white paper is authority to run a pilot program on six major weapon systems "in which we actually operate those as though they were a commercial operation." He said the specific programs for such a test have not been chosen yet.

The Pentagon also wants authority to award weapon system contracts on the basis of total benefit to the US government. Mr. Atwood said the current acquisition process does take into account such factors as quality and a contractor's past performance, "but basically, unless from a practical standpoint we can declare a contractor nonresponsive, most of our contracts are awarded on price alone." ■

AFA Advisors and Councils

By Toni Kuzma

AFA President Jack C. Price has appointed the following advisors and councils for 1990:

AFA Presidential Advisors: Dr. Ken Daly, Junior AFROTC Advisor; Col. Roy A. Davis, Senior AFROTC Advisor; Kenneth A. Rowe, Civil Air Patrol Advisor; P. L. Schittulli, Civilian Personnel Advisor; and Patricia Turner, Medical Advisor.

Enlisted Council: CMSgt. Deborah S. Canjar, USAFE (Chairman); SSgt. Michael L. Acker, AFTAC; MSgt. Mary F. Baker, USAFE; MSgt. Frederick Booker, Jr., AFRES; SSgt. David E. G. Butler, AFSC; CMSgt. (selectee) Cheryl G. Conrow, AFDW (Vice Chairman); TSgt. Thomas R. Gerber, AFSPACECOM; TSgt. John L. Hoffman, Jr., AU; MSgt. Lee A. Hoven, ESC; SMSgt. (selectee) John A. Kittel, AFMPC; SSgt. Stephen M. Kravitsky, SAC; MSgt. Ronald A. LaRosa, MAC; SMSgt. (selectee) Deborah L. Lee, AAC; MSgt. William H. Nodine, ATC; MSgt. Michelle D. Oakes, AFCC; TSgt. Vincent E. Paoletta, PACAF; MSgt. Alva G. Patterson, AFLC; SSgt. Timothy R. Rademacher, AFCC; CMSgt. (selectee) Jack Szalasny, Hq. USAF (Liaison); SMSgt. Gary L. Thomas, USAF Academy; SMSgt. (selectee) Thomas C. Voegtle, TAC (Recorder); MSgt. Raymond N. Walker, Jr., PACAF; MSgt. Stephen C. Woodard, ANG. CMSAF James C. Binnicker, Advisor.

Junior Officer Advisory Council: Capt. Paul A. Willard II, AFSC (Chairman); Capt. Mark A. Atwell, TAC; Capt. Daniel D. Badger, Jr., PACAF; 1st Lt. Bruce A. Botkin, AFLC; Capt. James R. Downey, AFRES; Capt. Phyllis M. Fitzpatrick, SAC; Capt. Peter J. Gvazdauskas, AFSPACECOM; Capt. Francis L. Hendricks, USAFE; Capt.

AFA Presidential Advisors

Daly | Davis | Rowe | Schittulli | Turner

Enlisted Council


Canjar


Acker


Baker


Booker


Butler


Conrow


Gerber


Hoffman


Hoven


Kittel


Kravitsky


LaRosa


Lee


Nodine


Oakes


Paoletta


Patterson


Rademacher


Szalasny


Thomas


Voegtle


Walker


Woodard


Binnicker

Richard Carr, USAF (Ret.); Col. Robert W. Gregory, USAF (Ret.); CMSAF Don Harlow, USAF (Ret.); Col. Nathan H. Mazer, USAF (Ret.); Robert Puglisi; Col. James E. "Red" Smith, USAF (Ret.); Maj. Gen. Paul D. Straw, USAF (Ret.); CMSgt. Robert H. Waldrup, USAF (Ret.). Lt. Gen. John P. Flynn, USAF (Ret.), Advisor.

Junior Officer Advisory Council


Willard


Atwell


Badger


Botkin


Downey


Fitzpatrick


Gvazdauskas


Hendricks


Kaufhold


MacIntyre


McCracken


Mudrock


Nelson


Paraska


Ritter


Scheppner

Shellner

Silveria

Workman

Porter

Michael E. Kaufhold, Hq. USAF (Liaison); 1st Lt. Jean MacIntyre, ESC (Recorder); Capt. Cheryl L. McCracken, AFMPC; Capt. Kathy L. Mudrock, AU; Capt. Charles A. Nelson, ANG; Capt. Susan E. Paraska, USAF Academy; Capt. David L. Ritter, AFCC; Capt. David J. Scheppner, AAC; Capt. Earl Shellner, AFNEWS (Vice Chairman); Capt. Jay B. Silveria, ATC; Capt. Kit K. Workman, MAC. Maj. Gen. William J. Porter, USAF Director of Personnel Plans, Advisor.

Civilian Personnel Council: Tony Kausal (Chairman); George Baum; Dr. Paul W. Brower; Garry D. Carter; Leonard Casaus, Jr.; Teresa DiCarlo; Louis K. Dumas; James A. Mattice; Marti Maust; G. Hammond Myers III; Robert Page; Albert Perez (Liaison); Dr. Allan Schell. P. L. Schittulli, USAF Director of Civilian Personnel (Advisor).

Veterans/Retirees Council: Col. Sherman W. Wilkins, USAF (Ret.) (Chairman); Maj. Gen. (Chaplain)

Civilian Personnel Council


Kausal


Baum


Brower


Carter


Casaus


DiCarlo


Dumas


Mattice


Maust


Myers


Page


Perez


Schell


Schittulli

Veterans/Retirees Council


Wilkins


Carr


Gregory


Harlow


Mazer


Puglisi


Smith


Straw


Waldrup


Flynn

Air National Guard Council: Maj. Gen. Raymond A. Matera, USAF (Ret.) (Chairman); Brig. Gen. Adolph R. Hearon, ANG; Col. Frank C. Khare; TSgt. David G. Mark; and Capt. Charles A. Nelson.

Reserve Council: Brig. Gen. John J. Closner III (Chairman); Brig. Gen. Robert A. McIntosh (Acting Chairman); Col. John Harvey; Col. John Kittelson, USAF (Ret.); Col. Keith Reiling; Lt. Walter Ruman; Col. Alec Sawyer; and SMSgt. Mark Warren. ■

Air National Guard Council


Matera


Hearon


Khare


Mark


Nelson

Reserve Council


Closner


McIntosh


Harvey


Kittelson


Reiling


Ruman


Sawyer


Warren

A 1918 printer's mistake now trades for a fortune among stamp collectors.

The Inverted Jenny

By C. V. Glines

MODERN stamp collectors call it "The Twenty-Four-Cent Airmail Inverted Center of 1918." It bears a most curious airplane image, which has helped make it one of the world's best-known stamps. It is also among the most expensive. Each costs thousands of dollars to acquire.

The story begins on May 9, 1918, when the Post Office Department published a routine press release. It stated that on May 13, 1918, the US would issue a new, twenty-four-cent postage stamp in Washington, D. C. Though "intended primarily for the new aeroplane mail service," the stamp would be valid for all postal uses. Its border would be red. The center would feature a blue "mail aeroplane in flight"—a Curtiss JN-4 Jenny, to be exact.

The "new aeroplane mail service" was a ninety-day experiment scheduled to open on May 15. The experiment would test whether it was feasible to fly mail between Washington, Philadelphia, and New York on a scheduled basis, "one round trip daily except Sundays." The Army Air Service provided pilots. *[See "The Day the Airmail Started," December 1989 issue, p. 98.]*

Word of the forthcoming stamp soon reached W. T. Robey, an ardent collector who lived in the Capital. On May 14, Robey went to the window of a downtown post office. He bought a full sheet of the new stamps, 100 in all, paying for them with money just withdrawn from savings. The clerk passed the stamps through the window. Upon looking at the sheet, Robey later recalled, "my heart stood still." On every stamp, the entire 100, the image of the Jenny had been engraved upside down!

Robey called this to the clerk's attention. The clerk left the window and ran to a telephone. "Needless to say," Robey recalled twenty years later in *Weekly Philatelic Gossip* magazine, "I left that office in a hurry with my sheet of inverts tucked safely under my arm."

Once outside, Robey was struck with the thought that other branches might have more of the strange stamps. He hurried off to another post office on Eleventh Street, six blocks away. No inverted stamps, however, were found. Robey returned to his office to tell a co-worker about his find. The colleague rushed out to search for more.

For a while, it appeared that Robey's good luck would be short-lived. His co-worker told the postal clerks about Robey's find and where he worked. "Within one hour of my return to work," Robey said, "two postal inspectors called to see me."

The inspectors offered Robey "good" stamps in trade. He refused. He felt he was within his rights to hold on to them. As soon as the news spread among stamp collectors, Robey began to receive offers. The sums ranged from $2,500 to $15,000 for the entire sheet. Robey finally sold the sheet to Eugene Klein of Philadelphia for

$15,000—625 times the amount of his investment. Klein himself later sold the sheet for $20,000 to Colonel E. H. R. Green. Green broke up the sheet so that other collectors could obtain some of the stamps.

It is believed that only eighty-one of these stamps exist today. A single stamp recently traded hands for $100,000. No section of more than four stamps survives. Only seven of these four-stamp blocks exist; each is worth about $500,000. Attempts are sometimes made to counterfeit the twenty-four-cent inverts, but the frauds always have been quickly spotted.

