OCTOBER 1989/$2

AIR FORCE

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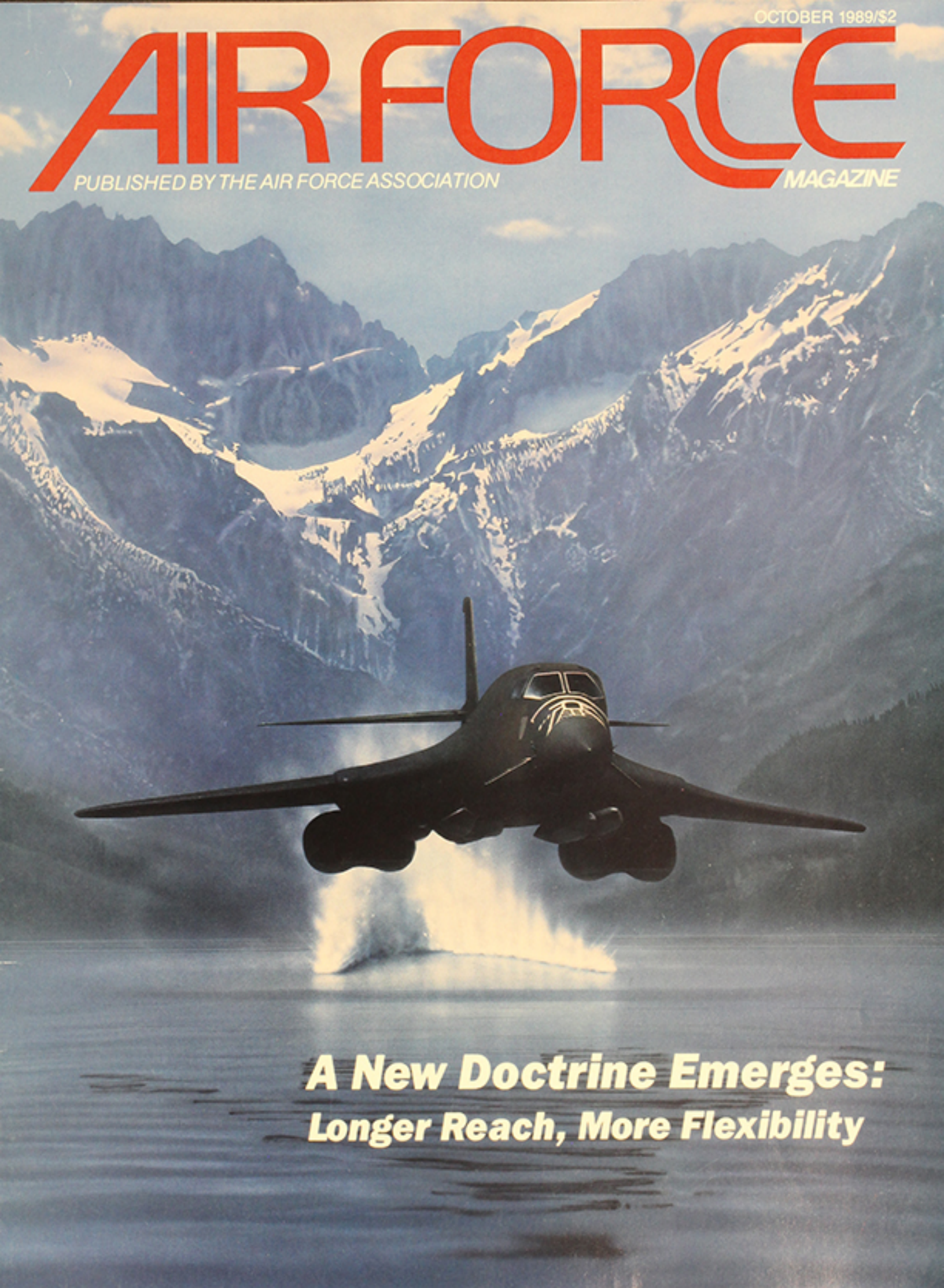
MAGAZINE



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Longer Reach, More Flexibility

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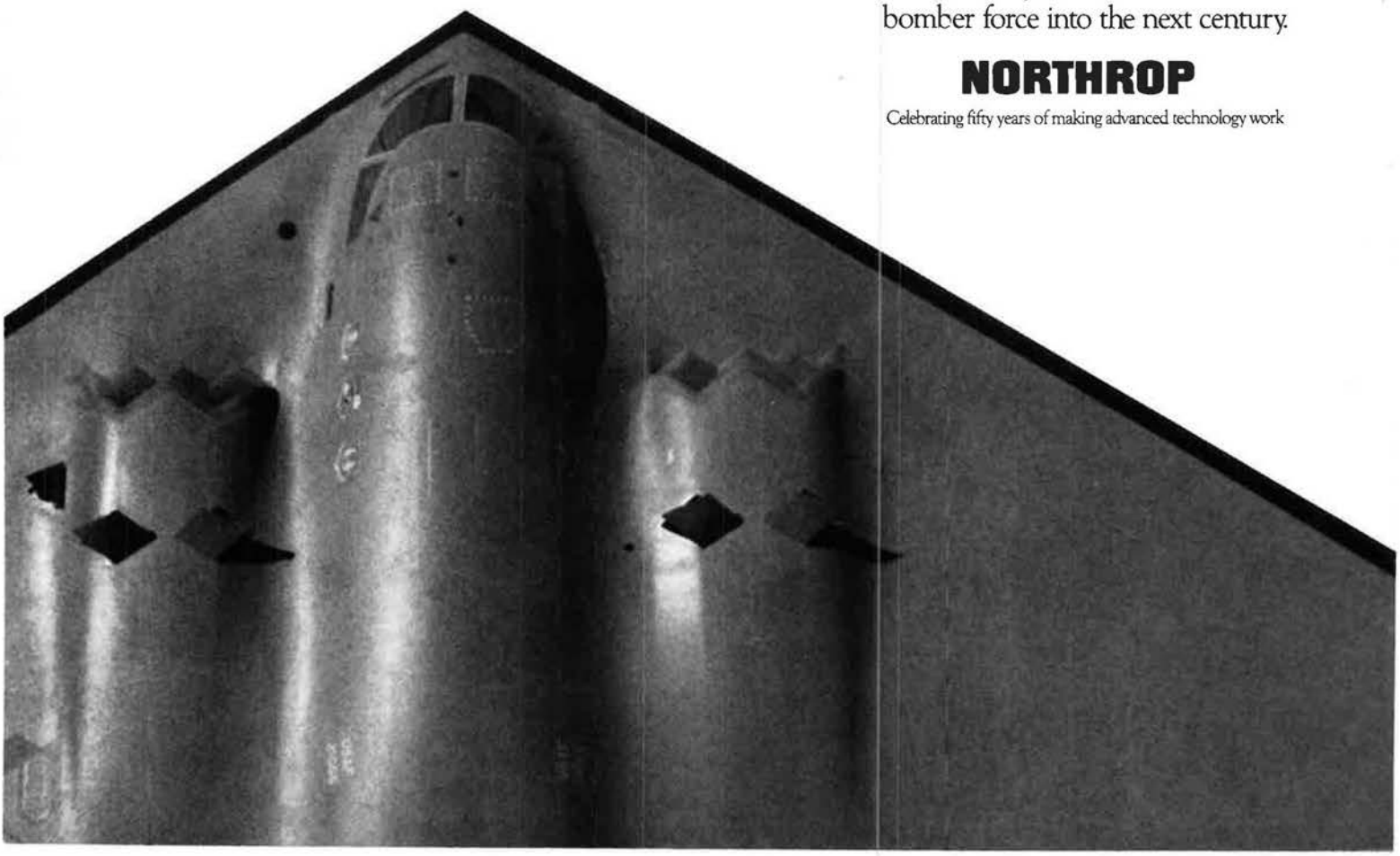

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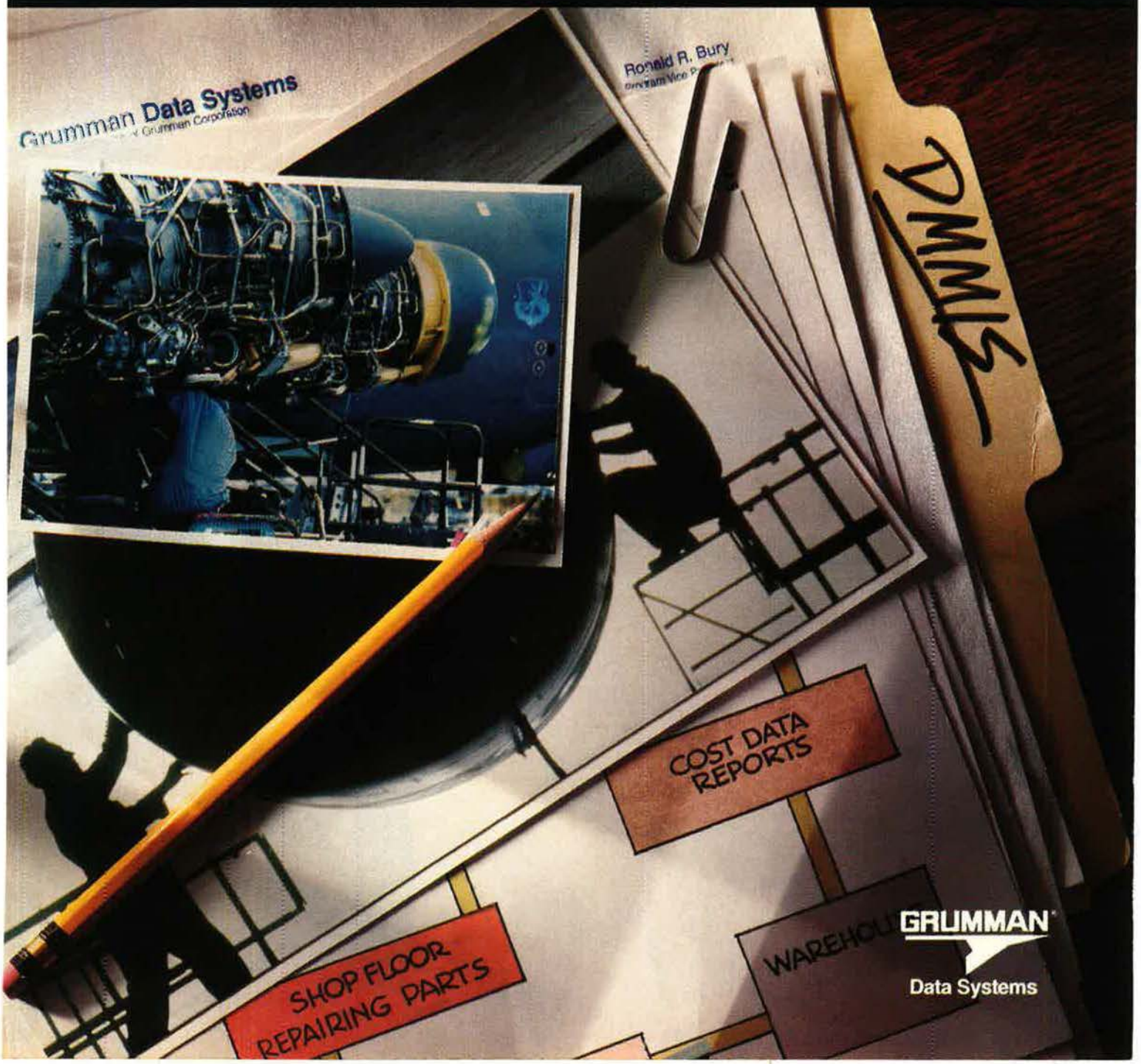

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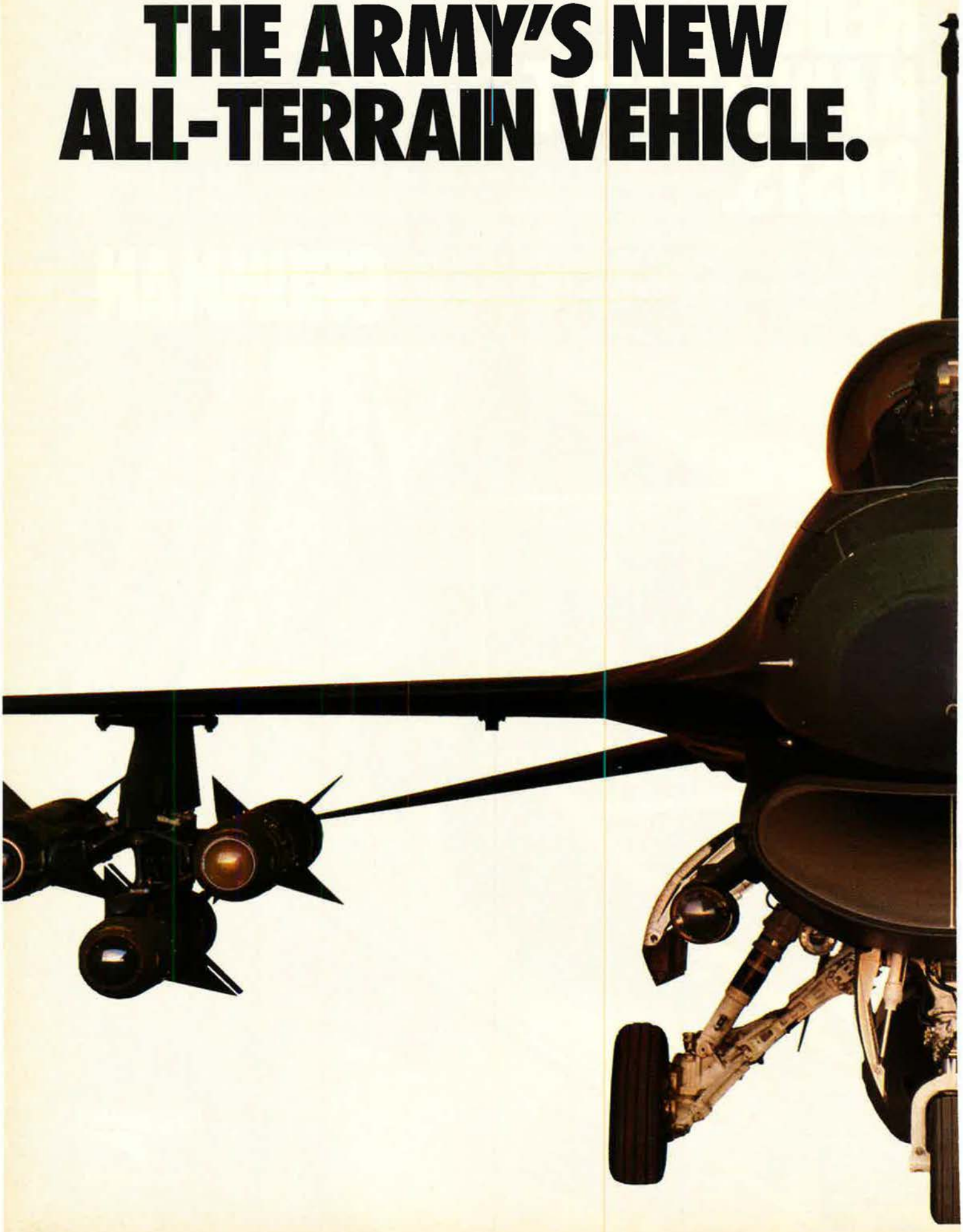

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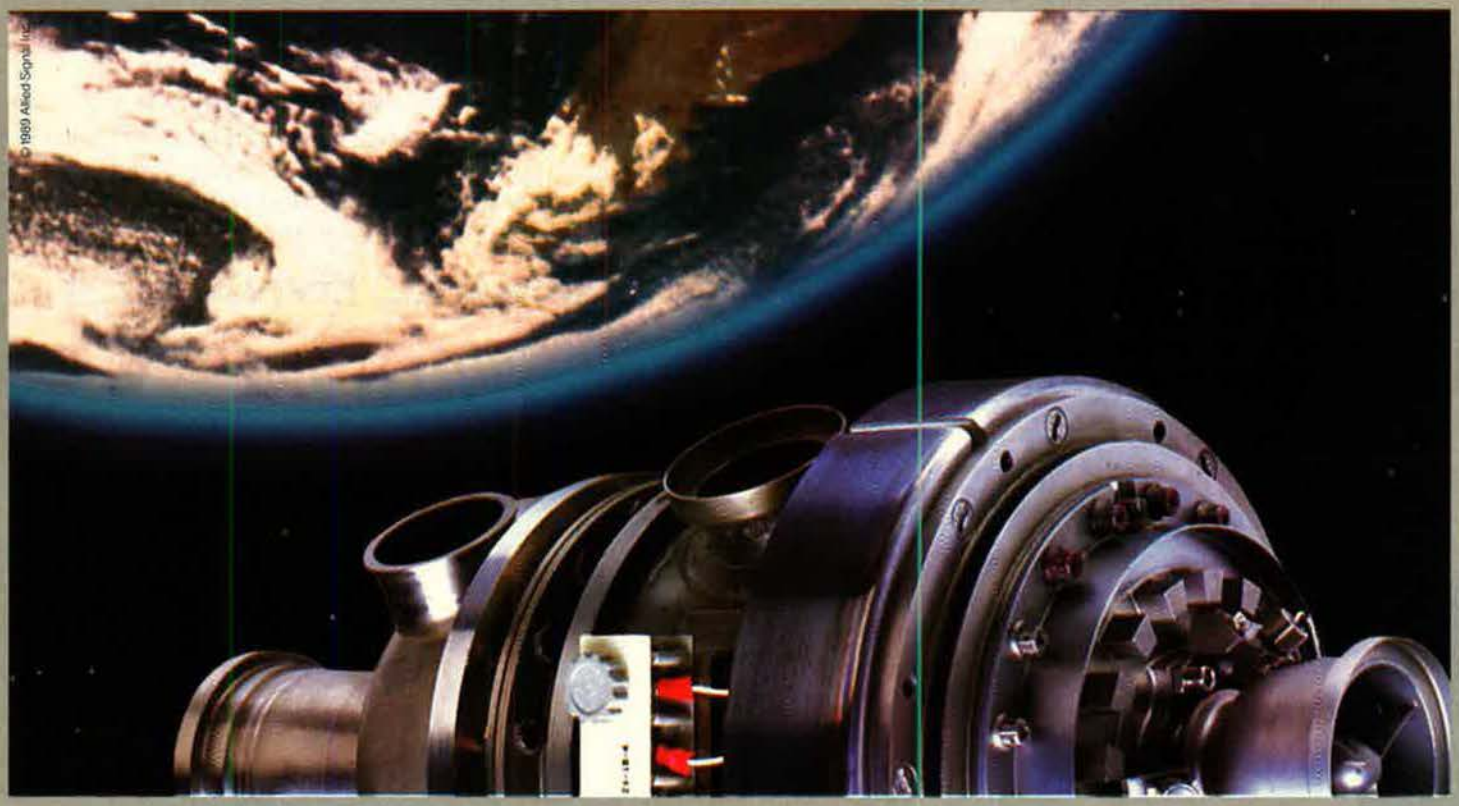

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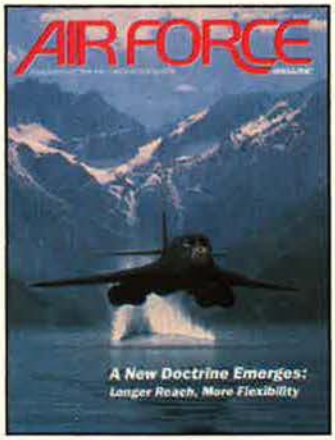

About the cover: This Dru Blair illustration depicts a B-1B zooming over a placid lake. The bomber is symbolic of the flexibility and reach offered by the indivis ble airpower doctrine.

A New Doctrine Emerges: Longer Reach, More Flexibility

Departments

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An Editorial

Unskilled and Unprepared

By John T. Correll, EDITOR IN CHIEF

"THE education system has failed the nation. It has not produced enough well-educated, technically qualified graduates who can enter the work force and become productive members of society. This is true at every tier from entry-level technician to research scientist. And the future doesn't look any better."

That is the somber conclusion of "America's Next Crisis: The Shortfall in Technical Manpower," a report published in September by AFA's Aerospace Education Foundation. "The United States," it says, "spends more than any other nation for education while simultaneously ranking at the bottom of the industrialized world in terms of educational achievement."

- The National Science Foundation predicts that the US will be short more than 700,000 scientists and engineers between 1989 and 2010. The number of engineering graduates will decline by forty percent—and the demand will increase by seventy percent.
- As the US labor pool shrinks over the next ten years, it will become increasingly difficult to find skilled replacements for older workers as they retire. The Commerce Department says that one company in three is already forced to provide basic or remedial instruction for new employees. "America's Next Crisis" recounts the case of a worker in a major firm who mismeasured yards of sheet steel and wasted nearly $700 worth of material in one morning. He was unable to read a ruler.

"We have diverted our schools from places of learning to places of play at a time when our international competitors have been pursuing academic excellence in their public schools," says Texas entrepreneur H. Ross Perot.

Indeed, American high school students take far fewer science and math courses than do their counterparts abroad. The trend continues in their selection of courses in college. Students and faculty in US graduate engineering schools are predominately foreign or foreign-born.

- More than a fourth of American twelve-year-olds cannot handle elementary-school arithmetic. Only six percent of the seventeen-year-olds can handle algebra or multistep math problems. The *average* Japanese high school student consistently does better at math than the top five percent of American students do. In a sixteen-nation comparison of science achievement, US ninth graders were next to last.

As the study makes clear, though, it is not a matter of US students emphasizing grammar instead of chemistry and long division.

- Twenty-seven million Americans over the age of seventeen are functionally illiterate. Another 45,000,000 are marginally literate, "usually unable to function productively in a work environment," according to the Business Council for Effective Literacy. Projecting from current data, the US Census Bureau says that seventy percent of the US population will be functionally illiterate by the year 2000. By an Aerospace Industries Association estimate, companies will be hiring 1,000,000 new people a year who cannot read, write, or count.

Scholastic Aptitude Test scores in this country improved somewhat in the 1980s, but, says Secretary of Education Lauro Cavazos, "the academic achievement of American students remains far below its level in the early 1960s and well behind the performance of students in most industrialized countries."

Society pays a huge penalty for this sorry mess. The Commerce Department says that school dropouts cost the nation more than $240 billion annually in lost taxes and wages and increased public assistance. Business spends $30 billion a year to train and retrain employees. The waste of human potential is incalculable. We can only guess at the price tag for lost productivity.

There are specific implications for defense. Seventy-two percent of the Air Force's enlisted career specialties require a technical background. Wish the recruiters luck. Officers of the future will be difficult to find, too. Only two percent of US high school graduates in 1988 had taken courses needed to qualify for entry *consideration* by the Air Force Academy.

Last year, the Pentagon said that massive deficiencies in US education and training were the worst long-term problem facing the defense industrial base. The shortage of skilled workers is a major reason why the industrial base today has virtually no capacity for surge production in wartime.

The United States is losing its edge in technology. It is already dependent on foreign sources for some critical components and defense systems. In 1986, the US balance of trade in high-technology goods was, for the first time, negative. The failure of the education system, says "America's Next Crisis," is among the leading reasons for our decline.

There are exceptions to the pattern. The study cites examples of partnerships between schools and industries that have achieved impressive results. Most of these, however, "are successful for a simple reason: They bypass the system because it does not deliver," the study finds.

The White House, Congress, industry, and H. Ross Perot cannot solve this one for us. The crisis is nationwide, but the real problem—and the solution—is in our local schools and communities. If Americans get worried enough, angry enough, and determined enough, the answers are within their reach. ■

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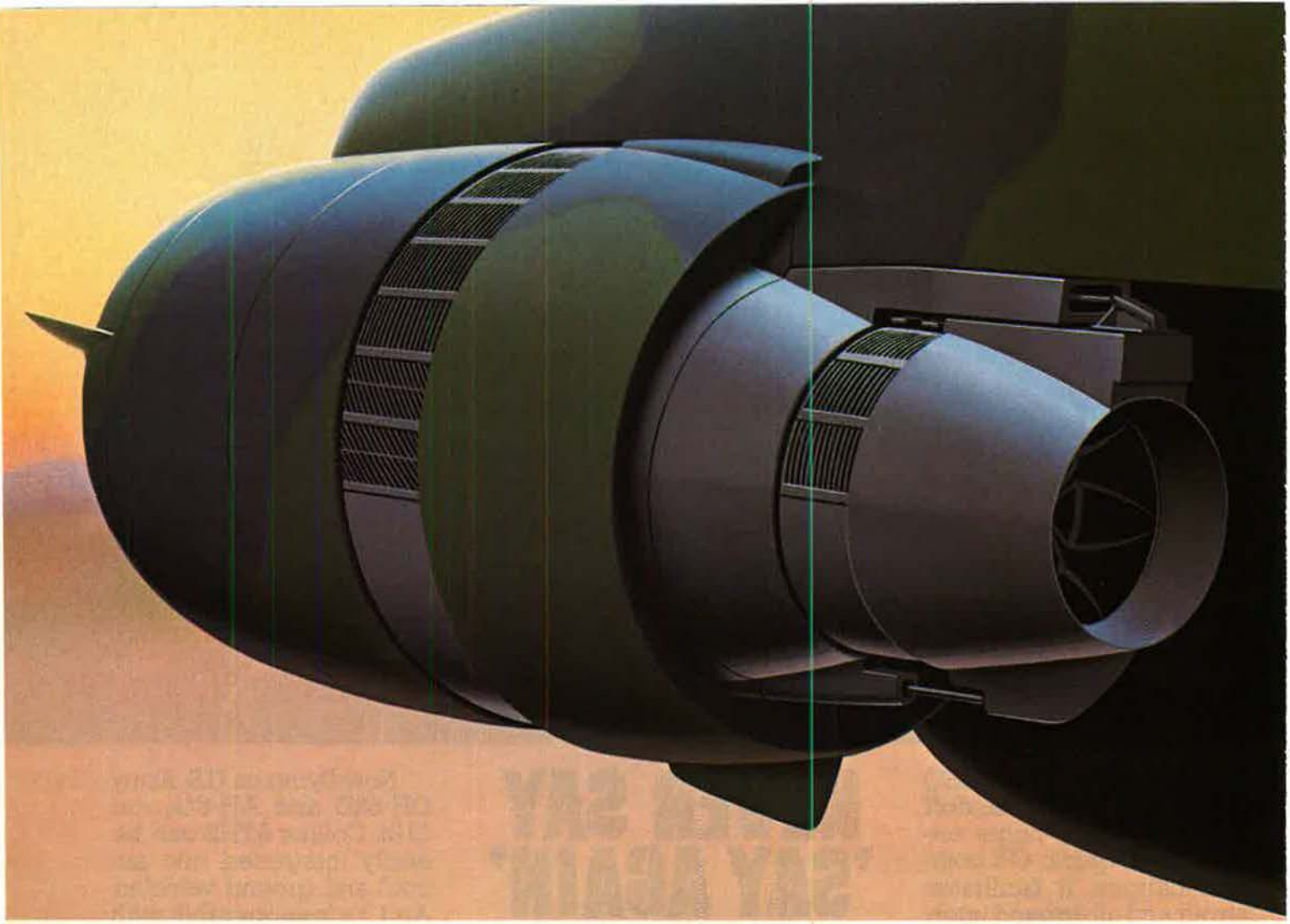

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L T V : L O O K I N G A H E A D

Airmail

Electronic Warriors

In reference to James Canan's article in your August issue *[see "How Electronic Countermeasures Went Wrong," p. 36]*, I agree with the major elements of his article, but I must add that there are, in my opinion, several other critical elements that have been omitted. These elements, along with those mentioned, strongly contribute to the embarrassing failures that all too regularly occur in electronic warfare.

First, the Air Force itself is contributing to the excessive EW failure rate by continuing to confuse operational prowess with technical prowess. It does so by continuing to place—with passing regard to formal electrical education and technical competence—Electronic Warfare Officers and Pilots in positions where they are required to determine and mandate EW technological requirements. These individuals are normally highly experienced in EW operations, but . . . the subjectivity of experience—regardless of its breadth—can rarely substitute for the requisite technological objectivity developed in and provided by a formal technical education (and which isn't provided by Electronic Warfare or Pilot training). This operational/technological mismatch within the using community has been, in my opinion, a major—if not the major—contributor to our EW morass; it's led us to overreach and/or distort technological reality.

A second contributing factor is our often excessive obsession with security. Many of our less-than-viable EW endeavors would have been killed early on had they been exposed to full technological and/or operational "daylight." Security considerations, however, often limit this exposure to a handful of individuals, many of whom possess a "let's make it work" agenda, which lets shortcomings escape notice until catastrophic failures occur.

I can think of many of our past and current EW endeavors, including some of the lethal-drone programs, that more than fit the foregoing failure-prone [criteria]. James Canan's article correctly identifies the embedded and endemic EW problem of having to aim continually at "moving [EW] targets," which is indeed a tough reality that we may never overcome. Notwithstanding, many of our problems are generated from within and not from without. Having viewed the EW situation from three sides (as an EW user/educator, a military EW developer, and a civilian EW developer/educator), I feel comfortable in making these assertions. We've looked outward for too long; it's time we looked within.

Jerry Stiles
RAND Graduate School
Playa del Rey, Calif.

Improved Mission Planning

I read F. Clifton Berry's article "New Tools for Mission Planners" *[see August '89 issue, p. 46]* with great interest. My division, TAC/DRIB (Directorate of Interoperability and Integration), is the focal point for mission planning systems in the tactical air forces (TAF), as Mr. Berry pointed out in his article. His article focused on the TAF effort and was fairly accurate. However, the picture [on p. 46] was not of an MSS II (Mission Support System II). It was the Fairchild Maps 300, which is only one component of the MSS II.

Mr. Berry failed to mention the struggle that was fought and won by relatively few people to make the MSS I and MSS II operational realities. Only about fifty people have done most of the work on the TAF MSS. We were called hobby-shoppers and amateurs who did not understand how the "system" works and could never make it happen. It has happened.

The bulk of the work on MSS I/II has been done by TAC, the 4443d Technical Evaluation Group, the 3246th Test Wing, MITRE Corp., and Georgia Tech Research Institute. Pacific Northwest Laboratories and Battelle Corp. have acted as system integrators for us. Using aircraft program money for the hardware, we fielded the software and developed the logistics infrastructure to support MSS deployment TAF-wide. All of these organizations work under TAC/DRIB management and have seen this program through some rough days and sleepless nights to meet seemingly impossible deadlines.

The point of Mr. Berry's article is that automated flight planning is sorely needed and is now a reality. That is indisputable, and his article made that point well. My point is that, for the TAF, it has been a long, tough fight to make it happen, and it required the tireless dedication of a few people who don't know the meaning of the words, "You can't get there from here."

Lt. Col. W. B. Thaler, USAF
Chief, Mission Planning Div.
Langley AFB, Va.

Normalizing Space

I would like to clarify some of the remarks made by 2d Lt. J. M. Bruce in his letter. *[See "Space as a Mission," July '89 "Airmail," p. 10.]* Air Force Systems Command (AFSC) is taking steps to lay out a roadmap and produce a transition plan to transfer space operations to AFSPACECOM as soon as possible. More important, we seek ways to improve our current mode of operations, regardless of who the space operator is. On July 19, 1989, AFSC Commander Gen. Bernard P. Randolph signed the charter directing AFSC to develop options that effectively normalize space operations. A final report is due later this year. Lieutenant Bruce stated that "for the USAF to become more aggressive in the space arena, they need to . . . turn over the launching of DoD

Do you have a comment about a current issue? Write to "Airmail," AIR FORCE Magazine, 1501 Lee Highway, Arlington, Va. 22209-1198. Letters should be concise, timely, and preferably typed. We are sorry we cannot acknowledge receipt of letters to "Airmail." 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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expendable vehicles to Space Command and make it a total blue-suit launch operation."

USAF has been and continues to be aggressive in the space arena. The Air Force took the lead in revitalizing the space launch program as part of the Space Launch Recovery Program after the *Challenger* disaster. The ongoing AFSC study focuses on current space systems, including satellite and ground network operations. I do not believe that Lieutenant Bruce's comment about a totally operational system being beneficial to both USAF and the commercial space program is entirely accurate. I question the need for a DoD crew and a commercial launch crew to duplicate each other's tasks while sharing limited and aging launch infrastructure resources. Through the present arrangement of sharing launch crews, contractors can spread their costs over a broader business base.

The AFSC study seeks to provide our management with sound options on how to conduct space operations more efficiently while maintaining a highly successful launch record. Launch vehicles are more than just "birds" that are flown pointed up, as Lieutenant Bruce stated—they also fly without wings and without a crew on board!

Maj. Adrian Gomez, USAF
Alexandria, Va.

A-10 vs. A-16

This might be a more appropriate title for Mr. Meyer's letter *[see "Guns vs. Tanks," July '89 "Airmail," p. 8]*. As a former Hogdriver and project manager for LAVP during my tour at Nellis in the late 1970s, I feel I am a little bit better versed than Meyer in what really transpired in this program. He, as I recall, left USAF for a job with General Dynamics. . . .

Certainly no test is ever 100 percent valid, and LAVP was no exception. The people from the Systems Program Office (SPO) at Wright-Patterson asked the Russians to provide us with their latest tanks, but, understandably, got no reply. Therefore, we—the test community collectively—made the best of the situation by utilizing resources that were available at the time, namely unmanned and seeded M47s and an occasional T-62.

Our goal, from the tactics-analysis and test-and-evaluation standpoint, was solely to evaluate and determine the capabilities of the GAU-8 and its API (armor-piercing incendiary) round when employed against armored targets. At times that goal differed from the SPO's, as it was mainly interested in catastrophic kills (K-kills) and verifying, as the test name implied, that production 30-mm ammo was indeed meeting design specifications. As a result, the attack aspects were at times not what might really be encountered on the battlefield, unless the enemy were in full retreat or had left his flanks unprotected.

From a tactical point of view, I would also love to see Ivan's turret and hatches blow sky high after a pass, but I—and I hope our Army counterparts feel the same way—would settle for seeing the tank stopped dead in its tracks.

During several of the shoots, no K-kills were recorded, but the tanks were assessed to be 100 percent mobility kills (M-kills), due to the damage to the mannequins inside or damage to the drivetrain. A tank that can't move with an advancing or retreating force does not present an immediate threat. Firepower kills (F-kills) were also fairly common. These assessments were not done by amateurs, but by two of the free world's most knowledgeable armor experts, Dr. Stolfi of the Naval Postgraduate School and Mr. McEachlin of Battelle Industries. Both of these men were under contract to the SPO at that time, and both had been involved in assessing battle-damaged tanks in the Sinai.

Reader Meyer might also be interested to know that during one shoot, four tanks were attacked from a frontal aspect and substantial damage was done to two of them, while only minimal damage was inflicted on the others. Lastly, during an exercise at Fort Stewart, Ga., one of our own newer tanks (manned, I might add) was accidently attacked by an A-10 firing ball ammo, not API, and was totally disabled.

One last point must be made concerning where the shoots occurred, so that other readers are not misled into thinking the setups were purposely made easy. There are only two ranges in the US that allowed the firing of the API round, Nellis being one of those, and we already knew that soft vehicles such as APCs were easy to kill from long range with the GAU-8. All things considered, a lot was learned about the GAU-8 and its delivery platform during LAVP, not the least of which was that in breakthrough situations where surgical removal of bad guys is important, in good weather or bad, a 450-knot A-16 loaded with iron bombs or six

AGM-65s on LAU-88s and a 20-mm peashooter is not going to be the answer. It sure seems difficult for the A-10 or its pilots to get any respect.

Chuck Haden
Tucson, Ariz.

Every time I see a photo of the A-16 with a GAU-13/A 30-mm cannon mounted on the centerline, I get a cold chill at the base of my spine. The A-16 may or may not be the best answer for our next Close Air Support (CAS) aircraft, but whatever we do, we should not put a 30-mm cannon on it. The official journal of the Air Force Fighter Weapons School, *Fighter Weapons Review,* admitted in its Spring 1983 issue that ranges of 2,000 feet or less are needed for firepower and mobility kills against heavily armored targets.

Any A-16 that presses in to 2,000 feet is going to lose the resulting gun battle with the ZSU-23/4s and 2S6s defending the tanks. (That distance is well within the maximum effective range of both guns.) The close range required, coupled with the relative "softness" of the A-16, means that A-16s will drop like flies in an antitank gunfight even if the A-16 is going fast. Any pilot who wants to fly an A-16 in to 2,000 feet against Soviet tanks would probably have felt at home flying a "Baka Bomb" for the Japanese in 1944.

However, there is nothing wrong with using kinetic-energy weapons against armor. In fact, they are probably the best weapons to use. Possibly the ideal weapon for putting kinetic energy on a target from the A-16 is the hypervelocity CRV-7 rocket with six depleted-uranium or tungsten carbide fléchettes in each rocket's warhead. From 10,000 feet, each .73-kilogram fléchette hits with seven times the kinetic energy of a single 30-mm slug fired from 2,500 feet. A six-shot salvo from one rocket pod at 10,000 feet would take out a tank and keep the A-16 outside ZSU-23/4 and 2S6 range.

If the A-16 does become our next CAS aircraft, a practical antitank load might be three six-shot CRV-7 pods under one wing—to be replaced by the Air Force's hypervelocity missile (HVM) when it becomes operational—and one or two AGM-65s under the other. That load would allow the A-16 to stay agile and have a standoff capability against armor.

I also can't help commenting on the article "Airlift to Khe Sanh" *[see "Valor," July '89 issue, p. 81].* While I admire Lt. Col. Howard Dallman's bravery, I can't say the same for his judgment. . . . In the heat of combat, decisions such as [whether to risk a three-engine takeoff] should have been strictly in the purview of the aircraft commander. In his attempt to "cover his six" by checking with higher echelons, he could easily have lost the aircraft. I suspect [today's pilots] would likely do the same. The peacetime habit of constantly checking with command posts and command centers gets so deeply ingrained that it doesn't disappear easily in combat when people must make rapid and critical decisions on their own. I am afraid that that habit is so widespread . . . it would cost us dearly in the first few days of our next war. . . .

The most valuable part of [my Southeast Asia] experience as a forward air controller was learning to think on my own. . . . If I had been in Colonel Dallman's shoes, I can truthfully say that it would have taken me less than five seconds to decide to press on with only three engines, as opposed to sitting on the runway watching incoming mortar shells burst around my airplane.

Lt. Col. Gary L. Dikkers, USAF
Roedelheim, Germany

Craig's Comeuppance

I am sure I am not the only person who is going to respond to Lieutenant Craig's letter concerning Navy pilots in space. *[See "Airmail," July '89 issue, p. 17.]* I would like to respond to Lieutenant Craig's unsubstantiated comments concerning Air Force regulations and the differences between Air Force and Navy pilots. I am an Air Force fighter pilot flying F-15s, so I will limit my discussion to this area of military aviation.

Before I start, I would like to concede two things: First, landing on an aircraft carrier day or night is a highly demanding task, with considerably less margin for error than using a runway. Second, shipboard life is tough, and I have the utmost respect for the pilots and sailors who spend so much time serving our country away from home, family, and friends.

Lieutenant Craig, you may have gotten a lot less flak from me if you had at least allowed a pilot to help you write your letter. I really don't think someone who earns their flight pay in the right seat of an A-6E is qualified to judge what develops a pilot "second to none." You don't even have a stick. Air Force WSOs and EWOs probably have some insight in this area since they have a stick and throttles. They also tend to excel in pilot training if they eventually attend UPT.

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aviation. However, it is a means to an end. That end is our mission—air superiority, interdiction, close air support, strike escort, and many others—not landing on a carrier. Practicing your mission on a daily basis develops a pilot second to none in that mission. Practicing landing on a carrier develops a carrier pilot second to none. It does not give a pilot the skills he needs to dominate an aerial flight or put his bombs on target.

The discussion of Air Force regulations contains examples that are utterly transparent and completely off base. I have yet to encounter any regulation concerning boarding ladders. There is a regulation, however, that requires every flight by an Air Force aircraft to have a flight plan signed by the pilot in command. The Air Force does have directives concerning ascots and flight suits, because, unlike the Navy, the Air Force considers the flight suit a uniform.

I am sure, Lieutenant Craig, if you had researched your letter more thoroughly, you could have come up with some better examples of the differences between Air Force and Navy regulations. I think many Air Force regs are more stringent than the Navy's (the one concerning aircraft appearance certainly is). Flying from an aircraft carrier miles from any land allows a great deal more freedom to do as you wish. The airspace of the United States and Europe is not ours to do with as we please, and we must work with the restrictions encountered in sharing that airspace. However, I [disagree] that these restrictions interfere with our ability to think or acquire realistic training.

You make it sound as if I have a library of reference manuals handy in my F-15 cockpit when I go out to fight. Let me assure you, flying that single-seat fighter requires a great deal of "free thinking" and "adapting to the new and unexpected." I have yet to run into any regulations that "lobotomize" my psyche. As a matter of fact, I think the Navy's emphasis on carrier ops, necessary as it may be, hinders aircrew development in the skills that make up their true mission.

Finally, Lieutenant Craig, we are all individuals, regardless of which service we are in. You cannot make a blanket statement concerning the abilities of such a diverse group of men. What does it mean if an F/A-18 pilot with the best landing scores in his squadron goes out and gets "killed" day after day by the same Air Force F-15 pilot? What about the other F-15 pilot who can't seem to beat this one Navy pilot, or the F-16 pilot who consistently gets lower bomb scores than a Navy A-7 driver? Would they do better if they could land on an aircraft carrier? The point here is that your mission is the number-one priority and that how well you do it is how you are judged as a pilot. Where you put your aircraft to rest if and when you return from that mission does not matter.

Lt. David Sveden, Jr.,
USAF
Tyndall AFB, Fla.

I could not let Lieutenant Craig's comments regarding the Navy in space (and what he thinks of the Air Force) pass without comment. Frankly, I am a bit surprised that the [magazine] bothered with his churlish and inflammatory remarks regarding his stereotype of Air Force pilots, training, and policy. It seems that sometimes junior officers need to put down others in the profession in order to massage their own egos. No one knows why this happens, it just does. Perhaps it keeps them fired up. Nonetheless, it makes no sense for you to publish such unproductive commentary.

I took the opportunity not too long ago to fly with an F-15 squadron to check out the Air Force for myself. The mission was a two vs. two, "Eagle vs. Flogger" training flight, which had a junior officer upgrading to flight leader with the Wing Standardization Officer on his wing. The other section had the Wing Ops Officer in lead, with me in the back of the "Tub," and a 1st lieutenant on his wing. In brief, everything was done as professionally as we do it in the Navy; that is, it could not have been done better.

The briefing was comprehensive, the professional knowledge of both junior officers impressive, and the airmanship superb. Since the Ops Officer was a friend, I was glad to see him get the upper hand in the fight. Following landing, I was struck by the enthusiasm and competence displayed by the maintenance squadron personnel. All in all, the experience instilled in me a strong measure of confidence in Air Force pilots, training, and policy. That makes my viewpoint quite different from Lieutenant Craig's. I bet I'm right. Nonetheless, when one must choose, Fly Navy!

Cmdr. Robert L. Rachor, Jr.,
USN
Fairfax, Va.

I was interested and amused to read the letter by Lt. Barrett Craig, USN, in

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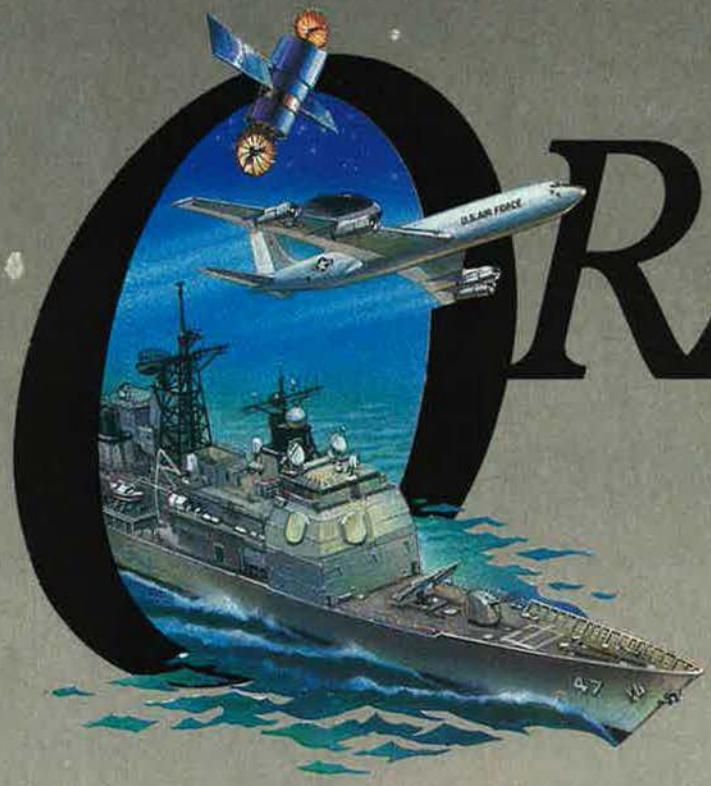

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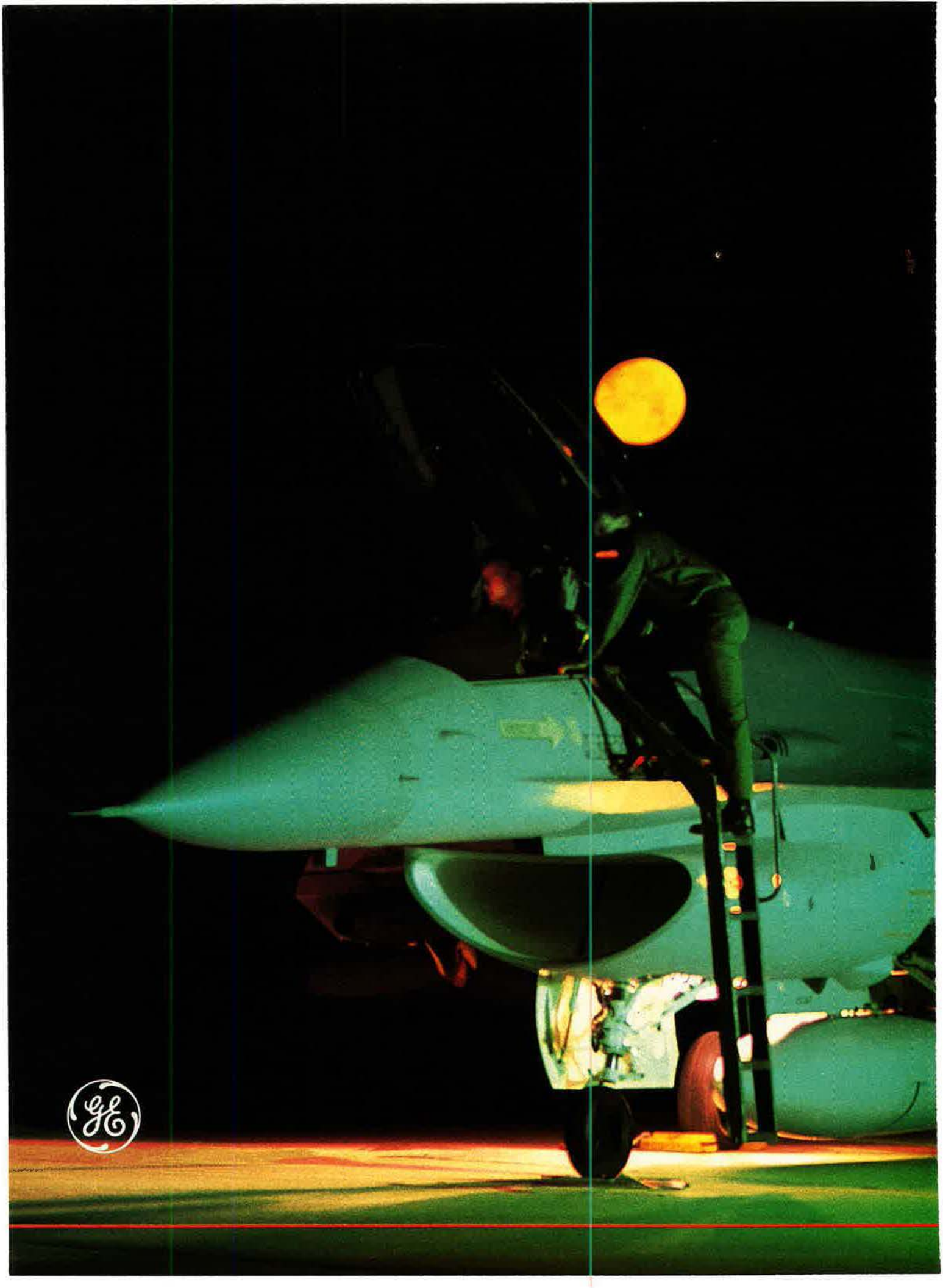

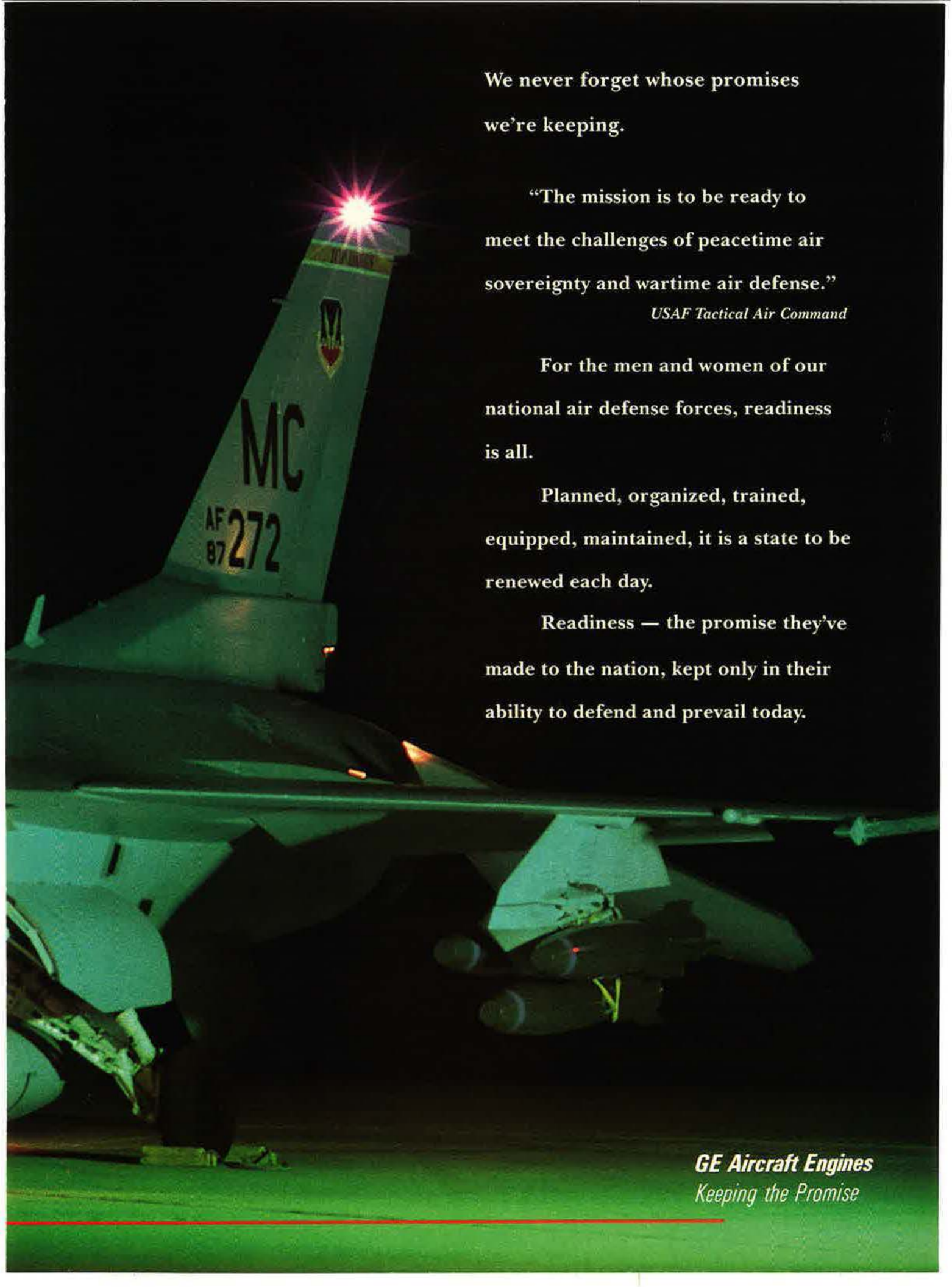

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which he enlightened the readers with his opinion that Navy pilots are better trained and more competent than their Air Force counterparts.

Way back in 1943, this same marvelous rivalry between our flying services was healthy and flourishing, so it seems nothing much has changed. As a P-38 fighter pilot wearing the uniform of the US Army Air Forces, I experienced some of this same happy/unhappy rivalry. . . .

Before going to England with the newly formed 474th Fighter Group, while based in California for operational training, on several occasions I had the twenty-one-year-old fighter pilot's joy of escaping from regulations set forth by the high brass, to meet in the air off the Pacific coast with Navy fighter jocks flying the wonderful old F4U Corsair. Our purpose was to determine which fighter, the twin-tailed yazoo—otherwise known as the Lockheed P-38—or the gull-winged marvel—the Vought Corsair F4U—was the better airplane flown by a better-trained pilot. We accomplished these experiments in a series of unsupervised and unauthorized mock dogfights, consisting of go-to-hell climbing, diving, tight-turning, rolling, and you-name-it.

I *always* figured Army beat Navy. No doubt the opposite opinion was held by the Navy and/or Marine pilots. . . . The question was never resolved in the bars of Los Angeles on Saturday night leaves by the contestants, with their temporarily overlooked dates yawning while the arguments ensued.

In view of the fact that history shows *both* services, *both* fighter planes, and *both* Army and Navy/Marine pilots vintage 1942–45 turned out to be pretty damn equal in skill and devotion to the cause, the healthy rivalry seems to have been a standoff back then. I choose to believe it still is.

Let me reply to Lieutenant Craig's comments on landing surfaces. Way back in the old days, Navy and Marine pilots did indeed take off and land on short-runway aircraft carriers. But I'm sure the wiser of these guys, while enjoying first-class meals after their missions, were well aware that a good number of their Army brothers were at the same moment managing to get their machines back on to a wire mesh strip cut out of some Far East jungle or a European apple orchard, sometimes at night and without fancy electronic navigational aids. And with a gourmet dinner waiting, consisting of a can of C-rations.

I have nothing but admiration for the likes of young Lieutenant Craig, and I sleep well nights knowing that he and his counterparts in our other services are doing good jobs coming along after us old guys. But *talk* to each other!

Capt. William E. Chickering, Jr., USAAF (Ret.)
Birmingham, Mich.

I guess it's time to toss my nickel into the torrent of responses to Lieutenant Craig's letter about "The Navy in Space."

I find it wonderful that an individual with 1,000 hours and 400 traps in the A-6E—as a passenger—can expertly discuss the relative merits of two very different pilot programs. Now I must admit I've never catapulted off a carrier at night (or day), or landed on one at night after a thirty-hour work day, or even worked a thirty-hour day (clocks must run faster on ships at sea). I can, however, land in a stiff crosswind, and I don't have to trap every time it rains or snows. Maybe this shows the good judgment of Air Force pilots—the most dangerous part of our missions is meeting the objectives (bombs on target, on time, or turning bad guys into smoking holes), not trying to get home.

Lieutenant Craig's letter [makes it seem that] the Navy has the corner on skill, courage, ingenuity, and free thinking. I don't think so. Although after the Navy shot down an unarmed Air Force RF-4 over the Mediterranean during an exercise, I could be mistaken, especially on the free-thinking part.

In my humble opinion, Lieutenant Craig is right in asserting the Air Force has a rule for everything, but wrong about its effect. We are not lobotomized automatons. Air Force pilots innovate with the best of them, sometimes to the chagrin of the Air Force leadership. Red Flag, Cope Thunder, and other exercises (all with eager Navy participants) make us think and innovate. Yes, we have too many rules, but I respectfully suggest the Navy put in a rule to "not shoot down allied aircraft during exercises." (I won't get into an argument over whether or not an Air Force aircraft constitutes a "friendly.")

I have flown with and against Navy and Marine pilots all over the world in my travels in the Air Force. We learn a lot from each other—and become better pilots in the process—because of our differences, not in spite of them. The key is we are on the same team—a man-for-man match for any other fighting force in the world. As for the space program, it takes a disciplined and courageous pilot who can turn computers on and off to go into space. It does not take an extraordinarily skilled free thinker.

Finally, will someone tell Lieutenant Craig the Navy doesn't have pilots. It has aviators. . . . And some of the Mercury astronauts were, believe it or not, Air Force pilots.

Maj. Buzz Bannister, USAF
Gunter AFB, Ala.

Fruitcake Alternative

Dr. Jacques S. Gansler's description of the specification for military fruitcake *[see "How the Pentagon Buys Fruitcake," June '89 issue, p. 94)* brought back buried memories.

When I enlisted in the Army Air Force in 1942, I was sent to armorer's school at Lowry Field. Just before Christmas, I drew KP duty along with a chap named Hollyday. I was sent to the bakeshop, where a sergeant set us to work preparing 1,000 pounds of fruitcake. We deyolked 144 dozen eggs, stirred in I can't recall how many pounds of flour, boxes of dates, candied fruit, etc. For lack of brandy, we added lemon extract. We greased 1,000 one-pound baking tins and lined each with wax paper the sergeant had carefully saved from commercial bread wrappers from days before. In one day's labor, we prepared the 1,000 pounds of cake ready for baking. The sergeant said we had been such good workers he would give each of us a fruitcake if we came around two days hence, which we did.

The only specification that we used was in the sergeant's head. Could we resort to local production of fruitcake today and save money?

Maj. Gen. I. B. Holley, Jr., USAF (Ret.)
Durham, N. C.

Flaig Remembered

I was saddened to see the note concerning the untimely death of Mr. Jack Flaig in your July issue. As a graduate of Penn State Air Force ROTC, I remember his active involvement with the cadets—inviting us to AFA picnics and attending dining-outs, award events, and commissioning ceremonies. He really enjoyed his interaction with the cadets, and many of us discovered AFA through him, becoming Life Members. I just wanted other readers to know that he served the AFA organization in a memorable manner.

1st Lt. Jennifer Whitnack, USAF
Moody AFB, Ga.

Wage Grade Slaves?

Your article "The Quiet Crisis in Civilian Personnel" *[see July '89 issue, p. 60]* put across a great fallacy. The report leads one to believe that the Wage Grade (WG) personnel in federal service are properly compensated. If we are to believe that a GS-14 cannot afford housing in California, how can we possibly believe that a WG-11 can afford housing when the difference in pay is about $16,000 (per year, according to locale)? Where should that WG-11 live?

In New Jersey, a WG-11 is paid nowhere near what comparable industrial employees are, and the benefits are not comparable either. The only thing the WG has going for him is time off, and that won't put a roof over his head.

You mention purchasing power, but all federal employees lost in this area, not just the senior executive service (SES). The gist of my letter is simple: You either pay the workers properly or you will lose them, no matter how much you pay the SES or any other high-level manager. I believe, as do many other WG employees, that we are grossly underpaid for what we do.

You should review the picture and caption on p. 61. Your depiction is of a WG employee, and the caption tells how hard it is to attract and hold them. That doesn't seem to agree with the meat of your report.

CMSgt. Bill Hubschman,
N. J. ANG
McGuire AFB, N. J.

Bye-Bye Blackbird

Your "There I Was . . ." cartoon in the August '89 issue stated as a "true story" the previously classified fact that the SR-71 can reach at least 140,000 feet.

Certainly the Soviet and Chinese military leaders know the capabilities of the SR-71. Why, then, does the Air Force keep these facts secret only from the American public, the very ones from whom the Air Force needs support?

Before the Blackbird is retired, I suggest that the SR-71 set a few significant records, records that will give us all reason to pause and appreciate what America can do when it has the vision. Records that won't fall next year to some Soviet aircraft polished and pushed to its limits just to erase the SR-71 from the history books.

How about an impressive altitude in horizontal flight record (above 120,000 feet)? Or a faster New York to Los Angeles record, or New York to Paris, London to Sydney, and Tokyo to San Francisco? These are records the National Aerospace Plane will have to shoot for. Or how about a nonrefueled distance and speed record?

Certainly the SR-71 Blackbird deserves such credit. Since it will no longer be in service, nobody should complain that national security is at stake. Please don't let them all be scrapped. Stored, perhaps, but not scrapped.

Don't let it just disappear! The Air Force and America will be the losers if we do not capitalize on this opportunity.

Give the American people an [example] of vision!

Everett Ratzlaff
Erie, Pa.

Not Only Antipersonnel

The caption of the picture on p. 22 of "Aerospace World" in the August '89 issue reports the launch of Hydra-70 "antipersonnel rockets" from the LTV Crossbow pedestal. My company manufactures the Hydra-70 free-flight rocket system. It is the US Standard 70-mm rocket system designed to attack all target types—armor, materiel, shipping, aircraft, buildings, bunkers, and personnel. Because it is free-flight with an extremely repeatable trajectory, it is unjammable and very accurate. It is an extremely versatile and cost-effective combined arms weapon system that can be launched from land and sea surface platforms as well as from rotary and fixed-wing high-performance aircraft. Far more than being simply an "antipersonnel rocket," it is a high-firepower, fire-and-forget, multipurpose weapon system whose presence on a platform is a major contributor to the platform's battle success and survival.

Jack E. King
BEI Defense Systems
Fort Worth, Tex.

Under the AEGIS

Of special interest to me was the article by Mr. Dudney titled "Back Into Harm's Way." *[See July '89 issue, p. 44.]*

I was, however, amazed and somewhat concerned by the obvious lack of accurate information pertaining to the construction of the CG-47-class cruiser program. The statement on p. 47, "The other part of the AEGIS team, the twenty-seven-ship force of CG-47-class cruisers, is paid for but will arrive late. Delays and overruns are afflicting construction," is incorrect.

The AEGIS Cruiser Program, which was initially awarded in 1978, is divided between two shipbuilders, Ingalls Shipbuilding, a division of Litton in Pascagoula, Miss., the lead shipbuilder, and Bath Iron Works, of Bath, Maine. In August 1989, Ingalls will deliver to the Navy the twelfth of nineteen CG-47-class cruisers contracted to Ingalls. This ship will be delivered eight weeks ahead of the originally scheduled contract date and significantly below the originally awarded contract price. Since 1978, on CG-47, not a single contract milestone date has been slipped, nor has the schedule been extended for any Ingalls-built ship. The cumulative early delivery of these twelve ships amounts to ninety-three weeks, and underruns to the awarded contract price amount to the price of another new ship.

I believe that there are many of your readers in the AEGIS community who would appreciate having the record set straight on this matter.

H. E. Robinson
AEGIS Cruiser Program Manager
Ingalls Shipbuilding
Pascagoula, Miss.

T-Bird Stunts

Having just caught up with your May issue, I think I can shed some light on Bob Stevens's "There I Was . . ." , in which a Laredo T-bird "tried" to take off without its aft fuselage. Yes, it really happened.

I went through T-33 Basic Flying Training in Class 58-I, from October 1957 to March 1958 (or thereabouts). One night at beercall, the wing's Maintenance Officer, a Major Marsh (nicknamed "Motormouth Marsh," from the raucous stories he told) came in bursting with laughter after having pulled just this stunt on the unsuspecting Control Tower. I don't recall whether they had to use the fire truck to block the runway, and I don't know whether there were any repercussions, but it had us students in stitches at the time.

However, when I recall that a fellow student (in Primary) flew into a cow on a T-28 night landing at Bartow AB some months before, and that I almost got a deer after a T-bird landing at McGuire AFB some fifteen years later, I'm not so sure that a mere aborted takeoff was anything special. On the other hand, if Mr. Stevens would like a *real* combat story, I'll tell him how I once went IFR [Instrument Flight Rules] in flying buffalo [excrement] while landing an O-1 at a Special Forces camp in Vietnam in 1966.

Col. Jonathan Myer,
USAF (Ret.)
Alexandria, Va.

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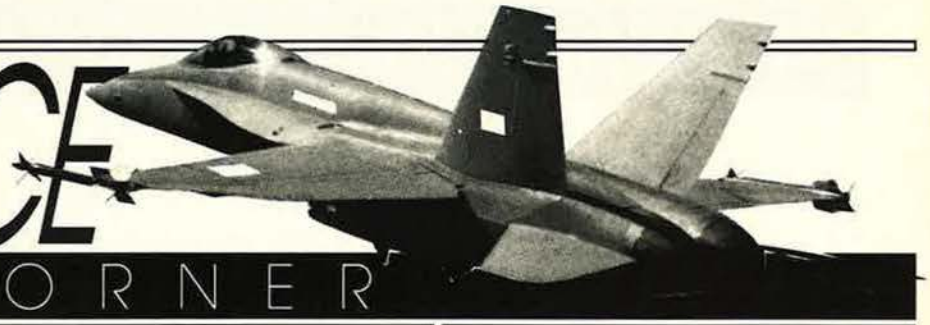

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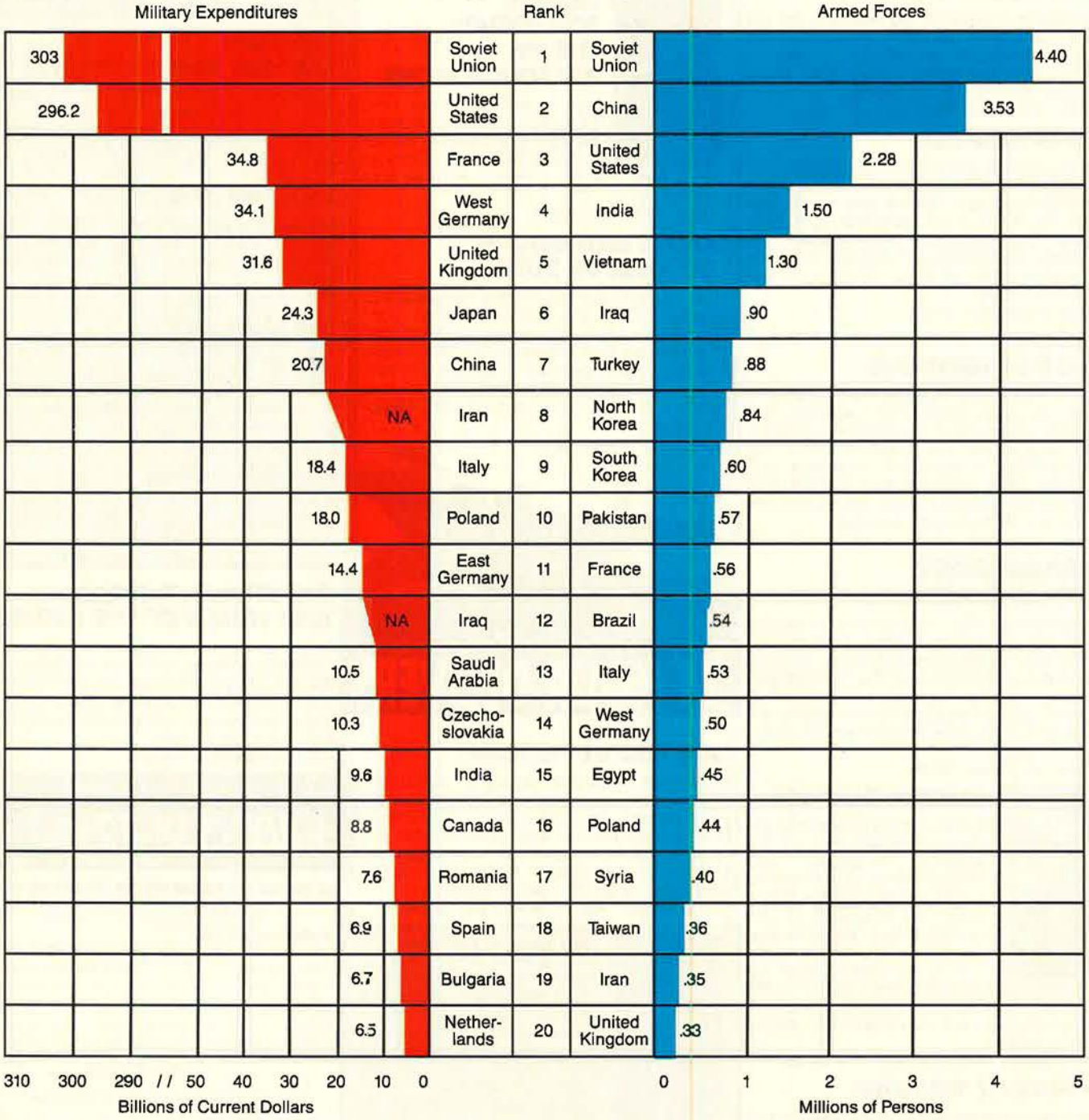
The Chart Page

Edited by **Colleen A. Nash,** ASSOCIATE EDITOR

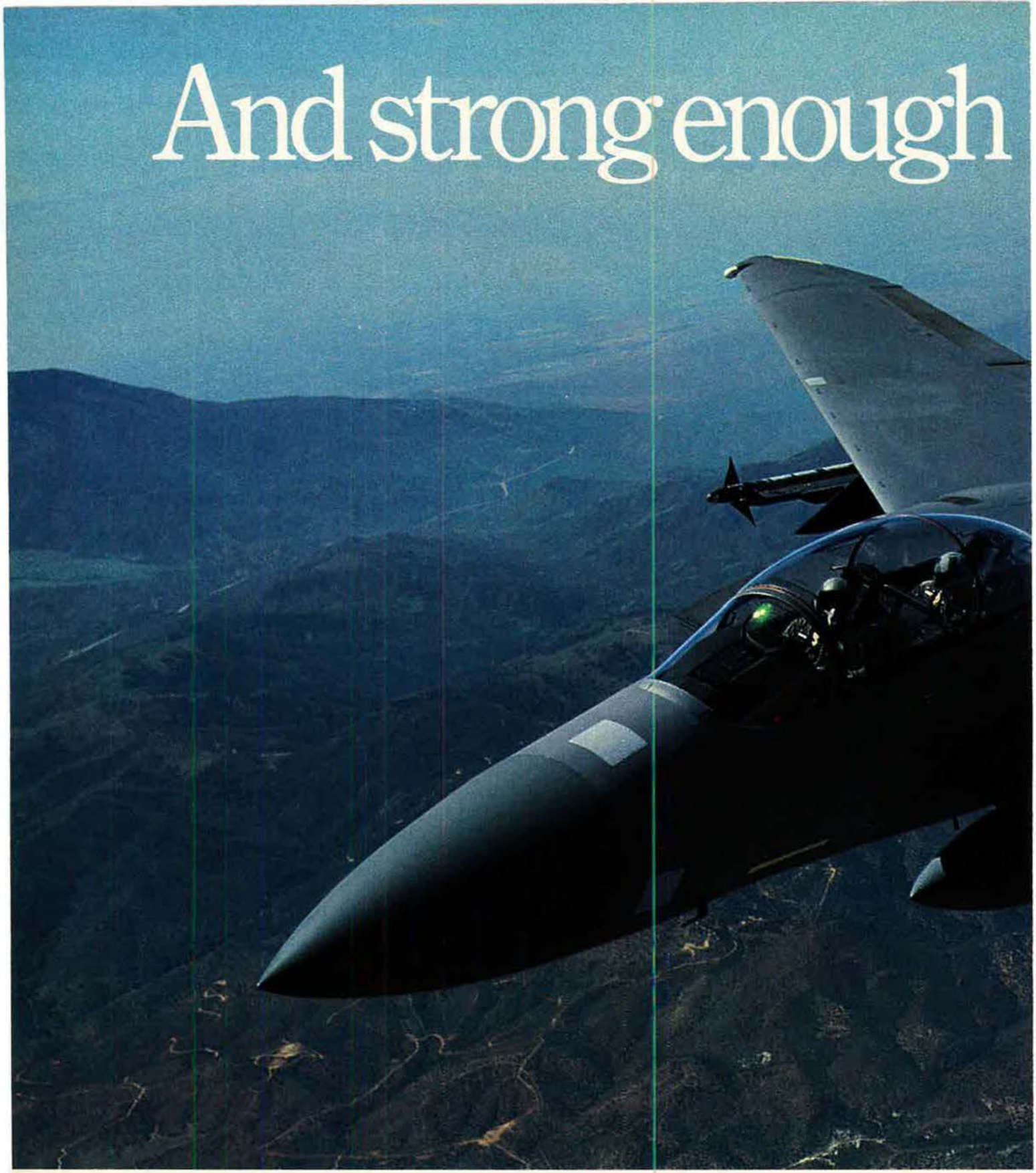
Standings in Military Power



No other nation spends as much as the Soviet Union does for military purposes, and none maintains a larger military establishment. This chart, reflecting 1987 data (more current data are not available for some nations) was published in June by the US Arms Control and Disarmament Agency. It was part of a larger study that reported that world military spending passed the $1 trillion mark in 1987. Some 5.5 percent of the global aggregate product goes for military purposes.

Only one bird is magnificent enough to be the symbol of a nation.

And strong enough



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THE F-15E

EAGLE

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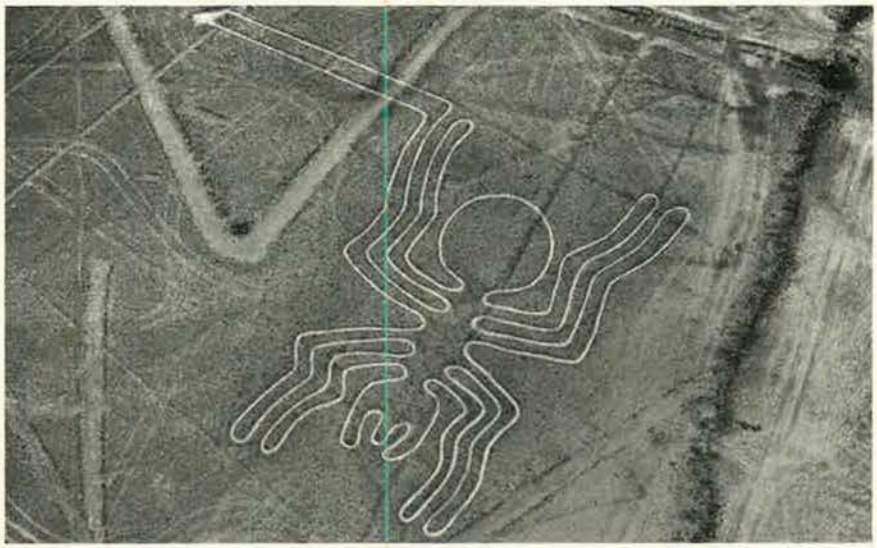

The Nazca Lines, believed to be 2000 years old, continue to fascinate and mystify observers from all over the world. Why and how did people from an ancient civilization create such magnificent lines? Given the tools of their time, how were they able to draw such precise geometrical shapes and forms? Is it significant that these lines can only be viewed in their totality from the sky?

The mystery surrounding the purpose, size and precision of the Nazca Lines continues to fascinate modern man, who can offer only theories to explain their origin and meaning. They are an impressive and puzzling achievement, far ahead of the typical abilities and tools of that time, leaving us in awe and respect of their creators.

At General Dynamics Space Systems Division, we are searching for people whose ideas are also ahead of their time. You'll be encouraged to create unique, innovative solutions to advanced, space-related challenges and have the opportunity to create precedent-setting achievements which will be viewed with respect for years to come.

We currently have opportunities available for individuals with a technical degree or the equivalent combination of formal education and related experience. Government or aerospace industry background is preferred.

If you have experience in one or more of the areas listed below, please send your resume to: Professional Staffing, GENERAL DYNAMICS SPACE SYSTEMS DIVISION, MZ C2-7143-I495, P.O. Box 85990, San Diego, CA 92138. (Opportunities also exist in Huntsville, AL, Harlingen, TX, Cape Canaveral Air Force Station, FL, and Vandenberg Air Force Base, CA.)

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Capitol Hill

By Brian Green, CONGRESSIONAL EDITOR

Washington, D. C.

HAC Bill Batters Air Force

The House of Representatives approved a Fiscal Year 1990 defense appropriations bill that, if it became law, would decimate the President's strategic modernization plan and cut key Air Force programs deeply.

The bill adopts reductions in strategic programs first imposed by the House defense authorization bill. These include cancellation of the Small ICBM, a $500 million reduction in the rail-garrison Peacekeeper program, a cut in the B-2 program from $4.7 billion to $3.7 billion, and a $1.8 billion reduction to the $4.9 billion SDI request.

The bill also includes:

- A $432 million cut in the C-17 program. The aircraft buy would be reduced from six to two. To justify the cuts, the House Appropriations Committee (HAC) report cites problems with the electronic flight-control system and excessive concurrency. The Air Force denies serious difficulties in the C-17 program.
- Deletion of the $1.1 billion request for the Advanced Tactical Fighter (ATF). The Committee report argues that program cost and technical difficulties require the action. The Air Force says that the reduction would cause a substantial delay of several years in the ATF program.
- Cancellation of the Milstar communications satellite program after deployment of the third satellite due to cost escalation in the $22 billion program. Cancellation would impair Air Force efforts to improve survivable, jam-resistant communications.
- Reduction of the Advanced Medium-Range Air-to-Air Missile (AMRAAM) program by $215 million and 635 missiles. The request had been for $903 million and 1,450 missiles. The cuts will keep this missile, critical to USAF air superiority in the future, in low-rate production.
- Termination of the Tacit Rainbow loitering antiradiation missile.
- Deletion of funding for the final two MC-130H Combat Talon II special operations airlifters.
- Cancellation of the C-27 short takeoff and landing airlifter intended for use by Southern Command.
- Deletion of procurement funds for the stealthy Advanced Cruise Missile.
- Reduction of Air Force end strength by 8,585 spaces. HAC based the reduction on the ground-launched cruise missile build-down in Europe. The Air Force, however, had already lost those spaces when they were reallocated in Europe.

The bill reduces Air Force procurement accounts by $3.6 billion from the $32.7 billion requested and chops Air Force R&D from $14.7 billion requested to $12.4 billion. The bill would also restore funding for the V-22 Osprey vertical takeoff and landing aircraft and the Navy F-14D fighter (both canceled in the Administration budget) and adds $2.9 billion to the Navy shipbuilding budget.

Cheney Blasts Representatives

In a recent speech, Secretary of Defense Richard Cheney accused the House of Representatives of ignoring a Soviet threat that continues to grow despite comforting rhetoric and announced, "[I]f the House-Senate [authorization] conference produces a bill like the House bill, you can be sure it will be veto bait."

While many House members seem "to think there is no real threat anymore," Secretary Cheney pointed out that Soviet defense expenditures have increased three percent a year since 1985. US defense spending has declined eleven percent in the same period. He also noted that House actions would eliminate development and deployment of mobile ICBMs, slow the B-2 bomber, and drastically reduce SDI, even as the Soviet Union is engaged in extensive improvement of its strategic arsenal. He also accused the House of ignoring the integral role of the B-2 bomber in US arms-reduction strategy. Each B-2, no matter how many bombs it might carry, would count as only one against a warhead limit. This counting rule jibes with the strategy of leading both the US and the Soviet Union away from excessive reliance on missiles.

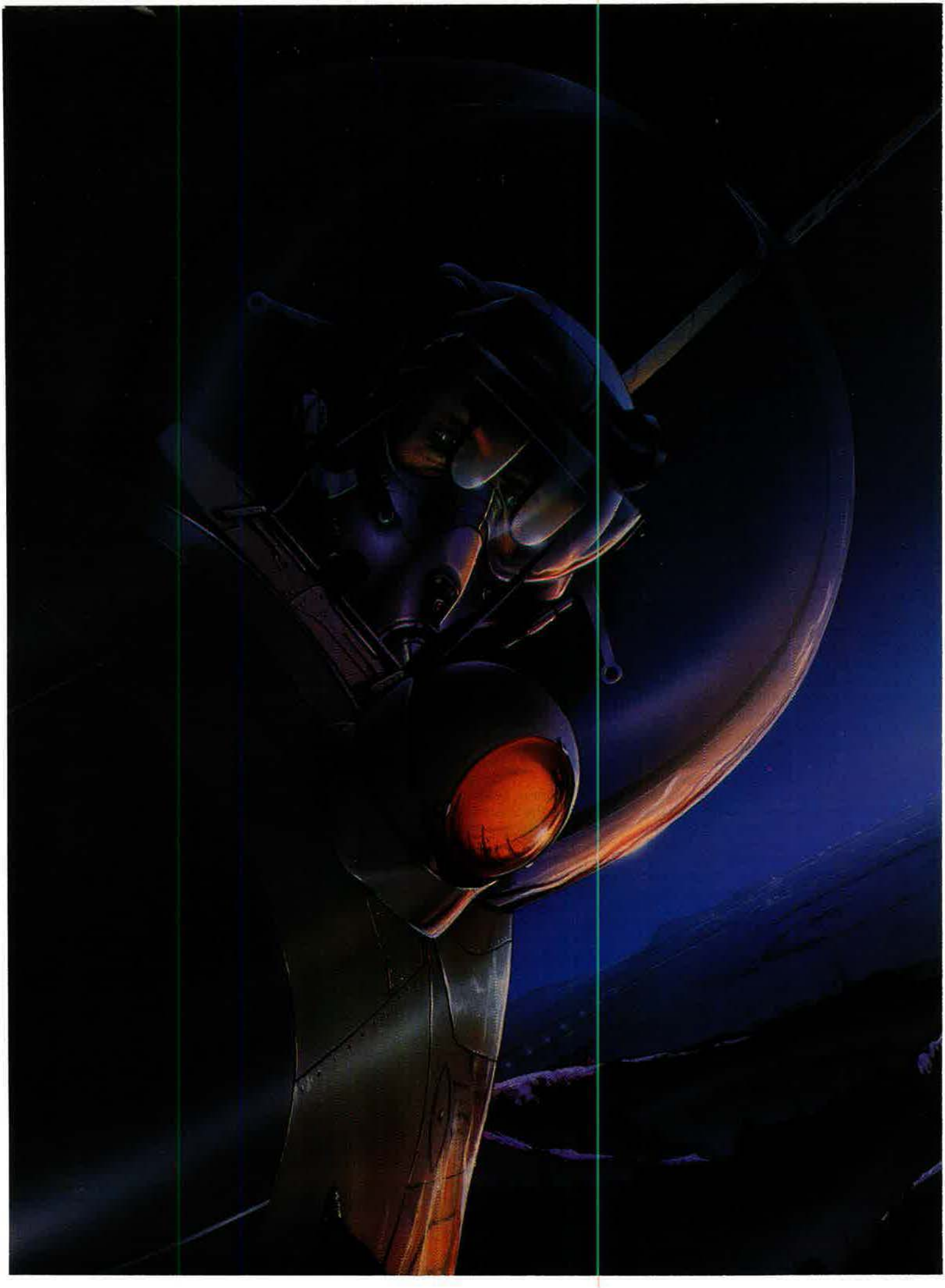
The fundamental problem, according to Secretary Cheney, is that the House "put short-term concerns ahead of . . . strategic and moral imperatives." The House restoration of major program cancellations requested in the Administration budget shows that "the House decided it was more important to use the defense budget as a local job-protection program" than to base its decisions on consideration of defense or budget requirements.

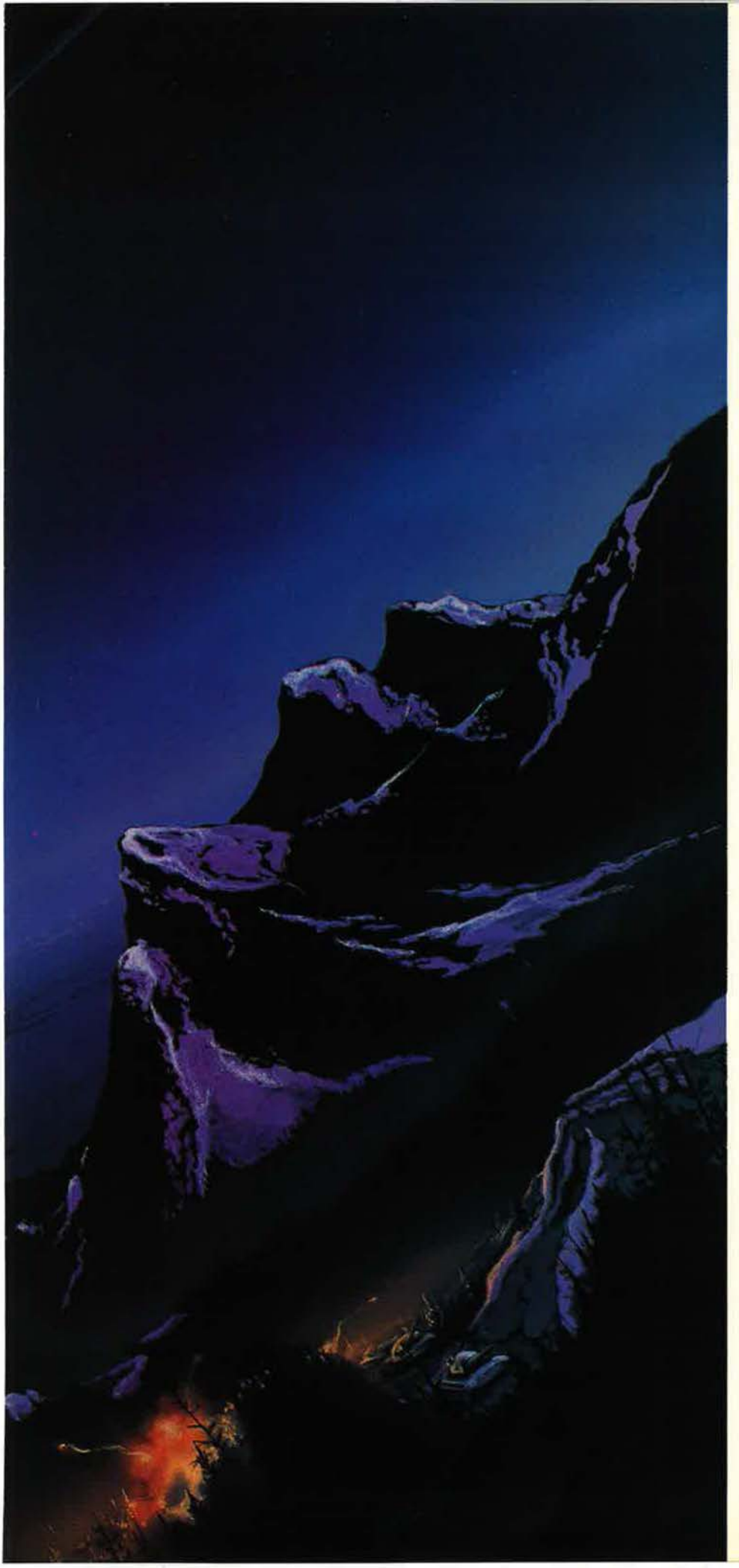
CatCap Reform?

The House Ways and Means Committee narrowly approved a proposal submitted by Reps. Pete Stark (D-Calif.) and Bill Gradison (R-Ohio) to reduce by fifty percent the surtax that funds Medicare coverage for catastrophic illness. Representatives Stark and Gradison proposed the original Medicare Catastrophic Coverage Act of 1988 (CatCap) legislation.

Under this proposal, the surtax would be 7.5 percent on 1989 income tax for people filing singly (down from fifteen percent in the current law) and would be raised to fourteen percent (up to a maximum of $850) by 1993. The maximum surtax for a couple filing jointly, however, would remain unchanged, starting at $1,600 for 1989 and increasing to $2,100 in 1993. The income level at which the maximum surtax would he imposed would increase from $35,000 to $45,000. The Stark-Gradison plan would make up some of the lost revenue by increasing the flat Part B premium. (Medicare Part B pays for doctor bills and outpatient charges.) It would also reduce CatCap prescription drug benefits.

The proposal would also allow seniors to opt out of CatCap. To exercise this option, however, Medicare beneficiaries would be required to give up all of their Part B coverage. Critics maintain that this option discriminates against military retirees who have paid their Social Security and Medicare payroll taxes all of their working lives and earned the entire Medicare package as it existed before CatCap was enacted. ■





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Falcon Eye — the head-steered FLIR. It's flying now.

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TEXAS INSTRUMENTS

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01-FE-AF

Aerospace World

By Jeffrey P. Rhodes, AERONAUTICS EDITOR

Washington, D. C.

★ The first completely new unmanned space launch vehicle to be introduced in the United States in two decades was rolled out in ceremonies at NASA's Ames-Dryden Flight Research Facility at Edwards AFB, Calif., on August 10. The Pegasus air-launched space booster was developed as a privately financed joint venture between Orbital Sciences Corp. and Hercules Aerospace. It is designed to launch small payloads into a circular polar orbit.

The Pegasus vehicle, which bears a superficial resemblance to the Air Force's 1950s-era Mace missile, is a three-stage, 49.2-foot-long, fifty-inch-diameter, winged booster that has a fueled weight (without payload) of about 41,000 pounds. It has a graphite composite delta wing with a twenty-two-foot wingspan and three five-foot-span movable control fins on the first stage.

Pegasus will be carried aloft by a bomber or a large commercial transport to level flight conditions at 40,000 feet and a speed of Mach 0.8. After release from the aircraft, the first stage will ignite, and the vehicle's autonomous flight-control system will provide guidance through the required suborbital or orbital trajectory. Pegasus can carry payloads of up to 900 pounds into low-earth orbits, or can boost payloads of up to 1,500 pounds on suborbital flights, high-Mach-number cruise flights, or ballistic flights.

This Pegasus has inert propellant and will be used for captive-carry tests. The NASA NB-52 used as the X-15 launch aircraft will be used for the Pegasus tests and the first couple of launches, which will take place over the Pacific Ocean.

The first full-up Pegasus booster will carry a Defense Advanced Research Projects Agency (DARPA) three-function payload called Pegsat, scheduled for launch this month. The Pegsat payload will include a small Navy experimental communications satellite and test instrumentation to determine stresses on and performance of the Pegasus vehicle. Pegsat will also perform a series of barium chemical-release experiments for NASA.

The first Pegasus air-launched unmanned space booster was rolled out at NASA's Ames-Dryden Flight Research Facility at Edwards AFB, Calif., in early August. Pegasus is designed to launch small payloads into a circular polar orbit.

DARPA will also have a payload aboard the second Pegasus launch, scheduled before the end of the year. All future Department of Defense Pegasus launches will be managed by Air Force Systems Command's Space Systems Division at Los Angeles AFB, Calif.

★ The Voyager 2 interplanetary space probe completed its grand tour of the solar system on August 24, as the 1,797-pound probe flew to within 3,000 miles of the planet Neptune. Now starting its thirteenth year of operation, Voyager 2 headed toward deep space and the heliopause (where the solar winds no longer have any effect) after the Neptune flyby.

Scientists at the Jet Propulsion Laboratory in Pasadena, Calif., were still receiving information at press time, because it takes four hours and six minutes to receive Voyager's signals even though they are sent at the speed of light. Voyager stored many images while it concentrated on other things, such as getting through Neptune's radiation field. Nonetheless, Voyager has once again provided a bonanza of new information on one of the outer planets and its moons.

Inbound, the probe was traveling at a speed of 37,500 mph, and it passed to within 2.8 million miles of Nereid, one of Neptune's two moons whose existence was known before Voyager 2's flight. It accelerated to approximately 60,000 mph as it passed over Neptune's north pole. Voyager 2 then flew to within 23,600 miles of Triton, the other large moon, before slowing to a leisurely 36,000 mph for the coast to outer space.

During its encounter with Neptune, Voyager discovered six new moons (given the clinical designations of 1989N1–N6) and three complete rings with bands of other material between them encircling Neptune. The probe also discovered that Neptune has a magnetic field. Triton was found to have an atmosphere and a volcanic surface made of nitrogen ice and ammonia. One spot on Triton was estimated to have a temperature close to absolute zero.

The Voyager program has been a scientific and engineering triumph beyond anyone's expectations. Voyager 1 was launched from Launch Complex 41 at Cape Canaveral AFS, Fla., on September 5, 1977, *after* Voyager 2. Voyager 1 took the faster route and flew by Jupiter on March 5, 1979, and Saturn on November 12, 1980, before it left the solar system.

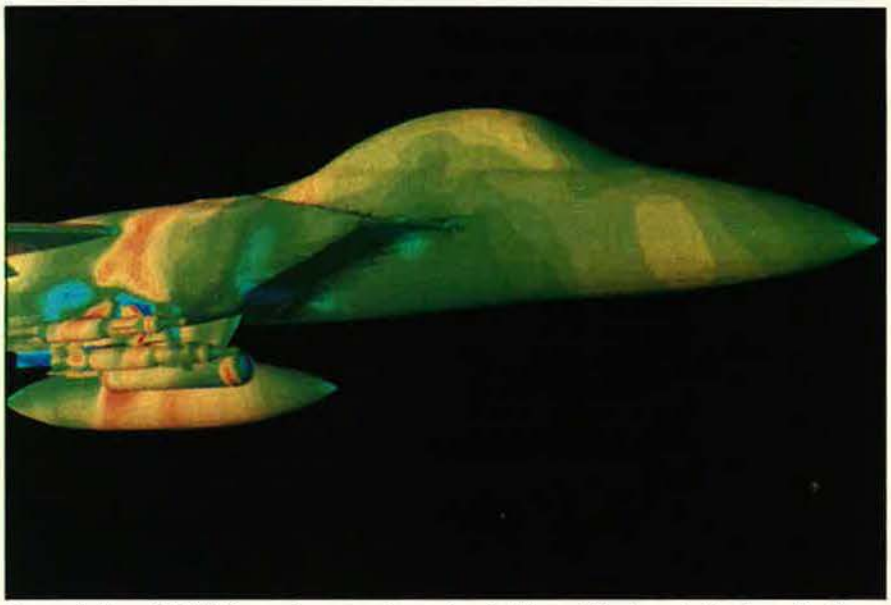
Like its twin, Voyager 2 was launched atop a Titan IIIE-Centaur booster when it took off on August 20, 1977. Taking a more roundabout route (Voyager 2 traveled some 4.43 billion miles, even though Neptune is only 2.793 billion miles away from Earth), Voyager 2 passed Jupiter on July 9, 1979, Saturn on August 25, 1981, and Uranus on January 24, 1986, before getting to Neptune. It used the gravitational pull of one planet to slingshot on to the next.

Together, the two probes have discovered at least thirty-one moons around the outer planets (sixteen around Uranus and Neptune discovered by Voyager 2) and sent back some five trillion bits of information. All this was done with on-board computers with only 32K bits of random-access memory, less than many home computers have now. Total cost of the Voyager program (including the spacecraft, launching, monitoring for more than twelve years, ground computer upgrades, etc.) was approximately $875 million. Counting the fuel used by the Titan IIIE booster, Voyager 2 averaged 32,000 miles to the gallon.

★ The space shuttle fleet got back to full strength as the recently reworked orbiter *Columbia* lifted off on a classified Department of Defense mission at 8:37 a.m. on August 8. This launch, the thirtieth in the shuttle program, was the eighth trip into space for *Columbia* and its first since January 1986, when it returned to earth ten days before *Challenger* exploded on liftoff.

The shuttle stack made a severe roll maneuver after launch, which put it on a course that took *Columbia* up the eastern seaboard of the US and on a direct course over the Soviet Union. Air Force Secretary Donald Rice said that the five-man crew deployed the main payload, a reconnaissance satellite, believed to be either the first KH-12 photographic satellite or the second Indigo Lacrosse radar-imaging satellite, on their first day in orbit. Two smaller payloads, believed to be Strategic Defense Initiative experiments, were also deployed on the mission.

The STS-28 crew of Air Force Col. Brewster H. Shaw, Jr. (mission commander), Navy Cmdr. Richard N. "Dick" Richards (pilot), Navy Cmdr. David C. Leestma, Army Lt. Col. James C. Adamson, and Air Force Maj. Mark Brown (payload specialists) also carried out checks of *Columbia*'s flight-control system while in orbit. Astronauts Richards, Adamson, and Brown were space rookies.



Computational Fluid Dynamics complements wind tunnel tests and shortens the time needed to get detailed information on aerodynamic effects. A supercomputer develops a computational grid to predict complex information. This is an F-15E, carrying two GBU-12 bombs, a LANTIRN pod, and an external fuel tank, as seen in the CFD "tunnel" at the Arnold Engineering Development Center in Tennessee.

Columbia, which contained several thousand pounds of test equipment for the first five shuttle flights, was used to supply parts for *Discovery* and *Atlantis* for the first couple of flights once shuttle missions resumed last year. *Columbia* recently underwent a complete renovation and 258 modifications that made it essentially identical to the other two orbiters.

The shuttle landed on Runway 17 at Edwards AFB, Calif., on August 13 after five days, one hour, and fifty-six minutes in space, making this flight the longest DoD shuttle flight to date. The orbiter suffered minor thermal tile damage, but no tiles were lost.

★ There was good news and bad news in the missile and satellite launch world recently. Here is a short rundown.

The Good News: After several delays, **the Air Force carried out the third successful launch of a Navstar Global Positioning System satellite** on August 18. The Rockwell-built Block II GPS satellite was launched aboard a McDonnell Douglas Delta II booster that took off from Launch Complex 17 at Cape Canaveral AFS, Fla., at 1:57 a.m.

This latest GPS satellite, unlike its predecessors, has no nickname. The whimsical practice of naming the satellites after deceased rock-and-roll singers has apparently been stopped.

Cover Prints Available

This month's cover depicting the B-1B is available as a high-quality print, measuring twenty-six inches by thirty-six inches and signed by the artist, Dru Blair. To order, send check or money order for $45.00 for each print (plus $5.00 for postage and handling) to: Blair Art Studios, 2329 Blossom St., Columbia, S. C. 29205. For Mastercard or Visa orders, call toll-free (800) 828-3634.

When completed, the twenty-four-satellite GPS constellation (twenty-one operational satellites in six planes with three on-orbit spares) will provide both civilian and military users with day and night navigational fixes that will be accurate to within sixty feet anywhere in the world.

The **Navy successfully carried out the second test of the AGM-84E Standoff Land-Attack Missile** (SLAM) on August 1 at the Pacific Missile Test Center range near Point Mugu, Calif. The missile, a derivative of the McDonnell Douglas Harpoon antiship missile, was launched and controlled by an A-6E crew. The SLAM was locked on to the smaller of two target buildings on San Nicolas Island by the Intruder's radar navigator, then autonomously guided itself to a direct hit. Eight more tests of the AGM-84E are planned.

The **Navy also successfully carried out the first undersea launch of the Lockheed UGM-133A Trident II, or D5, sea-launched ballistic missile** on August 2. The missile was launched from the USS *Tennessee* (SSBN-734) while cruising about fifty miles off the coast of Cape Canaveral. The Navy gave no details about the test. A planned launch on July 28 was halted when activists from Greenpeace sailed into the exclusionary zone in the test range. This successful test, however, led to . . .

The Bad News: On August 15, the **third undersea test of the Trident II failed.** The missile breached the surface, corrected and rose slightly, but then started to pinwheel. The missile's self-destruct mechanism then blew up the Trident II. Unlike the first failure on March 21, the debris missed the *Tennessee.*

Preliminary analysis indicated that a plume of seawater followed the forty-four-foot-tall missile after it broke the surface, and that, coupled with the 128,000-pound weight of the missile, put an excessive strain on the first-stage nozzle actuators. This occurred in the first test failure, and consequently the linkage had been redesigned and several modifications to the launch sequence had been made.

The Navy is investigating the failure and will make further engineering changes. The Trident IIs are scheduled to be deployed next March.

The AIM-120A Advanced Medium-Range Air-to-Air Missile **(AMRAAM) program suffered a notable setback** on August 2, **as the first multiple launch against multiple targets was a complete failure.** The test occurred over the Gulf Test Range near Eglin AFB, Fla., and the object was to launch four AIM-120s against four targets in an electronic countermeasures environment. All four missiles missed by a wide margin.

The Air Force's preliminary assessment is that the F-15's fire-control computer provided incorrect data to three of the missiles, causing them to miss. The remaining AMRAAM's miss is thought to have been caused by a terminal tracking mode software anomaly on the missile's radar. The test has been rescheduled.

—USAF photo by MSgt. Ed Boyce

As further evidence of the thaw in US-Soviet relations, two MiG-29 fighters and the giant An-225 transport landed and refueled at Elmendorf AFB, Alaska, on August 6 on their way to Airshow Canada. Here, 21st TFW F-15s turn escort duty over to a Canadian CF-18 from 441 Squadron as the MiGs cross into Canadian airspace.

★ **VCR ALERT—The Discovery Channel**, a cable TV network offering documentary entertainment, **will air eleven new episodes of its "Great Planes" series** starting on October 11. The new episodes will chronicle the history and development of the F-4, F4F Wildcat, F-104, B-25, Boeing 747, C-130, B-26, F-105, P-51, B-57, and F-15. The hour-long episodes will air on Wednesdays at 9:00 p.m. EST and will be shown again on Sundays at 11:00 p.m. EST through December 24.

Radar will be the subject of a new episode of the award-winning Public Broadcasting System documentary series **"Nova"** this month. The development of radar during World War II was one of the first large-scale collaborative efforts between civilian scientists and the military, and it had a dramatic effect on the war. The "Echoes of War" episode will air October 24 at 8:00 p.m. EST.