The famous stamp error received enormous publicity. The Post Office Department was not pleased. All remaining sheets in other post offices were called in. The printing plate was altered; plate-makers added the word "TOP" so that the printers could run the paper through the red and blue printing process properly.

The US executed a limited printing of this stamp, the first definitive airmail stamp in the world. It also was the first to display an airplane, the first airmail stamp to be printed in two colors, and the first airmail stamp to contain an error.

For philatelists—those who collect and study postage stamps—the original twenty-four-cent airmail stamp is the best known in the world. It has been reproduced on jewelry, ashtrays, posters, T-shirts, pillows, and wall hangings. It is better remembered than the fact that Air Service pilots were the pioneers of scheduled airmail service, the origin of the world's great air transportation network. ■

C. V. Glines, a retired Air Force colonel, is a free-lance writer, a magazine editor, and the author of numerous books. His most recent article for AIR FORCE *Magazine was "Squadron in the Ice," which appeared in the June 1990 issue.*

Viewpoint

By Gen. T. R. Milton, USAF (Ret.), Contributing Editor

Fire Sale

Responsible restructuring is possible if we hold defense cuts to a rate of two percent a year. At 3.5 percent or greater, the adjustments become chaotic.

It is not yet clear whether the current defense cutbacks will result in mindless demolition or in intelligent restructuring. The usual congressional gadflies are preparing for demolition, except for those projects in their districts, but, happily for the nation's security, they are not, so far, the decisive voices. There are still statesmen like Sen. Sam Nunn who are looking for sensible ways to reduce the defense budget now that the Soviet threat has receded.

Constructing a balanced, if smaller, defense establishment is proving to be a difficult task. One service's idea of essential capabilities is not another's, so we can look forward to some interservice bickering, if not an all-out scrap. The last time the country held a similar military fire sale was in the late forties, and the squabbles were both unseemly and fierce, almost childish in their rationale. Some of those old battles may have to be fought again.

This time, however, the Army and the Air Force would seem to have a close community of interest in preserving their conventional forces, and while the enemy may be indistinct at the moment, there are plenty of candidates for the role. The question still to be answered is what kind of conventional force will survive.

It appears that the Air Force will end up with about 470,000 people, along with a sharp reduction in tactical fighter squadrons, by Fiscal Year 1997. There will be a commensurate closing of bases, both foreign and domestic, assuming that our politicians can rise above local interests. One unpleasant result may be a reliance on dual basing, with the attendant morale problem that comes with frequent rotation. It has long since been forgotten, but the original reason for putting the 401st Tactical Fighter Wing at Torrejon AB in Spain was to ease the rotation problem. Torrejon had nice facilities and plenty of room, and the families were less far apart when the men deployed to Aviano in Italy.

This time, the Army and the Air Force seem to have a close community of interest in preserving their conventional forces, and while the enemy may be indistinct, there are plenty of candidates for the role.

The strategic picture is more complicated, depending as it does on START and, of course, on the fate of the B-2. Total unit cost for the B-2 Stealth bomber is now somewhere around $800 million, a figure that is calculated to inspire media indignation, attract the budget cutters, and immortalize any pilot who forgets to lower his gear. Nevertheless, the B-2 should not be judged on cost alone. This bat-winged machine is unique. With a range that will allow it to reach anywhere in the world with one air refueling and a radar signature about that of a Canada goose, the B-2 is a rapid-reacting and very sneaky power projector. Its admittedly horrendous price tag should be measured against what it can do and against the cost of other long-distance means of projecting power.

Then there is the exploitation of space, essential and expensive. In almost constant midnight budget sessions, the Air Force has protected space projects and research and development in general, an action that would get an approving nod from Gen. Hap Arnold, who was a believer in pursuing the edge of technology. Navstar, a satellite navigation system accurate to a few meters, has seven of its planned twenty-four satellites in place. Bare bases in remote lands now come equipped with instant navigation and penetration aids, opening a whole new vista for rapid deployment.

That is the rosy side of the story, but it will only stay rosy if the cuts are held at about two percent per year from now on. If they go, say, to 3.5 percent, the program adjustments become chaotic.

We continue to live in a perilous world, one in which the Soviets, for all their troubles, their *glasnost* and *perestroika,* have persisted in modernizing their strategic systems and refurbishing their conventional forces with fine new equipment. They have also begun to drag their feet on arms control, perhaps to take advantage of our anxiety to cash in the peace dividend. Those facts alone are enough to keep us on guard, but there are other and less distinct threats to the tranquil life. Right now, six nations have exploded nuclear weapons, and several others are capable of producing them. By the year 2000, say the intelligence seers, there will be at least eleven nations in the nuclear club. It is difficult to imagine anything more sinister than nukes in the hands of fanatics, particularly should the fanatics feel they have the upper hand.

The lights burn late in the Pentagon nowadays as the staff sweats away new lineups with each changing budget direction. The leadership is determined to maintain quality above all, and that is a fine objective. But if reducing the deficit becomes the overriding consideration, with even carefully slimmed down defense proposals swept aside, then we are in for what could be the most dangerous period in our history, a period in which we would no longer have much to do with the exercise of power. ■

Valor

By John L. Frisbee, Contributing Editor

Rabaul on a Wing and a Prayer

Capt. Harl Pease was determined to be part of that first "mass mission" to Japan's great base in the southwest Pacific.

WHEN Maj. Gen. George Kenney arrived in Australia early in August 1942 to be Gen. Douglas MacArthur's air man, he had under his command only sixty heavy bombers; most of those that were combat-ready belonged to the 19th Bombardment Group. The 19th had been the only heavy bomb group in the Philippines when the Japanese struck on December 8, 1941. What was left of its force of already obsolescent B-17Cs and Ds was evacuated to Australia late that month.

Almost immediately, ten B-17s that the group could muster were sent to Java in a heroic but futile attempt to check the enemy's drive south toward Australia. In March 1942, as the Japanese poured ashore at Java, it was back to Australia. From bases near Townsville, the 19th flew supply and combat missions to the Philippines, some 2,500 miles to the north, and evacuated survivors, including General MacArthur. In May, the 19th joined Navy carrier aircraft in the first Battle of the Coral Sea and bombed targets on the north coast of New Guinea. The latter were sixteen- to eighteen-hour missions requiring staging out of Port Moresby in New Guinea. During the first six months of the war, the 19th was awarded four Distinguished Unit Citations, with two more to come, and earned its place as one of the most renowned bomb groups of World War II.

Harl Pease was one of the Group's pilots who participated in all of these hazardous events. He had joined the 19th in June 1940, fresh out of flying school. Now a captain, Pease was operations officer of the Group's 93d Squadron. He was soon to earn a unique position in the history of the 19th Bombardment Group.

On August 7, the US Marines were to land on Guadalcanal. To prevent Japanese air attacks, General Kenney ordered a maximum effort mission (twenty B-17s of the 19th Group, a "mass" raid at that time and place) to hit enemy air bases at Rabaul at the northeast tip of New Britain Island. The Group staged forward from Mareeba, its base in Australia, to Port Moresby. Bomb bay tanks were installed for the long overwater flight to Rabaul.

The day before the mission, a small diversionary attack was flown against the Japanese airfield at Lae, New Guinea. Harl Pease's B-17 was on that diversion. Over the target, one of his engines failed. Since an engine change could not be performed at Port Moresby, Pease was directed to return to Mareeba, 600 miles south over open water. He was, it appeared, not going to Rabaul, the most heavily defended Japanese base in the southwest Pacific.

Pease knew the importance of the Rabaul strike and was determined to go with the Group. At Mareeba there was only one flyable B-17, a war-weary aircraft that was used for training. Its engines were tired, some of the armament had been removed, and the electric fuel-transfer pump was gone. Pease decided to take it anyway. A bomb bay tank was installed hastily, and a handpump was jury-rigged. In less than three hours, Captain Pease and his crew, all of whom had volunteered to accompany him, were en route to Port Moresby, where Pease made a risky night landing on the marginally usable runway at 1:00 a.m. on August 7. He had been flying almost continuously since 6:00 a.m. the previous day.

With less than three hours' rest, Harl Pease nursed the "war-weary" into the air and managed to hold formation throughout the long flight to Rabaul. Short of the target, Vunakanau airfield, the Group was jumped by thirty Zeros, with Pease's corner of the formation taking the brunt of the attack, but the thirteen B-17s that reached the enemy bomber base put their bombs squarely on the runways and dispersal areas.

On the withdrawal, enemy fighter attacks continued for twenty-five minutes until the formation dived into clouds. Captain Pease's B-17, which had suffered extensive combat damage, could not keep up. He was last seen dropping a burning bomb bay tank before he and his crew apparently went down in flames—the only combat loss of the mission. The Group Commander, Col. Richard Carmichael, twice awarded the Distinguished Service Cross, later wrote that had the condition of Pease's B-17 been known to anyone other than his crew, he would not have been allowed to go on the mission.