★ **APPOINTED—Army Gen. Colin L. Powell,** currently the Commander of Forces Command at Fort McPherson, Ga., was appointed by President George Bush on August 10 **to be the new Chairman of the Joint Chiefs of Staff.** General Powell, fifty-two, is the youngest Chairman ever and the first black to be appointed to the nation's top military post. A Vietnam veteran, he previously served as National Security Advisor to President Reagan. Pending Senate confirmation, General Powell will be the twelfth JCS chairman and the sixth soldier to hold that job. He will replace Adm. William J. Crowe, Jr., who is retiring.

★ **HONORS—The 2146th Communications Group's air traffic control complex** at Osan AB, Korea, was recently named **best in the Air Force** for 1988. The seventy-person complex is responsible for air traffic control support for Osan and Suwon ABs, Camp Humphreys, three satellite airports, ninety-five percent of the flying missions out of Kimpo International Airport, and Republic of Korea Air Force flights.

The maintenance complex of the **363d Tactical Fighter Wing** at Shaw AFB, S. C., has been named **winner of the Phoenix Award,** an annual Secretary of Defense honor for the best maintenance program in the Department of Defense. More than 2,100 people perform aircraft, munitions, and weapon delivery system maintenance on Shaw's F-16C/D and RF-4C aircraft.

★ **PURCHASES**—On July 28, Air Force Systems Command's Aeronautical Systems Division at Wright-Patterson AFB, Ohio, awarded **McDonnell Douglas** a $691,352,919 contract for **production of four additional C-17A airlifters.** Six C-17s are now in production. This is the first contract awarded under the new "event-based" plan for the plane. Under this plan, the company's Douglas Aircraft Co., in Long Beach, Calif., must complete a certain event, agreed to by both parties, before contracts are awarded for each of the annual production options. The Air Force required successful completion of a Critical Design Review of the mission computer software, which was done at the Delco Electronics plant in Goleta, Calif., in July. The 1990 contract option will be awarded after completion of the first aircraft, which is scheduled for early next year.

The **Aerotherm Division of Acurex** received a contract valued in excess of $20 million in late July for **Phase II of the Pyrotechnics Penetration Aids Development Program.** Awarded by Air Force Systems Command's Ballistic Systems Division at Norton AFB, Calif., the contract calls for Acurex to develop pyrotechnic countermeasures for ballistic missiles and to proceed through advanced research and flight testing. Morton Thiokol, Teledyne Brown Engineering, Physical Sciences, Inc., General Research Corp., and General Sciences, Inc., are the principal subcontractors.

Beech Aircraft recently received a $64 million Army contract for **nine RC-12K Guardrail electronic intelligence/electronic warfare aircraft.** The contract includes an option for five more aircraft. The RC-12K is a variant of the Beech Super King Air 200 with strengthened landing gear, a cargo bay, and a higher gross weight. Deliveries are scheduled to begin in February 1992.

AeroThrust Corp., an engine service company in Miami, Fla., was recently awarded a five-year **engine maintenance contract for the Air National Guard's C-22B aircraft.** The contract, which could exceed $15 million, was awarded by the Oklahoma City Air Logistics Center at Tinker AFB, Okla. The major work will include overhaul and conversion of the C-22's Pratt & Whitney JT8D-7B engines to -9A models, as well as hot-section inspection, repair, testing, and field-service support. The C-22Bs are military versions of the Boeing 727 airliner.

General Dynamics Commercial Launch Services, Inc., was selected in August **to provide launch boosters**

Missing From Our Masthead

Skinner Retires After 456 Issues

This month, for the first time in 456 issues, Richard M. Skinner's name is missing from our masthead. Mr. Skinner, who joined AIR FORCE Magazine in 1951 and who has been its managing editor since 1957, retired September 1.

Some readers may not know much about Mr. Skinner. Although he is an excellent writer, his by-line has appeared in our pages only sixteen times. His role was backstage, directing the process that converts the raw material of words and pictures into a polished magazine.

Rather than the single "deadline" of movie myth, our publication schedule is actually a series of thirty-odd phased gates through which material must pass on time and in good order. To make what you read as accurate as possible, the numbers, names, and facts will be challenged, verified, and, if necessary, corrected, along the way. Every word in every issue is checked several times for misspelling or error. If it's a complicated task you want, try putting together an almanac on the entire US Air Force, as this magazine does each May.

This was the arena over which Mr. Skinner presided for thirty-eight years. His mastery of it inspired something approaching awe among those of us who worked with him. Even readers who do not recognize his name immediately are nevertheless familiar with his work if they have read the magazine.

Mr. Skinner came to AIR FORCE Magazine by way of Illinois, New York, and two wars. He was born in Princeton, Ill., and entered Knox College in 1942. His study was interrupted, however, for service in World War II as an Army Air Forces cryptographer on Oahu, Saipan, Guam, and Okinawa. After his discharge as a staff sergeant at the end of the war, he returned to Knox, graduating in 1949 with honors and election to Phi Beta Kappa. He earned an MS degree from the Columbia Graduate School of Journalism in 1950. Recalled for a year during the Korean War, he was an information specialist with Military Air Transport Service until he joined AIR FORCE Magazine as assistant editor in 1951. He became managing editor in December 1957.

He was the co-editor of two magnificent AIR FORCE Magazine anthologies: *The Wild Blue* (with John F. Loosbrock) in 1961 and *Speaking of Space* (with William Leavitt) in 1962. At the time of his retirement, Mr. Skinner had been employed by AFA longer than anyone else on the staff.

Away from the combustion of magazine work, Mr. Skinner is a tenor of some ability. He sings in his church choir and with Washington-area choral societies. He also takes a leading hand in an unusual and ebullient group devoted to the work of author John Barth.

Part of the legacy that Mr. Skinner leaves to AIR FORCE Magazine is the tradition of high quality he built here. The staff bears his imprint, too. A significant number of our people were Skinner-recruited and Skinner-trained. Others were introduced to the Skinner way by corrections and query notes on their manuscripts or by a personal visit when the weak spots were really weak.

A handful of us—including a one-time intern named Correll—received our initial and formative introduction to the world of magazines from the finest managing editor there ever was, Richard M. Skinner.

—J. T. C.

for up to ten Navy UHF follow-on communications satellites. As a subcontractor to Hughes, which is building the $172 million satellites as well as managing the launches, GD will provide one Atlas booster for an expected 1992 launch from Launch Complex 36 at Cape Canaveral AFS, Fla. The Navy has the option to launch the other nine satellites on expendable boosters (which is expected) or on the space shuttle. Total value of GD's contract could be as much as $550 million.

★ **DELIVERIES**—The first two **production Boeing E-6A TACAMO II** (Take Charge and Move Out) aircraft were **delivered to the Navy** on August 4 at the company's plant in Seattle. The Navy has ordered fifteen of the aircraft, which are used to provide a communications link between the National Command Authorities and the ballistic missile submarine fleet. The E-6As are built on the same airframe as the Air Force's E-3 Sentry aircraft (but without the radar rotodome) and feature the GE/SNECMA F108-CF-100 turbofan engines found on KC-135R tankers. The E-6As will replace the Lockheed EC-130Q TACAMO I aircraft.

The **Navy also accepted the first** of eighteen **Sikorsky HH-60H** Helicopter Combat Support (HCS) aircraft for fleet service at NAS Point Mugu, Calif., in early August. The helicopter is now assigned to HCS-5 at Point Mugu, a Naval Air Reserve unit. The HH-60H is the latest model in the Black Hawk/Sea Hawk line, and will be used to rescue downed aircrews in hostile territory in all weather and to land and retrieve eight SEAL (Sea-Air-Land) troops within 200 nautical miles of its ship.

October Anniversaries

- *October 26, 1909:* Lt. Frederick E. Humphreys becomes the first Army pilot to solo in the Wright Military Flyer at College Park, Md.
- *October 30, 1919:* The reversible-pitch propeller is tested for the first time at McCook Field near Dayton, Ohio.
- *October 12–15, 1924:* As part of World War I reparations, the German zeppelin LZ.126 is flown from Friedrichshafen, Germany, to NAF Lakehurst, N. J. The Navy will later christen the airship USS *Los Angeles* (ZR-3).
- *October 28, 1924:* Army Air Service airplanes break up cloud formations at 13,000 feet over Bolling Field, D. C., by "blasting" them with electrified sand.
- *October 8, 1939:* A Lockheed Hudson crew from the Royal Air Force's No. 224 Squadron shoots down a German Do-18 flying boat. This is the first victory recorded by an American-built aircraft in World War II.
- *October 13, 1939:* Evelyn Pinchert Kilgore becomes the first woman to be issued a Civil Aeronautics Administration instructor's certificate.
- *October 4, 1949:* A Fairchild C-82 Packet crew airdrops an entire field artillery battery by parachute at Fort Bragg, N. C.
- *October 12, 1954:* The Cessna XT-37 Tweet trainer is flown for the first time at Wichita, Kan. The T-37 (called the "world's largest dog whistle" by crews) is still soldiering on as the Air Force's primary trainer.
- *October 13, 1964:* President Lyndon Johnson signs the ROTC Vitalization Act of 1964, which marks the first major revisions to the Reserve Officer Training Corps program in nearly fifty years.
- *October 24, 1974:* The Air Force's Space and Missile Systems Organization successfully carries out a midair launching of a Boeing LGM-30A Minuteman I intercontinental ballistic missile after it is released from the hold of a Lockheed C-5A at the Western Missile Test Range over the Pacific.
- *October 1, 1979:* All atmospheric defense assets and missions of Aerospace Defense Command are transferred to Tactical Air Command. Also on this date, the Aerospace Audiovisual Service becomes the single manager for Air Force combat audiovisual documentation.
- *October 5–13, 1984:* Several milestones are set on the thirteenth space shuttle mission. *Challenger* lifts off for the first time with a crew of seven, and Mission 41-G is the first to have two women astronauts (Sally Ride and Kathy Sullivan, who would become the first American woman to make a spacewalk) and the first to have a Canadian astronaut aboard (Marc Garneau). Commander Bob Crippen becomes the first to fly on the shuttle four times. Aloft, the crew refuels a satellite in orbit for the first time.

Bristol Aerospace Ltd. rolled out its first overhauled Canadian Forces CF-5 in August 21 ceremonies at its Winnipeg, Manitoba, plant. Canada operates fifty-six CF-5A/D aircraft (officially designated CF-116), a license-built version of the Northrop F-5A, mainly as lead-in trainers for CF-18 (F/A-18) pilots. Bristol will refurbish the CF-5s' wings, install new avionics and wiring, reinforce the dorsal longeron, and provide depot-level support for the planes.

★ **MILESTONES—Kristin Baker,** a twenty-one-year-old senior, is **the first woman appointed Brigade Commander and First Captain at West Point.** Cadet Baker will oversee a staff of forty and virtually all aspects of student life for the 4,400 cadets that make up the "long gray line." The US Military Academy has admitted women since 1976.

Army Secretary John O. Marsh, Jr., retired on August 11 after holding the post for eight years, six months, and fifteen days, **the longest tenure anyone has had as the department's top civilian.** He broke the mark of Henry Dearborn, who served as Thomas Jefferson's Secretary of War from 1801 to 1809. Mr. Marsh was pre-

sented the Medal for Distinguished Public Service by Defense Secretary Dick Cheney in a Pentagon ceremony. Next to occupy the chair is Michael P. W. Stone, who was sworn in on August 15.

The **second Bell-Boeing V-22 Osprey prototype made its first flight** on August 9 at Bell Helicopter Textron's facility in Arlington, Tex. The tilt-rotor aircraft, with Boeing pilot Dick Balzer and Bell pilot Roy Hopkins at the controls, hovered about thirty feet over the runway. That same day, the first Osprey made its sixteenth flight and, for the first time, retracted its landing gear after takeoff. The second V-22 will be used for flight-control system and flying qualities evaluation; the first is being used to test structures and expand the flying envelope. Four more V-22 prototypes are under construction.

The **Marine Corps's fleet of Bell AH-1W "SuperCobra" attack helicopters has passed the 25,000-flight-hour plateau.** The graybeard in the group of forty-six AH-1Ws now operating is Bureau Number 26208, which has accumulated 1,000 hours. That helicopter is assigned to Marine Air Group 39 at Camp Pendleton, Calif. Bell is converting the AH-1Ts to the "Whiskey" model and will also build thirty-four new AH-1Ws.

On August 1, the **first flight of BGM-109G Gryphon ground-launched cruise missiles was removed from RAF Greenham Common, England,** under the terms of the Intermediate-range Nuclear Forces Treaty. The sixteen missiles (without their W84 nuclear warheads) were flown in an Air Force C-5B to Davis-Monthan AFB, Ariz., where they will be destroyed. The remaining eighty BGM-109Gs will be removed from Greenham Common, the site of almost continuous protest since 1983, by 1991. In a related note, the Soviet Union recently destroyed the last of 718 SS-12 "Scaleboard" missiles at Saryozek, Kazakhstan, in accordance with the INF Treaty.

★ **NEWS NOTES—The second flight of the Northrop B-2 bomber was cut short** on August 16, when the "low oil pressure" indicator for an auxiliary hydraulic drive came on during the flight. The crew of Air Force Col. Richard Couch and Northrop pilot Bruce Hinds decided to return to Edwards AFB, Calif. The flight, scheduled to last three hours, was cut to sixty-eight minutes. The crew did, however, retract the plane's landing gear for the first time in flight. The third flight was made on August 27, and the plane remained aloft for nearly five hours. USAF acknowledged that the crew took the plane to an altitude of 25,000 feet and reached 300 knots, but no other details were released.

The **Air Force Accounting and Finance Center** at Lowry AFB, Colo., **has begun a new program to modernize and centralize the pay system for the Air Force's 262,000 civilian employees worldwide.** Called the Air Force Standard Civilian Automated Pay System, the program is the first major modernization in the civilian pay system in twenty years. Phase I of the program upgraded the current pay system to make some needed interim improvements, such as eliminating punch cards to record employee time and attendance data. Phase II, called the Centralized Civilian Pay System, will redesign and centralize the system. Phase II begins next month and runs through January 1991.

A **Boeing B-52G** being refueled at the San Antonio Air Logistics Center

Sabreliner to Extend Life of Air Force T-37s

Sabreliner Corp. has won the competitive Service Life Extension Program (SLEP) for the Air Force T-37B jet trainer. The Sabreliner team will design, test and deliver production SLEP kits to extend the service life of these vital jet training aircraft into the 21st century.

Sabreliner's principal team member, Southwest Research Institute of San Antonio, Texas will perform engineering design, analysis and structural testing. Together we represent a credible technical and aircraft modification team for the T-37B SLEP effort.

Sabreliner as the Prime Contractor has prior experience on SLEP aircraft modifications and will accomplish configuration management, manage subcontractors, and produce production kits. The Sabreliner team will provide a quality product for the T-37B SLEP in support of the San Antonio Air Logistics Command and the Air Training Command.

Proven past and current performance under Air Force and other government contracts makes Sabreliner a continued logical choice for other Department of Defense programs.

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On November 19, 1988, KC-135R crews from Altus, Grand Forks, McConnell and Robins Air Force Bases set 16 time-to-climb records for transport-type aircraft.

Beyond the professional pride of setting these records, the feat is one more indication of the outstanding performance of F108 (CFM56) engines.

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KC-135R/F108
16 TIME-TO-CLIMB WORLD RECORDS

Take-off performance. Under critical engine-out conditions, an F108-powered, fully loaded KC-135R needs only two-thirds of the runway required by predecessor KC-135A aircraft. Even under these conditions, the KC-135R can take off from all of today's SAC runways. With all engines operating, it normally needs only 7,000 feet.

Reliability/maintainability. The current engine-caused, 12-month IFSD rate is only .015 per 1,000 EFH, roughly equivalent to one shutdown every 66,000 hours. Time and material costs for maintaining the F108 are far below predecessor engines. On-wing maintenance has dropped to only 20% of the man hours formerly required.

Mission capabilities. In terms of fuel offload capability, two re-engined KC-135R aircraft now perform the work of three or more predecessor aircraft. And that enhances the mission capabilities of the entire United States Air Force.

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at Kelly AFB, Tex., **caught fire and was destroyed** on July 24. One civilian worker was killed and eleven others were injured in the blaze. A ground power unit, tow tug, and fuel truck were also damaged. The fire was brought under control in about an hour. The aircraft had been assigned to Eaker AFB, Ark., but was at Kelly for periodic depot maintenance. It had been scheduled to be sent to Barksdale AFB, La.

Military Airlift Command's **Aerospace Rescue and Recovery Service was redesignated Air Rescue Service** on August 1 and given its own headquarters at McClellan AFB, Calif. The name change gives the organization the same name it held when originally established on March 13, 1946. Although still under MAC on the organizational chart, ARS was administratively removed from 23d Air Force. Since its inception, ARS has been credited with saving more than 24,500 lives, including more than 14,000 civilians. Of the 10,069 military members saved, 3,776 were rescued in combat.

The recent scandals involving athletes using anabolic steroids have prompted the **Air Force** to reiterate a two-year-old **policy** that **prohibits use of "anabolic/androgenic steroids by otherwise healthy active-duty people."** Air Force members who use

Senior Staff Changes

PROMOTIONS: To be **General:** James P. **McCarthy;** Charles C. **McDonald.**

To be **Lieutenant General:** Leo W. **Smith** II.

RETIREMENTS: M/G William P. **Bowden;** M/G Thomas C. **Brandt;** Gen. Duane H. **Cassidy;** M/G Michael D. **Hall;** B/G Thomas W. **Honeywill;** B/G John R. **Hullender;** M/G Frank J. **Kelly,** Jr.; B/G Michael P. **McRaney.**

B/G Willard L. Meader; B/G Donald C. **Metz;** M/G Robert B. **Patterson;** M/G Randall D. **Peat;** B/G Basil H. **Pflumm;** Gen. Thomas C. **Richards;** B/G John **Serur;** B/G Victor S. **Stachelczyk.**

CHANGES: M/G Robert M. Alexander, from ACS/Studies & Analyses, Hq. USAF, and Cmdr., AFSCA, Washington, D. C., to Dir., Plans, DCS/P&O, Hq. USAF, Washington, D. C., replacing M/G Charles G. Boyd . . . **M/G Charles G. Boyd,** from Dir., Plans, DCS/P&O, Hq. USAF, Washington, D. C., to Ass't DCS/P&O, DCS/P&O, Hq. USAF, Washington, D. C., replacing M/G (L/G selectee) Leo W. Smith II . . . **B/G Jimmy L. Cash,** from Vice Dir., NORAD Combat Ops. Staff, J-31, Hq. NORAD, Cheyenne Mountain AFB, Colo., to Vice Cmdr., 7th AF, PACAF; C/S, ROK/US Air Component Cmd., Combined Forces Cmd.; Dir., Readiness & Combat Ops., ROK/US Air Component Cmd., Combined Forces Cmd., Osan AB, Korea, replacing B/G Peter D. Hayes . . . **M/G Thomas E. Eggers,** from Dep. Dir., Plans, DCS/P&O, Hq. USAF, Washington, D. C., to Cmdr., 23d AF, MAC, and Cmdr., USSOCOM, Hurlburt Field, Fla., replacing retired M/G Robert B. Patterson . . . **B/G Charles E. Fox, Jr.,** from Vice Cmdr., Ogden ALC, AFLC, Hill AFB, Utah, to Cmd. Dir., NORAD Combat Ops. Staff, J-31, Hq. NORAD, Cheyenne Mountain AFB, Colo., replacing B/G James W. McIntyre . . . **Col. (B/G selectee) Carl E. Franklin,** from Dep. Dir., Bases & Units, DCS/P&R, Hq. USAF, Washington, D. C., to Ass't C/S, P&P, UK Air Forces, NATO, High Wycombe, England, replacing B/G John C. Fryer, Jr.

B/G John C. Fryer, Jr., from Ass't C/S, P&P, UK Air Forces, NATO, High Wycombe, England, to Dep. Defense Advisor, US Mission to NATO, Brussels, Belgium . . . **Col. (B/G selectee) Gerald E. Hahn,** from Ass't Dep. Comptroller of the Air Force, OSAF, Washington, D. C., to Cmdr., AFAA, and Dep. Auditor General, Norton AFB, Calif., replacing retired B/G Basil H. Pflumm . . . **M/G George B. Harrison,** from C/S, Hq. USAFE, Ramstein AB, Germany, to ACS/Studies & Analyses, Hq. USAF, and Cmdr., AFCSA, Washington, D. C., replacing M/G Robert M. Alexander . . . **B/G Peter D. Hayes,** from Vice Cmdr., 7th AF, PACAF; C/S ROK/US Air Component Cmd., Combined Forces Cmd.; Dir., Readiness & Combat Ops., ROK/US Air Component Cmd., Combined Forces Cmd., Osan AB, Korea, to Vice Cmdr., USAF TFWC, TAC, Nellis AFB, Nev., replacing Col. John Freilino . . . **B/G James L. Jameson,** from Ass't DCS/Ops., Hq. USAFE, and Ass't Dep. Dir., Ops., EACOS, Ramstein AB, Germany, to DCS/Ops., Hq. USAFE, and Dep. Dir. of Ops., EACOS, Ramstein AB, Germany, replacing M/G Bruce J. Lotzbire . . . **Col. (B/G selectee) C. Jerome Jones,** from Dep. Dir., Ops. & Training, DCS/P&O, Hq. USAF, Washington, D. C., to Dep. Dir., Strategy and Policy, J-5, Joint Staff, JCS, Washington, D. C., replacing B/G Robert E. Linhard.

B/G Robert E. Linhard, from Dep. Dir., Strategy & Policy, J-5, Joint Staff, JCS, Washington, D. C., to Cmdr., 57th AD, SAC, Minot AFB, N. D., replacing B/G Raymund E. O'Mara . . . **M/G Bruce J. Lotzbire,** from DCS/Ops., Hq. USAFE, and Dep. Dir. of Ops., EACOS, Ramstein AB, Germany, to C/S, Hq. USAFE, Ramstein AB, Germany, replacing M/G George B. Harrison . . . **L/G (Gen. selectee) James P. McCarthy,** from DCS/P&R, Hq. USAF, Washington, D. C., to Dep. CINC, Hq. USEUCOM, Vaihingen, Germany, replacing retired Gen. Thomas C. Richards . . . **L/G (Gen. selectee) Charles C. McDonald,** from DCS/L&E, Hq. USAF, Washington, D. C., to Cmdr., Hq. AFLC, Wright-Patterson AFB, Ohio, replacing retiring Gen. Alfred G. Hansen . . . **B/G James W. McIntyre,** from Cmd. Dir., NORAD Combat Ops. Staff, J-31, Hq. NORAD, Cheyenne Mountain AFB, Colo., to Dir., NORAD Planning Staff, Hq. NORAD, Peterson AFB, Colo., replacing B/G (M/G selectee) James G. Andrus . . . **B/G Raymund E. O'Mara,** from Cmdr., 57th AD, SAC, Minot AFB, N. D., to DCS/Strategic Planning and Analysis, Hq. SAC; Dep. Dir., Force Employment Plans, JSTPS; and Dep. Dir., Strategic Planning and Analysis, STRACOS, Offutt AFB, Neb., replacing B/G Robert E. Dempsey.

B/G Garry A. Schnelzer, from Dep. Dir. (Acting), SDIO, OSD, Washington, D. C., to Special Ass't for Launch Matters, Space Systems Div., AFSC, Los Angeles AFB, Calif. . . . **M/G (L/G selectee) Leo W. Smith II,** from Ass't DCS/P&O, DCS/P&O, Hq. USAF, Washington, D. C., to Senior Military Comptroller of the Air Force, OSAF, Washington, D. C. . . . **Col. (B/G selectee) Edwin E. Tenoso,** from Cmdr., 62d MAW, MAC, McChord AFB, Wash., to Vice Cmdr., 22d AF, MAC, Travis AFB, Calif., replacing M/G Frank E. Willis . . . **B/G James P. Ulm,** from Cmd. Dir., NORAD Combat Ops. Staff, J-31, Hq. NORAD, Cheyenne Mountain AFB, Colo., to Vice Dir., NORAD Combat Ops. Staff, J-31, Hq. NORAD, Cheyenne Mountain AFB, Colo., replacing B/G Jimmy L. Cash . . . **L/G Henry Viccellio, Jr.,** from Vice Cmdr., Hq. TAC, and Vice CINC, USAFLANT, USLANTCOM, Langley AFB, Va., to DCS/L&E, Hq. USAF, Washington, D. C., replacing L/G (Gen. selectee) Charles C. McDonald . . . **M/G Frank E. Willis,** from Vice Cmdr., 22d AF, MAC, Travis AFB, Calif., to DCS/Requirements. Hq. MAC, Scott AFB, Ill.

SENIOR ENLISTED ADVISOR CHANGE: CMSgt. Robert L. Munns, to SEA, Hq. ESC, San Antonio, Tex., replacing retired CMSgt. Robert L. Sherwood.

SENIOR EXECUTIVE SERVICE (SES) CHANGES: Robert D. Stuart, to Dir., Budget Investment, SAF/ACBI, Washington, D. C., replacing John E. Lary . . . **Robert W. Zook,** to Dir., Budget Mgmt., SAF/ACBM, Washington, D. C., replacing Jerome S. Coleman. ■

them will be involuntarily separated, because the service considers steroid use to be drug abuse.

For the first time since the **Royal Air Force** was formed in 1918, **women will be allowed to serve as pilots and navigators.** The women will be restricted to noncombat aircraft, such as transports, tankers, search-and-rescue helicopters, and airborne early warning aircraft. The RAF needs to recruit 250 pilots and 100 navigators per year, and women will be allowed to fill ten percent of each of the slots.

Thirteen Air Force bases, one Air National Guard base, and an Air Force plant have been named as proposed additions to the Environmental Protection Agency's Superfund National Priorities List. The NPL ranks hazardous waste sites posing the greatest potential long-term threat to health and the environment. The Air Force sites include: Edwards, George, March, and Travis AFBs, Calif.; Eielson and Elmendorf AFBs, Alaska; Luke and Williams AFBs, Ariz.; Homestead AFB, Fla.; Loring AFB, Me.; Mountain Home AFB, Idaho; Pease AFB, N. H.; Plattsburg AFB, N. Y.; Otis ANGB, Mass.; and the Air Force plant in Waterton, Colo. The EPA is also expanding its determination on Mather AFB, Calif., because additional base sites are contaminating an underground drinking-water supply.

Bell Helicopter Textron's four-bladed AH-1W demonstrator has completed basic stability and safety-of-flight envelope expansion tests. This fall, it will be put through advanced maneuvers and aerobatics.

Gen. Alfred M. Gray, the Marine Corps's feisty commandant, **is requiring his troops to read books.** Saying, "Marines fight better when they fight smarter . . . [and] systematic and progressive professional reading contributes directly to that goal," General Gray and his educational leaders have come up with a two-page reading list that includes everything from former Navy Secretary Jim Webb's fictional *Fields of Fire* to *Maritime Strategy in the Nuclear Age.* NCOs and company- and field-grade commanders will be required to read two to six books a year under the program.

★ **DIED—George Vaughn,** the third-ranked American ace flying for the American Expeditionary Force in World War I, of unreported causes in a New York, N. Y., hospital on July 31. He was ninety-two. As a lieutenant, Mr. Vaughn shot down twelve aircraft and a balloon, which ranks him fourteenth overall among American aces for the war, but eleven of the others flew for Britain or France. He graduated from Princeton in 1920 and worked for Western Electric and Westinghouse before starting Eastern Aeronautical Corp. in 1928. Mr. Vaughn's decorations included the Distinguished Flying Cross and Silver Star.

Walter Ballard, the pilot of the plane that carried the first load of transcontinental airmail in 1932, at his home in La Mesa, Calif., after a long illness. He was ninety-three. As a pilot for American Airways, he flew the San Diego, Calif., to Phoenix, Ariz., leg of the first cross-country airmail flight. A Navy test pilot during World War II, he logged more than 20,000 flight hours in twenty-five types of planes.

Alexander S. Yakovlev, famed Soviet aircraft designer, of unreported causes on August 22. He was eighty-four. He completed his first military design (the Ya-22) in 1939, and went on to design the Yak-1 through Yak-9 fighters during World War II, of which almost 37,000 were built. As the Mikoyan-Gurevich fighters became increasingly dominant, Mr. Yakovlev turned to sport planes and commercial planes. His last military designs were the Yak-38 Forger and Yak-41 vertical takeoff and landing naval fighters. ■

Index to Advertisers

A new type of monolithic integrated circuit (IC) will operate at frequencies far beyond the capabilities of silicon-based ICs. The technology to produce these gallium arsenide microwave ICs in quantity is under development by Hughes Aircraft Company for the U.S. Air Force as part of the Microwave/Millimeter Wave Monolithic Integrated Circuits (MIMIC) program. The new devices will be capable of performing power amplification, low-noise amplification, and phase shifting and switching at far higher frequencies than allowed by current IC technology. MIMIC technology has the potential for a wide range of military and commercial applications, including radar electronic countermeasures, smart weapons, and satellite communications systems.

Communications satellites with more than twice the transmitting power of earlier models reduce the size and cost of earth receiving stations. The Ku-band HS 376 satellites, designed and built by Hughes, transmit with approximately 20 watts per transponder. At this power, earth station antennas as small as four to six feet in diameter, small enough to be mounted on rooftops, walls, or poles, can be used for both transmitting and receiving satellite signals. By comparison, lower power, C-band satellites require antennas six to ten feet in diameter for receiving capability. The high-power satellites are part of Hughes' Very Small Aperture Terminal network, which provides end-to-end satellite communications for data networking and videoconferencing.

An advanced semiconductor packaging technology will permit maximum utilization of the next generation of integrated circuits. Using packaging techniques based on its high-density multichip interconnect (HDMI) technology, Hughes will design, develop, fabricate and deliver test modules and large-area multi-chip packages for the Naval Ocean Systems Center. HDMI uses fine-line integrated circuit processes to build the substrate circuitry in a hybrid package. The packaging technology is aimed at meeting the need for higher density modules that operate at high speed using very-large-scale integrated circuits.

Transistors built using CMOS/Sapphire on Silicon (SOS) technology operate at higher frequencies than ever reported for silicon MOSFET devices. These Metal-Oxide-Silicon Field Effect Transistors, developed by Hughes, demonstrate cutoff frequencies greater than 20 gigahertz. The combination of mature digital technology with complementary silicon MOS microwave devices will allow the building, on a single chip, of such circuits as digitally controlled microwave shifters or Microwave/Millimeter Wave Monolithic Integrated Circuit amplifiers.

A fiber-optic guided missile proceeds to full-scale development after 13 years of research. A team from Hughes and Boeing Corp. will deliver eight fire units and 40 Non-Line-of-Sight Missiles starting in early 1991. Hughes will develop the TV-guided and imaging infrared-guided versions of the missile. As part of the U.S. Army's Forward Area Air Defense System, the missiles will be launched and guided to targets over six miles away even if the target is not within line of sight of the launcher. Video images from the missile seeker, and guidance commands from the launcher, travel back and forth via a hair-thin fiber optic cable, which pays out from the back of the missile. The optical fiber is immune to environmental and deliberate jamming.

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A new doctrine is taking shape. The Air Force of the future may eliminate artificial divisions of labor and project flexible power at great distances from US bases.

Global Power from American Shores

BY JAMES W. CANAN, SENIOR EDITOR

"AIRPOWER is indivisible. We don't speak of a 'strategic' or a 'tactical' Army or Navy, yet those terms are constantly applied to the Air Force. The overriding purpose of every plane, whether it is a bomber or a fighter, is to win the air battle on which victory on land or sea is predicated."

Those words were spoken thirty-eight years ago, in 1951, by Gen. Hoyt Vandenberg, then Chief of Staff of the Air Force. His message that strategic airpower and tactical airpower are all of a piece in terms of their military purpose had been borne out in World War II and in the Korean War, being waged even as he spoke. Its truth would again become evident in Vietnam.

In each of those wars, bombers assigned to strategic missions were used to support tactical operations—B-29s in the Pacific and Korean theaters and, in Vietnam, B-52s in close air support of US Marines besieged at Khe Sanh. In Vietnam, obversely, F-105s were flown on countless missions that purists would have defined as strategic.

Now the Air Force is moving to endorse indivisible airpower as official writ. It is updating the doctrine by which it lives, the doctrine for employing airpower. In the process, distinctions long drawn between strategic and tactical airpower and between the combat locations of air and space are going by the wayside.

That's not all. Ideas for projecting indivisible airpower in new and different ways are percolating in the Air Staff shop of Maj. Gen. Charles G. "Chuck" Boyd, Director of Plans for Lt. Gen. Jimmie Adams, Air Force Deputy Chief of Staff for Plans and Operations (XO).

Says General Boyd: "We're thinking about alternative futures, about the kinds of aerospace power that will be required. We're giving thought to what the world might look like ten years from now to forty years from now, and we're thinking about what kind of an Air Force, what kind of a national defense structure, might be appropriate for that altered world.

"We're going about this in a very serious way."

To General Boyd and his planners, the only thing that really matters about airpower, when you get right down to it, is its effect on the

—Illustration by Randy Lyhus

enemy in the pursuit of US military and political objectives. Whether the flying machines that apply airpower are called strategic or tactical, or whether they are flown in air or space or both, is unimportant.

For now, USAF's planners are continuing to call airpower just that—"air" power—even though they are factoring space into it. They are inclined to make space synonymous with air for purposes of simplification. But the term "aerospace power," as used by General Boyd, is an option.

Under whatever heading, USAF is making provision for projecting airpower into faraway conventional conflicts from bases in the United States. Plans are afoot for long-range combat aircraft to weigh in, if need be, with nonnuclear weapons in various scenarios all around the globe. This concept has already taken hold with B-52Gs and B-1Bs and is in the works for the stealthy B-2s.

The Air Force has never made any bones about the B-1B's potential for projecting nonnuclear airpower as a penetrating bomber. Four years ago, Gen. Lawrence Skantze, USAF (Ret.), then the Commander of Air Force Systems Command, declared that "the B-1B has been designed to support tactical forces behind the FEBA [forward edge of the battle area]. . . . There's no doubt it can play a significant role in the kind of tactical warfare expected in the AirLand Battle scenario."

In a Class by Itself

Amen, and then some, for the B-2. The Air Force puts the B-2 in a class by itself and has given it superstar billing in the streamlining of airpower doctrine. The B-2 can be seen as both cause and effect of that effort.

USAF trusts that it will be better able to justify its need for the controversial, costly B-2 by weaving into its updated airpower doctrine all the things that the bomber can do, thus making its prowess indispensable to that doctrine. However, the revolutionary capabilities offered by the B-2 have made it possible—indeed, necessary—to update the doctrine in the first place.

In arguing that the US should ante up for the B-2, the Air Force emphasizes the enormous military value that it expects from the bomber—value far surpassing the B-2 program's skyscraping price tag.

Says General Boyd: "The B-2's principal role will be that of a SIOP [single integrated operational plan] penetrating bomber, because the mission of nuclear deterrence will remain the most important one that we perform. I cannot envision a world just yet in which we can effectively deter nuclear war without a penetrating bomber, a land-based ICBM, and a sea-based ICBM—in short, the triad.

"But the B-2 may also be the best system for nonnuclear conflict that we have. Right from the outset, we have been thinking about, and planning, how to use it across a wide variety of tasks. We can't help but be intrigued by how useful this aircraft ultimately will be."

The B-2 translates into "open sesame" for indivisible airpower and the doctrine to make that airpower come to pass.

Asserts General Boyd: "Absolutely fundamental to the concept of indivisible airpower is the notion of a long-legged, stealthy penetrator that can be armed with conventional or nuclear weapons." Such a bomber becomes all the more important "if we have to put even more of a premium on our ability to project power from the shores of this nation."

More Integrated Airpower

The B-2 is shaping up as the cleanup hitter in a new lineup of Air Force operational organizations, now under conceptual development in General Boyd's shop, for doing just that. Each such unit might embody all, or most, types of combat aircraft—for example, long-range bombers, shorter-range ground-attack aircraft, air-combat fighters, and radar-attacking Wild Weasels—that are now segregated in single-purpose units.

The combat units with catch-all aircraft would also contain space specialists, perhaps formed into "space squadrons," responsible for making optimum use of such orbital assets as communications satellites and reconnaissance satellites.

"We can't think of the future without thinking about space," General Boyd declares. "Most, if not all, of the missions that we perform in the atmosphere today we will be able to perform from space.

"We should not turn to performing them from space just to be able to say we can. However, as technologies evolve, and if they make it possible for us to do our missions more efficiently, more effectively, and at less cost from space, then we must do so, whether those missions be close air support, interdiction, offensive counterair, defensive counterair, or whatever."

The National Aerospace Plane program is the seedbed of such technologies. The ultimate goal of the NASP program is a family of hypersonic aircraft/spacecraft for military and commercial purposes. They would be capable of taking off from runways, vaulting directly into orbit, and flying in the atmosphere at speeds up to Mach 25. But the NASP program has been stretched to cut its short-term costs and long-term technical risks, and Air Force planners must take a wait-and-see approach to its power-projection potential.

Action central for the updating of airpower doctrine is XO's Deputy Directorate for Warfighting under Col. John A. Warden III. He took on the job more than a year ago at the direction of General Boyd and his boss, Gen. Michael Dugan, then the three-star DCS/XO, who is now the four-star CINC of US Air Forces in Europe. General Dugan's successor as DCS/XO, General Adams, continues to back the directorate's doctrinal endeavors.

A Redefined Threat

The blue-suiters do not have stars in their eyes about the Soviets. No one in Air Staff planning circles expects the Soviet threat to go away. In fact, says General Boyd, "I have not seen any substantive changes in Soviet force structures or correlation of forces. . . . We are not at all certain that the world is changing in significant ways, but we are doing some conceptual thinking on the basis of the possibility that it is."

Whether the Soviet threat diminishes or resurges, it seems obvious to Air Force strategists that ever-graver threats to US interests—and to US national security—will rise up elsewhere, especially in the increasingly well-armed Third World.

As of now, those threats are nonnuclear, but there are disturbing indications that they may not stay that way. They cannot, in any case, be taken lightly.

The increasingly worrisome dimensions of Third World threats have prompted the Joint Chiefs of Staff to conclude that deterring or waging a so-called low-intensity conflict in those parts of the world will be the most demanding job for US military forces in the foreseeable future.

US politico-military strategists evidently have come to believe that the prospect of US involvement in such conflicts is greater than the likelihood of either general nuclear war with the USSR or a Warsaw Pact nonnuclear attack on NATO.

To USAF, a threat is a threat is a threat. Says Colonel Warden: "We need to examine whether the world changes all that much simply because the Soviets seem to be going away. The Soviets have been our principal, almost our exclusive, enemy, and everything that happened around the world was somehow associated with them.

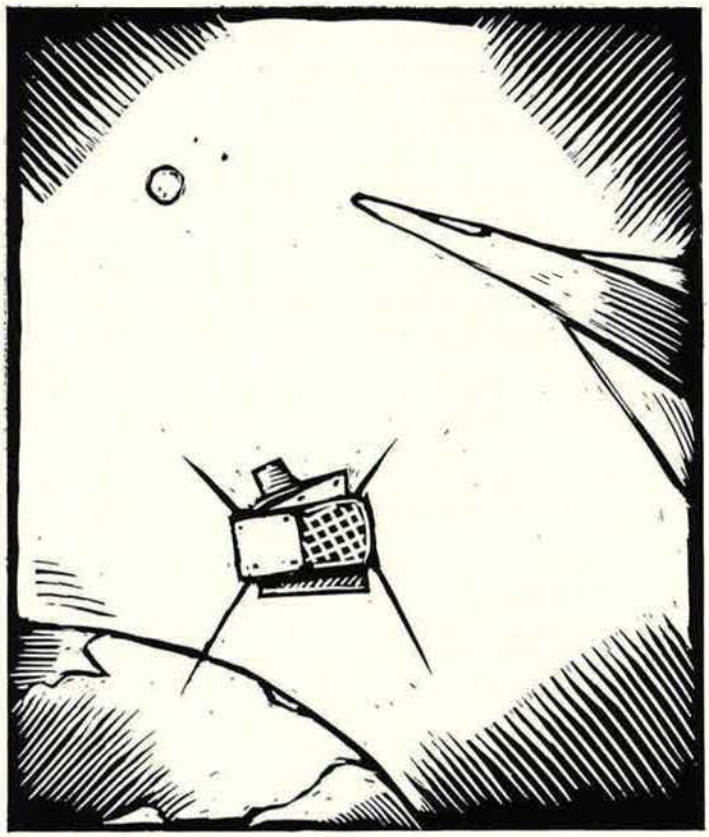
"Because we've had that focus, we might conclude that when the Soviet threat recedes—it isn't going away—the world becomes much safer. But in fact it may not."

Cases in point: the recent ordering of advanced Soviet MiG-29 and Su-27 fighters, respectively, by Iran and Libya, two demonstrably warlike nations likely to remain hostile to the US and to other states in their regions that support, or are sympathetic to, US interests.

There will almost certainly be many more instances of US-baiting nations arming to the teeth—not just with modern variants of fighters, tanks, and the like, but also with globally scarier things like ballistic missiles and the makings for chemical and biological warfare.

Lt. Col. (Col. selectee) Mike Hayden, acting director of the XO warfighting shop's Strategy Division, suggests that "the world may actually become more fearsome for us, not safer" if the Soviet threat lessens. The reason, he says, is that "there are lots of 'Balkans' all around the world where war could start. The Soviet influence tended to keep them under control. But they have their own dynamics, and they'll be more likely to create tensions as the superpower influence recedes.

"It may be difficult to explain this to the American people, but the threat to the US will nonetheless be at least as real as it is now. The potential threat to the United States at the height of the Cold War was probably greater in terms of nuclear exchange. But now the real threat, in terms of Americans really being put at risk and dying, could come at us from all angles and could be, in fact, much worse in a multipolar world."



Drawing the Right Conclusions

For USAF strategists, drawing the right conclusions about the dimensions and directions of future threats is the first order of business. Those conclusions are the wellsprings of Air Force thinking on how best to project airpower in the future and on the forces and weapons that will be required.

"We're looking at threats in a different way," explains Lt. Col. (Col. selectee) Dail Turner, chief of the warfighting directorate's Long-Range Planning Division. "In the past, we've tended to focus on military threats. Now we're taking a broader look at all threats to our national interests."

From that viewpoint, certain kinds of threats are seen as emerging from nations that are now allied militarily and geopolitically with the US. Such nations may find it expedient to team up with one another, as in western Europe, or with nations unfriendly or cool to the US, as perhaps in the Pacific basin and the Mideast, in order to strengthen their own economies and mount stronger economic challenges to the US.

Some such US allies may also see fit to oppose US policies vis-à-vis the Third World. Accordingly, they may forbid the US to use bases on their soil and may deny the US overflight rights to carry out military action in the furtherance of those policies.

There is already plenty of precedent for this kind of policy. It could get out of hand if US allies no longer see the Soviet threat as big enough to warrant their common cause with

Washington. Political pressures in such places as western Europe, Korea, the Philippines, and even, in the long run, Japan, could wear out USAF's welcome at more and more forward air bases, as at Spain's Torrejon, in years to come.

On top of all that, the US may take itself out of the action abroad. Washington and Moscow seem intent on working up an agreement to make big cuts in both sides' forces in Europe, and this could well lead to a significant US pullback.

The increasing difficulty for the US in standing fast on foreign soil was underlined in a 1988 report by the White House Commission on Integrated Long-Term Strategy, which said in part:

"The United States must develop alternatives to overseas bases. In some contexts, to be sure, bases will continue to be critically important—especially when our problem is to defend against possible Soviet aggression.

"But we should not ordinarily be dependent on bases in defending our interests in the Third World. We have found it increasingly difficult and politically costly to maintain bases there."

Deploying From Home

The Air Force is already hedging its bets on overseas bases. "We may not have a whole lot of forward presence," says XO's Colonel Turner. "Our units are more and more likely to be based in the United States. So we're thinking in terms of deploying airpower from home."

Many influential strategic thinkers are of like mind. For example, Gen. Russell E. Dougherty, who retired from the Air Force as Commander in Chief of Strategic Air Command and who still serves on the Defense Science Board, is convinced that "the key to our future will be our ability to project power without being there."

In turn, the key to projecting airpower may well lie in making it truly and thoroughly indivisible, in doctrine and in practice.

General Vandenberg was way ahead of his time in championing such airpower in 1951. But it was not to be. USAF assigned its intercontinental-range combat aircraft, along with the ICBMs that came along later, exclusively to SIOP missions. The bombers became synonymous with "strategic"—interpreted as "nuclear"—airpower only. On the other hand, shorter-range attack aircraft assigned to theater missions became synonymous with "tactical conventional" airpower, even though some of these aircraft have long since carried nuclear weapons, just in case.

In wartime operations and in peacetime deployments aimed at stopping trouble before it starts, USAF has used its combat aircraft more flexibly than its airpower distinctions would seem to allow.

Strategic bombers have never flown SIOP missions against the USSR, but they have been used in every war on long-distance tactical conventional missions. Thanks to in-flight refueling, tactical fighters have ranged far beyond their assigned theaters to make the US presence felt in relatively remote parts of the planet.

The Air Force, intent on preserving the top-priority, nuclear-deterrent, SIOP status of its long-range bombers, has been reluctant to raise its voice about their conventional capability—or, for that matter, about the nuclear capability of its in-theater, "tactical" fighter-bombers.

Now USAF is sounding off and coming around. The service is taking cues from a body of airpower literature that has built up in recent years, such as the 1986 Air University book *Aerospace Power: The Case for Indivisible Application.*

The author, Maj. Grover E. Myers, noted that General Vandenberg and other Air Force leaders of the post-World War II era "supported an end to the parochial strategic/tactical division of labor," but that they had to give way to "the requirements of nuclear deterrence and the realities of budget allocations."

Major Myers continued, "Since that time when we were still sorting through the lessons of World War II and developing a way to manage the nuclear nemesis, we have become so immersed in the mythology of nuclear deterrence and so accustomed to the presence of 'strategic forces'—nuclear bombers, nuclear missiles, and nuclear submarines—as to lose sight of the real military value of a large portion of our military forces."

Real Military Value

Refocusing on that real value is what USAF is now all about—in freshening up its airpower doctrine and, not coincidentally, in justifying its beleaguered B-2 bomber.

The B-2 program has managed to stay alive, but has taken a pounding in Congress this year. The outlook for a full-fledged force of the bombers is not bright.

Air Force leaders past and present insist that the US needs all, or nearly all, of the 132 B-2s originally planned and that a lesser force won't be able to cover all nuclear and nonnuclear contingencies in the threatening world seen ahead.

General Dougherty, for one, maintains that it will take "well over a hundred" B-2s to give SAC a "meaningful" force. Such a force, the former CINCSAC continues, "will provide an entirely different—but consequential—global power projection and warfighting capability, with either nuclear or nonnuclear weapons, across a full spectrum of conflict situations.

"And, importantly, it [the B-2 force] can do these critical strategic tasks from centrally located air bases within the United States."

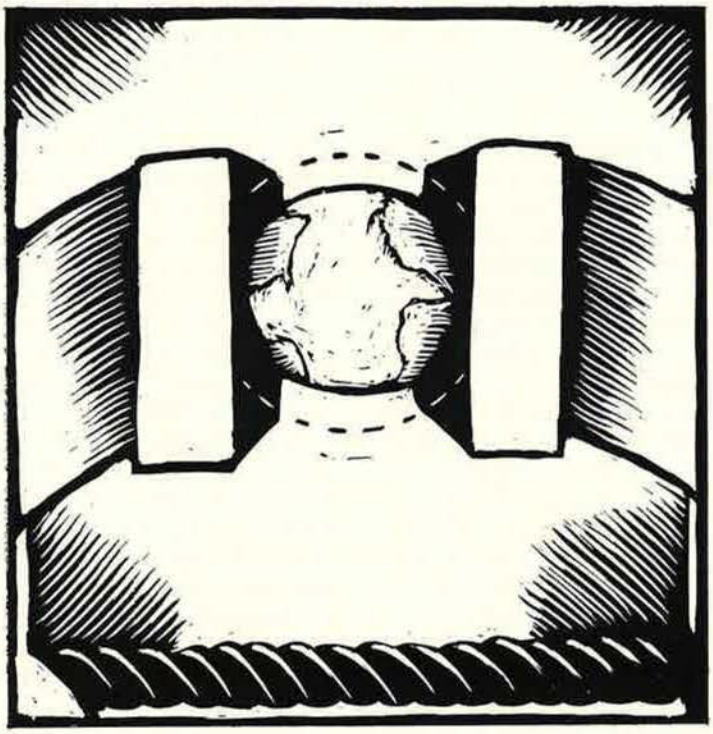
The B-2 could also operate from overseas bases that the US owns or occupies, such as those on Guam in the western Pacific and British-owned Diego Garcia in the middle of the Indian Ocean. The Air Force alluded to those bases in a report last summer that summed up unclassified congressional testimony on the B-2 by Chief of Staff Gen. Larry D. Welch and Secretary of the Air Force Donald Rice.

The report depicted the B-2 as the premier means of projecting US airpower until well into the next century. It emphasized that the B-2 is needed, first and foremost, as a SIOP weapon. It noted that nonnuclear missions are in the cards as well.

Air Force planners can easily envision the stealth bomber on such conventional missions against high-value targets in the Soviet Union and eastern Europe. This could happen in the unlikely—but not impossible—event of war in Europe remaining nonnuclear throughout.

The B-2 might also be used for shorter-range interdiction. Given the intensity of Warsaw Pact air de-

fenses and the problems that the US is having with electronic countermeasures, including those on its B-1B bomber, the stealthy B-2 may turn out to be the only "reusable" weapon system capable of delivering large nonnuclear payloads against targets deep behind enemy lines, in accordance with AirLand Battle doctrine and with long-established Air Force doctrine in support of theater CINCs.



Then there is the problem, which is expected to grow, of how to retaliate against nations or groups that foment terrorism against the US and its citizens.

In April 1986, Air Force and Navy aircraft were used for such a purpose in Operation Eldorado Canyon against Libya. All told, about 120 aircraft took part. Only thirty-two of them, or about one-fourth, carried out the actual strikes against five targets in Libya.

Of those attack aircraft, eighteen were Air Force F-111Fs based in England. They went after three targets in and around Tripoli. Several in-flight refuelings were required to get them to Libya and back, because France had denied them overflight rights. Constrained by stringent rules of engagement, roughly one-third of the F-111Fs were unable to deliver their payloads. One F-111F did not come back.

Fourteen of the attack aircraft in the operation were Navy A-6Es from the carriers *America* and *Coral Sea*. They attacked two targets at Benghazi.

Thirty-one Air Force aircraft were needed in support of the F-111Fs—twenty-eight KC-10 and KC-135 tankers and three EF-111 Ravens for jamming. The Navy devoted almost double that number of aircraft to supporting roles.

The Navy is said to have put more than fifty planes into the air to support its target-attacking A-6Es. Six A-7Es and six F/A-18s reportedly were used for defense suppression. The remaining forty-five or so Navy support aircraft were a handful of E-2C Hawkeyes, for airborne warning and control, and, in much greater numbers, F-14s and F/A-18s.

Those carrier-based fighter-interceptors provided cover for both the Navy and the Air Force attack aircraft and guarded the carriers and their escorting warships against air attack.

Simpler with B-2s

The Air Force claims that the B-2 would have made the operation a whole lot simpler. Not long before the B-2 was rolled out on November 22, 1988, General Welch declared that Eldorado Canyon could have been carried out "with three or four B-2s with no support of any kind."

That would depend on where the bombers came from. Critics of General Welch's statement claim that B-2s based in the central US—for example, at Whiteman AFB, Mo., where the first B-2 wing is indeed destined to be based—would have had to cover some 10,000 nautical miles round trip to Benghazi without overflying other countries. This, they say, would have required one in-flight refueling—and, thus, four or five tankers.

This argument seems to miss the point. Even with five tankers and five B-2s, including one along for the ride as an airborne spare, the five sets of Libyan targets could have been attacked—and likely destroyed—with fewer than one-tenth the total number of aircraft that took to the air in Eldorado Canyon.

This presumes, of course, that the B-2's stealthy characteristics are all they're cracked up to be and, thus, that the B-2s could have dispensed with covering, radar-picket, defense-suppression, and electronic-countermeasures aircraft.

The Air Force is confident that its presumptions of B-2 prowess would be proved in combat. It expressed this confidence in its report on the bomber last summer.

The report addressed a vital question often posed by B-2 critics—whether the Air Force would, or should, ever risk such a high-priced SIOP bomber on a raid against such low-value (meaning non-SIOP) targets as those in Libya.

The answer is yes. According to the Air Force report, the B-2's stealth "would have made the risk minuscule," would have made for "very high secrecy and surprise," and would have enabled "a small force from US soil" to destroy the targets.

In its report, USAF was also at pains to clarify the B-2's capabilities

in another controversial arena. It made a point of not claiming—as it had previously seemed to claim—that the B-2 would be surefire at striking so-called relocatable targets, such as mobile ICBMs.

Even so, the report noted that the B-2 would be the only SIOP weapon anywhere near capable of carrying out that mission and that it would continue to get better at doing so.

The report made a case for manned bombers in general. It predicted that they will carry forty percent of all US nuclear weapons by the year 2000, given the makeup of the US deterrent force to be expected as a result of Strategic Arms Limitation Talks. Furthermore, it said, penetrating bombers, as distinct from standoff cruise-missile bombers, will carry one-fourth of the total number of US nuclear weapons by then.

This puts the burden squarely on the B-2. It is expected to be the only bomber capable of getting through Soviet defenses by the year 2000. By then, in its SIOP role, the B-1B will have been turned into a cruise missile carrier—period—just like the B-52H before it.

Shows of Strength

The Air Force also contends that the B-2 could be used for deterrence in an impressive manner without actually bombing anything or resorting to overkill. For example, one B-2 could slip in and drop bags of flour on a chemical weapons plant or a nuclear weapons plant to show how easy it would be to come back with real bombs to blow it to smithereens.

Gen. John T. Chain, Jr., Commander in Chief of Strategic Air Command, makes a big point of the growing importance of such shows of strength. He claims that "long-range bomber striking power—the ability to reach anywhere in a few hours—is integral to future security." He also emphasizes that the stealthy B-2 "can respond with a full spectrum of retaliatory capability" in "dealing with terrorist acts or global conflict."

As CINCSAC, General Chain has done a great deal to promote the strategic bomber—both inside and outside the Air Force—as a nonnuclear powerhouse. He developed a concept called "strategic area of responsibility" in which US theater CINCs have been given operational control of B-52Gs, with no SIOP strings attached, for use on nonnuclear missions.

Using the bombers in this fashion, says CINCSAC, "gives us an extra long arm to reach far behind enemy lines with awesome conventional capability." He also notes that the B-52 is no slouch at sea duty. It can attack enemy ships with Harpoon missiles and can also deliver mines to close harbors, choke sea lanes, and thwart or destroy submarines.

Perhaps most important, "We can do these things from bases in the United States," General Chain declares.

Indeed, range is now, more than ever, the name of the game. Says Colonel Warden: "As we think about what our doctrine and our operational principles should be, one thing that we're emphasizing more and more and more is the fact that we have simply got to have range, range, range."

Penetrating bombers and others armed with cruise missiles figure heavily in USAF's contemplations on how to get that range. So do other kinds of flying machines. All are being considered in terms of how they could be made to work together as an organic whole.

Says Colonel Warden: "Range can come from the national aerospace plane. It can also come from organizations of what we now call tactical fighters that have the ability to move around the planet and operate out of relatively austere fields—not necessarily from established air bases or strips—with a minimum of mobility baggage accompanying them.

"Those fighters could conceivably conduct operations three, four, and five hundred miles from where they've landed."

Command Changes

Moreover, the fighters might belong to units that also embody CONUS-based long-range bombers, cruise missiles, and spaceplanes under the operational control of the unit commanders, possibly brigadier generals or colonels. Those commanders would be ultimately accountable to four-star generals or flag officers in charge of warfighting commands and theaters. They would nonetheless be given great latitude in making decisions and taking actions, just as air component commanders do today.

What counts, says Colonel Warden, is the effect that such commanders and their units will be able to achieve with their organic airpower resources, and "it ought to be immaterial whether those resources are bombers, fighters, space systems, cruise missiles, or whatever."

Air Force planners see the ability to attack strategic or tactical targets from afar with airpower that makes no strategic or tactical distinctions as the core—indeed, as the *sine qua non*—of US military strength in years to come. They tip their caps to the Navy's carrier-based airpower and applaud its recent successes under fire. But there is widespread concern, not just in Air Force circles, about the future vulnerability of aircraft carriers and associated warships to ever-quieter attack submarines and to increasingly potent and abundant antiship missiles around the world.

Land forces, too, may be in for a bit of a comedown in the strategic scheme of things. Those forces will always be important to the projection of US military power, because only they can take and hold territory. But some strategists believe that there may be less reason to capture real estate in the kinds of combat seen ahead.

The thinking in Air Force planning circles, for example, is that the US will resort more and more to airpower to quell conflicts before they get to the point where large land armies must be employed.

Colonel Warden, for example, sees the increasing likelihood of Libya-type "operations in which airpower would be used to hit hard" and "make them [enemies] stop what they're doing."

Adds Colonel Turner: "To our way of thinking, the US Air Force will have the greatest capability to conduct those kinds of operations, given our ability to move airpower around the earth and to strike as hard as necessary in virtually every circumstance.

"We see developing—perhaps very quickly—a new reliance on the Air Force as the most important contributor to national defense." ■

Mach's supersonic research was a half-century ahead of its time.

That Four-Letter Word

BY C. V. GLINES

Dr. Ernst Mach (1838–1916)

WE use the word "Mach" often these days. Chuck Yeager "went through the Mach" in 1947 to make his place in history. Aircraft speeds are displayed in jet cockpits on the "Machmeter." A number of related terms such as "Mach angle," "Mach effect," and "Mach line" have been derived from this four-letter word.

What does it mean? Where did it come from?

Simply explained, the Mach number deals with the measure of airflow. It assigns a numerical value to the ratio between the speed of a solid object through space (or gas) and the speed of sound through that same medium. When the speeds are equal, the object has reached Mach 1.

The word comes to us as a result of work done by Dr. Ernst Mach, a renowned Austrian scientist who specialized in ballistics and sonics (the study of sound) in 1870–90. Born in 1838 in the village of Turas, Austria, he graduated in 1860 from the University of Vienna at the age of twenty-two with a doctorate in physics.

After teaching physical sciences for three years, he became a professor of mathematics at the University of Graz in 1864. Three years later, he was named head of the physics department at the University of Prague and later the University of Vienna. He became fascinated with sonics during this period. The first results of his work were published in 1873.

In the 1890s, Mach intensified his study of sound and the effects of shock waves and turbulence on projectiles and ballistic objects hurtling through the air. He enunciated a theory that embodied what is known today as the Mach number. His work took him into high-speed photography, where he was the first to photograph a jet of air issuing from a vent at supersonic speed. This pioneer activity led to widespread use of this technique today in wind tunnel studies of the effects of airflow on aircraft, automobiles, and other types of vehicles.

While conducting his work in the laboratory, Mach stirred up controversy among his scientific peers. His writings gave rise to a new theory of philosophical thought rooted in the physical sciences. He was labeled a "positivist"—one who believes that all knowledge of phenomena in the natural sciences must be verifiable by observation and experience.

His ideas about verification were unique for the times. He developed very definite criteria that required rejection of such metaphysical concepts as absolute space and time and of certain theories concerning the atomic and molecular makeup of matter. His severe criticisms and his insistence on verification were taken to heart by later scientists. One was Albert Einstein, who developed his theories of relativity with Mach's views in mind.

Mach also became controversial for his political views. He rejected Karl Marx's dogma of dialectical materialism. Mach published his thoughts in a book, *Analysis of Sensations*, that incurred the wrath of Lenin, who blasted Mach and his theories in *Materialism and Empirio-Criticism*.

Mach eventually became such a "nonperson" in the Communist world that it was not until the 1950s that the Soviet Air Force began to use aerodynamic terms bearing Mach's name. In the 1930s, the term "Bairstow number" was used to designate supersonic speeds, after Sir Leonard Bairstow, a British aerodynamicist. Bairstow's work was based on Mach's, and his name is rarely used today. The first use of the term "Mach number" is found in a German scientific text published in 1929.

Mach published his final report on sonic research in 1898 and shortly thereafter suffered a stroke that left him partially paralyzed. Despite his handicap, he was named to the Austrian House of Peers in 1901. He moved to Munich before World War I and died there in 1916.

The Mach number is now an accepted measure of airspeed. The sonic boom heard every time an aircraft passes through Mach 1 is an indirect tribute to Dr. Ernst Mach, a man who dared to think differently. ■

C. V. Glines is a regular contributor to this magazine. A retired Air Force colonel, he is a free-lance writer, a magazine editor, and the author of numerous books. His most recent article for AIR FORCE *Magazine was "Flying Blind" in the September '89 issue.*

The questions are nearly all about money and politics. Ironically, a new consensus might emerge because the debate is so obviously deadlocked.

The ICBM Problem Rolls On

BY ROBERT S. DUDNEY
EXECUTIVE EDITOR

FOR a decade, no US arms debate has been complete without a scrap over ICBMs. Ronald Reagan, who entered the White House through the "window of vulnerability," provoked controversy with his missile ideas. Lawmakers vigorously promoted counterplans.

The actual objective—deployment of land-based missiles in ways less vulnerable to a sudden, devastating Soviet attack—fell into a black hole while Washington policymakers deadlocked over whose missile scheme provided the more perfect answer.

Now, the outlook for ensuring the viability of the overexposed US ICBM force may be improving for the most unexpected of reasons. In a sudden turnabout, exhausted missile partisans on all sides have begun to concede, in effect, that their own plans can't really work.

The Air Force and its backers have admitted that it is politically impossible to get the full force of 100 multiwarhead Peacekeeper missiles they sought; USAF will deploy no

Unarmed LGM-118A Peacekeeper Mk. 21 reentry vehicles plummet to a Pacific target area. USAF wanted 100 of the ICBMs, but the force was capped at fifty.

more than half that number. Supporters of the rival, single-warhead Midgetman ICBM have confessed that it is not feasible—again, for political reasons—to field their missile anytime soon.

The retreat from entrenched positions increased prospects for eventual compromise on the missile issue. Experts claimed a new political coalition might then provide sustained backing for a two-missile deal proposed by President Bush. If so, the Pentagon will at last be able to attend to one of its oldest problems.

What the President finally decided to propose, after spending months reviewing strategic and domestic political issues of extraordinary complexity, was a missile scheme to:

- Provide mobility for fifty LGM-118A Peacekeepers, fitted with 500 superaccurate warheads, that already are on alert in fixed silos in the Midwest. In a few years, the weapons would be based on trains garrisoned at USAF bases.
- Forgo production of a second batch of fifty Peacekeepers.
- Resuscitate the MGM-134A Small ICBM or "Midgetman" missile and increase research funding for its truck-like, road-mobile launcher.
- "Sequence" the deployment of the two ICBMs—Peacekeeper first, Midgetman later.

Even the President's staunch supporters warned that the verdict won't be in for some time. They noted that on Capitol Hill, House and Senate negotiators spent the better part of September locked in bitter debate over whether to go along with all aspects of it.

Though the Senate had adopted the Bush scheme without change, a shaky, bipartisan, dual-missile coalition in the House collapsed. In the House, the Administration's rail-garrison Peacekeeper budget request was slashed, and the Midgetman request was zeroed out.

"A Threat That Does Not Exist"

Even before the two sides reached a final resolution of the argument, however, it had become clear that the Administration must be prepared to weather months, if not years, of political battles before either weapon goes into operation.

Technicians work on a full-scale model of the single-warhead Midgetman Small ICBM. President Bush has pushed back deployment of the Midgetman to 1997.

Starts and stops were virtually certain, and there was no assurance of success.

The problem that the President's proposal was designed to remedy—nuclear vulnerability—certainly hasn't disappeared. That is true even though the debate about vulnerability has been raging for so long that some, such as former Under Secretary of Defense Fred Iklé, now wonder whether it really matters.

The push for mobile ICBMs, maintains Democratic Rep. Ron Dellums of California, is "an effort to respond to a threat that does not exist. . . . We have a leg of survivable mobile missiles. It is our [strategic-missile-firing] submarines."

But President Bush and his advisors did not accept this line of reasoning. They focused on a problem, remote but not unthinkable, that Pentagon analysts said the Chief Executive could face in a future crisis with Russia.

It was this: US ICBMs still form the backbone of deterrence. Currently, the land-based leg of the strategic nuclear triad consists of 450 single-warhead Minuteman II, 500 triple-warhead Minuteman III, and fifty ten-warhead Peacekeepers, which went into full operation last year. All are deployed in fixed silos.

But ever since the late 1970s, when fearsome new Soviet SS-17, SS-18, and SS-19 missiles began to exhibit unprecedented power and accuracy in test launches, the US has worried about the Soviets' presumed ability to blast most of America's silos without using more than a third of their missile warheads.

The American President—so the theory went—would be left to retaliate with bombers and strategic submarines, weapons ill-suited to a swift, discriminated, nuclear counterattack.

If anything, the vulnerability problem has grown worse since then, in part because the Kremlin has deployed a new, more accurate version of the monster, ten-warhead SS-18. One recent study, conducted jointly by the Center for Strategic and International Studies and The Johns Hopkins University's Foreign Policy Institute, claims that no more than five percent of US ICBMs could now ride out a full-scale Soviet attack.

In the report's words: "The ability of [the ICBM force] to carry out fully its deterrent function—retaliation in the wake of a Soviet first strike—is today clearly in doubt."

Fixed ICBMS at Risk

One of the strongest voices of warning has been that of Rep. Les Aspin, the moderate Wisconsin Democrat who chairs the House Armed Services Committee. He recently issued a report whose title, "Strategic 'Surprise Attack' Thinkable," left no doubt about the drift of his concerns.

Aspin says the threat to fixed US ICBMs is not likely to vanish under terms of a START agreement, even one that obliges the Kremlin to cut in half its premier force of 308 SS-18s weapons.

"What about the future?" he asks. "Accuracy improvements on other Soviet missiles, [ten-warhead] SS-24s and [single-warhead] SS-25s, are likely to be enough to allow them to target US silos. In fact, the missile accuracy may already be there. Suddenly, the Soviets would have 3,000 warheads, more than enough to shoot at 1,000 American missiles in their silos."

It sounds grim, but the view held by President Bush and his advisors was that the US land-based missile force isn't done for just yet. His conclusion was that, with a package of Peacekeeper and Midgetman weapons, the US could regain some survivability in the force *and* acquire additional counterforce power.

One who expressed agreement was Gen. Larry Welch, the Air Force Chief of Staff. In his estimation, the mobile Peacekeeper and Midgetman provide "a superb operational combination of capabilities."

Critics, however, contended that the Air Force might be placed in a situation analogous to that of driving a Cadillac to the poorhouse. The Bush plan was expensive, due to inclusion of the costly Midgetman program. What's more, others noted, there won't be all that many missiles, and most won't go operational for a decade.

In light of these shortcomings, why did President Bush decide to take the course that he did? The explanation, defense analysts agree, is that only a two-missile plan held out hope of political approval, inasmuch as neither Peacekeeper nor Midgetman enjoyed enough support to survive on its own.

Representative Aspin summarized the basic dilemma this way: "The central reality is that we have never had a problem coming up with technical solutions to the ICBM vulnerability problem. The real problem has been coming up with solutions that are politically acceptable" to enough lawmakers.

Relocating Peacekeeper

It was the recrafting of the Peacekeeper element of the strategic missile program that posed the greatest problems and controversy for the Administration and Congress. The Air Force and Pentagon have long viewed this as the top ICBM priority.

Deploying a full complement of 100 weapons equipped with 1,000 accurate and powerful warheads, proponents said, was of paramount importance. Now, all have conceded that this idea is dead.

The Administration turned thumbs down on all plans to produce the second batch of fifty missiles to match the number of Peacekeepers developed and deployed since 1986.

From the outset, the Administration frowned on the Air Force's plan to keep half the 100 missiles in silos while the rest were made mobile. The White House then decided to pull the existing fifty weapons from silos for use on the rail-garrison trains.

One explanation was that it made no sense to leave such valuable missiles in vulnerable silos. The strategic argument was not the only factor. Powerful Democratic lawmakers, and some Republicans, had demanded a cap on the number of Peacekeepers as the price for their support of the compromise missile package.

What finally emerged was a plan to put two Peacekeepers aboard each of twenty-five special trains that would be parked on USAF bases. In times of international crisis, they would be dispersed on the nation's rail lines to prevent an adversary from targeting them with blockbuster ICBMs.

The baseline Peacekeeper train consists of seven cars: one engine, one launch-control car, one maintenance car, two missile-launch cars, and two security cars. Each train would have some boxcars to provide camouflage. The first train would be ready in 1992.

The trains would be maintained on 100 percent alert while in garrison, with at least two launch-control cars in operation at all times. On command, Peacekeeper trains would disperse over the US rail network, becoming "lost" on 120,000 miles of track.

The plan has its weaknesses. Representative Aspin worries that the Pentagon has given little thought to the potential political and security problems posed by local protesters and saboteurs. Moreover, Peacekeeper trains would be under the direction of civilian workers, raising the danger that their locations could be revealed.

The major problem with the rail-garrison plan was the speed—or lack of it—with which the trains could deploy from their bases. Using the current plan of twenty-five rail-garrison trains at a minimum of seven bases, the Air Force reports that the trains can be dispersed widely enough within six hours to require Moscow to expend its entire force of more than 3,000 SS-18 warheads in order to conduct a successful strike.

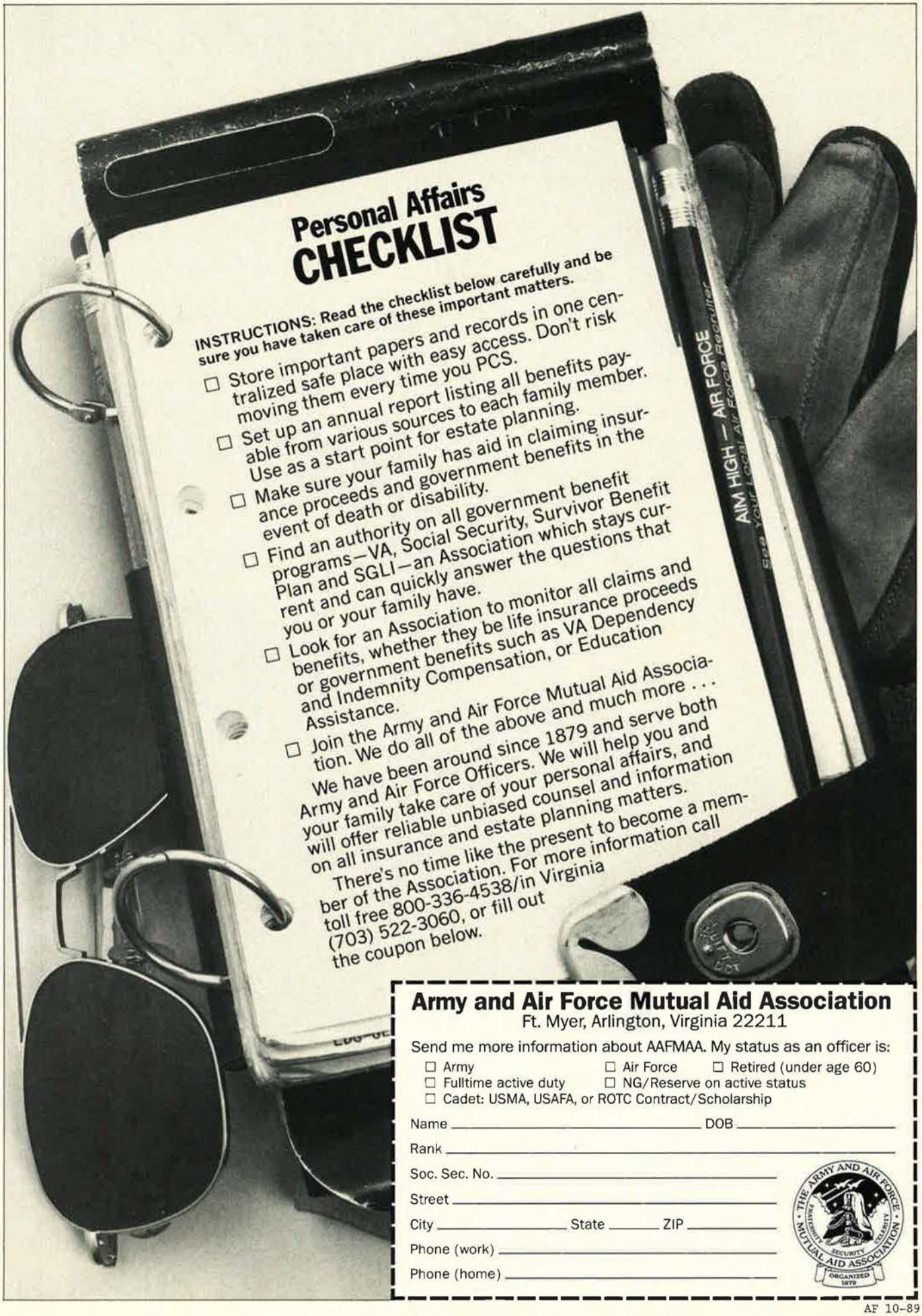
The problem, said many critics, was that Washington might not have that much warning, or might fail to act on it even if it came. Their point was that Peacekeeper survivability, being dependent on human decisions, could never be assured.

Is Midgetman the Answer?

Such was not the case with a proposed force of small, highly mobile Midgetman ICBMs. With their deployment in truck-like launchers, the weapons could be scattered widely on tactical warning of attack in only about thirty minutes.

The smaller weapon thus promised such flexibility in location and operations that an opponent would be required to expend excessively large barrages of high-value ICBMs in order to do a substantial amount of damage.

Aspin's analysis: Peacekeepers on trains "would require strategic warning—that is, at least several hours of notice—to flush out to safe-



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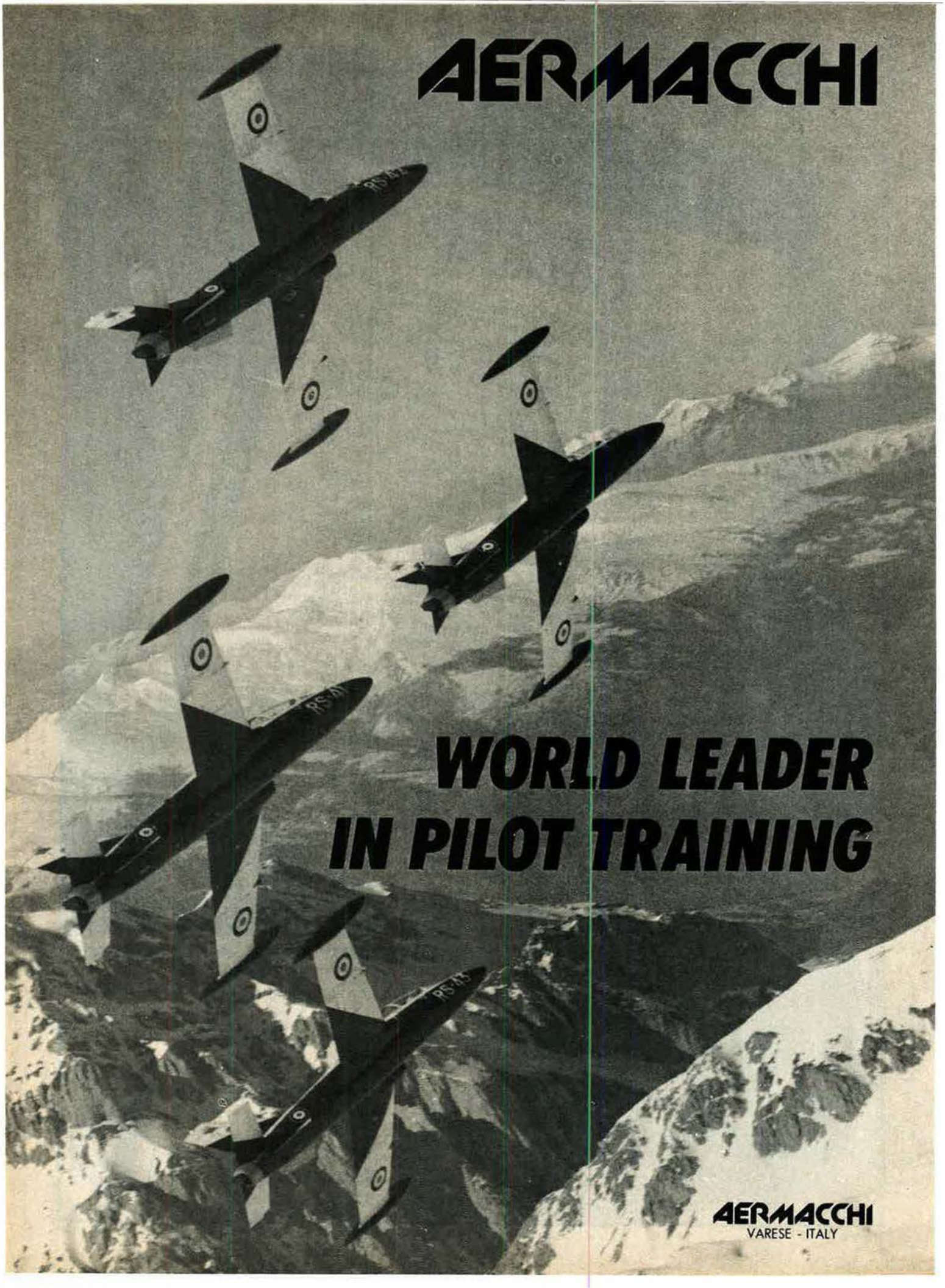
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ty on the rails. Therein lies the case for Midgetman. Midgetman is a system that does not rely on strategic warning for survivability."

The Midgetman program had generally been portrayed as a force of 500 one-warhead missiles on 500 hard mobile launchers. The current 37,000-pound missile has the volume to accommodate not only a warhead but penetration aids also.

The hard mobile launcher would consist of a manned tractor and an unmanned missile launcher possessing off-road capability. It would have the ability to park away from roads in a hardened position separated from the tractor. Command and control could be performed from remote sites.

Plans calling for initial deployment at Malmstrom AFB, Mont., include 150 to 200 hard mobile launchers. The next deployment of 150 to 200 hard mobile launchers would come at F. E. Warren AFB, Wyo. An additional 100 to 200 hard mobile launchers would be located at Ellsworth AFB, S. D.

In his reconsideration of the Midgetman program, President Bush also extracted concessions from proponents of the system. For one thing, Bush left the ultimate size of the force deliberately vague. Numbers have ranged anywhere from 100 to 500 missiles, with 300 considered to be a likely complement.

It was the proposed timing of Midgetman production and deployment, however, that underwent the greatest change. Initial operational capability, once planned to occur at more or less the same time as rail-garrison Peacekeeper, slipped four years. Advocates now grudgingly accept that first deployment won't take place until 1997, with full operations after 2000.

Politics was one reason for the rescheduling. Peacekeeper supporters on Capitol Hill, Republicans and some Democrats, insisted that deployment of the mammoth missile be put first in the queue, or they would not back Midgetman.

Phased Funding

A more pressing reason was money. With the bill for a host of major weapons programs coming due in the first part of the 1990s, and defense budgets leveling off or declining, President Bush and his advisors concluded the Pentagon couldn't afford full deployment of two missiles simultaneously.

In July 1989, a simulated Peacekeeper was launched from a full-scale model of a Missile Launch Car. Peacekeeper in rail garrison is the first step in the current ICBM plan.

As a result, plans called for Midgetman activities to be funded at relatively low levels over the next several years, with expenditures to grow steadily after that.

The White House itself was forced to make a concession. To mollify skeptical Midgetman partisans, Defense Secretary Richard Cheney added $947 million over three years for mobile launcher development. Air Force officials reported that the source of the new funding has not been identified.

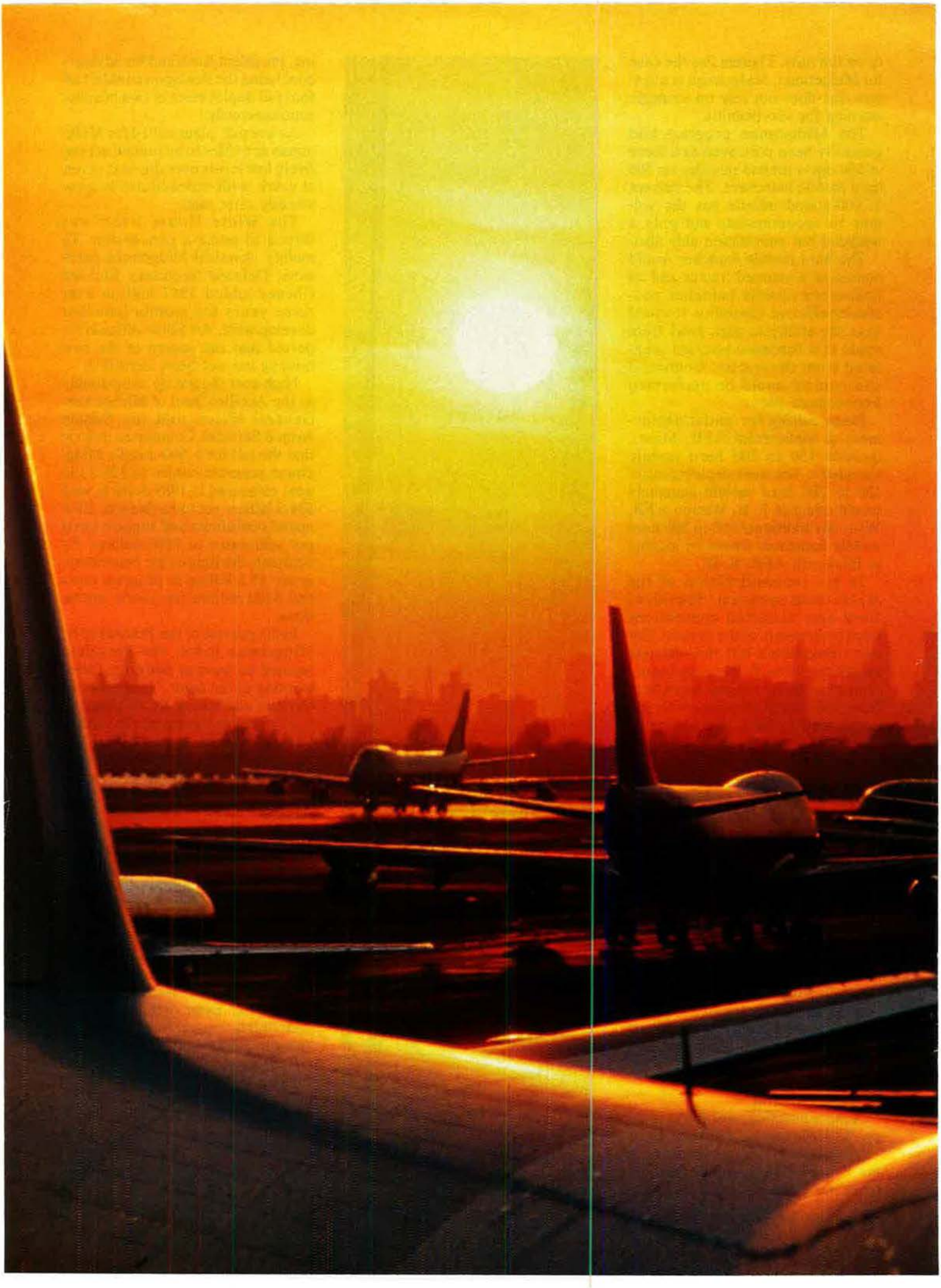
High cost shaped up immediately as the Achilles' heel of Midgetman. General Welch told the Senate Armed Services Committee in June that the tab for a 500-missile Midgetman program comes to $28.3 billion, measured in 1989 dollars, with $24.9 billion yet to be funded. Estimated operations and support costs per year came to $500 million. By contrast, the figures for Peacekeeper are $5.6 billion in program costs and $200 million for yearly operations.

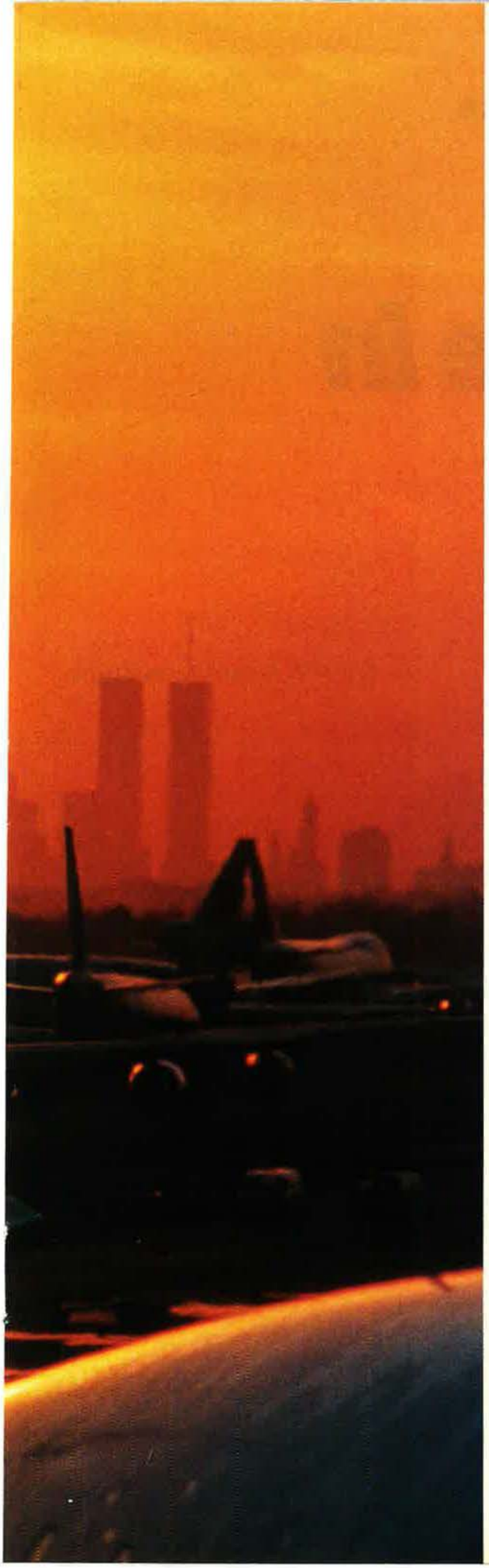
In his pursuit of the Peacekeeper/Midgetman force, the President seemed to have a powerful factor working in his favor: There was no obvious alternative to his plan.

Experts maintained that other basing options are not likely to emerge. Dozens have already been considered and rejected as unworkable, unaffordable, unpopular, or all three.

Nor did deployment of active ballistic missile defenses appear to hold out much promise for protecting ICBMs now based in silos. A recent Congressional Budget Office study reported that deployment of a modest system of 2,200 ground-based interceptors would cost $29 billion and require abrogation or renegotiation of the Antiballistic Missile Treaty. Even then, the report concluded, "uncertainties" would "plague" the system.

The sense that time had finally run out on the ICBM debate was expressed by House Armed Services Chairman Aspin. "We do not have to panic. We can take some time to correct [ICBM] vulnerability. But we can't take forever. We do need to act." ■





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General Piotrowski makes no bones about it: "We don't have a surveillance system worthy of the name."

The Big Hole in NORAD

BY JAMES W. CANAN, SENIOR EDITOR

FROM its nerve center deep within hollowed-out Cheyenne Mountain, Colo., North American Aerospace Defense Command stands guard over the continent. It keeps constant watch for threats to the US and Canada from intercontinental ballistic missiles, submarine-launched ballistic missiles, manned bombers, cruise missiles, and spacecraft.

By all accounts, NORAD has one vital part of this varied and demanding mission firmly in hand. Cheyenne Mountain's Missile Warning Center is said to be thoroughly capable of doing its life-or-death job—detecting, tracking, and assessing the magnitude and targets of attacks from ICBMs and SLBMs.

But NORAD is less proficient on other fronts, through no fault of its own. Its ability to detect threats other than ballistic missiles in air and space is getting better, but is not always a sure thing.

This concerns NORAD's Commander in Chief, Air Force Gen. John L. Piotrowski, who is also the CINC of the unified US Space Command, coheadquartered with NORAD at Peterson AFB, Colo.

The Missile Warning Center, operated by US Space Command in conjunction with NORAD, receives up-to-the-minute data on ballistic missile launches around the world—up to 600 real-life launches every year. The information comes from highly capable Defense Support Program (DSP) early warning satellites in space and from far-flung, sky-watching Ballistic Missile Early Warning System (BMEWS) radars and seaward-looking Pave Paws radars on land.

This information is fed into NORAD's command post inside Cheyenne Mountain. NORAD's Air Defense Operations Center and US Space Command's Space Defense Operations Center and Space Surveillance Center also serve the central command post. But their information is less dependable.

Limited Surveillance

NORAD's ability to detect bombers and cruise missiles penetrating US and Canadian airspace is improving, but it is a long way from perfect. The same is true of USSPACECOM's prowess at spotting and tracking the 7,000 objects

Defense Support Program (DSP) early warning satellites continuously transmit data to US Space Command and NORAD on ballistic missile launches around the world. TRW's "DSP 2000," shown in this artist's concept, would incorporate new technologies for increased mission capability.

now in orbit and new ones that show up there just about every day.

General Piotrowski makes no bones about such deficiencies. "The biggest limiting factor in NORAD is surveillance," he declares. "When aircraft shifted from high-altitude bombing to low-altitude penetration, and then to cruise missiles as well, surveillance became the weakest link in our chain.

"In fact, we don't have a surveillance system worthy of the name."

As to US Space Command's responsibility for keeping track of spacecraft, General Piotrowski asserts: "We are still tied to terrestrial surveillance of space objects. It has been getting better, but it isn't good enough. We have recognized that limitation for a long time."

To redress these surveillance shortcomings, General Piotrowski has long advocated the deployment of sensor systems, such as radars, in space. They would look up, down, and all around in a constant search for hostile aircraft and cruise missiles traversing the atmosphere and for satellites, including the anti-satellite (ASAT) variety, that are up to no good for the US in space.

There is growing evidence at the Pentagon and elsewhere in political Washington that General Piotrowski's persistence in pushing for such high-flying surveillance platforms is paying off—and that his warnings about the staying power and the unrelenting nature of the Soviet strategic threat—*glasnost* or no *glasnost*—are being heeded.

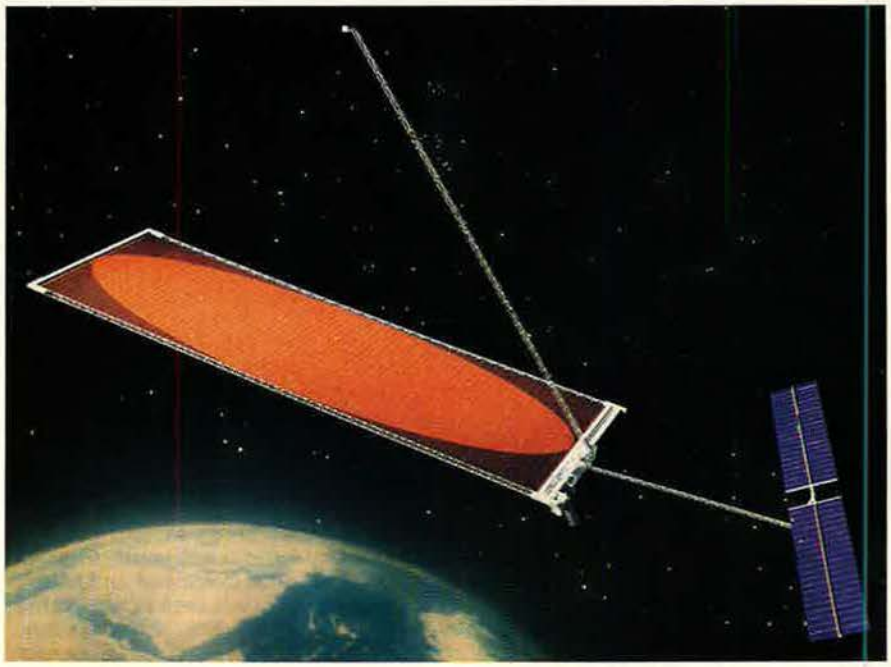
A year ago, for example, amid the initial agonies brought on by the defense budget crunch, the development of a space-based system for spotting bombers and cruise missiles on the fly was given little chance of approval by the Defense Department, let alone by Congress. Now things are looking up a bit for SBRs (space-based radars).

"The Pentagon is pretty well lined up in support of designing a system [of SBRs], so the question has become one of getting the money from Congress," General Piotrowski says.

Congress may not come through right away, but at least it has begun taking the advantages of space-based surveillance into account. NORAD has clout on Capitol Hill in such matters, and with good reason.

To Warn and Defend

The American-Canadian command, headquartered high on the eastern edge of the Continental Divide, has a make-or-break mission as the linchpin of the US strategy of nuclear deterrence and retaliation. NORAD is responsible not only for warning of an air attack on North America, but also for defending against it. The command does not have a comparable responsibility for orchestrating a defense against ICBMs, for the simple reason that the US has no defensive system for such purpose.



A space-based surveillance system incorporating radar satellites like this one would be much more capable of warning and defending North America than is NORAD's current network of land-based and airborne radars.

NORAD's ability to defend against manned and unmanned aircraft has come a long way in this decade. The command now has at its disposal state-of-the-art radars on land and in the air, in the form of Airborne Warning and Control System (AWACS) aircraft. Also on call are modern F-15 and F-16 fighter-interceptor aircraft operated by USAF's Tactical Air Command, Air National Guard, and Alaskan Air Command and CF-18s flown by the Canadian Forces.

Those fighters make it possible to intercept enemy bombers and cruise missiles more quickly and at much greater ranges than before.

The problem is that NORAD's modern, electronically manipulated radars, many of which have yet to be installed, may not be up to the job of spotting the attackers in time to mount an effective defense against them.

This is why General Piotrowski hammers away at persuading the powers that be to approve a space-based surveillance system. It presumably would be capable of spotting, right after takeoff, enemy bombers carrying cruise missiles for standoff launching and other bombers bent on penetrating continental airspace with gravity bombs and short-range attack missiles.

The radars or infrared sensors in space would spot and keep track of the enemy aircraft throughout their flights, espy cruise missile submarines heading out to sea, and take note of cruise missiles almost as soon as they were launched.

Land-based and airborne surveillance systems are much better and more reliable than they used to be, but they can do none of the above.

Long- and Short-Range Radars

Radar coverage of routes through Arctic airspace into the northern reaches of North America now falls to NORAD's new North Warning System. When fully installed in a few more years, NWS will have replaced the 1950s-vintage Distant Early Warning (DEW) Line, a 3,000-mile network of radars trained on the Arctic Circle from Alaska to Greenland. The NWS will be made up of fifteen long-range radars—eleven in Canada and four in Alaska—and thirty-nine short-range radars, including three in Alaska and the rest in Canada.

Teamed with the NWS in scanning the sky everywhere else around the compass will be four mammoth over-the-horizon backscatter (OTH-B) radars now in various stages of development and deployment. They are designed to detect air threats at all altitudes out to 1,800 nautical miles from the eastern, southern, and western extremities of the North American mainland.

The first OTH-B radar is in place in Maine. Three others, to complete the circumferential coverage of the continent, are expected to be fully in place by the mid-1990s. If plans pan out, this network will be augmented by a relocatable over-the-horizon radar (ROTHR) being developed by the Navy for initial deployment on Amchitka in the Aleutian Islands.

Testing of the first OTH-B radar, now fully operational, has concentrated on cruise missile detection, with mixed results.

The Soviets now operate two long-range cruise missile systems: the AS-15, a bomber-launched, low-altitude weapon, and the SS-N-21, a missile that is small enough to be launched from the standard torpedo tube of an attack-class submarine. A larger cruise missile, the SS-NX-24, a variant of the AS-15, is being developed specifically for Soviet Yankee-class cruise missile submarines.

The AS-15 and SS-NX-24 cruise missiles are believed to have a range of at least 1,800 miles. This would make it possible for Soviet bombers and submarines to launch them in a standoff posture, safely beyond the surveillance range of US OTH-B radars.

The cruise missiles can be carried by any of the 300 Soviet aircraft—subsonic Bear-H turboprop bombers and supersonic Blackjack jet bombers—that are capable of reaching targets in North America with gravity bombs and short-range attack missiles.

General Piotrowski acknowledges that the mere existence of the

OTH-B radars may make the Soviets think twice about attacking North America through the air.

"Our analysis shows that even under the worst conditions for detecting cruise missiles, the likelihood of OTH-B's detecting at least one out of ten of them is high enough that the Soviets probably couldn't count on bringing off a surprise attack."

He also notes, however, that the OTH-B radars are themselves vulnerable. "If a [Soviet] missile laydown comes first, those radars more than likely will be gone," the General declares.

"So we need a more survivable surveillance system, a system based in space. Just as AWACS is more survivable than ground radar, space radar is far more survivable than AWACS."

More Efficient from Space

Until recently, General Piotrowski made a point of saying that space-based surveillance systems would complement OTH-B, North Warning, and AWACS radars. Now he believes that "we might be able to do away with" those land-based and airborne radar systems once surveillance is established from space and they have served their purpose.

He maintains that a great deal of money would be saved and that the efficiency and breadth of surveillance would be greatly increased. "If we tried to maintain a twenty-four-hour-a-day surveillance of the Persian Gulf, we would need ten AWACS airplanes, some tankers, and very large crews for maintenance and so forth. We could do that job easily with a space system, at much lower cost, and with only about twenty-five people.

"In fact, we would be able to cover roughly one-third of the globe continuously with a space-based surveillance system for only two-thirds of the total cost of AWACS. So from all standpoints—capability, survivability, O&M [operation & maintenance], and manpower—it's clear that we should be in space."

General Piotrowski cites other operational advantages as well for space-based surveillance. He claims, for example, that it would enable US airlifters to steer clear of danger from enemy warships armed with antiaircraft guns or missiles. Moreover, "for US forces deploying into a contested area—in the Middle East or wherever—space-based radar would already be there. It would have a picture of the air defenses in the area, and our forces could roll out their antennas and their computer displays and plug into that picture as soon as they arrive."

About a year ago, USAF's leadership gave space operations a big boost, elevating them to the status of a "core mission" and according them high-priority status in the service's planning, programming, and budgeting.

General Piotrowski hails this move and believes that it augurs well for his long campaign for SBRs or some other sort of surveillance system in orbit.

USAF is now teamed with the Navy in exploring SBRs and infrared sensors, which the Navy would prefer, for "wide-area surveillance" from space. This is seen in some circles as the first step toward eventual deployment of satellites carrying both radars and infrared sensors.

There is a good chance that NORAD partner Canada would join in, and share the cost of, developing a system of surveillance satellites.

Such a system has long been championed by the CINCs of the unified and specified warfighting commands, if not by their budget-conscious parent services.

Says General Piotrowski: "I, as CINCNORAD, would probably make the greatest use of it [a wide-area space-based surveillance system] during peacetime. But every CINC wants it and needs it for his theater. All the field CINCs—SAC, MAC, you name it—have weighed in on this. They want an all-weather, day/night surveillance system capable of tracking aircraft and ships.

"With that kind of support, we were in a position to ask for enough money—$10 to $20 million—to explore whichever concept is chosen by the Defense Acquisition Board."

The DAB is expected to make its choice later this year from among concepts now being explored by the Air Force and the Navy. Meanwhile, the notion of space-based surveillance seems to be gaining favor in Congress, but with caveats.

The lawmakers are concerned about costs, maturity of technologies, and the vulnerability of orbiting surveillance platforms to attack by hunter-killer Soviet antisatellite (ASAT) systems already operational or by directed-energy weapons, such as lasers, that may or may not be operational.

For example, the Senate report on the Fiscal Year 1990 defense authorization bill noted that the Pentagon's plans for "expensive new missions in space" must be weighed against the threat of those ASAT weapons and against the absence of any defenses against them.

The report agreed with the Administration's assessment that the Soviet Union poses a threat in space. It said that the Soviets' monopoly on ASAT weapons is "a serious deficiency in our space control capability and should be redressed." But it stopped short of endorsing the Administration's proposal for a US ASAT system in the furtherance of such US space control.

"A US ASAT capability alone would be a weak deterrent unless or until the nation substantially improves satellite survivability, jamming resistance, launch responsiveness, and the way we approach satellite construction," the Senate report asserted.

General Piotrowski says "amen" to the need for all those improvements. But he sees no point in making them prerequisites to the deployment of a US ASAT system. Without such a system, he contends, Soviet "gunsight satellites" would be free to do their worst in wartime. His reference is to the Soviet reconnaissance and electronic intelligence satellites long since in space for the purpose of tracking and targeting US fleets and other military forces.