Capt. Harl Pease was awarded the Medal of Honor posthumously. On December 2, 1942, the Medal was presented to his father by President Roosevelt in a White House ceremony. It was the second Medal of Honor awarded to an airman during World War II, preceded only by Gen. Jimmy Doolittle's decoration for the Tokyo mission. In 1957, the SAC base at Portsmouth, N. H., near Pease's hometown of Plymouth, was named in his honor. That base is to be closed in September 1990, but the memory of Harl Pease's dedication and heroism will remain forever a part of the Air Force tradition of valor. ■

AFA/AEF Report

By Daniel M. Sheehan, Assistant Managing Editor

Iron Gate Does It Again

In early April, AFA's New York City Iron Gate Chapter held its twenty-seventh National Air Force Salute. The Chapter's top honor, The Maxwell Kriendler Memorial Award, named for its founder, was presented to the recently retired Vice Chairman of the Joint Chiefs of Staff, Gen. Robert T. Herres, USAF.

General Herres was recognized for his outstanding military career as a pilot, planner, commander, and strategist. He pioneered in two roles—as the first Commander in Chief of US Space Command and as the first Vice Chairman of the Joint Chiefs of Staff. The citation for the award read, in part, "His vision, intuitive interpretation, dynamic implementation, and innovative management decisions have established high standards for all who will follow."

Chapter President Richard A. Freytag presented an Aerospace Education Foundation Jimmy Doolittle Fellowship to Chapter Vice President (and AFA National Secretary) Tom McKee, in recognition and appreciation for his seven years as Salute Committee Chairman. The Salute achieved record totals of contributions during each year of his tenure.

Honored with AEF Ira Eaker Fellowships at the event were B-2 Program Director Maj. Gen. Richard M. Scofield and Strategic Defense Initiative Organization Director Lt. Gen. George L. Monahan, Jr. All told, the Chapter has given out 161 Jimmy Doolittle Fellowships and thirty-four Ira Eaker Fellowships.

Through 1989, the Chapter has raised more than $1.7 million for USAF-related charities. Besides AEF, recipients include the Air Force Assistance Fund, Air Force Historical Foundation, USAF Museum, National Aviation Hall of Fame, and New York City's Soldiers', Sailors', and Airmen's Club, which provides lodging and meals at reasonable prices to transient active-duty enlisted personnel. The Chapter also sponsors scholarships for local Civil Air Patrol cadets and the Falcon Foundation at the Air Force Academy.

The black-tie crowd was entertained by actress Dixie Carter of television's "Designing Women." Next year's Salute will take place in New York on April 13.

—James A. McDonnell, Jr.

—Photo by Ron Hall

As always, a galaxy of stars attended the annual National Air Force Salute, sponsored by the New York City's Iron Gate Chapter. Turning out to honor retiring Vice Chairman of the Joint Chiefs of Staff Gen. Robert Herres were (from left to right) Salute Chairman and AFA National Secretary Thomas McKee, Iron Gate Chapter President Richard Freytag, CINC of US Space Command Gen. Donald Kutyna, AFLC Commander Gen. Charles McDonald, CINCMAC Gen. H. T. Johnson, Salute Coordinator Dorothy Welker, CINCSAC Gen. John Chain, Jr., Chapter Vice President Robert Batta, and Chapter Treasurer William Lees.

The Scott Berkeley Chapter has signed its 100th Community Partner, Hal Walden of Pizza City USA, here receiving a plaque from Brig. Gen. (selectee) J. O. McFalls, commander of the 4th TFW. Flanking them are, from left, Chapter President Ed Kelly, National Director "Red" Smith, and Chapter Vice President Rick Rearick.

General McDonald (left) also made a trip to the Sooner State to discuss the state of USAF at an Oklahoma AFA dinner meeting. Seen with the General are State President Aaron Burleson; Maj. Gen. Joe Spiers, commander of the Oklahoma City Air Logistics Center; and Brig. Gen. John Allen, vice commander of the Center.

Hands Across the Pond

The Portuguese possession of the Azores and the state of New Jersey have more in common than is apparent at first glance. Geographically, both straddle the thirty-ninth parallel, both have economies with a strong maritime component, and both are home to major Military Airlift Command installations. This latter connection led **McGuire (N. J.) Chapter** member and State Vice President for Membership Bob Gregory to pay a visit to Lajes Field to lend his Chapter's support to a base membership drive there. He advised drive-project officer Maj. Paul Smith on AFA origins, programs, and objectives and gave a $1,000 check to 1605th Military Airlift Support Wing Commander Brig. Gen. Charles Barnhill to aid the wing's Community Relations program. Mr. Gregory arranged to maintain the connection with the overseas base through a weekly telephone contact.

Schittulli Honored

Mr. Pat Schittulli, who has served the Air Force for more than thirty-five years, both in the military and as a civilian, received a Special Presidential Citation from AFA National President Mr. Jack C. Price during a meeting in Orlando, Fla. Mr. Schittulli, currently USAF Director of Civilian Personnel, is the Advisor to AFA's Civilian Personnel Council.

Chapter News

Realizing that an ounce of firsthand experience is worth a pound of armchair punditry, the **Panhandle (Tex.) Chapter** became one of several chapters around the country to hear an address from a participant in Operation Just Cause. Col. H. Ross Becker, Director of Operations for 12th Air Force, headquartered at Bergstrom AFB, Tex., gave the audience an insider's perspective on the meticulous planning and execution that goes into an operation the size of Just Cause. The Chapter received much favorable publicity from the Colonel's talk, and those who heard the forty-five-minute presentation said it gave more insight into the Operation than the hours of network coverage did. National Vice President (Southwest Region) Ollie Crawford, National Treasurer William Webb, New Mexico President Louie Evers, Oklahoma President Aaron Burleson, Texas President Dan Heth, and Chapter President L. Ray McKee were at the meeting, which also saw Earle North Parker Essay Contest winner Amanda Roberson of Perryton High School honored with $300 in savings bonds for prize-winning essay, "What the Flag Means to Me."

The **Langley (Va.) Chapter** distributed accolades to the top squadrons in the 1st Tactical Fighter Wing (TFW) during a luncheon at the Langley AFB NCO Club. Chapter President Dick Price handed the award for outstanding flying squadron to the 94th TFS, while the 1st Mission Support Squadron picked up the laurels for the outstanding support squadron. Squadron Commander Lt. Col. Jim Smith and Aircraft Maintenance Unit

Coming Events

July 6–7, **Ohio State Convention,** Dayton, Ohio; July 6–7, **Oklahoma State Convention,** Tinker AFB, Okla.; July 6–8, **Arizona State Convention,** Litchfield Park, Ariz.; July 13–15, **Pennsylvania State Convention,** Philadelphia, Pa.; July 13–15, **Texas State Convention,** Fort Worth, Tex.; July 13–15, **Virginia State Convention,** Hampton, Va.; July 20–21, **Michigan State Convention,** Wurtsmith AFB, Mich.; July 21, **North Carolina State Convention,** Fayetteville, N. C.; July 26–28, **California State Convention,** Los Angeles, Calif.; July 27–29, **Florida State Convention,** Tampa, Fla.; July 27–29, **New Mexico State Convention,** Alamogordo, N. M.; August 3–4, **Louisiana State Convention,** England AFB, La.; August 4, **Indiana State Convention,** Indianapolis, Ind.; August 4, **Montana State Convention,** Malmstrom AFB, Mont.; August 10–11, **North Dakota State Convention,** Fargo, N. D.; August 17–18, **Wisconsin State Convention,** Milwaukee, Wis.; August 18, **Mid-America Ball,** St. Louis, Mo.; August 18–19, **Illinois State Convention,** St. Louis, Mo.; August 24–25, **Utah State Convention,** Hill AFB, Utah; August 25, **Minnesota State Convention,** Minneapolis, Minn.; August 24–26, **Nevada State Convention,** Las Vegas, Nev.; September 7–8, **Colorado State Convention,** Colorado Springs, Colo.; September 17–20, **AFA National Convention and Aerospace Development Briefings and Displays,** Washington, D. C.; October 13, **North Central Regional Workshop,** Bloomington, Minn.; November 17–18, **Southeast Regional Workshop,** Shaw AFB, Sumter, S. C.

Chief Capt. Katheryn Corbin accepted the award for the 94th TFS, which has a fine reputation for innovation, teamwork, and readiness. Lt. Col. Jack Miller, 1st Mission Support Squadron Commander, and TSgt. Ed Hughes, the squadron's first sergeant, accepted the support squadron trophy. Their unit received high praise for streamlining its activities, performing well under pressure, and completing a successful deployment to Egypt. Lt. Gen. Charles Horner, Commander of 9th Air Force and USCENTCOM's Air Forces, spoke at the luncheon, during which the achievements of former Chapter President Don Elliot and National Vice President (Central East Region) R. Donald Anderson were also recognized.