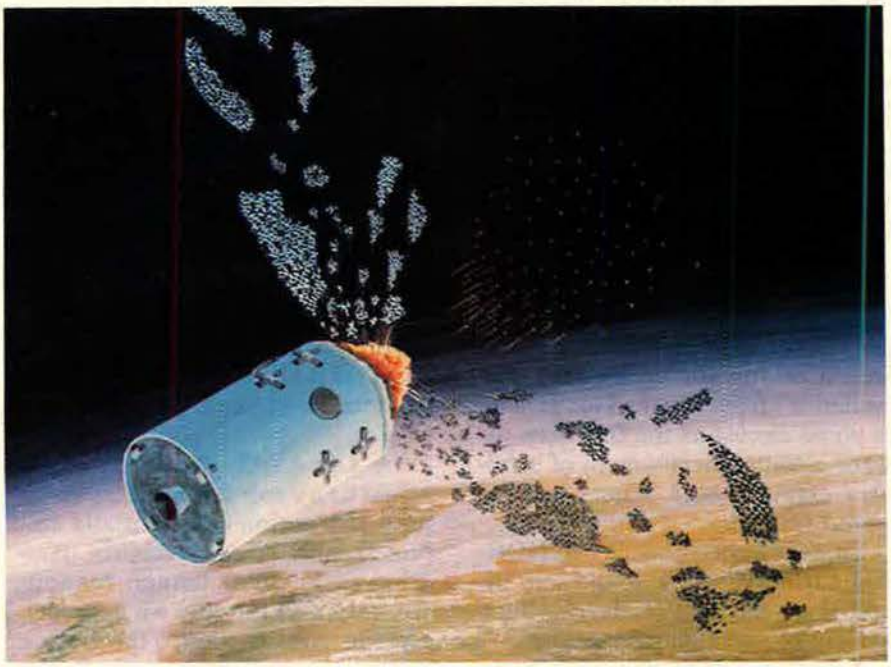
Watching Space

As with the threat from air-breathing systems, the threat from space systems must be detected before it can be resisted. Such detection is the responsibility of Cheyenne Mountain's Space Surveillance Center.

The SSC houses computers that constantly receive and process data from the Command's Space Surveillance Network (SSN), made up of land-based radars, telescopes, cameras, and radio receivers around the world.

SSN records up to 50,000 observations of satellites each day. But it is incapable of tracking all objects. There are worrisome gaps in its coverage of what is going on in space.

Objects in deep space—beyond geosynchronous-orbit altitude 22,300 miles above the planet—are out of range of most land-based sensors. For the time being, such objects are spacecraft on scientific missions, such as planetary probes, and are of no military significance. But this could change.



Future US orbiting surveillance platforms would be vulnerable to Soviet antisatellite (ASAT) systems, already operational, and other directed-energy weapons. In this artist's rendering, ASAT weapons attack a satellite with exploding shrapnel.

Conventional radars can look into deep space, but their beams are too narrow to search large areas. Some orbiting objects in the "space debris" category are simply too small and too far away to be seen by any sensors trained on the sky from Earth.

Optical sensors—cameras and telescopes—can be operated only in clear weather and in deep twilight or darkness, when objects in space within the sensor's range of vision can be seen to reflect sunlight. This is also true of electro-optical sensors and is why the relatively new Ground-Based Electro-Optical Deep-Space Surveillance System (GEODSS) network can see only so much in space.

Four GEODSS stations are in place, the latest one having gone into operation on Diego Garcia in the Indian Ocean in 1987. A fifth station is destined for Portugal if Washington and Lisbon, after years of delay, can resolve disagreements on the terms of deployment.

Even with the best of land-based equipment, gaps in space coverage would be likely. The reason, explains General Piotrowski, is that "the Space Surveillance Network is a predictive system. It does not provide continuous monitoring of space objects. Consequently, there are gaps in our surveillance coverage of near-earth orbits and deep-space orbits that could be exploited [by an enemy spacefaring power]."

SSN computers calculate when satellites should be in particular places in space, and the system keeps checking them out. If their actual positions in space do not square with their predicted positions, the system recalculates their movements.

Sometimes, the SSN simply loses track of this or that object in space for a time.

The problem would be solved and US Space Command's space-tracking requirements would be met by orbiting radars that constantly peered up and around. Such radars are being developed for the Strategic Defense Initiative (SDI) program's Space Surveillance and Tracking System (SSTS).

General Piotrowski points out that the Air Force had planned such a system of satellites to detect so-called "cold bodies" in space long before SDI was conceived in 1983 to develop technologies for defending against ballistic missiles. SDI picked up on the idea for space-tracker radars to detect ICBMs and their disgorged reentry vehicles in midcourse flight.

Says General Piotrowski: "If SDI goes forward, it will give us [USSPACECOM] the space surveillance capability we need. If it does not, then we'll have to go back to the Air Force's original plan for radars that would do space surveillance only."

Missile-Spotting Satellites

The Boost Surveillance and Tracking System (BSTS) satellites being developed in the SDI program were also thought up by USAF before SDI was a twinkle in the Pentagon's eye. Their purpose is to spot ICBMs and SLBMs on launch. The Air Force had conceived them as the successors to the Defense Support Program (DSP) satellites that have long been NORAD's lookouts for ICBMs.

The SSTS and BSTS satellites would come a lot cheaper for Space Command and NORAD purposes than for what SDI would need them to do. Their jobs would be much less complicated, and so would they.

Explains General Piotrowski: "We wouldn't use them for battle management—handing off to weapons—as SDI would, so their accuracy wouldn't have to be quite as good, and their software and power requirements would be much lower. There would be big savings in that."

He adds, "Of course, we'd have to convince Congress, the public, and—for arms-control purposes—the Soviet Union that we weren't fielding a ballistic missile defense system in disguise."

Fielding such a defensive system under its own name is exactly what General Piotrowski would like the US to do. He is a strong supporter of SDI.

The General takes great satisfaction in his command's ability to detect and track ICBM and SLBM launches and to sound the alarm in plenty of time for the National Com-

Inside the Mountain

NORAD officials compare recent activities inside Cheyenne Mountain with the task of repairing seven of a B-52's eight engines while the bomber is in flight and bearing down on its target.

Through most of this decade, the computers, computer displays, and communications gear in NORAD's central command center and supporting centers—those for missile warning, air defense, space defense, and the like—have been upgraded with new hardware and software without their around-the-clock operators missing a beat in performing missions.

The "Cheyenne Mountain Upgrade Program" will cost about $1.3 billion by the time it is completed in the mid-1990s. Its goal is an "integrated tactical warning and attack assessment" (ITWAA) system.

Col. Glen P. Doss, Director of Missile Warning, explains: "The ITWAA system will collect and correlate data . . . from all atmospheric, missile warning, and space sensors and intelligence sources into common displays that will provide the CINC with a coherent picture of what is happening—and corroborate it—in real time."

ITWAA will give CINCNORAD a quicker, better handle on the nature of an attack. This, in turn, will give the National Command Authorities—the President and the Secretary of Defense of the United States and the Prime Minister and Minister of National Defence of Canada, or their designated replacements—a big assist in deciding how best to respond to such an attack.

Influencing the nature of their response, says Colonel Doss, would be CINCNORAD's answers to such questions as: "Are they coming after us with everything they've got? Are they going after our ICBM silos? Our submarine bases? Our command control and communications setups?"

The characteristics of an ICBM or SLBM attack would quickly become clear—"within the first fifteen minutes," says Colonel Doss. But it could be hours before NORAD would know what was going on with enemy bombers. "We may know that they've taken off, but until we've tracked them a while, it's hard to know where they're going," Colonel Doss explains.

NORAD officials emphasize that Cheyenne Mountain is the only place that receives and collates all information from every sensor in space, in the air, and on land to keep tabs on missile launches, aircraft approaches, and space activity. Portions of such information go to Strategic Air Command at Offutt AFB, Neb., to the National Military Command Center at the Pentagon, and to the Alternate NMCC at Fort Ritchie, Md. But only NORAD has the whole picture.

False alarms sent out from NORAD to those other commands in 1979 and 1980 gave rise to the Cheyenne Mountain Upgrade Program. The alarms were based on erroneous data resulting from computer deficiencies, were quickly assessed as such and canceled, and were not taken lightly.

The NORAD upgrade was long overdue. The threat was becoming greater and more complicated, and NORAD's centers in Cheyenne Mountain had turned into a nearly unmanageable hodgepodge of communications cables and computers that used different languages and displays.

The modernization program is replacing computer hardware and software that date back to the mid-1970s. It is made up of the following projects and contractors:

- **Granite Sentry,** to upgrade, with integrated computer displays and communications, the NORAD Command Center, Air Defense Operations Center, Battle Staff Support Center, and Weather Support Center. Digital Equipment Corp. and Martin Marietta are principal contractors.
- **Survivable Communications Integration System (SCIS),** a new communications processing and routing-selection system to make sure that messages reach the Cheyenne Mountain Complex from sensor sites and command posts around the world in wartime. E-Systems.
- **Communications System Segment Replacement (CSSR),** to automate the apportioning of message traffic to and from various centers in Cheyenne Mountain. GTE.
- **Command Center Processing and Display System Replacement (CCPDSR),** for an all-new complement of Missile Warning Center computers, software, and display consoles. TRW.
- **Space Defense Operations Center (SPADOC),** to replace all computers and software in the US Space Command center responsible for detecting threats to US manned and unmanned spacecraft. Ford Aerospace.

SPADOC is "the only real problem child" among all these projects, says Gen. John L. Piotrowski, CINC of NORAD and US Space Command. "The others have been delayed, but mostly because of budgetary limitations and restructuring, and their cost increases have been modest."

SPADOC's rising cost and delays are more profound, but not all that surprising, says General Piotrowski, because they "unfortunately fit the mold of problems with many large computer software development programs."

The SPADOC project has fallen eight years behind and is now scheduled for completion in 1995. "I'm concerned," says General Piotrowski. "The longer it's delayed, the higher the risk that the Space Surveillance Center's outdated computer system will be saturated by our growing number of space observations."

mand Authorities to decide how best to retaliate. He is convinced that the US policy of strategic nuclear deterrence has been successful precisely because Soviet leaders have known that NORAD is always on the lookout.

In his opinion, though, being watchful is not enough. "My operators in Cheyenne Mountain would do an excellent job of warning that an attack was under way. But we have no active defenses—no bullets—to defend our homeland against even the most limited of attacks.

"If deterrence failed, for whatever reason, our nation could be destroyed in minutes by nuclear weapons."

General Piotrowski claims that changes in technology now make it possible to build a defense against ballistic missiles at no more—perhaps less—than it would cost to continue the buildup of offensive nuclear forces.

He also notes that "the Soviets, despite their rhetoric, are continuing to modernize their strategic weapons" and "have deployed two new, highly accurate ICBMs—the rail-mobile SS-24 and the road-mobile SS-25—in just the past four years."

He warns, too, that the US may also have to deal with nuclear threats from other quarters in years to come.

"It's no longer a bipolar world. Tomorrow's nuclear threats may come from elsewhere. The number of countries possessing ballistic missiles has increased significantly in the last two years, and if this proliferation continues at its present pace, nations that wish us harm may [soon] possess the capability to attack US forces with ballistic missiles."

General Piotrowski declares: "One of my greatest concerns is that several nations will have submarine-launched ballistic missiles. We wouldn't be able to retaliate against an attack from under the sea unless we knew who had attacked us, and it might be difficult to determine that."

In such an event, "deterrence would no longer be a viable defense, so we'd better be able to defend ourselves against the missiles," says the NORAD Commander in Chief. ■

Directed energy is out. Kinetic energy is in. Futuristic launch vehicles, no longer urgent for SDI, are in trouble.

The Scaled-Down Look of Star Wars

BY JOHN RHEA

THE Air Force for years has planned to consolidate its leadership in space by developing and building a brand-new family of cost-effective launch vehicles. Once, this step seemed assured in light of the massive orbital requirements generated by the Strategic Defense Initiative (SDI) program.

That is no longer the case. SDI has been reoriented, and the Air Force's proposed Advanced Launch System (ALS) is no longer essential to deploy the first phase of a space-based system to defend US intercontinental ballistic missiles (ICBMs) from Soviet attack.

Instead of creating an umbrella to protect the civilian population and thus render nuclear missiles "impotent and obsolete," as was envisioned by former President Reagan in his famous "Star Wars" speech of March 23, 1983, the SDI planners have cut their technological coat to fit their budgetary cloth. Expensive and complex directed energy weapons (DEWs), such as lasers and neutral particle beams, are out—at least until well into the twenty-first century—and kinetic energy weapons (KEWs) are in.

As a result, today's generation of expendable launch vehicles (ELVs), such as USAF's Titan, Atlas, and Delta, can do the job of putting the space-based segment of SDI into orbit, according to Air Force Col. Thad Shore, the space propulsion program manager at the SDI Organization (SDIO) in the Pentagon.

This removes a lot of the urgency for proceeding with USAF's ALS program, in which three teams of booster manufacturers are competing to develop the next generation of launch vehicles. The three are Boeing, General Dynamics, and a partnership of Martin Marietta and McDonnell Douglas.

With its original goal of slashing launch costs by ninety percent, ALS continues to be essential for future routine access to space. (Today, NASA's space shuttle and military ELVs have a launch cost of $3,000 to $4,000 per pound to low earth orbit.) Furthermore, ALS would be a family of modular launchers spanning the entire DoD payload spectrum from half a ton to 100 tons, according to Colonel Shore, who calls it a "dial-a-payload" system.

The space-based segment of SDI can be launched into orbit by today's generation of expendable launch vehicles, including Atlas, Delta, and Titan. This is the first Titan IV launch, conducted this past June.

The savings are supposed to come equally from three areas, he adds: improved manufacturing technologies derived from the commercial aircraft industry, reduced ground operations (particularly at the launchpad), and high launch rates (at least thirty a year). Reusability of at least the rocket engines and avionics packages becomes important at these launch rates.

The reductions in operating costs are now projected to be more like fifty percent, according to Col. John R. Wormington, ALS program manager at USAF Space Systems Division in Los Angeles, but that's still better than any savings expected from NASA's space shuttle.

Beyond the Shuttle

Even before the *Challenger* tragedy of January 28, 1986, it was obvious to everybody connected with the SDI program that the shuttle couldn't cut it. In addition to its excessive operating costs, the shuttle can only launch about twenty-five tons into orbit per mission. Even worse is the excessive ground preparation time, which limits the shut-

tle fleet to about a dozen missions a year, down from original estimates of sixty. As a result, the shuttle failed to meet the criterion that an antimissile system be "cost-effective at the margin."

Ironically, the only launch vehicle in the world today that could economically do the whole SDI job is the Soviet Union's reusable Energiya, which can launch 100 tons into orbit. The Soviets have announced that Energiya's payload capability is being upgraded to 200 tons.

Launch costs, along with the necessary computer power to pick out nuclear warheads from the swarm of accompanying decoys, have been the "long poles in the tent" of any SDI-type system for more than thirty years. They still are.

When what is now the Defense Advanced Research Projects Agency took the first steps to look at space-based antimissile defenses by initiating Project Defender on December 31, 1958, the United States had launched only five satellites into orbit (in twenty-one attempts) with a total weight of 240 pounds. Transistors were just beginning to replace vacuum tubes in computers, and integrated circuits were still in the laboratories.

Since then, tremendous strides have been made in shortening both poles. Wernher von Braun and his team of German rocket scientists put the US in space. The microelectronics revolution put more computing power at the disposal of one personal-computer user than existed in the entire world forty years ago.

But the launch costs of a space-based system, with total mass to orbit projected at 7,500 tons, remained daunting. Col. William Zersen, a program manager at Space Systems Division, estimated that a system deployable in 1994 by conventional ELVs would require 600 launches over a three-year period. That works out to one launch every forty-four hours, and not even the Soviets have ever been able to do that.

A Launch System Is Born

Out of this requirement ALS was born in March 1987, with a USAF Space Division request for proposals calling for paper studies of a new family of launch vehicles that would push operating costs down toward $300 a pound, with comparable improvements in reliability and on-time launch performance.

Under the ground rules, the study contractors were to start with a "clean sheet of paper" design and think in terms of a total launch system rather than of a vehicle. Seven firms received $5 million study contracts, and the number was cut to three last August. Hughes, Rockwell, and United Technologies failed to make the cut, and Martin Marietta teamed with McDonnell Douglas.

The semifinalists in the winner-take-all competition—Boeing, General Dynamics, and Martin Marietta/McDonnell Douglas—are under contract until the end of 1990, awaiting a Defense Acquisition Board (DAB) review and input from NASA next June on whether to proceed to the full-scale-development phase. The winner is expected to be selected by the following year, and USAF is now projecting the first ALS test flights for 1998 and initial operational capability for the year 2000. The latter two dates both represent a two-year slip from the original schedule.

However, ALS increasingly looks like an expensive solution in search of a problem. Colonel Shore estimates the total cost of ALS development at between $8 billion and $14 billion, including new ground facilities at Cape Canaveral. The Bush Administration, which has shown markedly less enthusiasm for SDI than had its predecessor, is understandably reluctant to invest that kind of money for a future space capability if it can get a scaled-down SDI into orbit with today's boosters.

Although nobody at SDIO will confirm the exact mass to orbit required by this version of the system, a reasonable estimate is about 1,500 tons, or one-fifth of the original estimate for a system incorporating both KEWs and DEWs. This translates into an annual requirement that Shore puts at "a couple hundred thousand pounds." Martin Marietta's Titan IV can routinely launch twenty tons, and the company has floated proposals for an uprated Titan V capable of launching nearly seventy tons.

The proposed Phase 1 Strategic Defense System that emerged from a DAB review last October anticipates spending $69.1 billion for a two-layer defense that would first attack Soviet missiles from space during their boost phase before they could release their warheads and accompanying decoys, then mop up the remaining incoming warheads with ground-based interceptors. The deployment decision will be made "in the mid-1990s," according to SDI officials, who maintain that the system can be fully deployed by the year 2000.

President Bush accordingly cut the SDI request he inherited for Fiscal Year 1990, which begins this month, from $5.6 billion to $4.6 billion and the projection for FY '91 from $6.7 billion to $5.4 billion. Future cuts are expected to be even deeper: The five-year SDI projection has been scaled back from $40 billion to $33 billion.

Although the initial system uses only KEWs, its system architecture would still be sufficiently open-ended to phase in DEWs later, according to Dr. O'Dean Judd, SDIO's chief scientist. "We do the easy stuff first and get experience and then build on it to improve our capability," he says.

Rocks Versus Pebbles

There is internecine warfare raging in the SDI community, however, over which kind of KEWs. The establishment favors the "smart rocks" approach of clustering small rockets with nonnuclear warheads in orbiting spacecraft, while the mavericks led by the indefatigable Lowell Wood of Lawrence Livermore National Laboratory are promoting the "brilliant pebbles" concept, in which individual rockets would be dispersed in space to attack on command.

Dispersing the rockets reduces their vulnerability—and also their launch requirements—but would require a major overhaul of SDI system architecture. The whole space-based interceptor (SBI) issue was turned over to the Jasons, a group of fifty academic scientists that does high-level studies for DoD, to thrash out at this year's annual gathering in La Jolla, Calif. The group will make its recommendation on the pebbles-vs.-rocks issue to the Bush Administration this fall. Sig-

nificantly, last year's summer study at La Jolla focused on free-electron laser propagation and discrimination and countermeasures.

Launch costs now are projected to account for only $8.6 billion, or about one-eighth of the scaled-down initial Strategic Defense System, and can no longer be considered one of the big-ticket items. The major reduction at last year's DAB review was in the SBI portion of the system. When the total costs of the Phase 1 system were cut from $115.4 billion to $69.1 billion, SBI was cut from $52 billion to $17.7 billion, the bulk of the decline.

Dr. Judd explains that this reduction was made possible by miniaturizing the homing warheads. The entire package of warhead, cryogenically cooled infrared sensors, computer, and rocket engine has been reduced to ten pounds. This reduction improves performance and lowers costs. These missile killers—"low hundreds" of them, according to Dr. Judd—would be housed in carrier satellites waiting for commands to tell them to attack.

The commands would come from another space-based segment of SDI, the Boost Surveillance and Tracking System (BSTS). This is an estimated $8 billion program to deploy a constellation of satellites (the exact number is classified) with infrared sensors to detect Soviet missile launches. Initiation of full-scale development has slipped six months into 1991. These are the heaviest payloads in the entire system, and Colonel Shore says they have always been carried on Titan launch vehicles.

BSTS is particularly important because it could also replace today's Air Force missile early warning satellites and thus might survive any cancellation of SDI. Grumman and Lockheed are doing preliminary designs on competing concepts.

The other half of the scaled-down SDI is the ground-based missiles (also with nonnuclear warheads) to attack the incoming nuclear warheads that "leak" through the SBI network. These are intended to provide area defense rather than point defense, as was envisioned in the Safeguard antimissile system studied in the 1960s to protect US ICBMs, but they will have much longer legs than the Nike-Zeus, Spartan, and Sprint antimissile missiles planned for Safeguard.

Hitting a Bullet with a Bullet

The new approach is known as the Ground-Based Interceptor (GBI) and is projected to cost $5.8 billion. GBI is based on the Exo-atmospheric Reentry-vehicle Interception System, being developed by Lockheed, which gave the whole SDI program a big boost with the now-famous homing overlay experiment in June 1984. In that test, a ground-based missile at Kwajalein successfully hit an incoming dummy missile warhead—what the Pentagon called "hitting a bullet with a bullet."

With SDI being cut back, there is less urgency to develop the very-heavy-lift Advanced Launch System. General Dynamics' proposed ALS (shown here in artist's concept) uses liquid fuel.

These KEW programs are responsible for reducing the launch requirements to the point where ALS becomes increasingly less attractive, but there is another complicating factor. NASA will need something more efficient than the shuttle to get its space station Freedom into operation before the end of the century, and it has a strong institutional bias against depending on USAF.

ALS would be perfect for that job, and it is even a joint DoD-NASA program with a NASA deputy manager, Harold W. Hallisey. Nonetheless, NASA has been studying an unmanned version of the shuttle known as Shuttle-C (the C stands for cargo) that could launch at least forty tons. Development cost is estimated at upward of $1.5 billion, but the congressional Office of Technology Assessment projected that the program would pay for itself on deployment of the space station alone. In March 1988, NASA awarded Shuttle-C study contracts to Martin Marietta, a Rockwell-Boeing team, and United Technologies.

Without commitments by SDIO or NASA, where does this leave ALS? If ALS is to be developed, it probably requires faith that this country will have enough traffic in space, civilian as well as military, to justify investing the money up front in a new family of launch vehicles that won't begin returning savings for at least a decade. This is the same kind of decision the Nixon Administration faced when it cut corners on shuttle development costs. "It's pay me now or pay me later," Colonel Shores comments.

"If SDI were to go away tomorrow, the country would still need it [ALS]," he maintains. "The philosophy behind ALS is to 'operationalize' space."

Dr. James Ionson, former Director of SDIO's Innovative Science & Technology Branch, puts it more bluntly. He calls some of the highly publicized SDI spinoffs so many "laser potato peelers" and says DoD should stress key enabling technologies that will create entire new industries.

He has a candidate industry in mind, space transportation. "The NASA spinoffs were not so much widgets and gadgets as they were access to a place, space," he says. "ALS can change the world. It can be our railway into space. The situation is analogous to that of oil. Today the price of a barrel of oil drives the entire economy. A hundred years from now, it will be the price of a barrel of rocket propellant." ■

John Rhea, a frequent contributor to Air Force *Magazine, has written about space-based antimissile defense since he began covering the issue in 1962 as editor of the defense and aerospace systems section of* Electronic News. *His first book,* SDI—What Could Happen: 8 Possible Star Wars Scenarios, *was published last year.*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—Staff photo by Jeffrey P. Rhodes

There's more to this than flying over and dropping retardant.

Giving

Smokey a Hand

BY JEFFREY P. RHODES, AERONAUTICS EDITOR

A MAELSTROM of smoke and flames obscures the pilot's vision. Updrafts toss the plane around violently. The forward air controller points out the target, and the pilot starts his run.

This, however, is a "combat" mission of a different sort: controlling a forest fire by air-dropping fire retardant along a precise line from treetop height into a blaze so hot that it often boils tree sap.

"Wildfires have no rules," said Capt. Bruce Strickland, an aircraft commander with the Air National Guard's 145th Tactical Airlift Group, a C-130B unit based in Charlotte, N. C. "That's why aerial firefighting is one of the most exciting and interesting, but dangerous, missions there is. I have never been as scared as I was on some of the fire missions."

The fires in Yellowstone National Park in the summer of 1988 and the blazes near Tucson, Ariz., in the summer of 1989 illustrate the necessity for Military Airlift Command's Volant Forest mission. Using the Modular Airborne Firefighting System (MAFFS), three Air National Guard units and a single Air Force Reserve group dropped more than 1,600,000 gallons of retardant on Yellowstone and vicinity in 1988 and more than a million gallons this year around Tucson in helping bring the flames under control.

The military's involvement in fighting forest fires is a response to a need. MAFFS-equipped units are called in to fight fires only when the commercial firefighting aircraft (called tankers) are committed and crews hired by the US Forest Service become overburdened by the size of a forest fire. Once the blaze is under control, the C-130 units are released.

Since their first operational use in 1973, MAFFS-equipped units have been called on to help fight fires in all but six years. All the units, which include the 153d TAG in Cheyenne, Wyo., and the Air Force Reserve's 943d TAG in Riverside, Calif., have to be federally activated before they can be tasked for fire duty. North Carolina's 145th TAG and the 146th Tactical Airlift Wing from Channel Island ANGB, Calif., can also be activated by their respective state governors.

Not As Easy As It Looks

Giving Smokey the Bear an airborne assist is not simply a matter of dropping retardant on or near a fire. It is a complex process similar to launching an air strike. A number of players are involved in every drop, including such outside elements as the highway patrol, which has to close roads before drops.

Coordinating the entire firefighting effort is a joint effort of the air attack supervisor (or "attack boss"), who is a Forest Service pilot, and the incident commander, or "fire boss," who directs the firefighters on the ground.

The attack boss usually directs three or more air tanker coordinators ("lead pilots" flying "lead planes") who take commercial and MAFFS tankers into a drop zone. The lead pilots, much like forward air controllers, have to explain where the drop is to be made, lead the tankers into the area, and—most important—lead the tankers out.

With lead planes, two different types of tankers, helicopters (used to drop retardant on small fires or on hot spots in large ones), cargo aircraft, and other aircraft carrying smoke jumpers all flying at low level, the airspace above a fire gets crowded. Consider the firefighters on the ground, and it is easy to see why effective communications are

—Staff photo by Jeffrey P. Rhodes

Aerial firefighting is a unique mission for four tactical airlift units. Using the palletized Modular Airborne Firefighting System, the C-130 crews can drop 3,000 gallons of retardant on a blaze. This 943d Tactical Airlift Group C-130 is being prepped for the day's practice runs near Knoxville, Tenn., earlier this year.

critical. A lead pilot often has to talk or listen on four radios at a time.

The fire itself and the terrain add to the confusion. "With poor visibility from the smoke over unfamiliar terrain, it is dangerous out there," said M. M. "Buzz" Dyer, a fixed-wing aircraft specialist with the Forest Service's National Aviation Management Office in Boise, Idaho. It is so dangerous, in fact, that aircrews earn the Air Medal after fifteen missions into the fires.

A forest fire is an example of the power of nature unleashed. "The retardant will put out small fires," said Ed Kral, an ex-smoke-jumper who is now an instructor lead pilot for the Forest Service. "But you get fifty-foot-tall trees burning from the ground, and there is no way it will put that out." A number of veteran MAFFS pilots have seen trees explode from the heat as they flew over them. An additional hazard is that the fires often generate their own lightning.

Unfamiliar terrain is often an equally large problem. In 1988, one C-130 was the last of three MAFFS tankers being led into a drop area by a lead plane. The tail-end Charlie's vision was obscured by smoke and the cloud of retardant ahead, and the aircraft hit a tree after coming over a ridgeline. The tree tore sheet metal from the underside of the aircraft, but the crew was able to land safely.

—Staff photo by Jeffrey P. Rhodes

The MAFFS-equipped C-130's loadmaster sits between the turrets on the MAFFS equipment and arms the system for the drop. This is the view from the backseat as a 145th TAG C-130 clears a ridgeline on a training run.

Every spring, MAFFS units get together with the Forest Service to practice by making water drops. A refresher course for the veteran crews, it allows new crew members to become MAFFS-qualified. For the ground troops, the week-long training session (held this year at the Southern Appalachian Air Attack Base at McGhee-Tyson Airport in Knoxville, Tenn.) is an opportunity to sharpen deployment skills and to practice loading the MAFFS equipment with water.

© Joe Cupido

The crews generally drop all 3,000 gallons of retardant on a fire in one six-second drop, although incremental drops can be made with two of the sets. The MAFFS equipment is owned and contract-maintained by the US Forest Service.

Tools of the Trade

Each of the eight MAFFS sets consists of five palletized 500-gallon tanks with twin eighteen-inch-diameter pipes, which can hold an additional 250 gallons of retardant each, running the length of the pallets. The pipes feed into movable nozzles, called turrets, that extend over the edge of the C-130's cargo ramp. Each MAFFS set takes about six hours to install, is owned by the US Forest Service, and is maintained by a Forest Service contract technician at the unit's home base.

Over the drop site, a loadmaster sitting at a control panel sets pressure and arms the system, although the copilot actually releases the retardant. Generally, all 3,000 gallons are dumped in one six-second release, but two of the MAFFS sets have the capability to drop retardant in 1,000- or 2,000-gallon increments.

The major difference between the commercial tankers, such as Lockheed P2V Neptunes, Douglas DC-4s, -6s, and -7s, and even six

World War II Consolidated PB4Y-2 Privateers, and the MAFFS C-130s is that the MAFFS equipment is pressurized and sprays its load of 3,000 gallons of retardant when released. The commercial tankers use gravity for their drops.

Retardant from the MAFFS equipment tends to swirl, and thus it coats the fire's fuel, even on the underside of branches. It also provides broader area coverage. Consequently, the C-130 crews make drops either to cut off a fire or to steer it into natural or man-made firebreaks where the blaze can be contained.

The retardant weighs about nine pounds per gallon, so a gravity-dropped load will dig a trench if it is released from too low an altitude. The concentrated nature of these drops enables the commercial tankers to extinguish a fire.

The Forest Service mainly uses two kinds of retardant: Phos-chek, made by Monsanto, and Fire-trol LCA, made by Chemonics Industries. Both cost about sixty cents per gallon. The retardant is mostly fertilizer, which holds moisture on the fire's fuel and helps promote reforestation. It also includes a red dye, so firefighters making subsequent drops can see where previous drops were made.

—Staff photo by Jeffrey P. Rhodes

The retardant, a mixture of fertilizer, red dye, and water, is highly corrosive to the aircraft. That fact, plus the cost, are the main reasons water alone is used during training. Here, a pump crew takes a breather while one of the 145th TAG's airplanes (in the background) is refueled and refilled.

When mixed with water, the retardant is a gloppy mixture the crews derisively call "elephant snot." This mixture is highly corrosive to the aircraft, so a rust inhibitor is included. At a fire, all of the panels on the rear of the aircraft are taped up, and the aircraft are pressure-washed after nearly every sortie. The extensive maintenance and the cost of retardant are the main reasons only water drops are made at the annual training session.

A C-130, loaded with fuel, the MAFFS set, and a full supply of retardant, has a gross takeoff weight of about 135,000 pounds. Takeoffs frequently take place on short or unprepared strips in hot weather. Just getting off the ground requires skill. The C-130s take off with the cargo door open and the turrets extended, in case there is a need to jettison the load on takeoff.

Fighting Fires

At the fire, the first order of business is to find the lead plane, which loiters in the fire area. At this year's training session, one lead pilot said to a MAFFS pilot on the radio: "You guys add the orange [temporary day-glo orange numbers and wingtips] so we can find you, and we are as bright as possible [white Beech Baron aircraft with orange trim] so you can find us, and we still have trouble seeing each other."

Once the two aircraft link up, the lead pilot has to bear in mind that the C-130 is considerably larger than and different from his or her plane. "We don't want to fly any closer to the fire than we have to," said Capt. Newton Huneycutt, an instructor navigator with the 145th TAG. "The lead pilots have a tendency to fly *in* the fire and want to take us with them."

The MAFFS tanker flies in trail formation 500 to 1,000 feet behind the lead plane and goes to the target at a minimum altitude of 150 feet above the tops of the trees at a speed of 130 mph. The drop has to be on target, because a delay of even a half a second will give the fire the chance it needs to keep burning. Most fires can be stopped with a four-foot-wide firebreak.

Coordination between the lead pilots and the crews gets better with practice. The lead pilots start think-

—Staff photo by Jeffrey P. Rhodes

The ground crews have to pull double duty on MAFFS deployments. During the day, they man the pumps that load the aircraft with retardant or water. At night, crew members do their regular job of maintaining the C-130s. Here, a 943d TAG C-130 is refilled for another drop. The paint for the numbers and trim is mixed with soap for easier removal.

ing like C-130 drivers and make their runs accordingly, and the C-130 crews remember to tell the lead pilot such things as when the crew has changed out from the last time a particular aircraft was in the area, so there are no references to "your last run."

The tactics used for the drops have evolved over the years. MAFFS units are more accustomed to formation work than the commercial tanker pilots are, so there used to be two or more tankers following one lead plane. After the tree-strike incident, though, that tactic was re-evaluated. It was determined that flying through a fire and watching one plane (rather than a lead plane plus one or more C-130s) was enough, and there are no longer any "daisy chains."

MAC and Forest Service regulations limit the crew duty day to eight flight hours, but there is no limit on how many hours the ground crew can put in. The Guard and Reserve technicians and specialists not only work on the airplanes, they also help load the retardant and service the C-130s.

The retardant-loading operation resembles the fevered activity of a race-track pit crew. Once the aircraft is marshaled in, it is refueled, the windows are washed, and box lunches for the crew are passed up to the cockpit.

Meanwhile, people who normally fix turboprop engines run hoses out to the MAFFS equipment and hook them on. Forest Service technicians or contract retardant-mixers check to make sure the retardant is the right consistency and also run the pumps. The retardant can be loaded in about thirteen minutes.

"The folks have to be flexible enough to do anything at a moment's notice," said Capt. Gary Jandrisevits, the 145th TAG's maintenance chief in Knoxville. "But they love it. It gives them the opportunity to become directly involved with the aircrew's mission."

There are no MAFFS missions at night; once the sun goes down, the ground crew starts on their "real" jobs. "These people put in long hours, grab dinner when they can, and then they have to turn the planes [get them ready to fly again], just to come out the next day and do it again," noted Captain Jandrisevits. After the Yellowstone fires, all of the ground crew members received the Humanitarian Service Medal.

The technicians also get practice in deployment and cross-training. All of the units brought an en-route war readiness spares kit to the training session, but the 145th TAG ran a shuttle aircraft to bring in parts and new people. The Charlotte unit also provided major spares support for the Cheyenne group, which reciprocates when the 145th TAG is out west. The MAFFS mission is especially hard on tires, brakes, and starters because of the repeated takeoffs and landings.

Despite the danger and hard work, those involved with the MAFFS mission are enthusiastic to a fault. Only a handful of newcomers are trained each spring. Nearly everybody comes back year after year—and the same goes for the Forest Service pilots and technicians. Only retirements or transfers create openings.

One reason for the MAFFS crews' enthusiasm could be the rewards that go beyond medals. "The people in Helena [Mont., out of which the MAFFS units worked while fighting the Yellowstone fires in 1988] were so grateful for what we were doing, we couldn't buy a beer if we tried," said Captain Huneycutt. "We might have torn shingles off the guy's house with the retardant, but we had saved his house, and he appreciated it." ■

Gallery of West European Airpower

BY JOHN W. R. TAYLOR AND PAUL JACKSON

Bombers and Maritime

MIRAGE IV-P

Eighteen Mirage IV-Ps of the French Air Force represent the only genuine strategic bomber force operated by any nation of Western Europe. They originated in the 1956 decision that, like the US and USSR, France should adopt a nuclear deterrent policy based on a triad of manned bombers, and silo based and submarine launched ballistic missiles. Using a minimum of imported equipment, Dassault scaled up its delta-wing Mirage III fighter airframe, installed tandem seats for a two-man crew, a large circular radome for DR-AA 8A ground mapping radar under the center fuselage, and a pair of uprated Atar turbojets. The prototype, which flew on 17 June 1959, was followed by three slightly larger preseries aircraft and 62 production Mirage IV-A bombers, which achieved initial operational capability in October 1964 carrying AN 11 free-fall nuclear bombs.

They were deployed in three wings, each comprising three four-aircraft squadrons, dispersed at a total of nine bases and with an underground HQ at Taverny near Paris. One aircraft at each base was held at permanent alert, ready to fly within 15 minutes of an order to go. They were kept in shelters from which they could emerge with engines running at full power. JATO rockets could be used to shorten the take-off run. Sorties were intended to be flown at high altitude, with up to 45 minutes at Mach 1.7, combat radius being extended by in-flight refueling from Boeing C-135F tankers. From 1967, this gave way to a low-level penetration role, carrying an AN 22 parachute-retarded 60-70KT nuclear free-fall weapon, and in 1976 the force was reduced to two wings with 34 first-line Mirage IV-As and ten reserves. Twelve aircraft were modified to carry a 2,200 lb CT 52 reconnaissance pod instead of the AN 22.

It was intended originally to retire the Mirage strategic bombers by 1985. Instead, 18 were upgraded between 1985 and 1987 to Mirage IV-P (for Penetration) standard as carriers for the far more potent ASMP supersonic thermonuclear missile. A nineteenth was ordered subsequently as an attrition replacement. Navigation and targeting capabilities are improved by installation of a Thomson-CSF Arcana pulse-Doppler radar and dual inertial systems. Uprated EW equipment includes, typically, a Thomson-CSF TMV 015 Barem self-protection jamming pod and a Philips BOZ-100 chaff/flare pod on underwing pylons, plus two 436 or 660 gallon external fuel tanks. Thomson-CSF Serval radar warning receivers are standard. The Mirage IV-P became operational with Squadron 1/91 *Gascogne* at Mont-de-Marsan (with a detachment at Orange) on 1 May 1986, followed by 2/91 *Marne* at St Dizier (with a detachment at Istres). A few aircraft are allocated to the OCU, CIFAS 328 *Aquitaine*, at Bordeaux. The last squadron equipped with AN 22 weapons was disbanded on 1 August 1988.

Contractor: Avions Marcel Dassault-Breguet Aviation, France.
Power Plant: two SNECMA Atar 9K-7 afterburning turbojets; each 14,770 lb st. Provision for 12 JATO rockets; total 11,000 lb st.
Dimensions: span 38 ft 10½ in, length 76 ft 5½ in, height 17 ft 8½ in.
Weights (approx): empty 31,965 lb, gross 70,550 lb.
Performance: max speed Mach 2 at high altitude, 745 mph IAS at low altitude, service ceiling 59,000 ft, radius of action 930 miles unrefueled.
Accommodation: crew of two.
Armament: one ASMP thermonuclear missile.

Mirage IV-P, French Air Force

HU-16B Albatross, Hellenic Air Force

Atlantic, Italian Air Force (J. M. G. Gradidge)

ALBATROSS (HU-16B)

In 1961, Grumman developed a special version of the HU-16B Albatross amphibian for antisubmarine missions, with a nose radome, retractable MAD tail 'sting', ECM equipment on the wing, an underwing searchlight, and provision for carrying depth charges. The Hellenic (Greek) Air Force continues to operate a single antisubmarine warfare squadron (No. 353) with eight surviving HU-16Bs of 12 acquired from Norway in 1969 and refurbished from 1986 for continued service.

Contractor: Grumman Aircraft Engineering Corporation, USA.
Power Plant: two Wright R-1820-76A piston engines; each 1,425 hp.
Dimensions: span 96 ft 8 in, length 62 ft 10 in, height 25 ft 10 in.
Weight: gross 37,500 lb.
Performance: max speed 236 mph at S/L, service ceiling 21,500 ft, max range 2,850 miles.
Accommodation: crew of five.
Armament and Operational Equipment: four underwing pylons for torpedoes, rockets, depth charges, and other stores; sonobuoys, marine markers, and depth charges in fuselage.

ATLANTIC

Breguet's Br 1150 Atlantic won a major NATO design competition for an antisubmarine aircraft to replace the Lockheed Neptune, and two (subsequently four) prototypes were ordered in December 1959. The first of these flew on 21 October 1961. Breguet then built 40 production Atlantics for the French Navy, nine (all now withdrawn) for the Netherlands, and 20 for the West German Navy, of which five were modified subsequently for elint/sigint duties with LTV-designed equipment, under the Peace Peek program. Italy purchased 18 which, being operated by the 86th and 88th *Gruppi* of the Italian Air Force, qualify for inclusion in this Gallery.

Production of the Atlantic was undertaken by a consortium of companies in France, Germany, Belgium, Italy, and the Netherlands, with landing gears built in Spain, some avionics from the UK and USA, and turboprop engines manufactured by a French/Belgian/German/Italian/UK team. Most of the airframe is skinned in metal honeycomb sandwich, and the upper deck of the 'double-bubble' fuselage is both pressurized and roomy. A relief crew can be carried on long missions, in addition to the normal two pilots, flight engineer, three observers, radio navigator, ESM/ECM/MAD operator, radar/IFF operator, tactical coordinator, and two acoustic sensor operators. Equipment includes a retractable radar, MAD tailboom, and an Arar ECM pod at the top of the tail fin. The whole of the upper and lower rear fuselage provides storage for sonobuoys and marker flares.

A much improved version, known as the Atlantique 2 (ATL2), is currently in production for the French Navy. Meanwhile, 14 German Navy Atlantics have undergone an operational capability upgrade, and an upgrade of the Italian aircraft began with the first flight of the initial conversion by Dassault in 1987. New equipment on Italian Atlantics comprises a GEC Avionics AQS-902C sonobuoy processing system and features of the Atlantique 2, including Thomson-CSF Iguane radar. Upgrade of the remaining aircraft, in Italy, will be completed by October 1992.

Contractor: Avions Marcel Dassault-Breguet Aviation, France.
Power Plant: two Rolls-Royce Tyne RTy 20 Mk 21 turboprops; each 6,106 ehp.
Dimensions: span 119 ft 1 in, length 104 ft 2 in, height 37 ft 2 in.
Weights: empty 52,900 lb, gross 95,900 lb.
Performance: max speed 409 mph at height, service ceiling 32,800 ft, range 5,590 miles.
Accommodation: crew of 12. Provision for 12 other personnel.
Armament: internal weapons bay accommodates all standard NATO bombs, mines, 385 lb depth charges, four homing or nine acoustic torpedoes. Underwing pylons for two AS 30 or Martel missiles.

AVIOCAR (C-212)

CASA has developed versions of its C-212 Aviocar STOL utility transport equipped for specialized military duties. Nine Srs 100/200s were ordered by the Spanish Air Force for maritime surveillance and search and rescue missions, three by the Spanish Ministry of Finance, one ASW version by the Swedish Navy, two for maritime patrol (with SLAR and IR/UV search equipment) by the Swedish Coast Guard, and 17 others by Mexico, Sudan, Uruguay, and Venezuela. Operational equipment can include a nose-mounted AN/APS-128 search radar with 270° scan, searchlight, FLIR, smoke markers, and camera in the maritime patrol version; an underfuselage radar with 360° scan, ESM, sonobuoy processing system, OTPI, MAD, tactical processing system, IFF/SIF transponder, sonobuoy and smoke marker launcher, and weapons in the ASW version. *(Data for Srs 200.)*
Contractor: Construcciones Aeronauticas SA, Spain.
Power Plant: two Garrett TPE331-10R-511C turboprops; each 900 shp.
Dimensions: span 62 ft 4 in, length 49 ft 8½ in, height 20 ft 8 in.
Weight (ASW version): gross 18,519 lb.
Performance: max cruising speed 219 mph, loiter speed 121 mph at 1,500 ft, service ceiling 24,000 ft, range 1,898 miles.
Accommodation: crew of five (ASW and maritime patrol versions).
Armament: provisions for carrying torpedoes such as Mk 46 and Sting Ray, unguided rockets, and air-to-surface missiles such as Sea Skua and AS 15TT.

Search and Rescue Aviocar, Spanish Air Force

Buccaneer S. Mk 2, Royal Air Force

Gulfstream SMA-3, Royal Danish Air Force

Nimrod MR. Mk 2, Royal Air Force

BUCCANEER

Like America's F-4 Phantom II, the Buccaneer began life as a naval aircraft. Its area ruled form reflected the fact that it was the first aircraft designed specifically to exploit the vulnerable gap beneath hostile radar defenses, by delivering its nuclear weapon at speeds above Mach 0.9 at extremely low altitude. The prototype, flown for the first time on 30 April 1958, had Gyron Junior turbojets, as did the first production batch of Buccaneer S. Mk 1s for the Royal Navy. The switch to Rolls-Royce Speys offered a 30 percent increase in thrust and reduced fuel consumption, and these engines became standard in all subsequent production Buccaneers, designated S. Mk 2, for the Royal Navy and Royal Air Force.

The Royal Navy lost its Buccaneers when its last large carrier was retired in December 1978. Budget cuts also cost the Royal Air Force its eagerly awaited supersonic attack aircraft. Instead, it got 65 ex-Navy and 49 new-build Buccaneers, the last completed in October 1977. Of these, 93 were built as, or converted to, S. Mk 2Bs with provision for four Martel TV-guided/antiradiation antiship missiles on wing pylons, plus an additional 510 gallon fuel tank in the bomb bay. The balance comprised non-Martel S. Mk 2As.

Today, six 2As and 52 2Bs remain in service with Nos. 12 and 208 Squadrons, and in No. 237 Operational Conversion Unit, operating in the maritime strike/attack role from RAF Lossiemouth in Scotland. The OCU has a wartime task of AN/AVQ-23E Pave Spike laser designation on the Central Front in Europe. Forty-two S. Mk 2Bs are being updated by British Aerospace in 1987–89 with Ferranti FIN 1063 INS, and Tracor AN/ALE-40 chaff/flare dispensers, plus enhancements to existing Ferranti AIRPASS III Blue Parrot radar and ARI 18228 RWR, the latter to Guardian 200 standard. Sea Eagle antiship missiles were issued to the Buccaneer force in January 1986.
Contractor: Hawker Siddeley Aviation Ltd, UK.
Power Plant: two Rolls-Royce RB168 Spey Mk 101 turbofans; each 11,100 lb st.
Dimensions: span 44 ft 0 in, length 63 ft 5 in, height 16 ft 3 in.
Weights: empty 29,980 lb, gross 62,000 lb.
Performance: max speed Mach 0.92 (690 mph) at S/L, service ceiling over 40,000 ft, tactical radius 500–600 miles on hi-lo-hi mission.
Accommodation: crew of two, in tandem.
Armament: max weapon load 16,000 lb, inside ventral bomb bay and on underwing pylons, including WE177 nuclear bombs, Martel and Sea Eagle missiles, 1,000 lb bombs, one AIM-9G Sidewinder missile, and an AN/ALQ-101(V)-10 jamming pod.

F27 MARITIME

The islands of the Canary Archipelago, being more than 800 miles from the Spanish mainland, have their own mini air force in the form of MACAN, Canaries Command of the Spanish Air Force. Its three squadrons, based at Gando, Las Palmas, include No. 802 maritime surveillance and search and rescue Squadron, equipped with four Super Puma helicopters and three F27 Maritimes (Spanish designation D.2). The F27 Maritime is generally similar to the basic F27 twin-turboprop transport (which see). Unarmed, it carries a crew of up to six persons, and has a Litton 360° search radar in a ventral radome. Its standard fuel gives it an endurance of 10–12 hours or a range of up to 3,107 miles.
Contractor: Fokker BV, Netherlands.

GULFSTREAM SMA-3

In 1982 the Royal Danish Air Force took delivery of three SMA-3 special missions aircraft, adapted from the Gulfstream III executive transport to meet the difficult requirements of Denmark's fishery patrols. These have to cover an area of more than 212,000 sq miles around Greenland and 112,700 sq miles around the Faeroe Islands. Bad weather can prevent landing at either place, necessitating a 920 mile diversion to an alternate. In addition, the aircraft had to be suitable for airdrop, medevac (including airborne surgery), SAR, tactical air transport, and VIP transportation for members of the nation's Royal Family. Allocated to No. 721 Squadron, they are based at Vaerløse, near Copenhagen, and detach in rotation for duty at Søndrestrøm AB, Greenland. Special features include a cargo door on the starboard side, forward of the wing, Texas Instruments APS-127 sea surveillance radar, and Litton 72R INS.
Contractor: Gulfstream Aerospace Corporation, USA.
Power Plant: two Rolls-Royce Spey Mk 511-8 turbofans, each 11,400 lb st.
Dimensions: span 77 ft 10 in, length 83 ft 1 in, height 24 ft 4½ in.
Weights: empty 36,173 lb, gross 69,700 lb.
Performance: max cruising speed Mach 0.85, service ceiling 45,000 ft, range with VFR reserves 4,537 miles.
Accommodation: crew of seven.
Armament: none.

NIMROD MR. Mk 2

Four squadrons of No. 18 Group of Royal Air Force Strike Command are equipped with this maritime patrol aircraft. Of these, No. 42 is based at St Mawgan in Cornwall, England. Nos. 120, 201, and 206 are at Kinloss in Scotland. The airframe is based substantially on that of Britain's pioneer Comet 4C jetliner, with an unpressurized pannier for operational equipment and weapons added under the fuselage. Spey turbofans replace the Comet's Avon turbojets. The tail unit is entirely reconfigured, with a large dorsal fin, a satellite communications pod on top of the fin, an MAD tailboom, and, on current aircraft, finlets on the tailplane leading-edges.

Forty-six of the original Nimrod MR. Mk 1 version were built, with deliveries beginning in 1969. Thirty-five were uprated to the current MR. Mk 2 operational standard, with Thorn EMI Searchwater long-range surface vessel detection radar, GEC Avionics AQS 901 acoustics processing system compatible with a wide range of passive and active sonobuoys, and Loral 1017 Yellow Gate EWSM in wingtip pods. The remaining 11 were converted for the now-abandoned airborne early warning Nimrod program. As a result of experience in the Falklands campaign in 1982, sixteen Nimrod MR. 2s now have an in-flight refueling probe, and provision for carrying Sidewinder and Harpoon missiles. These aircraft also have a small ventral fin.
Contractor: British Aerospace plc, UK.
Power Plant: four Rolls-Royce RB168-20 Spey Mk 250 turbofans; each 12,140 lb st.
Dimensions: span 114 ft 10 in, length with refueling probe 129 ft 1 in, height 29 ft 8½ in.
Weights (approx): empty 86,000 lb, normal gross 177,500 lb.
Performance: max speed 575 mph, typical low-level patrol speed 230 mph, service ceiling 42,000 ft, typical endurance 12 hours.
Accommodation: crew of 12.
Armament: up to nine torpedoes, Harpoon missiles, mines, or bombs in weapons bay; two underwing pylons for Sidewinder missiles.

ORION (P-3), AURORA (CP-140), and ARCTURAS (CP-140A)

Standard shore-based antisubmarine and maritime patrol aircraft of the US Navy since 1962, the P-3 flies in the insignia of five other NATO nations, including those of the Canadian, Norwegian, Portuguese, and Spanish air forces and the Netherlands Navy. The original P-3A Orion was based on the airframe of the Lockheed Electra airliner, with 4,500 ehp Allison T56-A-10W turboprops, APS-80 radar, ASQ-10 MAD in a tailboom, and an ASR-3 sensor to sniff the exhaust of submerged diesel-powered submarines. Mines, nuclear or conventional depth bombs, and torpedoes were carried in a weapons bay forward of the wings. Ten underwing pylons could carry more torpedoes, mines, or rockets, as well as a searchlight. Sonobuoys and acoustic devices were launched from the cabin.

Six P-3As were transferred from the US Navy to equip No. 221 Squadron of the Spanish Air Force at Jerez, under the Spanish designation P.3. Their replacement by five of the seven P-3Bs that were operated by No. 333 Squadron of the Royal Norwegian Air Force from Andøya, in the far north of Norway, began in October 1988. No. 333 is re-equipping with four of the latest Update III P-3Cs for its primary task of detecting Soviet submarines leaving Northern Fleet bases in the Murmansk area. These aircraft have much-improved avionics, including an IBM Proteus acoustic processor to analyze signals picked up from the sea, and a new sonobuoy receiver, as well as a Texas Instruments AAS-36 undernose IR detection set, and Harpoon missile capability. The two remaining RNoAF P-3Bs are being assigned to Coast Guard duties, with the new designation P-3N.

The Portuguese Air Force has six ex-RAAF P-3Bs, on which crew operational training began in September 1988 after a major retrofit and detection sensors upgrade. Now designated P-3P, these aircraft have an expanded processing capability able to accommodate Data Link 11, ALR-66(V)3 ESM, and interactive displays for the tactical coordinator and pilot. A new AN/APS-134 radar, dual AQA-7V9 sonar processor, IRDS and Harpoon capability have also been added, making the P-3Ps comparable to a P-3C Update II.5. They are operated by No. 601 Squadron at Ovar. The 18 CP-140 Auroras operated by the Canadian Forces since 1980 combine the P-3C airframe with the avionics and data processing system of the US Navy's S-3A Viking, including APS-116 search radar, ASQ-501 MAD, and AYK-10 computer. They are being supplemented by the last three production P-3Cs, which will operate as unarmed patrol aircraft under the designation CP-140A Arcturas. *(Data for P-3C.)*

Contractor: Lockheed Aeronautical Systems Company, USA.
Power Plant: four Allison T56-A-14 turboprops; each 4,910 ehp.
Dimensions: span 99 ft 8 in, length 116 ft 10 in, height 33 ft 8½ in.
Weights: empty 61,491 lb, normal gross 135,000 lb.
Performance: max speed at 15,000 ft 473 mph, patrol speed at 1,500 ft 237 mph, service ceiling 28,300 ft, mission radius (3 hours on station) 1,550 miles.
Accommodation: crew of ten.
Armament: max expendable load of 20,000 lb, including 500/1,000/2,000 lb mines, Mk 54/57 depth bombs, Mk 101 nuclear depth bombs, Mk 43/44/46 torpedoes, Harpoon missiles, sonobuoys, marine markers, acoustic sensors, and parachute flares.

TRACKER (S-2 and CP-121)

First flown in XS2F-1 prototype form on 4 December 1952, this veteran piston-engined aircraft continues to perform important shore-based maritime duties with two NATO air forces. About 15 S-2A/E Trackers are operated on antisubmarine patrol by No. 103 Squadron of the Turkish Air Force, with joint Air Force/Navy crews, from Topel on the Black Sea. A further 18 have been acquired, and are being refurbished by Grumman before delivery. Canadian Forces Maritime Command has 20 CP-121s, basically similar to the US Navy's S-2A, which were built by Canadian manufacturers in the late 1950s, under license from Grumman. In the 1970s, after the RCN had retired its last carrier, the CP-121s' ASW equipment was replaced by a Litton APS-504 search radar, Marconi Omega navigation system, cameras, and provision for 2.75 in rocket pods for armed reconnaissance. The naval arrester hook and MAD boom were removed, but the 85 million candlepower steerable searchlight under the starboard wing was retained. Today, the CP-121s are operated primarily by MR-880 Squadron, which shares its aircraft with personnel of No. 420 (Air Reserve) Squadron, at CFB Summerside on Prince Edward Island. Three other CP-121s are flown from CFB Comox on Canada's west coast by VU-33 (Utility) Squadron. Primary mission for all of these aircraft is coastal surveillance, including fisheries protection and pollution control, with a secondary search and rescue role carrying parachute flares and a SKAD (Survival Kit Air Droppable) underwing. Canada was considering a CP-121 life extension program, with PT6A turboprops and new avionics (including reinstalled ASW equipment) to meet its Medium Range Patrol Aircraft requirement, but the program has been canceled and the CP-121s will be withdrawn from use.

Prime Contractor: de Havilland Aircraft of Canada Limited, Canada.
Power Plant: two Wright 983C9HE1 (R-1820) piston engines; each 1,525 hp.
Dimensions: span 69 ft 8 in, length 42 ft 3 in, height 16 ft 3½ in.
Weights: empty 17,500 lb, gross 26,055 lb.
Performance: max speed 258 mph, search speed 161 mph, service ceiling 24,000 ft, range 1,150 miles.
Accommodation: crew of three.
Armament: 2.75 in rocket packs, depth bombs, and bombs.

CP-140 Aurora, Canadian Forces (Press Office Sturzenegger)

S-2 Tracker, Canadian Forces

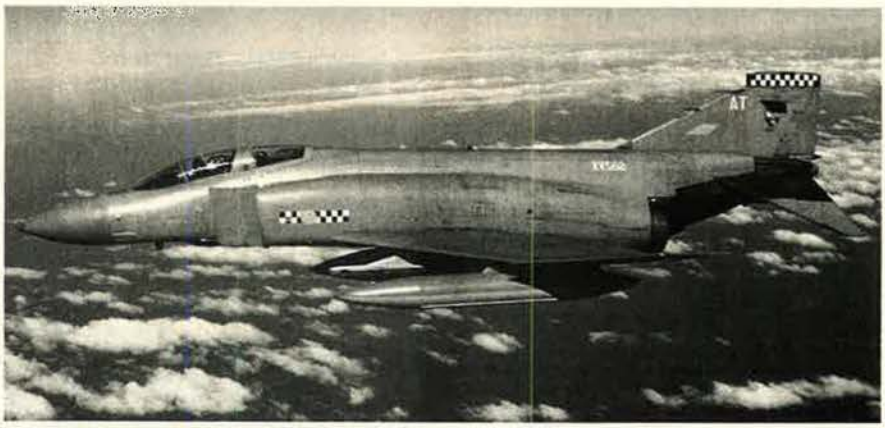
Fighters

F-4 PHANTOM II

Five NATO air forces in Europe continue to deploy the 30 year old Phantom II as first-line combat equipment. The Royal Air Force has five air defense squadrons, all under NATO command. No. 111, based at Leuchars in Scotland, has Phantom FG. Mk 1s (F-4Ks). No. 56 at Wattisham in England, and Nos. 19 and 92 at Wildenrath in Germany, have FGR. Mk 2s (F-4Ms). Both versions are comparable to US Navy F-4Js, except for having Rolls-Royce Spey engines. No. 74 Squadron, at Wattisham, has ex-USN F-4Js with J79 turbojets. Additionally, a detachment of FGR. Mk 2s serves with No. 1345 Flight at RAF Mount Pleasant for air defense of the Falkland Islands, and others with No. 228 OCU for crew training.

The German Air Force has eight squadrons of F-4Fs in two fighter-bomber wings (JBG 35 and 36) and two air defense wings (JG 71 and 74). From 1991 onward, it is planned to upgrade 110 of these aircraft, primarily from the air defense wings, to give them a lookdown/shootdown capability against multiple targets. MBB is prime contractor for the program, known as ICE (Improved Combat Effectiveness), which will replace the existing Westinghouse APQ-120 radar with an all-digital multimode Hughes APG-65 embodying advanced ECCM. The cockpit will be updated; new equipment will include a Litef digital fire control computer, Honeywell laser INS, GEC digital air data computer, improved IFF, and provisions for four AMRAAM missiles. A further 40 F-4Fs, serving in the fighter-bomber role, are undergoing partial update.

Spain has two squadrons of F-4Cs (known as C.12s) with 12 Wing of Air Combat Command (MACOM) at Torrejón AB, but replacement of these with EF-18s has been under way since March 1989. The two remaining Phantom operators have F-4Es, of which three squadrons (337, 338, and 339) serve with the Hellenic Air Force, and seven squadrons (111, 112, 131, 132, 171, 172, and 173) with the Turkish Air Force. *(Data for FGR. Mk 2.)*



F-4K Phantom FG. Mk 1, Royal Air Force (Paul Jackson)

F-4E Phantom II, Turkish Air Force

NF-5A of 316 Squadron, Royal Netherlands Air Force

Contractor: McDonnell Douglas Corporation, USA.
Power Plant: two Rolls-Royce RB168-25R Spey 202 afterburning turbofans; each 20,515 lb st.
Dimensions: span 38 ft 4¾ in, length 58 ft 3 in, height 16 ft 3 in.
Weights: empty 31,000 lb, gross 58,000 lb.
Performance: max speed at 40,000 ft Mach 2.1, at 1,000 ft Mach 1.15; service ceiling 58,050 ft; max range 1,750 miles.
Accommodation: crew of two in tandem.
Armament: one 20 mm M61 multibarrel gun in SUU-23/A pod; four Sky Flash or Sparrow air-to-air missiles and four Sidewinders. Provision for eleven 1,000 lb bombs, 126 SNEB 68 mm rockets, and 370 and 600 (centerline only) gallon external fuel tanks.

F-5 and CF-5

A prototype of this low-cost lightweight supersonic fighter, known as the N-156F, flew on 30 July 1959. Impressed by its potential for economical foreign military aid/sales, DoD ordered into production single-seat F-5A and two-seat F-5B versions. They were acquired by 17 foreign air forces, and are still assigned to fighter ground attack duties by four non-US NATO air forces. On NATO's

F-16C Fighting Falcons, Turkish Air Force

southern flank they are flown by Squadrons 341 and 343 of the Hellenic Air Force, and Squadrons 151 and 152 of the Turkish Air Force. The Royal Netherlands Air Force now has only two squadrons (Nos. 314 and 316) of Canadian-built NF-5As, others having re-equipped with F-16s. No. 314 will be next to receive F-16s, and 60 ex-RNLAF NF-5As are being passed to Turkey under NATO's LDDI (Less Developed Defense Industries) program. The two squadrons of CASA-built SF-5As (A.9s) and SF-5Bs (AE.9s) operated by Tactical Command of the Spanish Air Force (Nos. 211 and 212) are being updated with laser rangers and improved avionics, including a head-up display. CF-18s have replaced Canadair-built CF-5s (single-seat CF-116As and two-seat CF-116Ds) in Canadian operational squadrons, but the CF-5s continue to serve as fighter lead-in trainers. Similarly, Norway's No. 336 Squadron operates as an advanced training unit for its four squadrons of F-16s. *(Data for F-5A.)*

Contractor: Northrop Corporation, USA.

Power Plant: two General Electric J85-GE-13 afterburning turbojets; each 4,080 lb st.

Dimensions: span over tiptanks 25 ft 10 in, length 47 ft 2 in, height 13 ft 2 in.

Weights: empty 7,860 lb, gross 20,040 lb.

Performance: max speed at 36,000 ft Mach 1.4, service ceiling over 50,000 ft, max range 1,750 miles, range with max weapons 368 miles.

Accommodation: pilot only.

Armament: two 20 mm M39A2 guns in nose; Sidewinder missile on each wingtip; centerline pylon and two under each wing for about 4,400 lb of air-to-air or air-to-surface missiles, rocket packs, gun pods, bombs, or 275 gallon fuel tanks.

F-16 FIGHTING FALCON

On 7 June 1975, less than five months after USAF's decision to order the F-16, the Governments of four European NATO nations announced their selection of this aircraft to replace their F-104s. Final assembly lines for single-seat F-16As and two-seat F-16Bs were established in Belgium and the Netherlands, to which components, avionics, and equipment were supplied by about 30 European companies. With follow-on contracts, orders to date total 160 F-16s for the Belgian Air Force, 70 for the Royal Danish Air Force, 213 for the Royal Netherlands Air Force, and 72 for the Royal Norwegian Air Force. Ten further attrition replacements have been ordered from General Dynamics by the RNLAF; six are to be acquired for the RNoAF. All are similar to basic USAF F-16As and Bs, with some equipment changes. Belgian aircraft are to have Dassault Carapace passive ECM in an extended fin root fairing; those for Norway have a brake-chute in this location, and all RNLAF F-16s will receive a similar brake-chute, as well as internal modifications, under an operational capabilities upgrade program. The 23,830 lb st Pratt & Whitney F100-PW-200 afterburning turbofan and Westinghouse APG-66 radar are standard in all of these aircraft. Currently, they equip Squadrons 1, 2, 23, 31, 349, and 350 of the BAF; 723, 726, 727, and 730 of the RDAF; 311, 312, 313, 315, 322, and 323 of the RNLAF, with 314 forming; and 331, 332, 334, and 338 of the RNoAF.

EF-18 Hornet, Spanish Air Force

When Turkey and Greece joined the list of F-16 operators, they both opted for the uprated F-16C/D versions, with a General Electric F110-GE-100 engine and APG-68 radar. Deliveries of the 40 Greek aircraft started in November 1988, to 111 Wing at Nea Ankhialas, where three squadrons will be formed to replace two of F-5s. Eight US-built aircraft were supplied to Turkey in 1987; the remaining 152 are being built in Turkey by Tusas Aerospace Industries, and the first two (Nos. 141 and 142) of eight planned squadrons have formed in 1989. Portugal is expected to receive 20 ex-USAF F-16As. *(Data for Greek/Turkish F-16C.)*

Contractor: General Dynamics Corporation, USA.

Power Plant: one General Electric F110-GE-100 afterburning turbofan; 27,600 lb st.

Dimensions: span over missiles 32 ft 9¾ in, length 49 ft 4 in, height 16 ft 8½ in.

Weights: empty 19,100 lb, gross 42,300 lb.

Performance: max speed at 40,000 ft above Mach 2, service ceiling above 50,000 ft, radius of action more than 575 miles.

Accommodation: pilot only.

Armament: one 20 mm M61A1 multibarrel gun in port side wing/body fairing; Sidewinder missile on each wingtip; centerline hardpoint and three under each wing for total 12,000 lb of stores, including air-to-surface missiles (Penguin Mk 3 on Norwegian aircraft), single or cluster bombs, rocket packs, ECM packs, and fuel tanks. Internal chaff/flare dispensers.

F/A-18 HORNET

Two non-US NATO air forces have, so far, preferred the US Navy's twin-engined F/A-18 to the competing single-engined USAF F-16. The Canadian Forces placed their initial order for 113 CF-18A single-seaters and 25 CF-18B two-seaters in April 1980. This was later modified to 98 and 40 respectively, and Canada is believed currently to require 25 more to offset attrition to the year 2010. By comparison with the Navy versions, the CF-18s have a different ILS and an added spotlight on the port side of the fuselage for night identification of other aircraft in flight. Unique is the canopy shape painted on the underside of the front fuselage, which is intended to confuse hostile pilots during combat maneuvers. CF-18s have replaced CF-104s in Nos. 409, 421, and 439 Squadrons of No. 1 Canadian Air Division based at Söllingen, West Germany. Four squadrons of CF-18s (Nos. 416, 425, 433, and 441), plus an OCU (No. 410), have replaced CF-5s and the CF-101F Voodoos that contributed to northern European attack reinforcement and North American air defense. Two of them (416 and 433) are allocated to support Canada's NATO force in Central Europe in an emergency.

The Spanish Air Force ordered 72 EF-18s in May 1983, with an option on 12 more, designating the single-seaters C.15 and the two-seaters CE.15. Deliveries to equip two squadrons of Air Combat Command (MACOM) 15 Wing, at Zaragoza AB, began in 1986. The two Phantom squadrons of 12 Wing, at Torrejón AB, began converting to EF-18s in March 1989. *(Data for CF-18A.)*

Contractor: McDonnell Douglas Corporation, USA.

Power Plant: two General Electric F404-GE-400 augmented turbofans; each 16,000 lb st.

Dimensions: span over missiles 40 ft 4¾ in, length 56 ft 0 in, height 15 ft 3½ in.

Weights: empty 23,050 lb, gross (fighter escort mission) 37,175 lb.

Performance: max speed Mach 1.8, combat ceiling approx 50,000 ft, combat radius 660 miles.

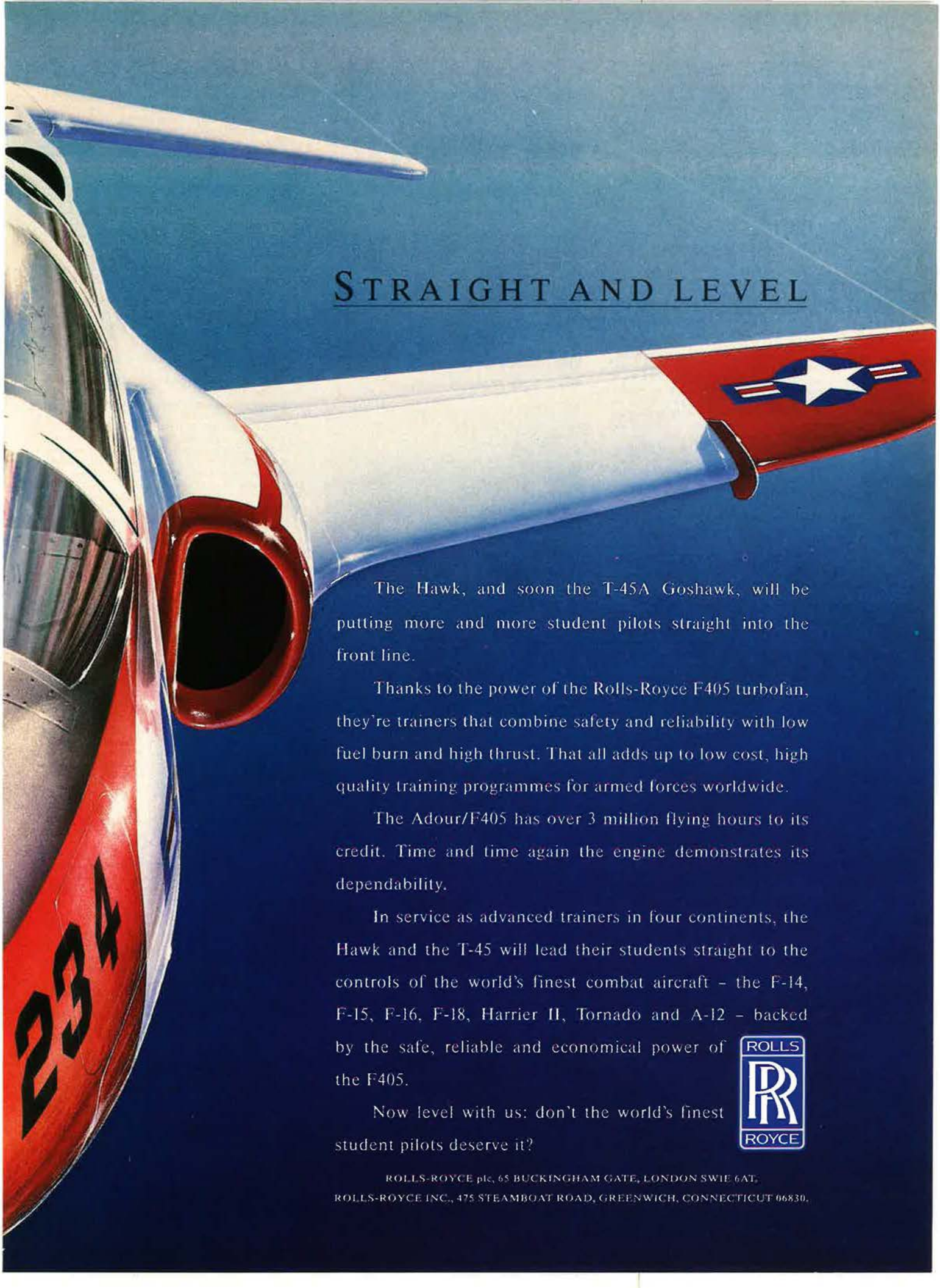
Accommodation: pilot only.

Armament: one 20 mm M61 multibarrel gun in nose; Sidewinder missile on each wingtip; centerline pylon, two on engine trunks, and two under each wing for Sparrow air-to-air missiles, CRV-7 rocket packs, bombs, BL755 cluster bombs, ECM pods, etc. (HARM and Harpoon missiles on EF-18.) Max external stores load 17,000 lb.

F-104 STARFIGHTER

Greece and Turkey have maintained large inventories of F-104s by acquiring surplus aircraft from other NATO air forces that have re-equipped. The Hellenic Air Force is believed to have three fighter-bomber squadrons of F-104Gs with 116 Wing at Araxos. The Turkish Air Force has six squadrons of F-104Gs and two-seat TF-104s, plus one air defense squadron of F-104Ss bought from Italy. The 'S' model was the final version of the Starfighter, developed by Aeritalia for the Italian Air Force, which bought 205. These now equip, partly or completely, eight squadrons within its Nos. 4, 5, 9, 36, 51, and 53 Wings. A total of 160 Italian Air Force F-104s have been undergoing a major weapons system update since 1982, bringing them up to F-104S ASA *(Aggiornamento Sistemi d'Arma)* standard. This includes installation of a Fiar R21G/M1 Setter lookdown/shootdown radar, advanced ECM, improved IFF and altitude reporting system, improved electrical generation and distribution, an armament computer and time delay unit for improved weapons delivery, and a new automatic pitch control computer. Selenia's Aspide medium-range air-to-air missile is now standard.


737



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as an alternative to the Sparrows which accounted for the 'S' in the aircraft's designation. *(Data for F-104S.)*

Contractor: Aeritalia SpA, Italy, under license from Lockheed.

Power Plant: one General Electric J79-GE-19 afterburning turbojet; 17,900 lb st.

Dimensions: span without tiptanks 21 ft 11 in, length 54 ft 9 in, height 13 ft 6 in.

Weights: empty 14,900 lb, gross 31,000 lb.

Performance: max speed at 36,000 ft Mach 2.2, at S/L Mach 1.2; service ceiling 58,000 ft; max combat radius 775 miles.

Accommodation: pilot only.

Armament: AIM-9L Sidewinder on each wingtip; seven pylons under fuselage and wings for bombs, rocket packs, fuel tanks, and air-to-air missiles, including two Aspides or Sparrow IIIs. Max external stores load 7,500 lb.

HAWK T. Mk 1A

A total of 88 Hawk trainers of Nos. 1 and 2 Tactical Weapons Units of the Royal Air Force, and of its Red Arrows aerobatic team, have been wired for carriage of two AIM-9L Sidewinder air-to-air missiles on their inboard underwing pylons, and for optional activation of the previously unused outer wing hardpoints. Seventy-two of these redesignated Hawk T. Mk 1As are declared to NATO for point defense and participation in the RAF's Mixed Fighter Force, in which they would accompany radar equipped Phantoms and Tornado ADVs on medium-range air defense sorties. They retain their underfuselage 30 mm Aden gun pod.

Contractor: British Aerospace plc, UK.

Power Plant: one Rolls-Royce Turbomeca RT172-06-11 Adour 151 turbofan; 5,340 lb st.

Dimensions: span 30 ft 9¾ in, length, excluding probe, 36 ft 7¾ in, height 13 ft 5 in.

Weights: empty 8,040 lb, gross 17,097 lb.

Performance: max speed approx 560 mph, service ceiling 48,000 ft, max range with external tanks 1,923 miles.

Accommodation: basically, crew of two in tandem. Pilot only in combat role.

Armament: one 30 mm Aden gun pack under fuselage; AIM-9L Sidewinder air-to-air missile on each inboard underwing pylon.

MIRAGE III

Thirty-three years after the first flight of the Mirage III prototype on 17 November 1956, this elegant delta-wing fighter remains in first-line service with the air forces of France and Spain, for both air defense and fighter-bomber duties. The Mirage IIIE is operated by Squadrons 1/3 *Navarre*, 2/3 *Champagne*, 3/3 *Ardennes*, and 1/13 *Artois* of the French Tactical Air Force (FATAC). This version originated as an all-weather low-altitude attack fighter with CSF Cyrano II fire control and ground mapping radar, Marconi Doppler, and navigation and bombing computers, but is equally effective for interception of Mach 2 targets in all weathers. The Mirage IIIEEs flown by two squadrons of 11 Wing, Air Combat Command (MACOM) of the Spanish Air Force, from Manises AB, under the Spanish designation C.11, are similar except for having no nuclear capability. They are being updated locally with APG-66 radar, a US mission computer, and other avionics including INS, RWR, and head-up and head-down displays. *(Data for Mirage IIIE.)*

Contractor: Avions Marcel Dassault-Breguet Aviation, France.

Power Plant: one SNECMA Atar 9C afterburning turbojet, 13,670 lb st.

Dimensions: span 27 ft 0 in, length 49 ft 3½ in, height 13 ft 11½ in.

Weights: empty 15,540 lb, gross 29,760 lb.

Performance: max speed at 40,000 ft Mach 2.1, at S/L Mach 1.14; service ceiling 55,775 ft; combat radius (lo-lo-lo) 305 miles.

Accommodation: pilot only.

Armament: two 30 mm DEFA 552 guns in fuselage, and one Martel antiradar missile on centerline pylon. Options include one Matra R.530 air-to-air missile under fuselage, and two Matra Magic missiles under wings, for interception missions; one AN 52 nuclear bomb under fuselage, bombs or rocket packs underwing, for ground attack missions.

MIRAGE F1

Unique in three decades of Dassault products for the French Air Force, the Mirage F1 reverted to sweptwing, rather than delta, configuration. The basic F1-C, first flown in prototype form on 23 December 1966, is intended primarily as an all-weather, all-altitude interceptor, but is also suitable for visual ground attack missions. Its fuselage and weapon systems are generally similar to those of the Mirage IIIE, but an uprated turbojet helps it to take off in under 2,000 ft on air defense missions, armed with air-to-air missiles. Its initial rate of climb is 41,930 ft/min, with a stabilized ceiling of 52,500 ft at supersonic speed. Automatic leading-edge flaps give it outstanding maneuverability in combat, matched by great stability at high speeds close to the ground. Standard equipment now includes a HUD and Cyrano IV-M multifunction radar with a high degree of resistance to ECM. In addition, many F1-Cs have been fitted with an inflight refueling probe, under the new designation F1-C-200. Using this capability, four of them flew nonstop 3,100 miles from Solenzara, Corsica, to Djibouti, East Africa, in six hours in 1960. Squadrons equipped currently with F1-Cs are 3/5 *Comtat Venaissin* at Orange; 1/12 *Cambrésis*, 2/12 *Picardie*, and 3/12 *Cornouaille* at Cambrai; and 1/30 *Valois* and 2/30 *Normandie Niemen* at Reims. One further squadron, 4/30 *Vexin*, is based in Djibouti; and there are a few F1-Cs with the two-seat F1-Bs of 3/30 *Lorraine*, the OCU at Reims. Mirage F1-Cs replaced in the air defense role by Mirage 2000s will be converted to F1-CT standard for attack duties.

The Hellenic Air Force has two squadrons of Mirage F1-CGs, Nos. 334 *Thalos* and 342 *Sparta*, at Tanagra. Air Combat Command 14 Wing of the Spanish Air Force at Albacete AB has two squadrons of F1-CEs (known as C.14As). In addition, a single squadron of multirole Mirage F1-EEs (C.14Bs), with INS, nav/attack computer, and HUD, serves with No. 46 Wing of Canaries Command (MACAN) at Gando AB, Las Palmas. *(Data for Mirage F1-E.)*

Contractor: Avions Marcel Dassault-Breguet Aviation, France.

Power Plant: one SNECMA Atar 9K-50 afterburning turbojet; 15,873 lb st.

Dimensions: span over missiles 30 ft 6¾ in, length 50 ft 2½ in, height 14 ft 9 in.

Weights: empty 16,314 lb, gross 35,715 lb.

Performance: max speed at height Mach 2.2, at S/L Mach 1.2; service ceiling 65,600 ft; combat air patrol endurance 2 h 15 min; attack radius, depending on flight profile and weapon load, 265–863 miles.

Accommodation: pilot only.

Armament: two 30 mm DEFA 553 guns in fuselage; seven hardpoints for practical external load of 8,818 lb: two Matra Super 530 air-to-air missiles, a Matra Magic or Sidewinder missile on each wingtip, and chaff/flare dispensers for interception mission; or fourteen 250 kg bombs, 30 antirunway bombs, 144 rockets, an ARMAT antiradar missile, AM39 Exocet antiship missile, or laser guided weapons and designator pod for ground attack missions.

MIRAGE 2000

The Mirage 2000 was selected on 18 December 1975 as the primary combat aircraft of the French Air Force from the mid-1980s. Under French Government contract, it was developed initially as an interceptor and air superiority fighter, powered by a single 19,850 lb st SNECMA M53-5 turbofan and with Thomson-CSF RDM multimode Doppler radar. The Mirage 2000 is equally suitable for reconnaissance, close support, and low altitude attack missions in areas to the rear of a battlefield. Commitments by the French Air Force total 273 to date, excluding prototypes. Of these, 136 are air superiority Mirage 2000Cs, which, from airframe No. 38, have a more powerful M53-P2 engine and RDI pulse-Doppler radar. Deliveries began in 1983, and Mirage 2000Cs now equip Squadrons 1/2 *Cigognes*, 2/2 *Côte d'Or*, and 3/2 *Alsace* at Dijon. Squadrons 1/5 *Vendée* and 2/5 *Ile de France* at Orange have converted from Mirage F1-Cs to Mirage 2000Cs with M53-P2 and RDI. The designation 2000DA *(Défense Aérienne)* is used in collective reference to Mirage 2000Cs and two-seat 2000Bs.

RDI radar has an operating range of 62 miles. Other equipment on the Mirage 2000C includes Sagem Uliss 52 INS, Thomson-CSF head-up and head-down displays, Thomson-CSF/ESD ECM jammers and chaff/flare dispenser, Matra Spirale passive countermeasures, and Thomson-CSF Serval radar warning receivers. Control is fly-by-wire. The standard detachable in-flight refueling probe enabled two Mirage 2000s of 2 Wing to fly nonstop more than 3,400 miles from Djibouti to Dijon on 6 February 1988, in 6 h 40 min, each refueled three times by a C-135FR tanker. Performance in air defense configuration includes the ability to attain a speed of Mach 2.26 at a height of 39,350 ft within 2½ min of leaving the runway. Minimum speed in stable flight is 115 mph.

Delivery to 114 Wing of the Hellenic Air Force, at Tanagra, of 36 multirole Mirage 2000EGs, plus four 2000BG two-seaters, began in March 1988. *(Data for Mirage 2000C.)*

Contractor: Avions Marcel Dassault-Breguet Aviation, France.

Power Plant: one SNECMA M53-P2 afterburning turbofan; 21,385 lb st.

Dimensions: span 29 ft 11½ in, length 47 ft 1¼ in, height 17 ft 0¾ in.

Weights: empty 16,534 lb, gross 37,480 lb.

Performance: max speed at height Mach 2.26, service ceiling 59,000 ft, range with four 250 kg bombs more than 920 miles.

Accommodation: pilot only.

Armament: two 30 mm DEFA 554 guns in fuselage; five hardpoints under fuselage and two under each wing

F-104G Starfighter, Hellenic Air Force

Hawk T. Mk 1A, Royal Air Force

C.11 Mirage IIIEE, Spanish Air Force (Paul Jackson)

Mirage F1, French Air Force

Mirage 2000C, French Air Force

for max external stores load of 13,890 lb. Two Matra Super 530 and two Matra Magic air-to-air missiles for interceptor mission. Ground attack weapons include eighteen 250 kg retarded bombs or BAP 100 antirunway bombs, 16 Durandal penetration bombs, two 1,000 kg laser guided bombs, six Belouga cluster bombs, two AS 30L or AM39 Exocet air-to-surface missiles, two ARMAT antiradar missiles, four packs of eighteen 68 mm rockets, two packs of 100 mm rockets, or a twin 30 mm gun pod.

TORNADO ADV

Full-scale development of this air defense variant (ADV) of the Tornado IDS was authorized by the UK Government in March 1976. Airframe modifications involved primarily an increase in fuselage length forward of the front cockpit, to accommodate the longer radome of the GEC Avionics AI.24 Foxhunter multimode pulse-Doppler radar, and a small 'stretch' aft of the rear cockpit to allow four Sky Flash missiles to be carried in tandem pairs under the fuselage. Together with an increase in wingroot chord, these changes reduced drag, especially at supersonic speed, and allowed a 10 percent increase in internal fuel capacity. One of the two guns was deleted, and RAF ADVs use only the two inboard underwing pylons.

A total of 165 (since increased to 180) Tornado ADVs have been ordered for the Royal Air Force, of which the first 18 were built as Tornado F. Mk 2s with 16,920 lb st RB199 Mk 103 engines. Most of these are being kept in store until the early 1990s, when they will be upgraded to F. Mk 2A standard, equivalent to F. Mk 3 except that they will retain their Mk 103 engines. All subsequent ADVs have been built to F. Mk 3 standard, with uprated RB199 Mk 104 turbofans, a retractable in-flight refueling probe, added head-down display for the pilot, a second INS, new IFF, automatic wing sweep, and other changes. The first F. Mk 3 flew on 20 November 1985, and deliveries to No. 229 OCU (No. 65 Squadron) at RAF Coningsby began in July 1986. Other units currently formed are Nos. 5 and 29 Squadrons at Coningsby, and Nos. 11 and 23 at Leeming. Seven squadrons and the OCU will eventually fly ADVs. Next to form, by the end of 1990, is expected to be No. 25 at Leeming.

On 24 September 1987, a Tornado F. Mk 3 made the first unrefueled transatlantic crossing by a British fighter, flying 2,530 miles from Goose Bay, Canada, to Warton, England, in 4 h 45 min. *(Data for F. Mk 3.)*

Contractor: Panavia Aircraft GmbH, a UK/German/Italian consortium.
Power Plant: two Turbo-Union RB199 Mk 104 afterburning turbofans; each approx 18,100 lb st.
Dimensions: span 45 ft 7½ in spread, 28 ft 2½ in swept; length 59 ft 3¾ in, height 19 ft 6¼ in.
Weights: empty 31,970 lb, gross 61,700 lb.
Performance: max speed at height (clean) Mach 2.2, service ceiling 70,000 ft, intercept radius more than 345 miles supersonic, 1,150 miles subsonic.
Accommodation: crew of two in tandem.
Armament: one 27 mm IWKA-Mauser gun in fuselage; four Sky Flash air-to-air missiles under fuselage, four AIM-9L Sidewinders under wings. Two 594 gallon tanks underwing. Provision for AMRAAM and ASRAAM.

Attack Aircraft

ALPHA JET

In parallel with production of the advanced trainer/light attack version of the Alpha Jet for the French and other air forces, 175 close support variants (formerly Alpha Jet A) were ordered for the German Air Force. They were delivered in 1979–83 for JBG 41, 43, and 49, plus a weapons training unit detached to Portugal, and now equip seven squadrons. An update program due to be implemented in 1989–92, although severely curtailed, will still include improved instruments, navigation and air data sensors; a stall warning indicator; improved wheel/tire/brake cooling; a three-axis damping system; and provision for two AIM-9L Sidewinder missiles. This is expected to permit the Alpha Jets to operate effectively in antihelicopter and point defense roles until the mid-1990s. Retrofit has replaced the original Larzac 04-C6 turbofans with 04-C20s.

Contractors: Avions Marcel Dassault-Breguet Aviation, France, and Dornier GmbH, Germany.
Power Plant: two SNECMA/Turbomeca Larzac 04-C20 turbofans; each 3,175 lb st.
Dimensions: span 29 ft 10¾ in, length 43 ft 5 in, height 13 ft 9 in.
Weights: empty 7,749 lb, gross 17,637 lb.
Performance: max speed Mach 0.86, service ceiling 48,000 ft, max mission radius, hi-lo-hi 668 miles.
Accommodation: basically, crew of two in tandem. Pilot only in combat role.
Armament: hardpoint under fuselage and two under each wing for up to 5,510 lb of stores, including centerline 27 mm gun pod, four BL755 cluster bombs, and 82 or 119 gallon tanks. Bombs and rocket packs optional.

Tornado F. Mk 3, Royal Air Force (Paul Jackson)

Alpha Jet, German Air Force (Paul Jackson)

AMX, Italian Air Force

A-7P Corsair II, Portuguese Air Force

F-35 Draken, Danish Air Force

G91Y, Italian Air Force (Paul Jackson)

AMX

Intended for close support, battlefield interdiction, and reconnaissance, the AMX is the product of a development program begun in January 1981 by Aeritalia and Aermacchi of Italy in conjunction with Embraer of Brazil. Program shares are 46.7, 23.6, and 29.7 percent, respectively, and despite the distance between participating countries, there is no dual-sourcing of components. The first of seven prototypes flew in Italy on 15 May 1984, and the first Italian production aircraft on 11 May 1988.

Italian requirements are for 150 single-seat and 37 two-seat AMXs to re-equip eight squadrons, including six currently flying the G91R, F-104G, and G91Y—which will be replaced in that order. Two batches totaling 80 aircraft (plus 34 for Brazil) are on firm order. The two-seat AMX-T is to be delivered initially in training configuration, but may be adapted for other roles requiring two crew. If chosen as a G91T replacement, a further 57 AMX-Ts will be required for advanced training.

On 1 January 1989, 103 Squadron left its G91Rs at San Angelo and transferred to Istrana, where it is now re-equipping with AMXs as part of 51 Wing. No. 14 Squadron (G91R) will be the next recipient.

Contractor: AMX International (Aeritalia, Aermacchi, Embraer).
Power plant: one Rolls-Royce Spey Mk 807 turbofan; 11,030 lb st.
Dimensions: span 32 ft 3½ in (over missiles), length 44 ft 6½ in, height 15 ft 0¼ in.
Weights: empty 14,770 lb, gross 28,323 lb.
Performance: max speed Mach 0.84, service ceiling 42,650 ft, combat radius 290 miles lo-lo-lo with 4,850 lb of external stores.
Accommodation: pilot only.
Armament: one 20 mm M61 multibarrel gun; twin centerline pylon and four underwing pylons for bombs, cluster bombs, air-to-surface guided missiles, and rocket pods; and two wingtip Sidewinder rails. Max external stores load 8,377 lb. Internal bay for reconnaissance or ECM pallets.

CORSAIR II (A-7H and A-7P)

Sixty land-based A-7H Corsair IIs were delivered to the Hellenic Air Force in 1975–77 to replace F-84F Thunderstreaks for tactical support of maritime operations. Equipping No. 347 Squadron at Lárisa, and Nos. 340 and 345 at Soùda, they retain the folding wings and 15,000 lb st non-afterburning Allison TF41 (Spey) turbofan of the US Navy's A-7E on which they are based, but have no in-flight refueling capability.

The 43 A-7Ps delivered to the Portuguese Air Force since 1981 are refurbished USN A-7As, with TF30-P-408 engine, a mix of A-7D and A-7E standard avionics, and a Westinghouse ALQ-131 (Block II) ECM pod. They equip Nos. 302 and 304 Squadrons for maritime and ground attack missions from Monte Real. *(Data for A-7P.)*

Contractor: Vought Corporation, USA.
Power Plant: one Pratt & Whitney TF30-P-408 non-afterburning turbofan; 13,400 lb st.
Dimensions: span 38 ft 9 in, length 46 ft 1½ in, height 16 ft 0¾ in.
Weights: empty 16,175 lb, gross 42,000 lb.
Performance: max speed at S/L 697 mph, service ceiling 41,000 ft, combat radius 675 miles.
Accommodation: pilot only.
Armament: two 20 mm Mk 12 guns; two pylons under fuselage and three under each wing for up to 15,000 lb of Sidewinder air-to-air missiles, Maverick and Shrike air-to-surface missiles, bombs, rocket packs, mines, 30 mm Mk 4 gun pods, ECM pods, sonobuoys, and flares.

DRAKEN (F-35)

In 1968–69 the Danish Defense Ministry ordered for the Royal Danish Air Force a total of 46 Saab 35XDs, comprising 20 fighter-bombers which it designated F-35, 20 RF-35 reconnaissance fighters, and six TF-35 fighter trainers. The number of TF-35s was increased subsequently to 11. Externally, the 35XD was similar to the Swedish Air Force's J 35F supersonic all-weather fighter, but with greatly increased attack capability. Its then-unique double-delta configuration and afterburning Avon turbojet enabled it to take off in 4,030 ft carrying nine 1,000 lb bombs. An update program in the first half of the 1980s added a Lear Siegler nav/attack computer, Singer Kearfott INS, Ferranti laser ranger, improved gunsight, and head-up display, giving the Danish Drakens an attack capability equal to that of the F-16A. The F-35s equip No. 725 Squadron at Karup, in a dual air defense/attack role.

Contractor: Saab-Scania Aktiebolag, Sweden.
Power Plant: one Volvo Flygmotor (Rolls-Royce) RM6C (Avon 300-series) afterburning turbojet; 17,650 lb st.
Dimensions: span 30 ft 10 in, length 50 ft 4 in, height 12 ft 9 in.

Weight: gross 33,070 lb.
Performance: max speed at 36,000 ft Mach 2, service ceiling 65,000 ft, combat radius (hi-lo-hi) with two 1,000 lb bombs and two drop tanks 623 miles.
Accommodation: pilot only.
Armament: nine hardpoints under wings and fuselage for four Sidewinder air-to-air missiles, or up to 9,000 lb of bombs, rockets, and fuel tanks.

G91R and G91Y

Having won an internationally contested NATO design competition, it was expected that the Fiat (now Aeritalia) G91 would become the standardized light strike fighter of NATO air forces. In fact, it entered service with only Italy and Germany, with assembly lines in both countries. Except for a small pre-series batch, all single-seaters built up to May 1966 were G91Rs, with a single 5,000 lb st Bristol Siddeley Orpheus 803 turbojet, and three Vinten 70 mm cameras in a glass paneled nosecone to give them a dual attack/reconnaissance capability. The Italian Air Force continues to operate one squadron (No. 14) of G91R/1 series aircraft. Many of the G91R/3s and 4s built for the German Air Force, with improved avionics and two 30 mm guns instead of the four 0.50 in guns of the G91R/1s, were transferred to the Portuguese Air Force between 1965 and 1980. The R/3s now equip attack Squadron 301 at Montijo, with limited interception capability since they were retrofitted with a Saab RGS 2 sighting system and Sidewinder air-to-air missiles. Germany retains more than 20 for target towing.

A version known as the G91Y, with the larger wing of the G91T trainer, and two 4,080 lb st General Electric J85 afterburning turbojets replacing the single Orpheus, flew for the first time on 27 December 1966. Over the next ten years, 20 pre-series and 45 production G91Ys were built for the Italian Air Force. They currently equip Squadrons 101 and 13, the latter with a primary anti-shipping role from Brindisi. All Italian G91s will be replaced eventually by the AMX aircraft now being developed and produced as a joint Italian/Brazilian program. *(Data for G91R/3.)*
Contractors: Fiat SpA, and ARGE-91 consortium, Germany.
Power Plant: one Fiat-built Orpheus 803 non-afterburning turbojet; 5,000 lb st.
Dimensions: span 28 ft 1 in, length 33 ft 9½ in, height 13 ft 1½ in.
Weights: empty 8,130 lb, gross 12,125 lb.
Performance: max speed 650 mph, service ceiling 40,000 ft, combat radius 196 miles.
Accommodation: pilot only.
Armament: two 30 mm DEFA 552 guns in fuselage; four underwing pylons for up to 1,000 lb of bombs, rocket packs, or Sidewinder missiles.

HARRIER GR. Mk 3

The Harrier was the world's first operational fixed-wing V/STOL combat aircraft, owing its success to use of a single vectored-thrust turbofan for both lift and forward thrust. The first prototype flew on 31 August 1966. Deliveries of production Harriers to the Royal Air Force's No. 233 OCU at Wittering in the UK began in April 1969, and No. 1 Squadron formed at the same base three months later. A total of 118 production aircraft were built for the RAF, of which 14 took part in the Falklands Campaign in 1982, with considerable success.

Harriers in current service with No. 4 Squadron of RAF Germany at Gutersloh, and No. 1417 Flight in Belize, Central America, are to GR. Mk 3 standard with a Pegasus 103 engine. Equipment includes a Ferranti FE 541 inertial navigation and attack system, Cossor IFF, Smiths electronic head-up display, Marconi radar warning receiver, a weapon aiming computer, and a Ferranti Type 106 laser ranger and marked target seeker in a lengthened nosecone.
Contractor: British Aerospace plc, UK.
Power Plant: one Rolls-Royce Pegasus Mk 103 vectored-thrust turbofan; 21,500 lb st.
Dimensions: span 25 ft 3 in, length 46 ft 10 in, height 11 ft 11 in.
Weights: empty 13,535 lb, gross 25,200 lb.
Performance: max speed in a dive at height Mach 1.3, in level flight at S/L 730 mph; service ceiling 51,200 ft; range with 4,400 lb external load, hi-lo-hi 414 miles, lo-lo-lo 230 miles.
Accommodation: pilot only.
Armament: typical load comprises two 30 mm Aden gun pods under fuselage; 120 gallon combat tank or 1,000 lb bomb on each inboard underwing hardpoint; Hunting BL755 cluster bomb or Matra 155 rocket pod on each outboard pylon. Some aircraft carry Sidewinder air-to-air missiles and a Tracor ALE-40 internal chaff/flare dispenser or Phimat chaff dispenser pod.

HARRIER GR. Mk 5

To meet US Marine Corps requirements for an improved version of the Harrier, which they had operated under the designations AV-8A/C, McDonnell Douglas and British Aerospace developed jointly the AV-8B Harrier II. This retains the basic Harrier/AV-8A fuselage, but with a raised cockpit similar to that of the Royal Navy's Sea Harrier, and with lift improvement devices under the fuselage. The all-new wing has a supercritical section and is made largely of carbonfibre and other composites. Compared with the wing of the orginal Harrier/AV-8A, it has greater span and area, and 10° less sweep. There are six underwing pylons, and the AV-8B can lift an external load of 9,200 lb at its max STOL weight. Equipment includes a Hughes Angle Rate Bombing Set with TV/laser target seeker/tracker, working in conjunction with a mission computer. RAF aircraft have an extra pair of wing pylons specifically for AIM-9L Sidewinder missiles.

Two AV-8As were modified as YAV-8B aerodynamic prototypes. The first of four genuine full-scale development AV-8Bs flew on 5 November 1981, by which time it had already been decided to put the aircraft into production for the Marines and the Royal Air Force. McDonnell Douglas manufactures all wings; sections of the fuselage, and other components, are produced by one or other of the British and US contractors, with an assembly line in each country. Delivery of the 94 production Harriers ordered to date for the RAF, with the initial designation GR. Mk 5, began in May 1987, the first unit being No. 233 OCU at Wittering, which has a mix of GR. 3s and GR. 5s. No. 1 Squadron was scheduled to be redeclared to NATO this month (October) with GR. 5s, and No. 3 Squadron in Germany began crew conversion in May. The last 34 RAF aircraft will be built to 'night attack' standard, with the designation GR. Mk 7. Their equipment will include GEC Avionics FLIR, new Smiths head-up and head-down displays, and cockpits compatible with night vision goggles. GR. 7 delivery will begin to No. 3 Squadron in 1991, allowing its Mk 5s to be passed to collocated No. 4 Squadron. When new Mk 7 deliveries have ended, the first 41 RAF aircraft will be retrofitted to the same standard, followed by Nos. 42–60 (which meanwhile are being completed to an interim specification and placed in storage). *(Data for Harrier GR. Mk 5.)*
Contractors: British Aerospace plc, UK, and McDonnell Douglas Corporation, USA.
Power Plant: one Rolls-Royce Pegasus Mk 105 vectored-thrust turbofan; 21,750 lb st.
Dimensions: span 30 ft 4 in, length 46 ft 4 in, height 11 ft 7¾ in.
Weights: empty 13,984 lb; gross for VTO 18,950 lb, for STO 31,000 lb.
Performance: max speed at height Mach 0.91, at S/L 661 mph; STOL T-O run 1,330 ft; combat radius (hi-lo-hi) with 4,000 lb weapon load 553 miles.
Accommodation: pilot only.
Armament: two 25 mm gun pods under fuselage; four hardpoints under each wing plus centerline position for two Sidewinder air-to-air missiles, seven BL755 cluster bombs, or five 1,000 lb bombs. Alternatively, 500 lb bombs, Matra 155 rocket pods, and 300 gallon tanks. Marconi Zeus internal ECM and Plessey MAW missile warning radar in tailcone. Provision for nose mounted IR reconnaissance sensor.

Harrier GR. Mk 3s of 4 Squadron, Royal Air Force Germany

Harrier GR. Mk 5s of 233 OCU, Royal Air Force (Paul Jackson)

Jaguar A with BAP 100 area denial bomblets, French Air Force (SIRPA "AIR")

JAGUAR

The Royal Air Force took delivery of 165 single-seat Jaguar GR. Mk 1s and 38 two-seat Jaguar T. Mk 2s, which were delivered between 1973 and 1982 in parallel with 160 single-seat Jaguar As and 40 two-seat Jaguar Es for the French Air Force. These aircraft were all completed with 7,305 lb st Adour Mk 102 afterburning turbofans. Between 1978 and 1984, RAF Jaguars were retrofitted with 7,900 lb st Adour Mk 104s. The total of approximately 85 Jaguars remaining in RAF service have also had their original NAVWASS nav/attack equipment replaced by the more compact and capable Ferranti FIN 1064 INS, leading to a change of designations to GR. Mk 1A and T. Mk 2A. Many Jaguar squadrons have converted to Tornados, leaving only Nos. 6 and 54 at Coltishall in the UK in the tactical support and ground attack roles. The French Air Force has a total of seven squadrons of Jaguar As in No. 7 Wing at St Dizier, and No. 11 Wing at Toul, plus Jaguar Es in Squadron 2/7, the OCU. No. 7 Wing is assigned to what are called 'prestrategic' missions, carrying AN 52 nuclear bombs. No. 11 Wing is intended primarily for close support duties in Europe and for rapid deployment overseas. Jaguar As have seen action in Mauritania, Chad, and Lebanon, and have crossed the Atlantic with the aid of in-flight refueling to participate in Red Flag training at Nellis AFB, Nev. *(Data for Jaguar A.)*
Contractor: SEPECAT Consortium, France and UK.
Power Plant: two Rolls-Royce Turbomeca Adour Mk 102 afterburning turbofans; each 7,305 lb st.
Dimensions: span 28 ft 6 in, length 55 ft 2½ in, height 15 ft 9½ in.
Weights: empty 15,432 lb, gross 34,612 lb.
Performance: max speed at height Mach 1.3, at S/L Mach 1.1; service ceiling 45,000 ft; typical attack radius, hi-lo-hi 875 miles, lo-lo-lo 570 miles.
Accommodation: pilot only.
Armament: two 30 mm DEFA 553 guns in fuselage; centerline pylon and two under each wing for 10,000 lb of stores, including AN 52 nuclear bomb, AS 30L laser-guided missiles, BGL 400 laser-guided bombs, 550

and 880 lb bombs, Belouga cluster bombs, BAP 100 area denial bomblets, BAT 120 antirunway bomblets, F1 rocket pods; Barracuda electronic emission detectors, Barem or CT 51J jamming pods, Phimat chaff/flare pods; 317 gallon tanks.