Westover AFB, Mass., recently celebrated its fiftieth anniversary with an assist from the nearby **Major John S. Southrey (Mass.) Chapter**, but dwelled on the past only briefly as it combined the anniversary with the dedication of its new maintenance hangar, designed to service sixteen 439th Military Airlift Wing (AFRES) C-5As. Keynote speaker Gen. H. T. Johnson, CINC of both Military Airlift Command and US Transportation Command, lauded the Air Force Reserve and expressed appreciation for the support given to the base by the surrounding community. On hand were many members of the Westover family (the base's namesake, Maj. Gen. Oscar Westover, the fourth Chief of Air Corps, was killed in a plane crash in 1938) and four generations of the Stonina family, longtime pillars of the Chicopee, Mass., community and AFA stalwarts for decades. Chapter President David R. Cummock presented a plaque to the Stonina family in recognition of the contributions of Anthony J. Stonina, former mayor of Chicopee, who was instrumental in bringing the base to the city. The anniversary/dedication ceremonies, attended by 2,000 members of the 439th MAW and 1,000 visitors, helped to cement the already solid relations between the base and the community.

The Reserve component of the Total Force was also at the forefront in North Carolina as the **Piedmont (N. C.) Chapter** heard Maj. Gen. Philip G. Killey, Director, Air National Guard, discuss "Current Issues Affecting the Department of Defense and the National Guard" during its quarterly meeting. Col. William Lackey, Commander of North Carolina ANG's 145th Tactical Airlift Group, also spoke, and the audience enjoyed both officers' cogent remarks. Lt. Gen. David Nichols, retired Commander of Alaskan Air Command; Brig. Gen. Frederick Keith, ANG Assistant to Air Force Communications Command; and CMSgt. Richard Green, ANG Senior Enlisted Advisor, also attended, as did AFA dignitaries National Director James E. "Red" Smith, National Vice President (Southeast Region) Roy P. Whitton, and North Carolina State President John White. The Chapter also took the opportunity to install a new President, Floyd Wilson, and honor a former President, Marshall Pratt.

The **Nathan F. Twining (Fla.) Chapter**, known for its outstanding support for education and the young people in the Pinellas County area, recently named its "Outstanding Cadets of the Year." AFJROTC Cadet Commander Marc Himelhoch of Countryside High School and Cadet CAP Commander of the Clearwater Composite Squadron, Aaron Staley, received the awards. The Chapter has also been vigorously supporting the areas libraries.

Have AFA News?

Contributions to "AFA/AEF Report" should be sent to Dave Noerr, AFA National Headquarters, 1501 Lee Highway, Arlington, VA 22209-1198. ■

Bulletin Board

Seeking information on **David Fairbanks,** who was an American RCAF pilot who flew Tempest V fighters with RAF Nos. 501, 274, and 3 Squadrons and was shot down in February 1944. **Contact:** Paul A. Ludwig, P. O. Box 15670, Seattle, WA 98115.

Seeking information on the whereabouts of **Joseph S. Clarke,** who served in England between 1962 and 1964 at either Lakenheath or Mildenhall. **Contact:** Wayne Radford, 7 Arbour Court, Lumbertubs, Northampton NN3 4HB, England.

Seeking an example of an **Air Medal** awarded to a Civil Air Patrol recipient for World War II service. **Contact:** Charles A. Pfeiffer, 1401 Druid Rd., Maitland, FL 32751.

Seeking historical data, photographs, or other memorabilia connected with the **Childress AAF Bombardier School** from 1942 to 1946. **Contact:** Maj. Walter Lockhoof, USAF (Ret.), Childress County Heritage Museum, 210 3d St. N. W., Childress, TX 79201.

Seeking contact with members of the **15th Bomb Squadron,** especially **Capt. Norman Segal,** for a history of the unit. **Contact:** Col. Hal Radetsky, USAF (Ret.), 4204 Inman Ct., Fort Worth, TX 76109.

Seeking the whereabouts of **Billy W. Morris,** who was at RAF Lakenheath from 1985 to 1987. **Contact:** Nikki Gaunt, 44 Carters Mead, Harlow, Essex CM17 9ER, England.

Seeking information, pictures, or pamphlets on the **MiG-29 Fulcrum. Contact:** Scott Beaty, 5507 Greentree, Wichita Falls, TX 76306.

Collector seeks **patches** from F-4, F-106, and F-16 squadrons, groups, and wings. **Contact:** Christian Sabon, 23815 Manila, Mount Clemens, MI 48045.

Seeking information on the whereabouts of **Quentin R. "QR" Wolfe,** who was a radar observer with the 414th Nightfighter Squadron, 12th Air Force, in World War II. **Contact:** Wayne A. Dohrman, 649 Chambers Rock Rd., Landenberg, PA 19350.

Collector seeks Vietnam-era **patches. Contact:** Johnny "Siggy" Signor, 3418 Carolyn Ln., Cocoa, FL 32926.

Seeking early Air Force **recruiting posters. Contact:** Helen Clark, 10102 Crestberry Pl., Bethesda, MD 20817.

Seeking information on **SSgt. John Thomas Dorris,** who was in the 613th Squadron, 401st Bomb Group, and was shot down over Politz, Germany, on October 7, 1944. **Contact:** J. W. Bryson, 566 Vallejo St. #33, San Francisco, CA 94133.

Collector seeks USAF **patches,** pilot scarves, and pilot name tags. **Contact:** Marcel Voorsluijs, Hogendorplaan 32, 3931 Hp, Woudenberg, Holland.

Seeking information on the whereabouts of **Alfred R. Berger** and **Howard Crall,** who were both members of the 815th Bomb Squadron, 483d Bomb Group, stationed at Sterparone, Italy, during World War II. Berger's last known address was Sioux City, Iowa; Crall's was Jacksonville, Fla. **Contact:** Alex Dewa, 27580 Roan, Warren, MI 48093.

Seeking contact with members of the **3910th Air Police Squadron** stationed at RAF Mildenhall and members of the **3909th Air Police Squadron** at RAF Lakenheath, who were there between 1952 and 1954. **Contact:** Beryl Foreman, 59 Scotland Rd., Cambridge CB4 1QW, England.

Collector seeks **patches** from 1st SOW and 37th and 35th TFW. Can buy or trade manufacturer's stickers and patches. Especially interested in anything from "Wild Weasel" units from the Vietnam era through today. **Contact:** G. Aceto, 1501 Lee Highway, Arlington, VA 22209-1198.

For sale, a **Norden Bombsight,** type M-9, including sight head and stabilizer. **Contact:** Carroll J. Watkins, 415 Plantation Dr., New Bern, N. C. 28562.

Seeking the whereabouts of members of B-17 crew 5-21 who trained at **Drew AAF,** Tampa, Fla., from March through May 1945. The pilot's last name was Raab, and he was from California; the copilot was Gilbert Schneider of Oklahoma City, Okla. **Contact:** Victor Konicki, Jr., 9333 North Church Dr., Apt. #409, Parma Heights, OH 44130-4718.

Seeking information and photos on **Cessna O-2A/B** flight and maintenance crews at Bergstrom AFB, Tex., from 1970 to 1979, who were in the 602d TAIRON and 4502d CAMS. I am trying to rebuild an O-2A aircraft 69-7656 and write its history. **Contact:** Lt. Col. Don Nieser, AFRES, 6221 Commodore Ln., Oklahoma City, OK 73162.

Seeking the whereabouts of **Capt. Steven Balkovec,** who was stationed at Griffiss AFB, N. Y., in the mid-1970s and on Guam in 1977. Also seeking contact with his daughter, Debbie. **Contact:** Christine Rahn Osterhoudt, R. D. 1, Box 224, Rome, NY 13440.

Seeking detailed information pertaining to the position of **Air Weapons Director/Controller. Contact:** Leland M. Heath III, 2805-22 Brigadoon Dr., Raleigh, NC 27606.

Seeking Amarillo Technical Training Center **patch,** with the logo "Victory Through Knowledge," or a clear color photo of the patch. Would like to have new patches made for those who served at Amarillo AFB, Tex. **Contact:** Elmer W. Ross, P. O. Box 807, Everett, WA 98206.

Collector seeks USAF, Navy, ANG, and Army **patches,** decals, and photos. Also seeking USAF or Navy flight jacket and American Optical pilot's sunglasses. Will trade Spanish decals, photos, patches, and Air Force clothing. **Contact:** Ramon Rodriguez Areces, Rio Guadalentin #42, San Javier 30730, Murcia, Spain.

Seeking contact with members of 417th Bomb Squadron and **A-20 pilots** from the 418th, 419th, 420th, and 421st Nightfighter squadrons for a history of the A-20. **Contact:** M. C. Langford, 3236 Ryan Ave., Fort Worth, TX 76110.

Seeking crew members of **MATS Mobile Maintenance C54AC,** who were at Orly Field, Paris, France, between 1949 and 1952. **Contact:** CMSgt. Ed H. Ricketts, (Ret.), 101E Tam O'Shanter, Phoenix, AZ 85022.

Membership in the newly formed **Association of Air Force Manpower Management Professionals** is open to all military personnel and civil-service employees, active and retired, who have served in the Manpower Management career field. **Contact:** Lt. Col. D. L. Cohen, USAF (Ret.), 2946 Concord Ave., Suite 109, Davis, CA 95616-4811.