MIRAGE 5

The Mirage 5F entered service with the French Air Force in April 1972 and is currently operational with Squadrons 2/13 *Alpes* and 3/13 *Auvergne*. Its basic airframe, power plant, and gross weight are identical with those of the Mirage IIIE. By simplifying the avionics and other systems and deleting the radar, Dassault was able to increase the internal fuel capacity by 132 gallons, and the external stores load to 8,820 lb on seven wing and fuselage hardpoints. Belgium acquired 106 Mirage 5s, comprising 63 5BAs with comprehensive avionics, 16 5BD two-seat trainers, and 27 5BRs for reconnaissance. Following partial replacement by F-16s, surviving 5BAs serve at Bierset with No. 8 Squadron. *(Data for Mirage 5F.)*

Armament: 550 and 880 lb bombs, JL100 rocket and fuel pods, and Belouga cluster bombs, plus Phimat chaff/flare pods, Magic missiles for self-defense, and 317 gallon tanks.

Performance: combat radius with 2,000 lb bomb load 808 miles hi-lo-hi or 404 miles lo-lo-lo.

Mirage 2000N with ASMP nuclear missile

Tornado GR. Mk 1 of 27 Squadron, Royal Air Force (Paul Jackson)

MIRAGE 2000N

This tandem two-seat attack aircraft is now in service with Squadrons 1/4 *Dauphiné* and 2/4 *La Fayette* at Luxeuil, and a third 15-aircraft squadron will eventually replace the three Jaguar squadrons of No. 7 Wing that have been responsible for 'prestrategic' missions carrying AN 52 tactical nuclear bombs. By comparison with the Mirage 2000C, the 2000N has a strengthened airframe for flight at a typical 690 mph at 200 ft above the terrain. Its primary weapon, like the Mirage IV-P strategic bomber, is the ASMP medium-range air-to-surface nuclear missile. Equipment includes ESD Antilope V terrain following radar, two Sagem inertial platforms, improved TRT radio altimeter, Thomson-CSF color CRT, Omera vertical camera, special ECM, and two Magic air-to-air missiles for self-defense. Although threatened by budget constraints, the French requirement is for at least 148, of which 114 are scheduled to be funded by the end of FY '89. These include the first 25 Mirage 2000N' aircraft, intended primarily for nonnuclear attack roles. Additional fuel is contained in 528 gallon underwing tanks. Specification is generally similar to that of the Mirage 2000C, except for a length of 47 ft 9 in.

TORNADO IDS

Operational since June 1982, Tornado GR. Mk 1 interdictor/strike aircraft equip Nos. 27 and 617 Squadrons of RAF Strike Command at Marham in the UK, Nos. 15, 16, and 20 with RAF Germany at Laarbruch, and Nos. 9, 14, 17, and 31, also with RAF Germany at Brüggen. Their equipment includes a Texas Instruments multimode ground mapping and terrain-following radar, Ferranti FIN 1010 digital INS, Decca Doppler, HUD, and laser rangefinder and marked target seeker in an undernose pod. Weapons include nuclear bombs and anti-airfield JP233s (UK) or MW-1s (Germany and Italy).

German Air Force Tornados equip eight squadrons, two each with JBG 31, 32, 33, and 34, plus an OCU. Two more squadrons (comprising JBG 37) will convert from Alpha Jets in the mid-1990s. The IDS version also equips Nos. 154, 155, and 156 Squadrons of the Italian Air Force. Current development includes integration of HARM, ALARM, Kormoran, and Maverick missiles, and a night vision FLIR system into the IDS, of which more than 700 have been ordered to date by five air forces and the Germany Navy.

Contractor: Panavia Aircraft GmbH (BAe, UK; MBB, Germany; Aeritalia, Italy).

Power Plant: two Turbo-Union RB199 Mk 103 afterburning turbofans; each more than 16,000 lb st.

Dimensions: as Tornado ADV, except length 54 ft 10¼ in.

Weights: empty 31,065 lb, gross 60,000 lb.

Performance: max speed at height Mach 2.2 clean, Mach 0.92 with external stores; radius of action, hi-lo-hi 863 miles.

Accommodation: crew of two in tandem.

Armament: two 27 mm IWKA-Mauser guns in fuselage; seven fuselage and wing hardpoints for 19,840 lb of external stores, including air-to-air, air-to-surface, and antiradiation missiles; cluster bombs; napalm; 'smart', retarded, and conventional bombs; rocket packs; flare bombs; jamming/deception and chaff/flare ECM pods; and fuel tanks.

Canberra T. Mk 17, Royal Air Force

Reconnaissance and Special Mission Aircraft

AVIOCAR (C-212)

Two EC-212 Aviocars are operated by No. 502 Squadron of the Portuguese Air Force for electronic intelligence/ECM duties. They carry equipment for automatic signal interception, classification, and identification in dense signal environments, data enabling a map to be drawn plotting the position and characteristics of hostile radars. Jamming emitters are also carried. No. 408 Flight of the Spanish Air Force has three C-212s (designated TR.12D), with blunt radome and fin-tip pod, for ECM duties. Both the Spanish and Portuguese Air Forces also have a few Aviocars fitted with Wild RC-10 cameras for survey work. *(Data generally as for C-212 transport.)*

BRONCO (OV-10B)

Rockwell Bronco twin-turboprop target-towing aircraft are operated by a commercial company on behalf of the German Air Force. They are generally similar to the OV-10As flown by USAF, but have the option of being fitted with a 2,950 lb st General Electric J85-GE-4 auxiliary turbojet added above the central nacelle, changing the designation to OV-10B(Z).

C-135FR

Like the KC-135 Stratotankers of SAC, the eleven C-135FRs of the French Air Force have had their lower wing skin renewed to make possible another 25,000 flying hours. This justified re-engining them with CFM56 turbofans, and the last updated aircraft rejoined the three squadrons of the 93d Flight Refueling Wing in April 1988. C-135FRs have a standard USAF-type flying boom, but this terminates in a drogue for compatibility with the probe-equipped aircraft of the French Air Force. Range is nearly 3,400 miles. In their other role, as transports, each can carry 75 fully equipped troops on sidewall seating, or 77,000 lb of freight over a range of 2,235 miles, or 44 stretchers and 54 other persons in a medevac mission.

Contractor: Boeing Military Airplanes, USA.

Power Plant: four CFM56-2 turbofans; each 22,000 lb st.

Dimensions: span 130 ft 10 in, length 136 ft 3 in, height 42 ft 0 in.

Weights: empty 110,230 lb, gross 319,665 lb.

Performance: max speed 560 mph, service ceiling 50,000 ft.

Accommodation: crew of four.

CANBERRA

Of 782 Canberras built to fly with bomber, intruder, and photographic reconnaissance squadrons of the Royal Air Force, 60 remain in service in the UK. A few Canberra PR. Mk 9s of No. 1 PRU, with cameras and infrared linescan in their belly, form the only dedicated strategic photo reconnaissance unit in the RAF. Examples of several other variants provide target facilities under the banner of No. 100 Squadron, with TT. Mk 18s towing targets for live fire, and others simulating low-level, high-speed attackers against ships or land targets. Twelve bulbous-nosed Canberra T. Mk 17s of 360 Squadron provide specialized electronic countermeasures training by transmitting radio interference and using jammers and wingtip chaff dispensers. *(Data for Canberra PR. Mk 9.)*

Contractor: English Electric Co Ltd/Short Brothers and Harland Ltd. UK.

C-135FR of the French Air Force refueling a Mirage F1-C-200 (Paul Jackson)

Power Plant: two Rolls-Royce Avon 206 turbojets; each 11,250 lb st.
Dimensions: span 67 ft 10 in, length 66 ft 8 in, height 15 ft 7 in.
Weight: gross 57,500 lb.
Performance: max speed Mach 0.83, service ceiling 50,000 ft, max range 4,000 miles.
Accommodation: crew of two.
Armament: none.

CHALLENGER (EW VERSIONS)

Seven Canadair Challenger 600s are employed on electronic support and training missions by No. 414 Squadron of the Canadian Forces. An eighth was delivered to the Aeronautical Engineering and Test Establishment at Cold Lake, Alberta, as a testbed for developing such future military applications as maritime reconnaissance. Canadian Forces designation is EC-144A.
Contractor: Canadair Inc, Canada.
Power Plant: two Textron Lycoming ALF 502L turbofans; each 7,500 lb st.
Dimensions: span 61 ft 10 in, length 68 ft 5 in, height 20 ft 8 in.
Weights: empty approx 23,300 lb, gross 41,100 lb.
Performance: max cruising speed 529 mph, service ceiling 41,000 ft, range 3,220 miles.
Accommodation: crew of four and up to 12 passengers in transport role; wide variety of electronic warfare equipment in 414 Squadron aircraft.

CL-215

Some air forces are responsible for civilian tasks such as firefighting. The Hellenic Air Force has taken delivery of 16 CL-215 amphibian water-bombers for this purpose, and the Spanish Air Force has received 20. All are capable of other tasks, and eight of the Spanish aircraft are equipped for search and rescue, and coastal patrol. Each air force has lost several aircraft during firefighting operations, but results have been impressive. Single CL-215s have frequently made more than 100 drops, totaling more than 141,230 gallons, in one day. Full loads of water have been scooped up from the Mediterranean by the amphibians in wave heights up to 6 ft.
Contractor: Canadair Inc, Canada.
Power Plant: two Pratt & Whitney R-2800-CA3 piston engines; each 2,100 hp.
Dimensions: span 93 ft 10 in, length 65 ft 0¼ in, height 29 ft 5½ in.
Weights: empty 28,082 lb, gross 43,500 lb.
Performance: max cruising speed 181 mph, max range 1,301 miles.
Accommodation: crew of two; payload of 12,000 lb for water-bomber, 8,518 lb for utility version. Crew of six in patrol and SAR versions, with provision for additional seats and stretchers.

DHC-8 DASH 8M (CT-142)

The Canadian Department of National Defence operates four Dash 8M-100s with No. 429 Squadron at Winnipeg, as CT-142 navigation trainers with an extended nose. Basically similar to the standard Dash 8 transport, these aircraft have long-range fuel tanks, rough-field landing gear, high-strength floors, and mission-related avionics.
Contractor: Boeing of Canada Ltd (de Havilland Division), Canada.
Power Plant: two Pratt & Whitney Canada PW120A turboprops; each 2,000 shp.
Dimensions: span 85 ft 0 in, length 73 ft 0 in, height 24 ft 7 in.
Weights: empty 22,000 lb, gross 34,700 lb.
Performance: max speed 310 mph, service ceiling 25,000 ft, range 575 miles.
Accommodation: crew of two; four students and two instructor navigators.

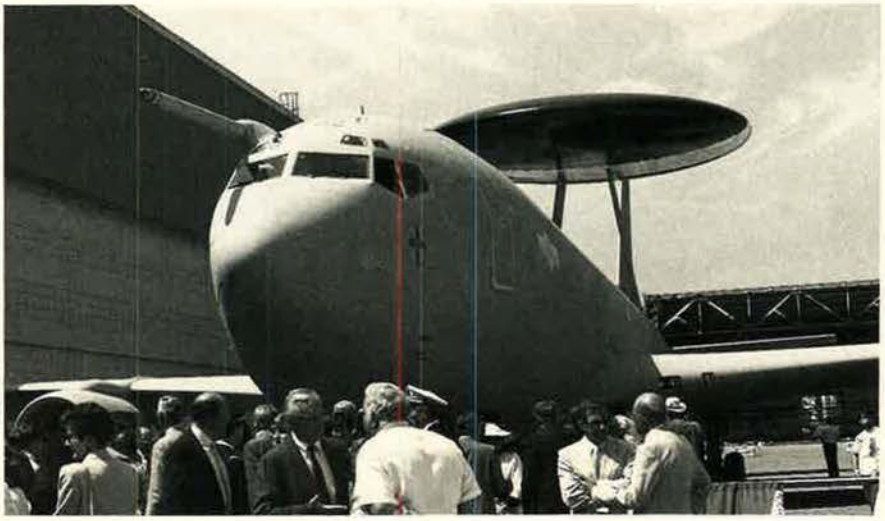
DRAKEN (RF-35)

No. 729 Squadron of the Royal Danish Air Force is equipped with Saab S 35XD Drakens, which operate from Karup under the designation RF-35. Equipped initially with cameras in the nose for daylight reconnaissance only, these aircraft have been able to operate round the clock since 1975 when Red Baron infrared pods were bought from Sweden. *(Data as for F-35 Draken.)*

E-3A SENTRY

NATO operates 18 airborne warning and control system (AWACS) aircraft equipped to the original standard of USAF E-3A Sentry Nos. 27 to 35. Much of the avionics was produced in West Germany, with Dornier as systems integrator. NATO funded a third HF radio, to cover the maritime environment; a new data analysis and programming group; underwing hardpoints on which optional ECM pods could be attached; and a radio teletype to link the aircraft with NATO maritime forces and commands. The 18 aircraft were delivered between January 1982 and April 1985 and are the only operational military aircraft to bear the insignia of Luxembourg on their fin.

CL-215, Spanish Air Force (Ivo Sturzenegger)



Rollout of first RAF Sentry E-3D, 11 July 1989

Hansa Jet ECM trainer of 3 Squadron, JBG 32, German Air Force (Paul Jackson)

Jaguar GR. Mk 1As of 41 Squadron, Royal Air Force

They have Luxembourg/US registrations, comprising their US military serial number prefixed by LX-N. This satisfies international legal requirements, as NATO has no national identity. Main operating base for the NATO E-3As is at Geilenkirchen in Germany. Forward operating bases are at Oerland, Norway; Konya, Turkey; Preveza, Greece; and Trapani, Italy.

Seven E-3s have been ordered for the Royal Air Force and four for the French Air Force, all with CFM56 turbofans. Deliveries to both air forces will begin in 1990. *(Data for NATO E-3A.)*
Contractor: Boeing Aerospace, USA.
Power Plant: four Pratt & Whitney TF33-PW-100/100A turbofans; each 21,000 lb st.
Dimensions: span 145 ft 9 in, length 152 ft 11 in, height 41 ft 9 in.
Weight: gross 335,000 lb.
Performance: max speed 530 mph, service ceiling over 29,000 ft, max unrefueled endurance more than 11 hours.
Accommodation: basic crew of 20, including 16 AWACS specialists.
Armament: none.

F-16A(R) FIGHTING FALCON

The aircraft of No. 306 Squadron of the Royal Netherlands Air Force are assigned to reconnaissance duties, with the designation F-16A(R). They are fitted with a radar altimeter, and carry on their centerline pylon an Oude Delft Orpheus pod of the type fitted to the RF-104G Starfighters that they replaced. Orpheus will be withdrawn in April 1991 and, with no funding available to replace it, 306's aircraft will then be reassigned to attack duties, including laser target designation.

G222GE and G222RM

The Italian Air Force has two G222GEs for electronic warfare duties with the 71st Squadron *(Guerra Elettronica)* at Pratica di Mare. Carrying a pilot, copilot, and up to ten systems operators, this version has a modified cabin fitted with racks and consoles for detection, signal processing, and data recording equipment, with an electrical system providing up to 40kW of power for its operation. It is externally distinguishable by a small thimble radome beneath the nose, and a larger 'doughnut' radome at the tip of the tail fin. Four G222RMs are used by No. 8 Squadron, also at Pratica, for in-flight calibration of ground radio nav/com facilities. Equipment includes a nose-mounted spotlight. *(Data as for G222 transport.)*

HANSA JET

No. 3 Squadron of JBG 32 Tornado Wing operates seven distinctive sweptforward wing Hansa Jets for ECM training. Features include a cylindrical nose radome and a boat shape fairing under the rear fuselage.
Contractor: Messerschmitt-Bölkow-Blohm GmbH, Germany.
Power Plant: two General Electric CJ610-9 turbojets; each 3,100 lb st.
Dimensions: span 47 ft 6 in, length (excl radome) 54 ft 6 in, height 16 ft 2 in.
Weight: gross 20,280 lb.
Performance: max speed at 25,000 ft 513 mph, service ceiling 40,000 ft, range 1,472 miles.

HERCULES C. Mk 1 ELINT

At least three Royal Air Force Hercules (including a C. Mk 1(K) tanker and a 'stretched' C. Mk 3) have been fitted with Orange Harvest elint/sigint equipment, which includes wingtip pods, each with three radomes. They operate normally from Mount Pleasant in the Falkland Islands, where additional duties include maritime surveillance.

JAGUAR GR. Mk 1A (RECONNAISSANCE)

The Jaguar GR. Mk 1As of No. 41 Squadron of RAF Strike Command at Coltishall in the UK are assigned to tactical reconnaissance missions. Standard equipment is a 1,230 lb centerline pod containing five cameras and a British Aerospace 401 infrared linescan system.

MIRAGE IV-A (RECONNAISSANCE)

Twelve of the original Mirage IV-A strategic bombers of the French Air Force were modified to carry a 2,200 lb CT 52 reconnaissance pod for long-range surveillance missions. Four of them are based currently with the Mirage IV-P OCU at Bordeaux.

MIRAGE 5BR

The Belgian Air Force's tactical reconnaissance unit is No. 42 Squadron, equipped with license-built Mirage 5BR aircraft. Except for their five-camera nose, these are similar to the Mirage 5 fighter.

MIRAGE F1-CR-200

All three tactical reconnaissance squadrons of the French Air Force (1/33 *Belfort*, 2/33 *Savoie*, and 3/33 *Moselle*) are now equipped with Mirage F1-CRs. Full designation of these aircraft is F1-CR-200, implying that they have a fixed in-flight refueling probe. They differ from the basic F1-C fighter in being fitted with the IVMR model of Cyrano radar (with additional ground mapping, contour mapping, air-to-ground ranging, and blind let-down modes), a Sagem Uliss 47 inertial platform, and ESD 182 navigation computer. An SAT SCM2400 Super Cyclope infrared linescan reconnaissance system replaces the starboard gun, and an undernose bay houses either a 75 mm Omera 40 panoramic camera or a 150 mm Omera 33 vertical camera. F1-CR-200s have a secondary ground attack role and can also carry a centerline podded sensor in the form of a Thomson Raphaël TH SLAR or a Thomson-CSF Astac electronic reconnaissance system for detecting ground radars. ECM pods can be carried underwing, together with two Magic air-to-air missiles for self-defense. *(Data as for Mirage F1-C, except length 50 ft 2½ in.)*

MYSTÈRE-FALCON 20

The Canadian, French, Norwegian, and Portuguese air forces all use small numbers of Mystère-Falcon twin-jet transports modified for ECM training and combat area duties. The Norwegian aircraft, and the EW-117 Falcons of No. 414 Squadron in Canada, are equipped for radar and communications intelligence and jamming duties. The Mystère-Falcons of the French Centre d'Instruction Tactique 339 at Luxeuil are fitted with the combat radar and navigation systems of various Mirage types for training interceptor, strike, and reconnaissance pilots. France and Spain have calibration aircraft in service.

Contractor: Avions Marcel Dassault-Breguet Aviation, France.

Power Plant: two General Electric CF700-2D2 turbofans; each 4,500 lb st.

Mystère-Falcon 20 ECM trainer, Royal Norwegian Air Force (Paul Jackson)

Reims-Cessna FTB 337G, Portuguese Air Force

RF-4E Phantom II, German Air Force

Shackleton AEW. Mk 2, Royal Air Force (Air Photo Supply)

Dimensions: span 53 ft 6 in, length 56 ft 3 in, height 17 ft 6¾ in.

Weights: empty 16,600 lb, gross 28,660 lb.

Performance: max cruising speed 490 mph at 40,000 ft, service ceiling 42,000 ft, range 2,180 miles.

Accommodation: flight crew of two; up to ten other persons or 3,750 lb of equipment or cargo according to role.

NIMROD R. Mk 1 and 1P

Three Nimrod R. Mk 1s, delivered to No. 51 Squadron of RAF Strike Command, at RAF Wyton, are specially equipped for electronic intelligence missions. They can be identified by the short tailcone that replaces the MR. Mk 2's MAD boom, and by modifications to the wing leading-edge pods. When an in-flight refueling probe is fitted, the designation is changed to Mk 1P. *(Data generally as for MR. Mk 2.)*

PD-808ECM and RM

Together with its PD-808VIP and TA light jet transports, the Italian Air Force acquired six PD-808ECMs for electronic warfare training, and four PD-808RMs for navaid calibration and other duties, in the 1970s. Recent conversions of some of the transports have increased these totals to eight ECMs with No. 71 Squadron and seven RMs with No. 8 Squadron, both at Pratica di Mare. Except for their specialized role equipment, they are similar to the PD-808TA for which data follow:

Contractor: Rinaldo Piaggio SpA, Italy.

Power Plant: two Rolls-Royce Viper Mk 526 turbojets; each 3,360 lb st.

Dimensions: span over tiptanks 43 ft 3½ in, length 42 ft 2 in, height 15 ft 9 in.

Weights: empty 10,650 lb, gross 18,000 lb.

Performance: max speed at 19,500 ft 529 mph, service ceiling 45,000 ft, range 1,322 miles.

Accommodation: flight crew of two; up to nine other persons or 1,600 lb of equipment according to role.

REIMS-CESSNA FTB 337 G

The Portuguese Air Force operates 32 of these militarized versions of Cessna's 'push and pull' twin-engined light aircraft, for counterinsurgency, photographic reconnaissance/survey, training, and utility duties. They embody STOL modifications in the form of high-lift flaps, and 16 are able to carry gun pods, rocket launchers, or bombs on underwing pylons, although this option is no longer employed.

Contractor: Reims Aviation SA, France.

Power Plant: two Continental TSIO-360-D turbocharged piston engines; each 225 hp.

Dimensions: span 39 ft 8½ in, length 29 ft 9 in, height 9 ft 4 in.

Weights: empty 3,206 lb, gross 4,630 lb.

Performance: max speed 236 mph, service ceiling 23,950 ft, range 1,325 miles.

Accommodation: pilot and up to five passengers, two stretchers, or cargo on non-combat missions.

RF-4 PHANTOM II

Four of America's European allies continue to operate reconnaissance versions of the Phantom. The German Air Force has four squadrons of RF-4Es in AG 51 and 52 Wings at Bremgarten and Leck, respectively. The Hellenic Air Force operates a few similar aircraft alongside the F-4Es of 110 Wing, and the Turkish Air Force also has RF-4Es in No. 113 Squadron. The four RF-4Cs (CR.12s) serving in 12 Wing of the Spanish Air Force were augmented by eight others, ex-USAF, in 1988. *(Data generally as for F-4 Phantom II.)*

RF-5A

No. 184 Squadron of the Turkish Air Force is the largest NATO operator of reconnaissance RF-5As, with up to 20 aircraft at Diyarbakir. The Hellenic Air Force is believed to have eight in No. 349 Squadron. Spain has 13 (designated AR.9) alongside the F-5As of Nos. 211 and 212 Squadrons in 21 Wing. Original standard equipment of the RF-5A comprised four KS-92 cameras in a modified nosecone. *(Data generally as for F-5A.)*

RF-104G STARFIGHTER

Based at Villafranca-Verona, the 3rd Reconnaissance Fighter Wing of the Italian Air Force comprises No. 28 Squadron with RF-104Gs and No. 132 Squadron with F-104Gs, all equipped to carry Oude Delft Orpheus pods bought from the Netherlands since 1977.

SHACKLETON AEW. Mk 2

The six surviving Shackletons of the RAF's No. 8 Squadron, based at Lossiemouth in Scotland, must continue to provide vital airborne early warning coverage for UK airspace until replaced by E-3D Sentrys in the early 1990s. The first of 12 Shackleton AEW. Mk 2s flew on 30 September 1971. All were conversions of MR. Mk 2 maritime reconnaissance aircraft, which were themselves developments of the wartime Lancaster/Lincoln bomber line. Despite their longevity, they have given good service, with all their former armament replaced by a variety of new equipment. This includes AN/APS-20F search radar (transferred from retired Royal Navy Gannets) in an underbelly radome, Orange Harvest wideband passive ECM, APX7 IFF, Doppler nav, and an airborne moving target indicator.

Contractor: A.V. Roe & Co Ltd, UK.

Power Plant: four Rolls-Royce Griffon 57A piston engines, each 2,455 hp.

Dimensions: span 119 ft 10 in, length 92 ft 6 in, height 16 ft 9 in.

Weight: gross 98,000 lb.

Performance: max speed 260 mph, endurance up to 10 hours.

Accommodation: crew of ten.

Armament: none.

TORNADO (RECONNAISSANCE)

Formed in January 1989 in Laarbruch, Germany, the RAF's No. 2 Squadron is the first to equip with a camera-less reconnaissance version of the Tornado IDS, designated GR. Mk 1A, with which it will become operational in 1990. No. 13 Squadron is due to form at RAF Honington, in the UK, at the end of this year. Identifiable by a small underbelly blister fairing to the rear of the laser rangefinder pod, this aircraft has a BAe sideways looking IR system, BAe Linescan 4000 IR surveillance system, and Computing Devices signal processing and video recording system.

Germany and Italy have developed jointly a reconnaissance pod to equip Tornados of the first squadron of MFG 2, German Navy, and No. 155 Squadron of the Italian Air Force. Weighing 838 lb, and hung from the centerline pylon, the pod contains two Zeiss cameras, TV sensors, and Texas Instruments RS-710 IR linescan.

The German Air Force will receive 35 specially developed Tornado ECR (electronic combat and reconnaissance) versions of the Tornado IDS, to equip single new squadrons within JBG 32 and JBG 38 in 1990–92. Retaining its air-to-surface role, except for removal of its guns, the ECR will be fitted with a ground emitter locator, a Honeywell/Sondertechnik IR linescan, FLIR, onboard systems for processing, storing, and transmitting reconnaissance data, and advanced tactical displays for the pilot and weapons officer. It will normally be configured to carry two HARM antiradiation missiles, two Sidewinders, an active ECM pod, chaff/flare dispenser pod, and two underwing 396 gallon fuel tanks. A Mk 105 version of the RB199 engine will provide about 10 percent more thrust than the IDS's Mk 103. Italy intends to buy 16 of the ECR Version. *(Data generally as for Tornado IDS.)*

TRANSALL ASTARTÉ and GABRIEL

Four of the second-series Transall C-160s built for the French Air Force are equipped as communications relay aircraft on behalf of the nation's nuclear deterrent forces. Designated Astarté *(Avion STAtion Relais de Transmissions Exceptionelles)*, and operated under the Ramses *(Réseau Amont Maillé Stratégique Et de Survie)*

Transall Gabriel elint/ESM aircraft, French Air Force

program, each is equipped with a Collins VLF system of the kind fitted to US Navy TACAMO aircraft. To ensure maximum survivability and effectiveness in a nuclear combat environment, they are able to operate as in-flight refueling tanker/receivers. Operating unit is No. 59 Squadron at Evreux.

Two other Transalls, delivered to No. 54 Squadron at Metz in February 1989, are equipped as elint/ESM aircraft, and are designated Gabriel. Also equipped as tanker/receivers, they have a row of large blade antennae above the forward fuselage, a retractable ventral Thomson-CSF radome, and slender wingtip pods with UHF/DF blade antennae. *(Data as for Transall C-160 transport.)*

TRISTAR TANKERS

To meet a growing requirement for in-flight refueling tanker support, the Royal Air Force is converting to this role six Lockheed L-1011-500 TriStar airliners purchased from British Airways and three more from Pan Am. The first four aircraft are to TriStar K. Mk 1 tanker/transport standard, with an increased max T-O weight of 540,000 lb. Each has twin Flight Refuelling Ltd Mk 17T hose drums (one of which is a reserve) in the fuselage, and seven tanks in the baggage compartments, raising total fuel capacity to 300,000 lb. Features include a refueling receiver probe over the flight deck, a crew rest area for nonoperating personnel on long missions, and closed-circuit TV to monitor all refueling operations. Two other aircraft are being converted to KC. Mk 1 tanker/freighter role, with a large cargo door, strengthened cabin floor, and cargo handling system; a similar door will be fitted later to two of the four K. Mk 1s. Conversion of the six ex-BA aircraft was done by Marshall of Cambridge. The three ex-Pan Am aircraft will become TriStar K. Mk 2 tanker/passenger transports, with only standard TriStar fuel tanks and a Flight Refuelling Mk 32 pod under each wing. The Mk 1 aircraft will also receive these pods, and all will be fitted with AN/ALR-66 radar warning receivers. They are operated by No. 216 Squadron.

Contractor: Lockheed Aircraft Corporation, USA.
Power Plant: three Rolls-Royce RB211-254B4 turbofans; each 50,000 lb st.
Dimensions: span 164 ft 6 in, length 164 ft 2½ in, height 55 ft 4 in.
Weights: empty 242,864 lb, gross 540,000 lb.
Performance: max speed 545 mph at 30,000 ft, service ceiling 43,500 ft, range with max payload 4,310 miles.
Accommodation: crew of three.

VC10 TANKERS

No. 101 Squadron of the Royal Air Force has five VC10 K. Mk 2 in-flight refueling tankers, converted by British Aerospace from ex-BOAC Model 1101s, and four VC10 K. Mk 3s converted from East African Airways Super VC10 Model 1154s. Each has a Flight Refuelling Ltd Mk 17B hose drum in the rear fuselage, and a Mk 32 pod under each wing, plus a receiver probe on its nose, and closed-circuit TV to monitor refueling operations. Fuel tanks in the cabin give the K. Mk 2 a total capacity of 24,490 gallons, and the K. Mk 3 a capacity of 26,475 gallons.

A further five ex-British Airways Super VC10s held in storage will be converted to VC10 K. Mk 4 standard. Although having a fuselage-mounted Mk 17B hose drum unit in the fuselage and a Mk 32 pod under each wing, they will have no extra fuel tanks in the fuselage. Eight of the 13 VC10 C. Mk 1 strategic transports serving with No. 10 Squadron are to be converted to C. Mk 1Ks with only two wing pods and no additional fuel, thereby retaining full passenger/freight capability. An option is held on conversion of the remaining five.

TriStar K. Mk 1 tanker refueling Tornado F. Mk 3

VC10 K. Mk 2 tanker trailing its three hoses (Air Photo Supply)

Victor K. Mk 2, Royal Air Force

Data are generally as for the RAF's VC10 C. Mk 1 transports, except that the K. Mk 2 is 166 ft 1 in long, and the K. Mk 3 is 179 ft 1 in long.
Weights: gross (K. Mk 2) 313,933 lb, (K. Mk 3) 334,875 lb.

VICTOR K. Mk 2

Survivors of the RAF's once-mighty fleet of four-jet nuclear V-bombers, the 15 Victor K. Mk 2 in-flight refueling tankers of No. 55 Squadron were converted from operational B. Mk 2s and SR. Mk 2s in the early 1970s. Fuel capacity is 18,960 gallons. Like the VC10s of 101 Squadron, they are able to refuel three small aircraft simultaneously. Retirement in 1992 is planned.

Contractor: Handley Page Ltd, UK.
Power Plant: four Rolls-Royce Conway RCo 17 Mk 201 turbofans, each 20,600 lb st.
Dimensions: span 117 ft 0 in, length 114 ft 11 in, height 30 ft 1½ in.
Weight: gross 238,000 lb.
Performance: max speed over 600 mph at 40,000 ft, service ceiling over 60,000 ft, max range 4,600 miles.
Accommodation: crew of four.

Tactical and Strategic Transports

ANDOVER/HS 748

The Belgian Air Force has three HS 748 Srs 2A tactical transports, with side freight door, in its No. 21 Transport Squadron at Melsbroek, but these are to be sold because of funding cuts. Conventional Andover CC. Mk 2s, and C. Mk 1s with an upswept tail and rear loading ramp, continue in Royal Air Force use, for a variety of tasks. The six E. Mk 3s of No. 115 Squadron are C. Mk 1s modified for radar calibration and special duties. *(Data for Andover C. Mk 1.)*

Contractor: Hawker Siddeley Aviation Ltd, UK.
Power Plant: two Rolls-Royce Dart RDa 12 Mk 301 turboprops; each 3,245 ehp.
Dimensions: span 98 ft 3 in, length 78 ft 0 in, height 30 ft 1 in.
Weights: empty 27,709 lb, gross 50,000 lb.

Andover E. Mk 3, Royal Air Force (Paul Jackson)

Performance: max speed 302 mph, service ceiling 23,800 ft, range with 8,530 lb payload 1,158 miles.
Accommodation: crew of two or three; up to 44 troops, 18 stretchers and eight seated passengers, or 14,000 lb of freight.

AVIOCAR (C-212)

More than 50 Aviocars equip No. 35 Transport Wing of the Spanish Air Force and No. 461 Squadron of its Canaries Command, under the designations T.12B/C. Each aircraft can accommodate up to 18 troops, 15 paratroops and a jumpmaster, or 4,410 lb of freight, including light vehicles, loaded via the rear ramp. Two medevac conversions (D.3As) can each carry up to 18 stretcher patients. Squadrons 502 and 503 of the Portuguese Air Force fly standard C-212 tactical transports. Data are generally as for the maritime version, except for operational equipment.

BOEING 707

Boeing 707s serve in military roles with three NATO air forces besides USAF. Those of the Canadian Forces include two tanker/transports that were modified to support CF-5s and now support CF-18s. Spain will base two similar tankers at Zaragoza to refuel its EF-18 Hornets. Four 707s handle VIP and support flights with the German Air Force's Special Missions Squadron at Köln/Bonn. Dornier of Germany heads a team that is modifying three 707-320Cs as trainer cargo aircraft (TCA), with cockpit similar to that of the E-3A, for training of NATO AWACS flight crews and to provide NATO with air transport capability. These aircraft have an in-flight refueling system installed.

BUFFALO (CC-115)

Fifteen Buffalo medium transports were acquired for the Canadian Forces in 1967–68, for their ability to operate under all weather conditions in areas where short, rough, unprepared strips provide the only takeoff and landing surface. About 11 are now assigned primarily to search and rescue missions, together with helicopters, in No. 442 Squadron at Comox on Canada's west coast, No. 413 at Summerside on the east coast, and No. 424 at Trenton, Ontario.

Contractor: The de Havilland Aircraft of Canada Ltd, Canada.
Power Plant: two General Electric CT64-820-3 turboprops; each 3,060 shp.
Dimensions: span 96 ft 0 in, length 79 ft 0 in, height 28 ft 8 in.
Weights: empty 24,500 lb, gross 41,000 lb.
Performance: max cruising speed 260 mph, service ceiling 25,000 ft, range 1,400 miles.
Accommodation: crew of three; up to 41 troops, 24 stretchers and six seated persons, or freight.

C-130H Hercules, French Air Force (SIRPA "AIR")

C-130 HERCULES

Except for Germany and the Netherlands, all NATO air forces operate transport versions of this classic aircraft, which first flew in prototype form 35 years ago. Canada has mainly C-130Es, with 4,050 ehp T56-A-7 engines, plus a few more powerful C-130Hs. Designated CC-130 by Canadian Forces, these aircraft are used for strategic airlift, tactical airdrop/airlift, and search and rescue from Edmonton. Belgium, Denmark, Greece, Italy, Norway, Portugal, Spain, and Turkey all have small numbers of C-130Hs. Ten C-130Hs were delivered to France in 1987–89, including seven 'stretched' C-130H-30s. The Royal Air Force acquired 66 C-130Ks, basically 'Hs' with UK equipment, as Hercules C. Mk 1s. Six were converted into C. Mk 1K in-flight refueling tanker/receivers by Marshall of Cambridge, with four fuel tanks and a hose drum unit in the cabin. Thirty were lengthened to C-130H-30 standard, as Hercules C. Mk 3s, able to carry seven cargo pallets instead of five, or four Land Rovers and trailers, or 128 troops, 92 paratroops, or 97 stretcher patients. All have been fitted with an in-flight refueling probe, becoming C. Mk 1Ps and 3Ps. RAF Hercules equip Squadrons 24, 30, 47, and 70 of Strike Command, and No. 1312 Flight in the Falkland Islands. *(Data for C-130H.)*

Contractor: Lockheed Aeronautical Systems Company, Georgia Division, USA.

Power Plant: four Allison T56-A-15 turboprops; each 4,508 ehp.

Dimensions: span 132 ft 7 in, length 97 ft 9 in, height 38 ft 3 in.

Weights: empty 76,469 lb, gross 175,000 lb.

Performance: max cruising speed at 20,000 ft 374 mph, service ceiling 23,000 ft, range with max payload 2,356 miles.

Accommodation: crew of five; up to 92 troops, 64 paratroops, 74 stretcher patients, or five 463L freight pallets.

CARIBOU (T.9)

Two squadrons of the Spanish Air Force, Nos. 371 and 372 of 37 Wing, are equipped with Caribou (Spanish designation T.9), some of which were acquired as USAF/ANG surplus.

Contractor: The de Havilland Aircraft of Canada Ltd, Canada.

Power Plant: two Pratt & Whitney R-2000-7M2 piston engines; each 1,450 hp.

Dimensions: span 95 ft 7½ in, length 72 ft 7 in, height 31 ft 9 in.

Weights: empty 18,260 lb, gross 28,500 lb.

Performance: max speed 216 mph, service ceiling 24,800 ft, range with max payload 242 miles.

Accommodation: crew of two; up to 32 troops, 22 stretchers and eight seated persons, or three tons of freight.

CN-235 M (T.19)

This twin-turboprop transport was developed, and is being manufactured, as a joint program by CASA of Spain and IPTN of Indonesia, with a final assembly line in each country. The only NATO military operator in summer 1989 is the Spanish Air Force, which has acquired two as VIP transports under the designation T.19C. It has a stated requirement for 18 more as Caribou replacements, and six for short-range maritime patrol. The French Air Force may also purchase eight.

Contractor: Aircraft Technology Industries (Airtech: CASA, Spain, and IPTN, Indonesia).

Power Plant: two General Electric CT7-9C turboprops; each 1,870 shp.

Caribou (T.9), Spanish Air Force (Paul Jackson)

F27M Troopship, Royal Netherlands Air Force (Paul Jackson)

G222, Italian Air Force (J. M. G. Gradidge)

Transall C-160, German Air Force

Dimensions: span 84 ft 8 in, length 70 ft 0¾ in, height 26 ft 10 in.

Weights: empty 18,960 lb, gross 33,290 lb.

Performance: max cruising speed at 15,000 ft 280 mph, service ceiling 25,000 ft, range with max payload 770 miles, with 5,300 lb payload 2,653 miles.

Accommodation: crew of three; up to 48 troops, 46 paratroops, 24 stretchers and four attendants, 11,025 lb of freight (loaded via rear ramp), or equipment for ASW/maritime patrol, EW or photographic duties.

F27 and F27M TROOPSHIP

The Royal Netherlands Air Force has only one transport squadron, No. 334 at Soesterberg, equipped with three standard F27-100 Friendships and nine F27M Troopships with a large parachuting door on each side in addition to the freight loading door. *(Data for Troopship.)*

Contractor: Royal Netherlands Aircraft Factories Fokker, Netherlands.

Power Plant: two Rolls-Royce Dart RDa.7 Mk 532-7R turboprops; each 2,140 ehp.

Dimensions: span 95 ft 2 in, length 77 ft 3½ in, height 27 ft 11 in.

Weight: gross 45,000 lb.

Performance: cruising speed at 20,000 ft 298 mph, service ceiling 30,000 ft, max range with freight 2,727 miles.

Accommodation: crew of two or three; 45 paratroops, 24 stretchers and nine seated persons, or 13,283 lb of freight.

G222

Two of the three transport squadrons of the Italian Air Force are equipped with these general purpose transports. Six quick-change kits are also held, for in-the-field conversion to aeromedical configuration. The Italian Air Force has eight of the G222SAA firefighting version of the aircraft, with a modular palletized pack carrying 1,585 gallons of water and retardant. These have been used extensively and successfully in many parts of Italy. The Air Force also operates five G222s ordered by the Italian Ministry for Civil Defense as a rapid intervention unit for firefighting, oil slick dispersal, medevac, and airlift of supplies to earthquake and other disaster areas. *(Data for G222.)*

Contractor: Aeritalia SpA, Italy.

Power Plant: two General Electric T64-GE-P4D turboprops; each 3,400 shp.

Dimensions: span 94 ft 2 in, length 74 ft 5½ in, height 32 ft 1¾ in.

Weights: empty 33,950 lb, gross 61,730 lb.

Performance: max speed 336 mph, service ceiling 25,000 ft, range with max payload 852 miles.

Accommodation: crew of three; 53 troops, 40 paratroops, 36 stretchers and four attendants, or 19,840 lb of freight, vehicles, and guns.

TRANSALL C-160

The French Air Force received 50, and the German Air Force 90, of the original C-160s, of which production ended in 1972. A second series was authorized in 1977, with updated avionics and an optional additional center-section fuel tank. Of 29 built for the French Air Force, eight are standard transports, ten are equipped as probe-and-drogue in-flight refueling tankers, five others have provision for rapid conversion to tankers, and six are Astarté/Gabriel special missions aircraft (which see). All have an in-flight refueling receiver boom. Five squadrons of the French Air Force, and three squadrons of the German Air Force, fly C-160s. In addition, first-series C-160s equip a single squadron of the Turkish Air Force.

Contractor: Arbeitsgemeinschaft Transall (Aérospatiale and MBB); France and Germany.

Power Plant: two Rolls-Royce Tyne RTy.20 Mk 22 turboprops; each 6,100 ehp.

Dimensions: span 131 ft 3 in, length, excluding probe, 106 ft 3½ in, height 38 ft 2¾ in.

Weights: empty 63,935 lb, gross 112,435 lb.

Performance: max speed at 16,000 ft 319 mph, service ceiling 27,000 ft, range with max payload 1,151 miles.

Accommodation: crew of three; 93 troops, 61–88 paratroops, 62 stretchers and four attendants, tanks, vehicles, or up to 35,275 lb of freight.

VC10 C. Mk 1

No. 10 Squadron of the Royal Air Force has 13 VC10 transports for long-range strategic operations. Although dimensionally similar to the commercial standard VC10 airliner, these were built with uprated engines, additional fuel tankage in the tail fin, a side freight door, reinforced cabin floor, rearward facing seats, an optional in-flight refueling probe, an APU in the tailcone, and autoland blind-landing system. Eight are to be adapted for dual-role transport/tanker use, under the designation C. Mk 1K, as described earlier.

Contractor: British Aircraft Corporation, UK.

Power Plant: four Rolls-Royce Conway 301 turbofans; each 22,500 lb st.

Dimensions: span 146 ft 2 in, length, excluding probe, 158 ft 8 in, height 39 ft 6 in.

Weights: empty 146,000 lb, gross 323,000 lb.

Performance: max speed at 30,000 ft 580 mph, service ceiling 42,000 ft, range with 24,000 lb payload 5,370 miles.

Accommodation: crew of four; 150 passengers, 76 stretcher patients and six attendants, or 57,400 lb of freight.

Helicopters

ALOUETTE II

Twenty-two nations operated military versions of the Alouette II, which continues to fly with the air forces of Belgium, France, and Portugal. Initial major production version was the SE 313B, with an Artouste turboshaft. It was followed by the SA 318C, with an Astazou IIA engine of the same power. *(Data for SE 313B.)*

Contractor: Sud-Aviation SNCA, France.
Power Plant: one Turbomeca Artouste II C 6 turboshaft; derated to 360 shp.
Dimensions: rotor diameter 33 ft 5¾ in, length of fuselage 31 ft 10 in, height 9 ft 0 in.
Weights: empty 1,973 lb, gross 3,527 lb.
Performance: max speed 115 mph, service ceiling 7,050 ft, range with max payload 62 miles, with max fuel 350 miles.
Accommodation: pilot and four passengers or two stretcher patients and attendant.

ALOUETTE III

Like the Alouette II, the Alouette III was produced first with an Artouste turboshaft, as the SA 316B, and then with an Astazou, as the SA 319B. Both versions continue in NATO service, with the air forces of France, the Netherlands, Portugal, and Spain. Main uses are now light transport, search and rescue, and training, although a wide variety of armament could be carried. *(Data for SA 319B.)*

Contractor: SNI Aérospatiale, France.
Power Plant: one Turbomeca Astazou XIV turboshaft; derated to 600 shp.
Dimensions: rotor diameter 36 ft 1¾ in, length of fuselage 32 ft 10¾ in, height 9 ft 10 in.
Weights: empty 2,527 lb, gross 4,960 lb.
Performance: max speed 136 mph, range with max payload 375 miles.
Accommodation: pilot and six passengers or two stretchers and two attendants.

BELL 47

An early version of the Bell Model 47 was the first helicopter certificated for commercial use, in 1946. Later versions entered worldwide civil and military service, and the 47G and 47J variants were produced under license by Agusta, in Italy, until 1976. Both remain in service with the Italian Air Force, mainly for training. The Hellenic Air Force uses a few 'Gs' for cropspraying on behalf of civil authorities. *(Data for 47G-3B-2A.)*

Contractor: Costruzioni Aeronautiche Giovanni Agusta SpA, Italy.
Power Plant: one Lycoming TVO-435-F1A piston engine; 280 hp.
Dimensions: rotor diameter 37 ft 1½ in, length of fuselage 31 ft 7 in, height 9 ft 3¾ in.
Weights: empty 1,893 lb, gross 2,950 lb.
Performance: max speed 105 mph, service ceiling 19,000 ft, range 247 miles.
Accommodation: three persons side-by-side; provision for two external stretchers, or 1,000 lb slung load.

BO 105 CB

The Royal Netherlands Army owns the BO 105 CB helicopters of No. 299 Squadron, and the SA 316B Alouette IIIs of Nos. 298 and 300 Squadrons, but they are flown and maintained by the Royal Netherlands Air Force. Duties are light transport, observation, and forward air control on behalf of the Army. No armament is fitted, but the BO 105 CBs are equipped for operation at night and in adverse weather.

Contractor: Messerschmitt-Bölkow-Blohm GmbH, Germany.
Power Plant: two Allison 250-C20B turboshafts; each 420 shp.
Dimensions: rotor diameter 32 ft 3½ in, length of fuselage 28 ft 1 in, height 9 ft 10 in.
Weights: empty 2,813 lb, gross 5,511 lb.
Performance: max cruising speed 150 mph, service ceiling 17,000 ft, range with max payload 408 miles.
Accommodation: up to five persons; rear bench seat removable to permit carriage of two stretcher patients or equivalent freight.

CH-113 LABRADOR

Together with fixed-wing Buffalos, CH-113 Labrador helicopters form the mainstay of Canada's coastal and inland search and rescue units. Each has a 900 gallon fuel capacity for relatively long-range missions, an 11,000 lb cargo hook for external loads, a rear ramp for easy loading, a watertight hull for landing on water, a rescue hoist, a scoopnet for retrieving survivors from the water, and Stokes litters. Under an upgrade program, the entire fleet has been fitted with improved avionics and a high powered searchlight.

Contractor: The Boeing Company, Vertol Division, USA.
Power Plant: two General Electric T58-GE-8F turboshafts; each 1,350 shp.
Dimensions: rotor diameter each 50 ft 0 in, length of fuselage 44 ft 7 in, height 16 ft 10 in.
Weights: empty 11,532 lb, gross 21,400 lb.
Performance: max speed 170 mph, service ceiling 13,700 ft, range 690 miles.
Accommodation: crew of three; provision for up to 20 survivors.

Alouette II, French Air Force (Paul Jackson)

Alouette III, Royal Netherlands Air Force (Paul Jackson)

BO 105 CB, Royal Netherlands Air Force (Paul Jackson)

CH-147 Chinook, Canadian Forces

CHINOOK (CH-47)

Chinook helicopters similar to the US Army's CH-47s, but with uprated engines and other improvements, are used by Nos. 447 and 450 Squadrons of the Canadian Forces under the designation CH-147, and by the Royal Air Force as Chinook HC. Mk 1s. The latter have an autoflight control and stability augmentation system and operate at a much greater gross weight than US Army CH-47Cs, including 28,000 lb loads on a triple cargo hook. Instrument lighting is compatible with pilots' night vision goggles. Squadrons 7, 18, and 78 are based in the UK, Germany, and the Falklands respectively. *(Data for Chinook HC. Mk 1.)*

Contractor: Boeing Helicopters, USA.
Power Plant: two Avco Lycoming T55-L-712 turboshafts; each 3,750 shp.
Dimensions: rotor diameter each 60 ft 0 in, length of fuselage 51 ft 0 in, height 18 ft, 7¾ in.
Weights: empty 20,547 lb, gross 50,000 lb.
Performance: max speed 180 mph, service ceiling 15,000 ft, mission radius 115 miles with 14,728 lb payload.
Accommodation: crew of four; up to 44 troops, or 24 stretcher patients, or internal or external freight.
Armament: one machine-gun in forward hatchway.

ECUREUIL 2

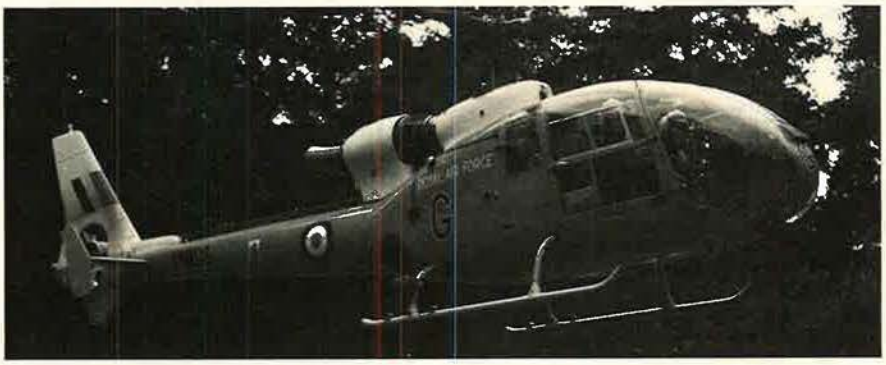
The French Air Force is acquiring 44 of these twin-turbine light helicopters for surveillance of strategic military bases and other support duties. The first eight are AS 355F$_1$s, as described below. The remainder are AS 355Ns, with 456 shp Turbomeca TM 319 turboshafts.