Seeking unit **patches** from the Korean War, 58th FBW, 311th FBS, 450th FDW, 721st FDS; and the 86th Bomb Squadron, 47th Bomb Wing patch from USAFE. **Contact:** MSgt. Guy K. Moore, USAF (Ret.), 104 N. Crescent Dr., Blytheville, AR 72315.

RAF Binbrook in Lincolnshire, England, is being restored to create the "Allied Memorial Airfield." Seeking books of remembrance of the 8th USAAF to include in this memorial. **Contact:** Dr. Keith Percival-Barker, Bomber Airfield Society, Lynford Hall, Thetford, Norfolk, England.

For a book on the subject, seeking information and reminiscences from US servicemen and servicewomen who were stationed within a twenty-five-mile radius of **Swindon, England. Contact:** Hazell W. Sheppard, 21 Grosvenor Rd., Swindon, Wiltshire SN1 4LT, England.

If you need information on an individual, unit, or aircraft, or if you want to collect, donate, or trade USAF-related items, write to "Bulletin Board," AIR FORCE Magazine, 1501 Lee Highway, Arlington, VA 22209-1198. Letters should be brief and typewritten. We cannot acknowledge receipt of letters to "Bulletin Board." We reserve the right to condense letters as necessary. Unsigned letters are not acceptable. Photographs cannot be used or returned.—THE EDITORS

Seeking information on the whereabouts of **John Revak,** who was from Myrtle Beach, N. Y., and was a member of Observer Class 54-13C at Lackland AFB. **Contact:** Dr. Neil Randle, 6517 6th Ave., Tacoma, WA 98406.

Seeking the whereabouts of **John McCartney,** who was from Connecticut and was stationed in Southport, Lancashire, England, as a lieutenant in the Army Air Forces in 1945. **Contact:** Ben Andrews, Flat 4, 44 Lansdowne Rd., London N17 9XG, England.

Seeking information on a **B-17** named "Voice of Waukesha, Wisconsin," especially its wartime history and crew. **Contact:** Chuck Farber, Warren S. O'Brien Museum, 655 Poplar Creek Dr., Waukesha, WI 53186.

Seeking the whereabouts of **Maj. Howard J. Knabenshe,** whose last known address was in Washington, D. C. Also seeking **James H. Hamilton,** who was from Albany, Ga., and graduated from the Army Flight School in 1945. **Contact:** Earl F. Nelson, 19753 E. 42d St., Broken Arrow, OK 74014.

For an upcoming biography, author seeks contact with individuals who can supply anecdotal or other information on **Brig. Gen. Kenneth N. Walker,** particularly from those who flew with him in 5th Bomber Command from 1942 to 1943. **Contact:** Martha Byrd, P. O. Box 1659, Davidson, NC 28036-1659.

For display and collection, seeking **World War II USAAF artifacts,** especially clothing, personal items, photographs, logbooks, and other written material. **Contact:** Brian Goodman, 22 Castlehall, Glascote, Tamworth, Staffordshire B77 2EQ, England.

Seeking contact with members of the **8th Combat Cargo Squadron,** (World War II). **Contact:** Dr. Dubose Egleston, R. R. 1, #124, Rockbridge Baths, VA 24473.

Seeking names of those from the **448th Squadron,** 321st Group, 57th Command, 12th Air Force, who joined the unit too late to have their names in *Headlines.* **Contact:** Earl Hornbeck, 4311 E. 75th Terrace, Kansas City, MO 64132.

Unit Reunions

Air Commandos
The Air Commando Association will hold a reunion October 5–7, 1990, in Fort Walton Beach, Fla. **Contact:** Reunion Committee, Air Commando Association, Box 7, Mary Esther, FL 32569.

AFLC Big Safari Program
The Air Force Logistics Command Big Safari Program staff is planning to hold three reunions in October 1990 for its members, alumni, associates, and supported organizations. Tentative dates are October 12, in Ontario, Calif.; October 19, in Dayton, Ohio; and October 26, in Dallas, Tex. Your location preference and number of people attending should be included in your reservation. **Contact:** Big Safari Reunion, Box 1248, Fairborn, OH 45324.

CBI Veterans Ass'n
China-Burma-India theater veterans (World War II) will hold a reunion September 4–9, 1990, at the Hyatt Regency Hotel in Dallas, Tex. **Contact:** Ted Faaborg, 830 Shady Ln., Bedford, TX 76021.

Korean War Veterans
Veterans of the Korean War will hold a reunion October 18–21, 1990, in Phoenix, Ariz. **Contact:** Jim Bork, 3301 W. Encanto, Phoenix, AZ 85009. Phone: (602) 272-2418.

P-40 Warhawk Pilots
The P-40 Warhawk Pilots will hold a reunion September 26–29, 1990, at the Holiday Inn in Hampton, Va. **Contact:** Col. Robert W. Klump, 1443 Big Bethel Rd., Hampton, VA 23666. Phone: (804) 766-3485.

P-51 Mustang Pilots
The P-51 Mustang Pilots will hold their reunion October 26–28, 1990, at the Santa Maria Airport Hilton Hotel in Santa Maria, Calif. **Contact:** Pete Hardiman, 3233 San Pedro Way, Union City, CA 94587. Phone: (415) 487-2391.

1st Photo Recon Squadron
Members of the 1st Photo Reconnaissance Squadron will hold a reunion September 28–30, 1990, at the Holiday Inn in Dayton, Ohio. **Contact:** Raymond Schafer, 274 Hwy. 22 West, Ponchatoula, LA 70454. Phone: (504) 386-3445.

1st/69th Pilotless Bomber Squadrons
The 1st and 69th Pilotless Bomber Squadrons will hold a reunion September 15–16, 1990 in Denver, Colo. **Contact:** Quint "Micky" Hart, 156 E. 2d St., Preston, ID 83263. Phone: (208) 852-1863.

7th Photo Recon Group
Members of the 7th Photo Reconnaissance Group, including assigned squadrons who served during World War II at Mount Farm, Chalgrove, and High Wycombe, England, will hold a reunion September 30–October 4, 1990, at the Riviera Hotel in Las Vegas, Nev. **Contact:** George Lawson, 4390 14th St. N. E., St. Petersburg, FL 33703. Phone: (813) 526-8480.

11th Air Force
The 11th Air Force will hold a reunion August 4–11, 1990, in Anchorage, Alaska. **Contact:** Ralph M. Bartholomew, 615 Stedman St., Ketchikan, AK 99901. Phone: (907) 225-2121.

12th Tactical Air Command
Members of the 12th Tactical Air Command (Headquarters/Headquarters Squadron) who served during World War II will hold a reunion September 7–9, 1990 in Seattle, Wash. **Contact:** Mrs. Joseph P. Kranak, Jr., 2215 21st Ave. South, Seattle, WA 98144. Phone: (206) 322-1139.

15th FIS
The 15th Fighter Interceptor Squadron will hold a reunion September 28–30, 1990. **Contact:** George Clasey, 2140 N. 58th St., Lincoln, NE 68505. Phone: (402) 466-5034.

19th Bomb Group
Members of the 19th Bomb Group will hold a reunion October 2–7, 1990, in Colorado Springs, Colo. **Contacts:** James A. Kiracofe, 274 Quinn Rd. West, Alexandria, OH 45381. Phone: (513) 839-4441. Robert E. Ley, 3574 Wellston Ct., Simi Valley, CA 93063. Phone: (818) 703-7717.

19th Troop Carrier Squadron
Members of the 19th Troop Carrier Squadron (World War II) will hold a reunion September 27–29, 1990, in Reno, Nev. **Contact:** Jesse E. McSwain, 1012 N. Larrimore St., Arlington, VA 22205. Phone: (703) 533-1390.

Readers wishing to submit reunion notices to "Unit Reunions" should mail their 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.

20th ATS/MAS
Members of the 20th Air Transport Squadron/Military Airlift Squadron (1942–1990) will hold a reunion October 3–8, 1990, at the International Inn in Orlando, Fla. **Contact:** CMSgt. Elmer R. Andrews, USAF (Ret.), 898 S. E. Seahouse Dr., Port St. Lucie, FL 34983. Phone: (407) 878-2486.

20th Combat Mapping Squadron
The 20th Combat Mapping Squadron will hold a reunion September 13–16, 1990, at Virginia Beach, Va. **Contact:** Lt. Col. David W. Ecoff, Sr., USAF (Ret.), 13850 Tulane St., Brookfield, WI 53005-7146.

25th FIS
Fighter pilots of the 25th Fighter Interceptor Squadron, 51st Fighter Interceptor Group and Wing, will hold a reunion in mid-1990 at Nellis AFB, Nev. This unit served at Suwon AB, Korea, and at Naha AB, Okinawa, Japan, in 1954. **Contact:** Dr. Robert N. Cleaves, 1224 Roberto Ln., Los Angeles, CA 90077. Phone: (213) 472-2593.

34th Air Depot Group
Members of the 34th Air Depot Group will hold a reunion September 6–9, 1990, in Kansas City, Mo. **Contacts:** Nolan Price, 12318 W. 61st St., Shawnee, KS 66216. Phone: (913) 631-8890. Hartman Williams, 2005 Freeman, Kansas City, KS 66102. Joe Myers, 2729 Ostrom Ave., Long Beach, CA 90815. Phone: (213) 421-2166.

35th Troop Carrier Squadron
The 35th Troop Carrier Squadron will hold a reunion September 13–15, 1990, in Scottsdale, Ariz. **Contact:** Arvie Korstad, 8220 E. Sage Dr., Scottsdale, AZ 85250. Phone: (602) 945-8720.

36th Photo Recon Squadron
The 36th Photo Reconnaissance Squadron will hold a reunion October 15–18, 1990, at the Riviera Hotel in Las Vegas, Nev. **Contact:** Harold Geist, 6338 Orinda Dr., Apt. 1147, Dallas TX 75248. Phone: (214) 458-9392.

39th Troop Carrier Squadron
Members of the 39th Troop Carrier Squadron, 317th Troop Carrier Group (World War II), will hold a reunion September 7–9, 1990, in Denver, Colo. **Contact:** Bruce Davidson, Sr., 221 Savano Ave., Salida, CO 81201.

40th Bomb Group Ass'n
The 40th Bomb Group Association and the 28th Air Service Group will hold a reunion October 31–November 4, 1990, at the Holiday Inn in Tucson, Ariz. **Contact:** Neil W. Wemple, 9717 E. Shiloh, Tucson, AZ 85748. Phone: (602) 296-8880.

Class 40-F
Members of Flying Cadet Class 40-F will hold a fiftieth-year anniversary reunion October 4–7, 1990, at the Menger Hotel in San Antonio, Tex. **Contact:** Gorden L. Paulson, #7 Camden Circle, San Antonio, TX 78218. Phone: (512) 820-0560.

Class 41-E
Members of Flying Cadet Class 41-E will hold a fiftieth-year anniversary reunion September 11–15, 1990, at Wright-Patterson AFB, Ohio. **Contact:** Lt. Col. Lawrence O. Berglund, USAF (Ret.), 1510 Tatum Dr., Arlington, TX 76012. Phone: (817) 861-2581.

Class 41-G
Members of Flying Class 41-G will hold a reunion September 26–30, 1990, in Orlando, Fla. **Contact:** Col. Lee E. Baker, USAF (Ret.), 1318 Maury Rd., Orlando, FL 32804. Phone: (407) 425-0358.

Class 42-K
Members of Class 42-K will hold a reunion October 10–14, 1990, in Dayton, Ohio. **Contact:** Melvin M. Smith, P. O. Box 2913, Santa Rosa, CA 95405.

43d Air Service Squadron
The 43d Air Service Squadron, 5th Air Force (World War II), will hold a reunion September 6–8, 1990, in Pentwater, Mich. **Contact:** Howard Schrumpf, 214 S. Wythe, P. O. Box 740, Pentwater, MI 49449. Phone: (616) 869-5346.

43d Bomb Group
The 43d Bomb Group will hold a reunion October 8–14, 1990, at the Marriott Pavilion in St. Louis, Mo. **Contact:** Lloyd Boren, 102 Beechwood, Universal City, TX 78148. Phone: (512) 658-5978.

Class 45-A
Members of Class 45-A (Enid Field, Okla.) will hold a reunion October 5, 1990, in Enid, Okla. **Contact:** Frank Therrell, 3303 Shady Cove, Tyler, TX 75707. Phone: (214) 566-2616.

45th Air Depot Group
The 45th Air Depot Group will hold a reunion August 16–19, 1990, in Amarillo, Tex. **Contact:** Charles F. Guemelata, 119 Aigler Blvd., Bellevue, OH 44811. Phone: (419) 483-4371.

Class 47-C
Pilot Class 47-C graduates and nongraduates will hold a reunion October 18–21, 1990, in Pensacola, Fla. **Contact:** Maj. William R. Forrester, Jr., USAF (Ret.), 304 Lynch St., Edgefield, SC 29824. Phone: (803) 637-3959.

48th Fighter Squadron
Members of the 48th Fighter Squadron, 14th Fighter Group (World War II), will hold a reunion October 7–9, 1990, at the Radisson Inn in Dayton, Ohio. **Contact:** Burt Cox, 3640 Kelso

Rd., North Adams, MI 49262. Phone: (517) 287-4289.

58th Bomb Wing
The 58th Bomb Wing will hold a reunion September 10–16, 1990, at the Red Lion Inn in Omaha, Neb. **Contact:** James L. Pattillo, 1143 Glenview Rd., Santa Barbara, CA 93108. Phone: (805) 969-2796.

62d Troop Carrier Group
The 62d Troop Carrier Group (World War II) will hold a reunion October 24–27, 1990, in St. Louis, Mo. **Contact:** Jack Lesher, 3051 Octavia Pl., Atlanta, GA 30340. Phone: (404) 938-4270.

71st/341st Air Refueling Squadrons
Members of the 71st and 341st Air Refueling Squadrons and the 4060th Air Refueling Wing who served at Dow AFB, Me., between 1954 and 1964 will hold a reunion September 27–29, 1990 in Las Vegas, Nev. **Contact:** James R. Everett, 1615 Woodcrest Ln., Carrollton, TX 75006. Phone: (214) 242-1932.

138th Tactical Fighter Group
The Tulsa, Okla., ANG and the 138th Tactical Fighter Group will hold a reunion September 7–9, 1990. **Contact:** Lt. Col. Jack R. Seay, USAF (Ret.), 1219 E. 13th St., Tulsa, OK 74120. Phone: (918) 583-3181 or (918) 599-9803.

302d Tactical Recon Squadron
The 302d Tactical Reconnaissance Squadron will meet on October 11, 1990, in conjunction with the 14th Tactical Reconnaissance reunion on October 12–14, 1990, in McAllen, Tex. **Contact:** Lt. Col. Roger S. Wilkes, USAF (Ret.), 8918 Taft Hill Ct., Sandy, UT 84093. Phone: (801) 943-0529.

315th Bomb Wing
The 315th Bomb Wing, 20th Air Force (World War II), will hold a reunion September 27–29, 1990, at the Sheraton Hotel in Colorado Springs, Colo. **Contact:** Col. George E. Harrington, USAF (Ret.), 3165 N. Atlantic Ave., Apt. B409, Cocoa Beach, FL 32931. Phone: (407) 784-0342.

325th Air Service Group
Members of the 325th Air Service Group and the 86th Air Depot Repair Squadron (World War II) will hold a reunion October 25–27, 1990, in San Antonio, Tex. **Contact:** Jack Wait, 201 Mayfair Dr., Shreveport, LA 71107. Phone: (318) 222-7747.

345th Bomb Group
Members of the 345th Bomb Group (World War II) will hold a reunion October 15–18, 1990, at the Riviera Hotel, in Las Vegas, Nev. **Contact:** Kenneth D. McClure, 2770 E. Main St., Columbus, OH 43209. Phone: (614) 237-4251.

367th Fighter Group
The 367th Fighter Group (World War II) will hold a reunion November 8–11, 1990, in Orlando, Fla. **Contact:** Col. Al Diefendorf, 25985 Holly Vista, San Bernardino, CA 92404.

384th Bomb Group
Members of the 384th Bomb Group will hold a reunion October 11–14, 1990, at the Ramada Inn Hotel in Wichita, Kan. **Contact:** Fred Nowosad, P. O. Box 1021A, Rahway, NJ 07065.

454th Bomb Squadron
The 454th Bomb Squadron, 323d Bomb Group, 9th Air Force, will hold a reunion August 29–September 2, 1990, at the Hyatt Regency in Bellevue, Wash. **Contact:** Joe Havrilla, 1208 Margaret St., Munhall, PA 15120-2048. Phone: (412) 461-6373.

456th Fighter Squadron
Member of the 456th Fighter Squadron, 414th Fighter Group (World War II), will hold a reunion October 4–7, 1990, at the Stouffer Center Plaza Hotel in Dayton, Ohio. **Contact:** James H. Baird, 1645 Plummer Dr., Rockwell, TX 75087. Phone: (214) 771-8529.

459th Fighter Squadron
The 459th Fighter Squadron will hold a reunion October 9–11, 1990, in Fredericksburg, Va. **Contact:** Wayne Sneddon, P. O. Box 117, Pilot Hill, CA 95664.

467th Air Service Squadron
The 467th Air Service Squadron, 8th Air Force (Honington, England), will hold a reunion in September 1990 in Whiteville, N. C. **Contact:** Charles Ross, 110 69th St., Darien, IL 60559. Phone: (708) 920-0341.

482d Bomb Group
Members of the 482d Bomb Group (World War II) who served in Alconbury, England (Station 102), including the 36th, 812th, 813th, and 814th Bomb Squadrons and attached units, will hold their reunion September 30–October 4, 1990, in Las Vegas, Nev., during the annual reunion of the 8th Air Force Historical Society. **Contact:** Dennis R. Scanlan, Jr., One Scanlan Plaza, St. Paul, MN 55107. Please send a stamped, self-addressed envelope for additional information.

494th Bomb Group
Members of the 494th Bomb Group, including the 864th, 865th, 866th, 867th, and 373d Bomb Squadrons (World War II), will hold a reunion September 6–9, 1990, in Colorado Springs, Colo. **Contact:** Richard H. Stansfield, 13 Chicory Ct., Pueblo, CO 81001. Phone: (719) 544-2186.

756th Troop Carrier Squadron
Members of the 756th Troop Carrier Squadron/Military Airlift Squadron/Tactical Airlift Squadron, which has operated from Andrews AFB, Md., since 1954, are planning to hold a reunion October 19–21, 1990 in Camp Springs, Md. **Contact:** Bert Stewart, P. O. Box 8396, Temple Hills, MD 20757. Phone: (301) 899-7470.

3650th Military Training Wing
The 3650th Military Training Wing and all personnel who served at Sampson AFB, N. Y., between 1950 and 1956 will hold a reunion August 31–September 1, 1990, at the Holiday Inn in Waterloo, N. Y., and Sampson State Park. **Contact:** Walter W. Steesy, P. O. Box 299, Interlaken, NY 14847. Phone: (607) 532-4997.

3d Airdrome Squadron
I am trying to locate members of the 3d Airdrome Squadron, 5th Air Force (World War II), who served in Australia, New Guinea, the Philippines, and Tokyo, Japan, who would be interested in holding a reunion. **Contact:** M. G. Henderson, Rte. 1, Box 198, Barboursville, VA 22923. Phone: (804) 973-3860.

6th Bomb Group
For the purpose of planning a reunion in 1991, I am trying to locate World War II veterans of the 6th Bomb Group. **Contact:** Newell W. Penniman, Jr., 6 Porter Ln., South Hamilton, MA 01982. Phone: (508) 468-2806.

Class 43-G
For the purpose of planning a reunion, I am trying to locate members of Cadet Pilot Class 43-G who trained at Lakeland, Macon, and Moody AFBs. **Contact:** Lew Johnston, 2665 Chestnut St., San Francisco, CA 94123. Phone: (415) 567-4717.

Class 71-04
I am trying to locate members of Class 71-04 (Laredo AFB, Tex.) for the purpose of organizing a reunion for late October or early November 1990 in the Dallas–Fort Worth, Tex., area. **Contact:** Stan Heaston, 7919 Upper Hamlet Ct., Apple Valley, MN 55124. Phone: (612) 454-6417.

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While CHAMPUS Supplement coverage was originally intended to cover the cost of medical services not provided by CHAMPUS, practitioners and service institutions may charge fees that are considerably greater than those approved for payment by CHAMPUS. And, because Supplement policies traditionally base their payments on the amount paid by CHAMPUS, the insured can be left with sizable out-of-pocket expenses. AFA's ChamPLUS® coverage includes a special feature which places a limit on these out-of-pocket expenses.

Called the 'Expense Protector' Benefit, this program limits out-of-pocket expenses for CHAMPUS covered charges in any single calendar year to $1,000 for any one insured person (or $2,000 for all insured family members combined). Once those out-of-pocket expense maximums are reached, ChamPLUS® will pay 100% of CHAMPUS covered charges for the remainder of that year.

An example of the way the 'Expense Protector' works follows. Assume you are hospitalized for 35 days, that the hospital charges you $330 per day and that this is $75 per day *more* than allowed by CHAMPUS. This would mean that you have an out-of-pocket expense of $2,625. With AFA's 'Expense Protector' benefit, your cost would be limited to $1,000. All covered costs over this amount—for the whole calendar year—would be paid by ChamPLUS®!

It's an important benefit that ca mean significant savings to you ar your family.

CALIFORNIA and HAWAII RESIDENTS—If you would like details on AFA's supplement to CHAMPUS Prime, please contact AFA's Insurance Division at 1/800/727-3337.

Who Is Eligible?

1. All AFA members under 65 years of age v are currently receiving retired pay based u their military service and who are eligible f benefits under Public Law 89-614 (CHAMPU their spouses under age 65 and their unman

AFA ChamPLUS® Benefit Schedule

Care	CHAMPUS Pays	AFA CHAMPLUS® PAYS
For Military Retirees Under Age 65 and Their Dependents		
Inpatient civilian hospital care	CHAMPUS pays the balance of the Diagnostic Related Group (DRG) allowance after the beneficiary's cost share* is deducted.	CHAMPLUS® pays the 25% of allowable charges not paid by CHAMPUS . . . plus 100% of covered charges after out-of-pocket expenses exceed $1,000 per person (or $2,000 per family) during any single calendar year.
Inpatient military hospital care	The only charge normally made is a daily subsistence fee, not paid by CHAMPUS.	CHAMPLUS® pays the daily subsistence fee.
Outpatient care	CHAMPUS covers 75% of out-patient care fees after an annual deductible of $50 per person ($100 maximum per family) is satisfied.	CHAMPLUS® pays the 25% of allowable charges not paid by CHAMPUS after the deductible has been satisfied . . . plus 100% of covered charges after out-of-pocket expenses exceed $1,000 per person (or $2,000 per family) during any single calendar year.
For dependents of Active Duty Military Personnel		
Inpatient civilian hospital care	CHAMPUS pays all covered services and supplies furnished by a hospital less $25 or the total of daily subsistence fees, whichever is greater.	CHAMPLUS® pays the greater of the total subsistence fees, or the $25 hospital charge not paid by CHAMPUS
Inpatient military hospital care	The only charge normally made is a daily subsistence fee, not paid by CHAMPUS.	CHAMPLUS® pays the daily subsistence fee.
Outpatient care	CHAMPUS covers 80% of out-patient care fees after an annual deductible of $50 per person ($100 maximum per family) is satisfied.	CHAMPLUS® pays the 20% of allowable charges not paid by CHAMPUS after the deductible has been satisfied . . . plus 100% of covered charges after out-of-pocket expenses exceed $1,000 per person (or $2,000 per family) during any single calendar year.

NOTE: Outpatient benefits cover emergency room treatment, doctor bills, pharmaceuticals, and other professional services. There are some reasonable limitation and exclusions for both in-patient and outpatient coverage. Please note these elsewhere in the plan description.

*The beneficiary cost share is the lesser of 25% of CHAMPUS-allowable billed charges or a daily fixed amount. For fiscal year 1989, the daily limit is $210.

New 'Expense Protector' Benefit!

ependent children under age 21, or age 23 if
n college.

. All eligible dependents of AFA members on
ctive duty. Eligible dependents are spouses
nder age 65 and unmarried dependent chil-
ren under age 21 (or age 23 if in college).
There are some exceptions for older age chil-
ren. See "Exceptions and Limitations.")

Renewal Provision

As long as you remain eligible for CHAMPUS
benefits and the Master Policy with AFA remains
n force, termination of your coverage can occur
only if premiums for coverage are due and
unpaid, or if you are no longer an AFA member.
Your certificate cannot be terminated because
of the number of times you receive benefits.

Exceptions and Limitations

Coverage will not be provided for conditions
or which treatment has been received during
he 12-month period prior to the effective date
of insurance until the expiration of 12 consec-
utive months of insurance coverage without
further treatment. After coverage has been in
force for 24 consecutive months, pre-existing
conditions will be covered regardless of prior
treatment. Children of active duty members over
age 21 (age 23 if in college) will continue to
be eligible if they have been declared inca-
pacitated and if they are insured under
CHAMPLUS® on the date so declared. Cover-
age for these older age children will only be
provided upon a) notification to AFA and b)
payment of a special premium amount.

Plan 1
For Military Retirees and Dependents
QUARTERLY PREMIUM SCHEDULE

In-Patient Benefits Only

Member's Attained Age*	Member	Spouse	Each Child
Under 50	$22.97	$ 45.12	$16.34
50-54	$34.33	$ 56.21	$16.34
55-59	$50.32	$ 60.17	$16.34
60-64	$62.98	$ 69.27	$16.34

In-Patient and Out-Patient Benefits

Under 50	$33.90	$ 61.02	$40.84
50-54	$46.59	$ 69.87	$40.84
55-59	$64.41	$ 96.11	$40.84
60-64	$77.38	$102.15	$40.84

*Note: Premium amounts increase with the member's attained age

Plan 2
For Dependents of Active Duty Personnel
ANNUAL PREMIUM SCHEDULE

In-Patient Benefits Only

	Member	Spouse	Each Child
All Ages	None	$ 9.68	$ 5.94

In-Patient and Out-Patient Benefits

All Ages	None	$38.72	$29.70

Coverage After Age 65

Upon attainment of age 65, the coverage of members insured under CHAMPLUS® will automatically be converted to AFA's Medicare Supplement program so that there will be no lapse in coverage. Members not wishing this automatic coverage should notify AFA prior to their attainment of age 65.

Exclusions

This plan does not cover and no payment shall be made for:

- routine physical examinations or immunizations
- domiciliary or custodial care
- dental care (except as required as a necessary adjunct to medical or surgical treatment)
- routine care of the newborn or well-baby care
- injuries or sickness resulting from declared or undeclared war or any act thereof
- injuries or sickness due to acts of intentional self-destruction or attempted suicide, while sane or insane
- treatment for prevention or cure of alcoholism or drug addiction
- eye refraction examinations
- prosthetic devices (other than artificial limbs and artificial eyes), hearing aids, orthopedic footwear, eyeglasses and contact lenses
- expenses for which benefits are or may be payable under Public Law 89-614 (CHAMPUS)

APPLICATION FOR AFA CHAMPLUS®

Group Policy GMG-FC70
Mutual of Omaha Insurance Company
Home Office: Omaha, Nebraska

Full name of Member _____
Rank Last First Middle

Address _____
Number and Street City State ZIP Code

Date of Birth _____ Current Age ____ Height ____ Weight ____ Soc. Sec. No. _____
Month/Day/Year

This insurance coverage may only be issued to AFA members. Please check the appropriate box below:

☐ I am currently an AFA Member.

☐ I enclose $21 for annual AFA membership dues (includes subscription ($18) to AIR FORCE Magazine).

PLAN & TYPE OF COVERAGE REQUESTED

Plan Requested (Check One)
☐ AFA CHAMPLUS® PLAN I (for military retirees & dependents)
☐ AFA CHAMPLUS® PLAN II (for dependents of active-duty personnel)

Coverage Requested (Check One)
☐ Inpatient Benefits Only
☐ Inpatient and Outpatient Benefits

Person(s) to be insured (Check One)
☐ Member Only
☐ Spouse Only
☐ Member & Spouse
☐ Member & Children
☐ Spouse & Children
☐ Member, Spouse & Children

PREMIUM CALCULATION

All premiums are based on the attained age of the AFA member applying for this coverage. Plan I premium payments are normally paid on a quarterly basis but, if desired, they may be made on either a semi-annual (multiply by 2), or annual (multiply by 4) basis.

Quarterly (annual) premium for member (age ____) $_____

Quarterly (annual) premium for spouse (based on member's age) $_____

Quarterly (annual) premium for ____ children @ $ $_____

Total premium enclosed $_____

If this application requests coverage for your spouse and/or eligible children, please complete the following information for each person for whom you are requesting coverage.

Names of Dependents to be Insured	Relationship to Member	Date of Birth (Month/Day/Year)

(To list additional dependents, please use a separate sheet.)

In applying for this coverage, I understand and agree that (a) coverage shall become effective on the last day of the calendar month during which my application together with the proper amount is mailed to AFA, (b) only hospital confinements (both inpatient and outpatient) or other CHAMPUS-approved services commencing after the effective date of insurance are covered and (c) any conditions for which I or my eligible dependents received medical treatment or advice or have taken prescribed drugs or medicine within 12 months prior to the effective date of this insurance coverage will not be covered until the expiration of 12 consecutive months of insurance coverage without medical treatment or advice or having taken prescribed drugs or medicine for such conditions. I also understand and agree that all such pre-existing conditions will be covered after this insurance has been in effect for 24 consecutive months.

Date _____, 19 ____ _____
Member's Signature

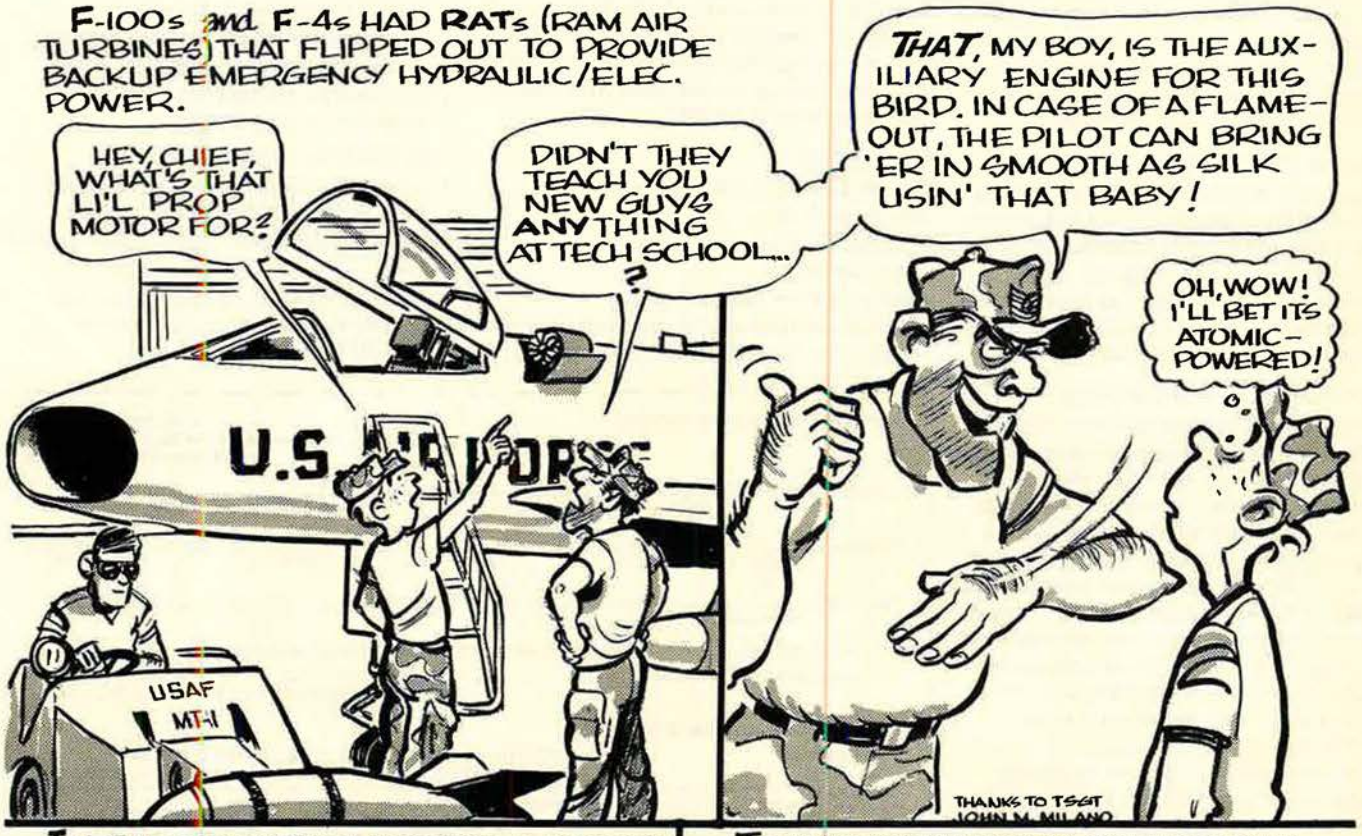
Form 6173GH App.
7–90

Application must be accompanied by a check or money order. Send remittance to: Air Force Association, Insurance Division, 1501 Lee Highway, Arlington, VA 22209-1198

Bob Stevens'

"There I was..."

MAINTENANCE TROOPS HAVE THEIR OWN DIRTY TRICKS DEPT. FOR NEW GUYS. HERE'S A COUPLE THAT ARE A CUT OR TWO ABOVE THE "GO GET ME SOME PROP WASH and 50 FT. OF FLIGHT LINE" CATEGORY–



TAKE A VETERAN INTO COMBAT.

When the fight's on, and a pilot finds himself in a high threat environment, the AN/ALQ-126B can mean the difference for survival. This Lockheed Sanders electronic countermeasures system is a combat-tested veteran, now protecting U.S. and allied fighter and attack aircraft.

Sanders is the world's largest producer of on-board ECM systems. The 126B is battle-proven and in serial production, with more than 1,000 units delivered to the U.S. Navy, Marines and a number of allied air forces.

Combined with either the AN/ALQ-162 or an off-board decoy system, the 126B assures a full range of protection from radar-guided threats. The system is fully integrated and deployed aboard all Navy tactical aircraft, including the latest F/A-18s. And, the 126B is compatible with current Air Force fighters, including the F-16. The technology is modern and an extensive logistics infrastructure is in place. Performance, reliability, and maintainability all meet or exceed design parameters. Above all, the 126B is affordable.

Sanders is currently integrating advanced gallium-arsenide circuitry into the 126B so it will outpace the evolving threat, making sure tactical aircraft can meet the challenge – present and future.

Lockheed Sanders

MDMSC: Smart choices for tough decision

NOTHING BEATS TODAY'S HARPOON FOR KEEPING THE SEA LANES OPEN-EXCEPT TOMORROW'S HARPOON.

The Harpoon missile with its new Block 1D upgrade will raise Harpoon's legendary effectiveness to a whole new level.

Long recognized as America's premier anti-ship missile, Harpoon is facing a future of new challenges. Low-intensity conflicts anticipated for the years ahead will require more sophisticated targeting. Improved electronic countermeasures and advanced enemy radars signal a need for expanding Harpoon capabilities.

McDonnell Douglas Missile Systems Company's (MDMSC) Block 1D Harpoon will do the job. Existing Harpoon inventories can be retrofitted to provide Block 1D capabilities. At a fraction of the cost of new development, this newest version of Harpoon will provide reattack capability to ensure effectiveness against tomorrow's sophisticated electronic countermeasures. Block 1D is the enduring weapon system needed by armed forces to meet challenges beyond the year 2000.

A preplanned product improvement, Block 1D Harpoon delivers far greater capability at far lower cost than you might have thought possible. Harpoon —poised and ready for the future.

MCDONNELL DOUGLAS

A company of leaders.