Contractor: Aérospatiale SNI, France.
Power Plant: two Allison 250-C20F turboshafts; each 420 shp.
Dimensions: rotor diameter 35 ft 0¾ in, length of fuselage 35 ft 9½ in, height 10 ft 4 in.
Weights: empty 2,840 lb, gross 5,511 lb with slung load.
Performance: max cruising speed 143 mph, service ceiling 12,140 ft, range 447 miles.
Accommodation: pilot and up to five passengers.
Armament: provision for carrying Mistral missiles.

GAZELLE

The 34 Gazelles supplied to the Royal Air Force have been used mainly for training at No. 2 FTS, and at the Central Flying School, under the designation HT. Mk 3. A few Gazelle HCC. MK 4s are used by No. 32 Communications Squadron.

Contractors: Westland Helicopters Ltd, UK, and SNI Aérospatiale, France.
Power Plant: one Turbomeca Astazou IIIA turboshaft; 590 shp.
Dimensions: rotor diameter 34 ft 5½ in, length of fuselage 31 ft 3¼ in, height 10 ft 2¾ in.
Weights: empty 1,874 lb, gross 3,970 lb.
Performance: max cruising speed 164 mph, service ceiling 16,400 ft, range 416 miles.
Accommodation: pilot and up to four other persons.



Gazelle HT. Mk 3, Royal Air Force

AS 355F$_1$ Ecureuil 2, French Air Force (SIRPA "AIR")

HH-3F PELICAN

Agusta of Italy began license production of this Sikorsky multipurpose search and rescue helicopter in

1974, and has since received orders for 35 for the Italian Air Force. They equip No. 15 Wing, with 85 Squadron at Ciampino (Rome Airport) and detachments at Trapani, Rimini-Miramare, and Brindisi. Italy also has two similar AS-61A-4s for VIP transport.

Contractor: Costruzioni Aeronautiche Giovanni Agusta SpA, Italy.
Power Plant: two General Electric T58-GE-100 turboshafts; each 1,500 shp.
Dimensions: rotor diameter 62 ft 0 in, length of fuselage 57 ft 3 in, height 18 ft 1 in.
Weights: empty 13,255 lb, gross 22,050 lb.
Performance: max speed 162 mph, service ceiling 11,100 ft, range 886 miles.
Accommodation: crew of two or three; six stretchers and 10 seated persons, or 26 troops, or 15 stretchers and two attendants, or equivalent freight.

HUGHES 300

The Hellenic and Spanish Air Forces both utilize small numbers of Hughes 300C light helicopters for training. The Greek aircraft were built under license in Italy by BredaNardi as NH-300Cs.

Contractor: Hughes Helicopters Inc., USA.
Power Plant: one Avco Lycoming HIO-360-D1A piston engine; derated to 190 hp.
Dimensions: rotor diameter 26 ft 10 in, length overall 30 ft 10 in, height 8 ft 9 in.
Weights: empty 1,100 lb, gross 2,050 lb.
Performance: max cruising speed 94 mph, service ceiling 10,200 ft, range 232 miles.
Accommodation: pilot and two other persons.

KIOWA and AB-206A

Seventy-four Bell COH-58As, generally similar to the US Army's OH-58A Kiowa, were delivered to the Canadian Forces to fill the roles of observation, reconnaissance, command and liaison, target acquisition, and fire adjustment. Known in Canada as CH-136s, they were supplemented by 14 Bell 206B JetRanger IIIs (CH-139s) for pilot training, from 1981. The Hellenic Air Force uses similar Agusta-Bell 206As for transport tasks. *(Data for CH-136 Kiowa.)*

Contractor: Bell Helicopter Company, USA.
Power Plant: one Allison T63-A-700 turboshaft; 317 shp.
Dimensions: rotor diameter 35 ft 4 in, length of fuselage 32 ft 7 in, height 9 ft 6½ in.
Weights: empty 1,797 lb, gross 3,000 lb.
Performance: max speed 140 mph, service ceiling 10,000 ft (restriction, as oxygen not available), range 230 miles.
Accommodation: crew of two.
Armament: one 7.62 mm Minigun, or 2.75 in rockets.

PUMA

One of the major successes of the French helicopter industry, the Puma serves in Europe with the Royal Air Force and the air forces of France, Portugal, and Spain. The basic SA 330 was produced under a joint Anglo-French program that included the Gazelle and Lynx. French Air Force version, partly equipping four utility helicopter squadrons, is the SA 330Ba (equivalent to SA 330H); RAF version is the SA 330E. Both have Turmo IIIC$_4$ engines. RAF Puma HC. Mk 1 assault helicopters have a cargo hook as standard equipment; a rescue hoist is optional. They equip No. 33 Squadron in the UK, No. 230 with RAF Germany, and No. 1563 Flight in Belize. The ten remaining Pumas of the Portuguese Air Force are SA 330 S$_1$s, with Makila IA1 turboshafts; five are fitted with ORB-31 nose radar. They equip No. 751 Squadron in Portugal, and 752 in the Azores, primarily for search and rescue. Spain's five Pumas are VIP transports.

Contractors: Westland Helicopters Ltd, UK, and SNI Aérospatiale, France.
Power Plant: two Turbomeca Turmo IIIC$_4$ turboshafts; each 1,435 shp.
Dimensions: rotor diameter 49 ft 2½ in, length of fuselage 46 ft 1½ in, height 16 ft 10½ in.
Weights: empty 7,403 lb, gross 14,110 lb.
Performance: max speed 174 mph, service ceiling 15,100 ft, range 390 miles.
Accommodation: crew of two; up to 16 troops, six stretchers and four seated persons, or internal or external freight.
Armament: two 7.62 mm machine-guns; other weapons optional.

SEA KING

Under an agreement signed in 1959, Westland was enabled to utilize the airframe and rotor system of Sikorsky's SH-3 helicopter, with extensive changes to the power plant and specialized equipment, to meet a Royal Navy requirement for an advanced antisubmarine helicopter with prolonged endurance. The resulting Westland Sea King can undertake other roles, such as search and rescue, tactical troop transport, medevac, and cargo carrying. The Royal Air Force uses Sea King HAR. Mk 3s to equip Flights of No. 202 (SAR) Squadron throughout the UK, and (with Chinooks) No. 78 Squadron in the Falklands. Equipment of the HAR. Mk 3 includes MEL radar, and a Decca TANS F computer, accepting inputs from a Mk 19 Decca nav receiver and Type 71 Doppler. Sea King Mks. 43 and 48 are similar SAR versions used by the Norwegian and Belgian air forces, respectively. Denmark has Sikorsky-built S-61As for search and rescue. Canadian Forces deploy CH-124As on board ships for ASW duties, and for search and rescue, passenger transport, and carriage of slung loads; these are generally identical to the USN's SH-3A Sea Kings, with General Electric T58-GE-8D turboshafts. *(Data for Sea King HAR. Mk 3.)*

Contractor: Westland Helicopters Ltd, UK.
Power Plant: two Rolls-Royce Gnome H 1400-1 turboshafts; each 1,660 shp.
Dimensions: rotor diameter 62 ft 0 in, length of fuselage 55 ft 9¾ in, height 15 ft 11 in.
Weights: empty 13,672 lb, gross 21,400 lb.
Performance: max speed 131 mph, service ceiling 14,000 ft, range 690 miles.
Accommodation: crew of four; six stretchers, or two stretchers and 11 seated persons, or 19 passengers.

HH-3F Pelican, Italian Air Force

SA 330 S$_1$ Puma, Portuguese Air Force (J. M. G. Gradidge)

Wessex HC. Mk 5C, Royal Air Force (Paul Jackson)

SUPER PUMA

The French Air Force uses three of these AS 332 developments of the original Puma for support duties at nuclear firing ranges in the Pacific and two more to equip a VIP transport squadron at Villacoublay. The Spanish Air Force acquired ten for search and rescue missions from bases in Madrid, Seville, Gando in the Canaries, and Palma de Mallorca. Two more operate alongside Pumas on VIP duties with No. 402 Squadron from Cuatro Vientos Airport, Madrid. Spanish designations are HD.21 (SAR) and HT.21 (VIP).

Contractor: Aérospatiale SNI, France.
Power Plant: two Turbomeca Makila IA1 turboshafts; each 1,877 shp.
Dimensions: rotor diameter 51 ft 2¼ in, length of fuselage 50 ft 11½ in, height 16 ft 1¾ in.
Weights: empty 9,458 lb, gross 19,841 lb.
Performance: cruising speed 163 mph, service ceiling 13,450 ft, range with standard fuel 384 miles.
Accommodation: crew of two or three; up to 21 passengers, or six stretchers and 11 seated persons, or nine stretchers and three seated, or internal freight, or 9,920 lb slung load.

UH-1 (single-engine)

Variants of the single-engine Bell UH-1 Iroquois serve with six non-US NATO air forces. Those operated by Canada and Turkey were built in the US; the German aircraft were manufactured under license by Dornier; those flown by Greece, Italy, and Spain came from Agusta license production in Italy. Canada uses its CH-118s (UH-1Hs) for transport and base rescue. Germany's large force of UH-1Ds is intended for liaison, with four assigned to the Air Force's special missions wing. Greece has Agusta-Bell 205As (UH-1D/H series) for light transport and SAR. AB-204Bs are used by Italy for training. Spain's AB-205s are assigned primarily to SAR. The Turkish UH-1Hs are used for support, liaison, and training. *(Data for CH-118.)*

Contractor: Bell Helicopter Company, USA.
Power Plant: one Avco Lycoming T53-L-13 turboshaft; 1,400 shp.
Dimensions: rotor diameter 48 ft 0 in, length of fuselage 41 ft 10¾ in, height 14 ft 8 in.
Weights: empty 4,800 lb, gross 9,620 lb.
Performance: max speed 140 mph, service ceiling 10,000 ft (restriction, as no oxygen available), range 360 miles.
Accommodation: two crew and 11 other persons, or up to 4,000 lb of slung cargo.

UH-1 (twin-engine) and MODELS 212 and 412 ARAPAHO

The Bell Model 212 was developed as a twin-engine version of the Iroquois utilizing a Canadian-built power plant. Canada placed the first order, for 50, as CUH-1Ns. Now designated CH-135, they are combat area transports, able to carry 12 troops with weapons only, ten with packs in summer, eight with packs in winter, or six stretcher patients. Options include various types of armament, or a rescue hoist for SAR operations. Italy uses Agusta-built AB-212s for SAR. Greece has a few for transport duties; and Norway has 16 of the developed Model 412SP Arapahos, with a new four-blade advanced technology rotor and improved performance. Seventeen of these were assembled in Norway, to replace UH-1Bs of Nos. 339 and 720 Squadrons of the Royal Norwegian Air Force. *(Data for 412SP.)*

Contractor: Bell Helicopter Textron, Canada.
Power Plant: one Pratt & Whitney Canada PT6T-3B-1 Turbo Twin Pac; 1,400 shp.
Dimensions: rotor diameter 46 ft 0 in, length of fuselage 42 ft 4¾ in, height 14 ft 2¼ in.
Weights: empty 6,470 lb, gross 11,900 lb.
Performance: max cruising speed 143 mph, service ceiling 16,300 ft, range with max payload 432 miles.
Accommodation: pilot and up to 14 passengers.

WESSEX

Three versions of this turbine-powered development of the Sikorsky S-58 remain in service with the Royal Air Force. Wessex HC. Mk 2 tactical transports equip No. 72 Squadron at Aldergrove, in support of the Northern Ireland garrison, No. 28 in Hong Kong, and No. 22 for SAR missions throughout the UK. Two Wessex HCC. Mk 4s wear the red and blue livery of The Queen's Flight. Ex-Royal Navy Wessex HC. Mk 5Cs of No. 84 Squadron provide SAR and United Nations support from Akrotiri, Cyprus. *(Data for HC. Mk 2.)*

Contractor: Westland Aircraft Ltd, UK.
Power Plant: two coupled Rolls-Royce Bristol Gnome Mk 110/111 turboshafts; each 1,350 shp.
Dimensions: rotor diameter 56 ft 0 in, length of fuselage 48 ft 4½ in, height 14 ft 5 in.
Weights: empty 8,304 lb, gross 13,500 lb.
Performance: max speed 132 mph, service ceiling 12,000 ft, range 478 miles.
Accommodation: crew of two or three; 16 troops, seven stretcher patients, or 4,000 lb of freight.
Armament: provision for air-to-surface missiles, rocket packs, or machine-guns.

Strategic Missiles

S3D (SSBS)

Second element of France's Forces Aériennes Stratégiques (FAS), after its Mirage IV-P bombers, is the 95th Strategic Missile Wing of S3D *sol-sol balistique stratégique* (SSBS) missiles based in hardened silos throughout 385 sq miles of the Plateau d'Albion, east of Avignon. Each of the two components of nine S3D second-generation missiles has its own fire control center, with No. 1 PCT (Poste Centrale de Tir) at Rustrel, and No. 2 at Reilhannette. Reaction time for the S3D is reported to be about 3½ minutes. Its silo is claimed to be able to survive a nuclear first strike. *(Data are provisional.)*

Contractor: Aérospatiale SNI, Space and Strategic Systems Division, France.
Propulsion: first stage: SEP Type 902 solid-propellant motor; 99,200 lb thrust for 76 seconds. Second stage: SEP Rita II solid-propellant motor; 70,550 lb thrust for 52 seconds.
Guidance: inertial.
Warhead: thermonuclear (1.2 mT). Reentry vehicle is

hardened against the effects of a high-altitude nuclear explosion by an ABM and carries penetration aids.
Dimensions: length overall 45 ft 11 in, diameter of first stage 5 ft 0 in.
Weight: 56,880 lb.
Performance: range over 2,175 miles.

Air-Launched Missiles

ALARM

ALARM (Air Launched AntiRadiation Missile) is being developed for use by Royal Air Force Tornado IDS aircraft against hostile gun and missile radars. Sufficiently small and lightweight to be carried also by aircraft as small as the Hawk and military helicopters, it has several operational modes. These include direct attack and a loiter mode in which the missile climbs to height and deploys a parachute, from which it remains suspended until a suitable target has been identified. The parachute is then released, and the missile falls on the target. IOC is expected in the early 1990s.
Contractor: British Aerospace plc, UK.
Propulsion: Bayern Chemie solid-propellant rocket motor.
Guidance: passive homing, using Marconi seeker that homes on hostile radar emissions.
Warhead: high-explosive type, by MBB, with Thorn EMI laser proximity fuze.
Dimensions: length 13 ft 1½ in, body diameter 9 in, wing span 2 ft 5 in.
Weight: 617 lb, incl launcher.

AS 12

The Turkish Air Force still has AS 12 air-to-surface missiles in its inventory. The armor-piercing version will penetrate more than 1½ inches of steel armor. Alternatives include an antitank shaped charge and a pre-fragmented antipersonnel type.
Contractor: Nord-Aviation/Aérospatiale, France.
Propulsion: two-stage solid-propellant rocket motor.
Guidance: wire-guided, under manual control.
Warhead: high-explosive type; weight 62.6 lb.
Dimensions: length 6 ft 2 in, body diameter 7 in, wing span 2 ft 1½ in.
Weight: 170 lb.
Performance: speed at impact 210 mph, max range 3.7 miles.

AS 30 L

The AS 30 L (for laser) supersonic air-to-surface missile is intended for use against hardened and heavily defended targets on land and at sea, normally in conjunction with a Thomson-CSF Atlis 2 target illuminating pod carried by the launch aircraft. The guidance system is claimed to provide the optimum standoff distance for direct target acquisition. The warhead's hard steel casing allows penetration of more than 6 ft of concrete before detonation, using a delayed fuze. The AS 30 L replaced the earlier, radio command AS 30 in production, and is carried by French Air Force Jaguars. It has been exported to operators of the Mirage F1, and is compatible with such types as the Mirage 2000, AMX, Tornado, F-15, and F-16.
Contractor: Aérospatiale SNI, Division Engins Tactiques, France.
Propulsion: two-stage solid-propellant rocket motor.
Guidance: pre-guidance phase on gyro reference, followed by semiactive laser terminal homing using a Thomson-CSF Ariel seeker.
Warhead: high-explosive type; weight 529 lb.
Dimensions: length 11 ft 11¾ in, body diameter 1 ft 1½ in, wing span 3 ft 3¼ in.
Weight: 1,146 lb.
Performance: speed at impact above Mach 1.32, range 1.8–6.2 miles.

ASMP

The ASMP (Air-Sol Moyenne Portée) was developed as primary armament of the French Air Force's Mirage IV-P strategic bomber and Mirage 2000N attack aircraft, and to replace AN 52 nuclear bombs on Super Étendard fighters of the French Navy. It is powered in supersonic cruising flight by a kerosene-burning ramjet, supplied with air by a pair of two-dimensional side intakes that also provide lift. Intended targets are airfields, command communications centers, and other heavily defended sites, from standoff range.
Contractor: Aérospatiale SNI, Division Engins Tactiques, France.
Propulsion: SNPE solid-propellant booster is integrated in the combustion chamber of a kerosene-burning ramjet, forming a two-stage rocket-ramjet.
Guidance: Sagem preprogrammed inertial system, with terrain following capability.
Warhead: nuclear type; yield 300 kT.
Dimensions: length 17 ft 8 in, body diameter 1 ft 3 in, fin span 3 ft 11¼ in.
Weight: estimated at 1,895 lb.
Performance: cruising speed Mach 2 at low altitude, Mach 3 at high altitude; range 50 miles after low-altitude launch, 155 miles after high-altitude launch.

ASPIDE

Aspide is interchangeable with the externally similar Sparrow on F-104S ASA Starfighters of the Italian Air Force. It is an all-weather, all-aspect, air-to-air and surface-to-air weapon, suitable for air-launch at very low altitudes and offering multiple target engagement and resistance to advanced ECM. A fully automatic 'fire and forget' guidance system is expected to be available for Aspide in the early 1990s.
Contractor: Selenia Industrie Elettroniche Associate SpA, Italy.
Propulsion: single-stage solid-propellant rocket motor.
Guidance: semiactive CW radar guidance, employing monopulse techniques.
Warhead: high-explosive type; weight 73 lb.
Dimensions: length 12 ft 1½ in, body diameter 8 in, wing span 3 ft 3¼ in.
Weight: 485 lb.
Performance: cruising speed Mach 2 plus speed of launch platform, range 22–37 miles.

BULLPUP (AGM-12B)

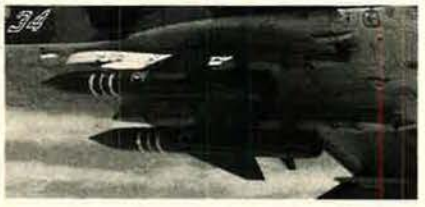
Developed originally for the US Navy, Bullpup began as a simple weapon built around a standard 250 lb bomb. The pilot steered it in flight by radio command, via a hand switch in the cockpit, using tracking flares above and below the rocket nozzle to keep Bullpup on a line-of-sight path to the target. License manufacture in Europe was undertaken by a consortium led by Kongsberg Vaapenfabrikk of Norway, whose production rounds are still available to the air forces of Denmark, Norway, and Turkey.
Prime Contractor: Kongsberg Vaapenfabrikk, Norway.
Propulsion: Thiokol LR58-2 storable liquid-propellant rocket motor; 12,000 lb st.
Guidance: radio command.
Warhead: high-explosive type; weight 250 lb.
Dimensions: length 10 ft 6 in, body diameter 1 ft 0 in, wing span 3 ft 1½ in.
Weight: 569 lb.
Performance: cruising speed Mach 1.8, max range 4.35 miles.

HARM (AGM-88A)

America's HARM (High-speed AntiRadiation Missile) has been ordered by the German Air Force, to equip its Tornados, and by the Spanish Air Force. It was developed on the basis of experience in Vietnam, where Soviet-built radars often detected approaching first-generation antiradiation weapons such as Shrike, and shut down before the missile could home on their emissions. HARM offers both higher performance and coverage of a wide range of frequencies, through the use of programmable digital processors in the launch aircraft's avionics and the missile. It can be launched at heights from sea level to 40,000 ft.
Contractor: Texas Instruments, Inc, USA.
Propulsion: Thiokol smokeless dual-thrust solid-propellant rocket motor. Hercules second source.
Guidance: passive homing, using seeker that homes on hostile radar emissions.
Warhead: high-explosive type; weight 145 lb.
Dimensions: length 13 ft 8½ in, body diameter 10 in, wing span 3 ft 8½ in.
Weight: 796 lb.
Performance: cruising speed supersonic, range 15.5 miles.

AGM-88A HARM antiradiation missile on a German Tornado

AS 30 L missiles and Atlis pod on Mirage 2000



Kormoran antiship missile on an Italian Tornado

HARPOON (AGM-84A)

During the 1982 Falklands War, some Nimrod maritime patrol aircraft of the Royal Air Force were fitted with Sidewinder air-to-air missiles for self-defense and were given an attack capability with bombs and Harpoon antiship missiles similar to those carried by USAF B-52Gs. Retained for possible future use, the Harpoons are designed to follow a sea-skimming path after launch and are able to perform high-*g* maneuvers when operating against fast maneuvering targets. Counter-countermeasures are installed.
Contractor: McDonnell Douglas Astronautics Company, USA.
Propulsion: Teledyne CAE J402-CA-400 turbojet; 660 lb st.
Guidance: sea-skimming cruise monitored by radar altimeter; active radar terminal homing.
Warhead: penetration high-explosive blast type; weight 488 lb.
Dimensions: length 12 ft 7½ in, body diameter 1 ft 1½ in, wing span 3 ft 0 in.
Weight: 1,145 lb.
Performance: cruising speed high subsonic, range 75 miles.

KORMORAN

The basic Kormoran 1 version of this rail-launched sea-skimming antiship missile can be carried by any aircraft able to maintain a speed between Mach 0.6 and 0.95 during the attack and equipped with target acquisition radar and an autonomous navigation system such as an inertial platform. On modern aircraft like the Tornados of the German and Italian air forces, the Kormoran system requires a minimum of special equipment for signal adaptation and missile control. A Kormoran launcher provides the mechanical interface between a standard 30 in pylon and the missile, and houses missile related electric interface units. Launch information is received from the aircraft's radar and navigation system. The missile can be operated in range-and-bearing and bearing-only modes, the latter being used when firing optically without use of radar.

Kormoran is designed for maximum effectiveness against ships up to destroyer size and is immune to a high degree of all contemporary types of ECM. An improved Kormoran 2 is available, with a new radar seeker, a strapdown INS, and digital signal processing. Interchangeable with Kormoran 1 on the Tornado, it offers improved target engagement capability, advanced ECCM, a longer range (22 miles), better penetration capability, and increased warhead weight (485 lb). *(Data for Kormoran 1.)*
Contractor: Messerschmitt-Bölkow-Blohm GmbH, Germany.
Propulsion: two built-in boosters, and solid-propellant sustainer rocket motor.
Guidance: 'fire and forget' type, employing inertial midcourse guidance and active radar terminal homing.
Warhead: high-explosive type; weight 352 lb.
Dimensions: length 14 ft 5 in, body diameter 1 ft 1½ in, wing span 3 ft 3¼ in.
Weight: 1,320 lb.
Performance: cruising speed Mach 0.9, max range 18.5 miles.

MAGIC (R.550)

The basic version of this highly maneuverable short/medium-range dogfight missile can be launched at ranges between 1,640 ft and 4.35 miles in the hemisphere behind the target, is stressed for 50*g* maneuvers, and can be fired from an aircraft in a 7*g* turn, singly or at one second interval between rounds. There is no minimum launch speed; maximum is more than 805 mph IAS.

The Magic 2 all-sector version, operational on Mirage 2000 aircraft of the French and Hellenic air forces, has a new infrared seeker with a multi-element cell and great sensitivity, and can be slaved to the launch aircraft's AI

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radar as an alternative to autonomous operation. Many thousands of Magics have been sold, 75 percent of them for export. They have been adapted to A-4 Skyhawk, Alpha Jet, F-5, F-8E(FN) Crusader, F-16, Jaguar, MB-339, MiG-21, MiG-23, Mirage III, Mirage 5, Mirage F1, Mirage 2000, Super Étendard, Sea Harrier, and other types. *(Data for basic Magic.)*

Contractor: SA Matra, France.
Propulsion: single-stage solid-propellant rocket motor.
Guidance: infrared homing.
Warhead: high-explosive type; weight 27.5 lb. Impact and infrared proximity fuzes.
Dimensions: length 8 ft 11 in, body diameter 6½ in, wing span 2 ft 2 in.
Weight: 196 lb.
Performance: cruising speed above Mach 2, range 1,640 ft to 4.35 miles.

MARTEL (AS 37)

Martel (Missile AntiRadar and TELevision) was developed in two forms, as a joint Anglo-French program. The command guided AJ.168 has been superseded by Sea Eagle. The all-weather antiradiation AS 37 continues in use on Mirage IIIEs and Jaguars of the French Air Force and on Royal Air Force Buccaneers.

Contractors: SA Matra, France, and British Aerospace, UK.
Propulsion: solid-propellant rocket motors by Aérospatiale and Hotchkiss-Brandt.
Guidance: AS 37 has passive seeker that homes on hostile radar emissions.
Warhead: high-explosive type; weight 330 lb. Proximity fuze.
Dimensions: length 13 ft 6¼ in, body diameter 1 ft 3¾ in, wing span 3 ft 11¼ in.
Weight: 1,168 lb.
Performance: cruising speed subsonic, range 18.5 miles.

MAVERICK (AGM-65)

The air forces of Germany, Greece, and Spain are European operators of this launch-and-leave TV-guided air-to-surface missile. The version bought by Germany is the AGM-65B, with a 'scene magnification' seeker that enables the pilot to identify and lock on to smaller or more distant targets than with the original AGM-65A. *(Data for AGM-65B.)*

Contractor: GM-Hughes, Missile Systems Group, USA.
Propulsion: Thiokol TX-481 solid-propellant rocket motor.
Guidance: self-homing electro-optical guidance system.
Warhead: high-explosive type, shaped charge; weight 125 lb.
Dimensions: length 8 ft 2 in, body diameter 1 ft 0 in, wing span 2 ft 4½ in.
Weight: 462 lb.
Performance: range 0.6–14 miles.

PENGUIN

The air-launched Penguin Mk 3 antiship missile has been selected as armament of F-16s of the Royal Norwegian Air Force. It can be carried by aircraft flying at speeds up to Mach 1.2 and launched at any height between 150 and 30,000 ft. Target acquisition can be via the launch aircraft's radar or in a completely passive mode using the head-up display. It is claimed to be immune to ECM and able to discriminate between real targets and decoys.

Contractor: Norsk Forsvarsteknologi A/S, Norway.
Propulsion: two-stage solid-propellant rocket motor.
Guidance: programmed inertial midcourse guidance; infrared terminal homing.
Warhead: high-explosive armor-piercing type; weight 265 lb.
Dimensions: length 10 ft 4¾ in, body diameter 11 in, wing span 3 ft 3¼ in.
Weight: 838 lb.
Performance: cruising speed above Mach 0.9, range over 25 miles.

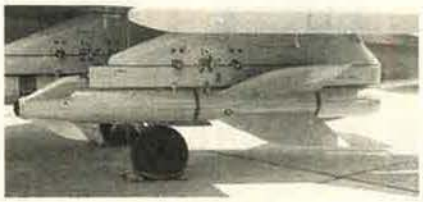
R.530 and SUPER 530

The R.530 all-weather air-to-air missile was built in two forms, with alternative semiactive radar and infrared homing heads. Carried under the fuselage of Mirage III interceptors and under the wings of Mirage F1s, it can be launched at any altitude between sea level and 69,000 ft. Operators include the French and Spanish air forces.

The Super 530 is an all-sector development of the R.530, able to attack targets flying 29,500 ft higher or lower than the launch aircraft. It is fitted with advanced ECM antijamming circuits. The basic Super 530 F is deployed on Mirage F1 interceptors. The Mirage 2000 is armed with the Super 530 D, compatible with its Doppler radar, and able to attack targets flying at speeds up to Mach 3 and heights from sea level to 80,000 ft. *(Data for Super 530 D.)*

Contractor: SA Matra, France.
Propulsion: dual-thrust solid-propellant rocket motor, by Thomson-Brandt.

Matra Magic and Super 530 F missiles on Mirage F1



Penguin Mk 3 antiship missile (Paul Jackson)

Tornado F. Mk 3 armed with Sky Flash missiles (top), with a Sidewinder armed Hawk T. Mk 1A

Guidance: semiactive pulse-radar homing, by Electronique Serge Dassault.
Warhead: fragmenting high-explosive type; weight 66 lb. Active radar proximity fuze.
Dimensions: length 12 ft 5½ in, body diameter 10¼ in, wing span 2 ft 1¼ in.
Weight: 595 lb.
Performance: cruising speed Mach 4.5, range more than 25 miles.

SEA EAGLE

Sea Eagle is an all-weather, day and night, 'fire and forget' antiship missile. Its turbojet engine gives it a longer range than that of the rocket powered AJ.168 Martel, which it replaced. Prior to launch, the on-board microprocessor is supplied with target positional information from the carrier aircraft. The computer controls the flight path of Sea Eagle until the target is acquired by the radar seeker during the final sea-skimming phase of attack. The missile can discriminate between several potential targets and is designed to destroy or disable targets protected by sophisticated ECM and decoys, including heavy cruisers and aircraft carriers. A helicopter launched version has a small additional boost motor. Sea Eagle equips Royal Air Force Buccaneers.

Contractor: British Aerospace plc, UK.
Propulsion: Microturbo TRI-60 turbojet; 787 lb st.
Guidance: inertial navigation, with active radar terminal homing.
Warhead: high-explosive type; weight more than 507 lb.
Dimensions: length 13 ft 7 in, body diameter 1 ft 3¾ in, wing span 3 ft 11¼ in.
Weight: 1,320 lb.
Performance: cruising speed Mach 0.85, range more than 68 miles.

SIDEWINDER (AIM-9)

This pioneer infrared homing air-to-air missile is used by all NATO air forces except that of France. Versions in service include the AIM-9B, -9G, -9N, and -9P, but the major current model in Europe is the third-generation AIM-9L, which is manufactured by a consortium of British, Italian, Norwegian, and German companies, under the leadership of Bodenseewerk. *(Data for AIM-9L.)*

Contractor: Bodenseewerk Gerätetechnik GmbH, Germany.
Propulsion: Mk 36 Mod 7/8 solid-propellant rocket motor.
Guidance: infrared homing, with AM/FM conical scan and active laser proximity fuze.
Warhead: annular blast fragmentation high-explosive; weight 192 lb.
Dimensions: length 9 ft 5 in, body diameter 5 in, fin span 2 ft 1 in.
Weight: 191 lb.
Performance: cruising speed above Mach 2, range 5 miles.

SKY FLASH

The 'boost and coast' Sky Flash all-weather air-to-air missile has the same general configuration and dimensions as the AIM-7E Sparrow, but is fitted with a British semiactive radar homing head of inverse monopulse design. The advanced radar proximity fuze is claimed to offer a high single-shot kill capability against targets flying at subsonic and supersonic speeds, singly and in formation, at high, medium, and low (250 ft) altitudes, in severe ECM environments. Sky Flash is the primary weapon of the RAF's Tornado ADV.

Contractor: British Aerospace plc, UK.
Propulsion: Aerojet Mk 52 Mod 2 solid-propellant rocket motor.
Guidance: semiactive radar homing, by Marconi Defence Systems.
Warhead: high-explosive type; weight 66 lb. Thorn EMI radar proximity fuze.
Dimensions: length 12 ft 0 in, body diameter 8 in, wing span 3 ft 4 in.
Weight: 430 lb.
Performance: cruising speed above Mach 2, range 18 miles.

SPARROW (AIM-7)

Sparrow is in service with the air forces of Canada, Greece, Italy, Spain, Turkey, and the UK. Most widely used version is the AIM-7E, which was also manufactured in Italy by Selenia; but the Spanish Air Force has AIM-7Ds and Fs, and the latest AIM-7M serves with the Canadian and Hellenic Air Forces. *(Data for AIM-7E.)*

Contractor: Raytheon Company, USA.
Propulsion: Rocketdyne Mk 38 Mod 2 solid-propellant rocket motor.
Guidance: semiactive CW radar homing.
Warhead: high-explosive type; weight 68 lb.
Dimensions: length 12 ft 0 in, body diameter 8 in, wing span 3 ft 4 in.
Weight: 450 lb.
Performance: cruising speed above Mach 3.5, range 20 miles.

Red Erwin's Personal Purgatory

Without counting the cost to himself, SSgt. Henry Erwin did what had to be done to save the B-29 crew.

BY JOHN L. FRISBEE

We may marvel at the heroism and tenacity of the men whose stories have been told in this column, but few readers can truly comprehend the suffering of many Vietnam POWs, the epic struggle of Lance Sijan, or the gallantry of Jack Mathis. What they did lies beyond the realm of our experience. But most of us have borne in some small degree the kind of anguish SSgt. Henry E. Erwin endured to save the lives of his fellow crewmen. We can empathize with his suffering and perhaps more fully appreciate the depth of his heroism.

On April 12, 1945, the *City of Los Angeles,* a 29th Bombardment Group aircraft commanded by Capt. George Simeral, led a formation of Guam-based B-29s in a low-level attack on a chemical plant at Koriyama, some 120 miles north of Tokyo. It was the eleventh combat mission for Captain Simeral's lead crew. Alabama-born Henry Erwin, known to his family as "Gene" and to his squadron mates as "Red," was the B-29's radio operator. According to retired Colonel Simeral, a holder of the DSC, Erwin was "a country boy, quiet, unassuming, religiously devout," and the best radioman of the 52d Bomb Squadron.

One of Erwin's additional duties was to drop a phosphorus smoke bomb through a chute in the B-29's floor when the lead plane reached an assembly area over enemy territory. He was given the signal to drop the bomb when the *City of Los Angeles* was off the south coast of Japan and under attack by flak ships. Erwin, bare-headed and with shirtsleeves rolled up, pulled the pin and released his bomb into the chute. The fuse malfunctioned, igniting the phosphorus, which burned at a temperature of 1,300 degrees. (The heating element of an electric range glows red at 1,100 degrees.) The canister blew back up the chute into Red Erwin's face, blinding him, searing off one ear, and filling the B-29 with heavy smoke that obscured the pilots' instrument panel.

Erwin knew that the bomb would burn through the metal floor into the bomb bay. It had to be jettisoned or the aircraft and crew were lost. Totally blind, he located the burning bomb on the floor, picked it up in his bare hands, and stumbled forward toward the flight deck, aiming to throw it out the copilot's window. As he groped his way around the gun turret, his face and arms covered with ignited phosphorus, his path was blocked by the navigator's folding table, hinged to the wall but now down and locked. The navigator had left his table to make a sighting.

Erwin needed both hands to release the table's latches. While he felt for them, he held the white-hot bomb under his bare right arm. In those seconds, the phosphorus burned through his flesh to the bone. Now a walking torch, Red Erwin staggered on into the cockpit, threw the bomb out the window, and collapsed between the pilots' seats.

Sergeant Erwin bore unbelievable pain to save his crewmates.

Captain Simeral, no longer blinded by smoke, pulled the B-29 out of a dive at 300 feet above the water and turned toward Iwo Jima where Sergeant Erwin could be given emergency treatment. Horrified crew members extinguished the flames consuming Erwin's clothing and administered first aid. Whenever the sergeant's burns were uncovered, phosphorus embedded in his flesh began to smoulder. In terrible pain, Erwin remained conscious throughout the flight to Iwo. He spoke only to inquire about the safety of the crew.

The medics at Iwo did not believe Erwin could survive. Cutting through red tape, AAF officials, spurred by Maj. Gen. Curtis LeMay and Brig. Gen. Lauris Norstad, approved award of the Medal of Honor in a matter of hours, so a presentation could be made while Erwin lived. A Medal was flown to Guam and presented in the hospital there.

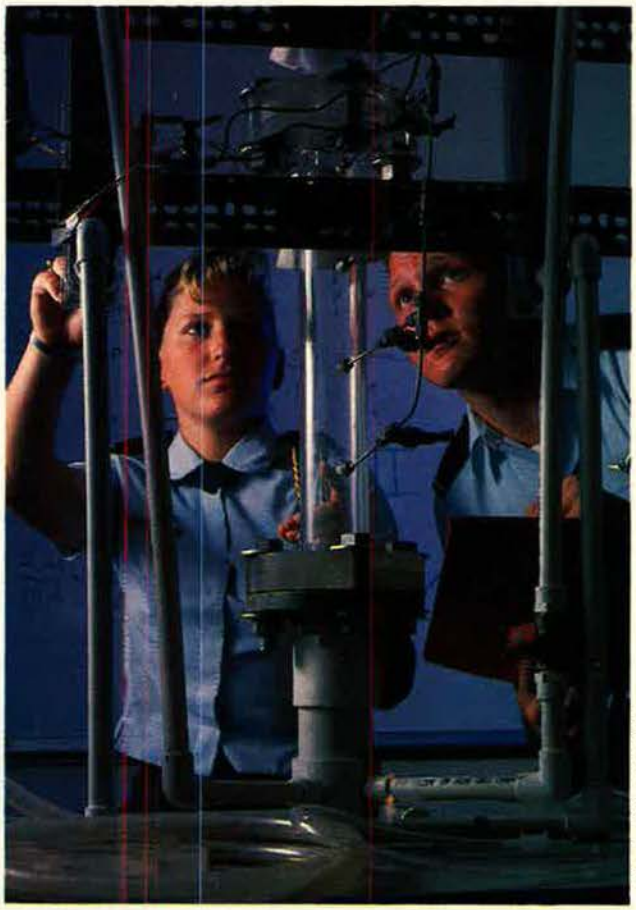
Contrary to the flight surgeons' opinion, Sergeant Erwin did survive. He was evacuated to the States, and after thirty months and reconstructive surgery that restored his eyesight and the use of one arm, Red Erwin was given a disability discharge from the AAF as a master sergeant in October 1947. For thirty-seven years he served as a Veterans' Benefit Counselor at the VA Hospital in Birmingham.

While Sergeant Erwin lay swathed in bandages in the hospital at Guam, Gen. Hap Arnold wrote: "I regard your act as one of the bravest in the records of this war." No one could argue with that judgment. Red Erwin was, and always will remain, a hero among heroes. ■

Cadets at 148 colleges and universities make the Arnold Air Society a going concern.

THE ARNIES

BY MAJ. RONALD FUCHS



—Photo by SMSgt. Bob Wickley

The Arnold Air Society, an AFA affiliate, gives its AFROTC members at colleges and universities across the country an opportunity to sharpen their leadership skills while they exercise their academic skills. At the University of Central Florida in Orlando, Cadets Katherine Lesman and Bob E. Smith, Jr., go over a lab experiment.

GENERAL H. H. Arnold, patriarch of the United States Air Force, helped foster *another* organization, which proudly bears his name. The Arnold Air Society, an AFA affiliate, is an academic society of cadets selected from the nation's leading colleges and universities.

Since its birth in 1947 during an AFROTC summer encampment, the Arnold Air Society has done its spiritual parent proud. More than 5,200 cadets currently wear the Society's distinctive gold and blue fourragères on their AFROTC and Air Force Academy uniforms. These cadets—also known as Arnies—are spread around the country at some 148 universities and colleges.

While these statistics may be noteworthy, they don't measure the spirit behind the Society. The Arnold Air Society provides tomorrow's blue-suit leaders the opportunity to improve their communication skills and develop their management and leadership talents today.

The Society's executive administrator, retired Air Force command

pilot William G. Morley, believes the Arnold Air Society has one mission: "to help enhance the Air Force officer candidate recruiting and training program in the American university system. If we want good Ph.D.-level physicists, we can hire them already qualified. If we want good leaders, we have to start with bright, young people and sharpen their skills over a period of time."

Colonel Morley and his wife Elise—Society staff leadership is a two-person job—are only the second team to head the group in its history. The first was Lt. Col. Louis J. "Chick" Ciccoli and his wife Sara. Colonel Ciccoli died in 1971, and Mrs. Ciccoli ran the Society until 1973, when Colonel Morley took over.

The Society's newly elected cadet commander, Arnold Air Society Brig. Gen. Laree K. Mikel, explains that the Society is much more than a fraternity or sorority. "The AAS provides us a training ground beyond the parameters of ROTC," she says. "As future officers, we need the latitude to develop and try out leadership styles, even if it means making mistakes. The Arnold Air Society gives us the extra dimension to do that."

Arnies can command local squadrons and hold regional offices corresponding to those they might hold once commissioned. For some, there are national positions that include serving at the Society's cadet leadership headquarters or organizing the $100,000 annual national conclave. Lessons learned include long-range planning, financial management, team work, and protocol procedures.

Arnold Air Society's auxiliary association is the Angel Flight/Silver Wings organization. Its women and men are college students who, while not primarily interested in pursuing a military career, are interested in learning about the Air Force.

Arnies and Angels also serve their campuses and communities through a variety of projects. These range from raising thousands of dollars for the handicapped and underprivileged to holding events aimed at raising the public's awareness of the POW/MIA issue.

"Each of these community projects requires tremendous planning and communication skills," says Colonel Morley. "It's all part of our mission—to build leaders for the Air Force and the nation."

—Photo by SMSgt. Bob Wickley

Col. Robert E. Ceruti, AFROTC Detachment Commander and Professor of Aerospace Studies at the University of Central Florida, instructs Arnies (clockwise from Colonel Ceruti) April Lubliner, Buddy Hosier III, Pat Doubleday, and Keith Sherrer.

Newly commissioned 2d Lt. Alan Jagolinzer, the Society's former national public-affairs officer, says that the Arnie and Angel projects go beyond building stronger citizen-soldiers.

"By helping to refurbish a summer camp for disabled children or leading a sing-along at a nursing home, we also show that we are caring members of the society we're volunteering to defend," he says. "That can go a long way toward giving us credibility with taxpayers. It helps them to see us as participants in the community experience."

A key factor in the Arnie and Angel experience is their relationship with AFA. "It's crucial," says Cadet Mikel. "As prominent figures who support our country, AFA members serve as role models to the cadets. This helps us better understand and appreciate the civilian role needed in the aerospace power equation."

AFA is "the alumni organization for Arnies," explains Morley.

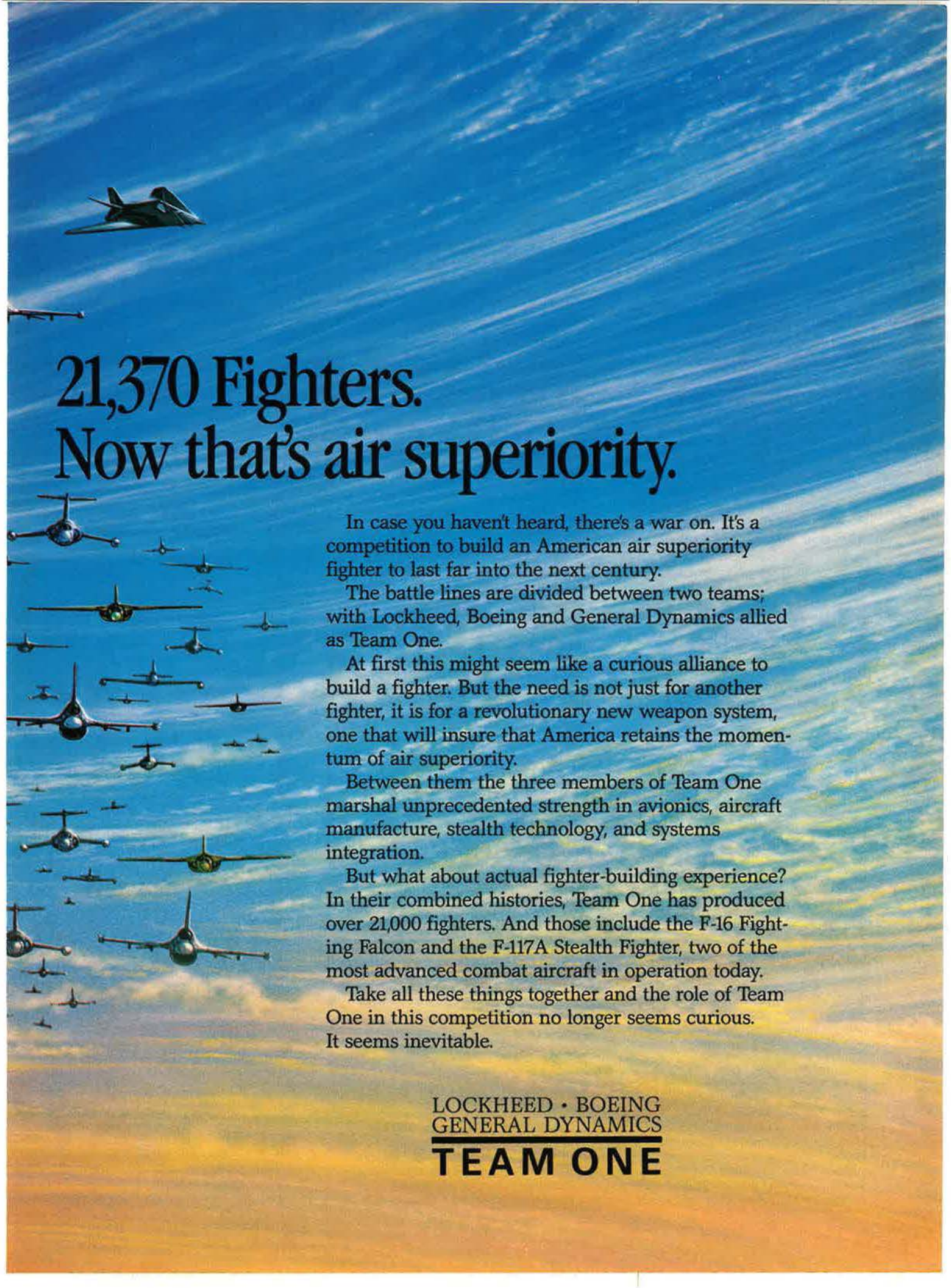
The Society's year-round efforts culminate in an annual national conclave, commonly called Natcon. This year's Natcon was held at the Broadmoor Hotel in Colorado Springs. The event was packed with business meetings and working seminars and included a tour of the Air Force Academy and a speech by retired brigadier general and flying ace Robin Olds.

AFA President Jack C. Price and AFA Board Chairman Sam E. Keith, Jr., also attended the 1989 Natcon. So, too, did several senior officers, a fact that underscores the Air Force's recognition of the Arnold Air Society and Angel Flight. They included AFROTC Commandant Brig. Gen. Jeffrey T. Ellis, AFLC Commander Gen. Alfred G. Hansen, and USSPACECOM Commander in Chief Gen. John L. Piotrowski.

In addition, the outgoing and incoming honorary national commanders of the AAS spoke. The 1987–89 honorary commander, Air Force Comptroller Lt. Gen. Claudius E. Watts III, told the conclave: "My association with the Arnold Air Society has rejuvenated and reinvigorated me. It is most important for the Air Force to recruit, train, and retain the highest quality people—people like you."

The incoming honorary national commander, Air Force Chief of Staff Gen. Larry D. Welch, also had some insights for members. "We don't expect blind obedience," said General Welch. "What we do expect from you is hard work and personal accountability." ■

Maj. Ronald Fuchs, USAF, is stationed in Los Angeles, Calif. This is his first article for AIR FORCE *Magazine.*



21,370 Fighters. Now that's air superiority.

In case you haven't heard, there's a war on. It's a competition to build an American air superiority fighter to last far into the next century.

The battle lines are divided between two teams; with Lockheed, Boeing and General Dynamics allied as Team One.

At first this might seem like a curious alliance to build a fighter. But the need is not just for another fighter, it is for a revolutionary new weapon system, one that will insure that America retains the momentum of air superiority.

Between them the three members of Team One marshal unprecedented strength in avionics, aircraft manufacture, stealth technology, and systems integration.

But what about actual fighter-building experience? In their combined histories, Team One has produced over 21,000 fighters. And those include the F-16 Fighting Falcon and the F-117A Stealth Fighter, two of the most advanced combat aircraft in operation today.

Take all these things together and the role of Team One in this competition no longer seems curious. It seems inevitable.

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TEAM ONE

Intercom

By John R. "Doc" McCauslin, CHIEF, FIELD ORGANIZATION SUPPORT GROUP

AFA State Conventions

State conventions have been held recently in Alaska, Arizona, Arkansas, California, Delaware, Florida, Illinois, Indiana, Michigan, Mississippi, Missouri, Montana, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Texas, and Utah. AFA Chairman of the Board Sam E. Keith, Jr., National President Jack C. Price, National Vice Presidents, and senior Air Force personnel participated in these annual events to install officials, present and receive awards, and conduct AFA business. Among convention highlights:

The **North Carolina State Convention** was held at Seymour Johnson AFB, N. C., with National Vice President (Southeast Region) James "Red" Smith and State President Robert C. Newman, Jr., presiding. The base displayed numerous aircraft, including an F-4, an F-15E, and a KC-10, for the event. The keynote speaker for the evening banquet was Lt. Gen. (Gen. selectee) Hansford T. Johnson, Director, Joint Staff, JCS. His talk, "America in the 1990s: International/ Cosmetic Challenge," focused on challenges to the US in response to the political, social, military, and economic changes taking place in the Soviet Union.

AFA President Jack C. Price (left) traveled to Italy to meet with the Italian Air Force Association and senior Italian military leaders, including (center) Gen. Franco Pisano, Chief of Staff of the Italian Air Force, and Gen. Catullo Nardi, IAF (Ret.), President of the Italian Air Force Association.

On the Daytona International Speedway after the Florida State AFA Convention, National Vice President (Southeast Region) James "Red" Smith (center) signed up two of his flying crewmates from the Birmingham, Ala., ANG of 1947–49. The new AFA members are (left) Bob Weeks, Sponsor Services Manager, NASCAR, Daytona Beach, and (right) A. E. "Gene" Matthieu, a NASA photographer. Mr. Weeks contacted Mr. Smith after seeing his picture in the June '89 issue's "Intercom."

The **Florida State Convention** was held at Daytona Beach, Fla., with speeches by Daytona Beach Mayor Lawrence J. Kelly, an AFA member; Rep. Craig T. James, a Republican of Florida's Fourth District; Maj. Gen. Paul Harvey, USAF, Commander of Keesler Technical Training Center; and Lt. Gen. Kenneth L. Tallman, USAF (Ret.), President of Embry-Riddle Aeronautical University. Representative James, a member of the House Veterans' Affairs Committee, gave an excellent talk on "Tough Choices" facing the current session of Congress. General Harvey discussed USAF's training goals, capabilities, and budget.

The John C. Stennis Chapter host-

The Col. Kenneth O. Wofford Scholarship for aerospace studies was recently established at Tuskegee University, Ala., by the General E. W. Rawlings (Minn.) Chapter. At the founding ceremony were (from left) Charles Melby, Chapter President; Lt. Gen. Edward J. Heinz, USAF, Director, Intelligence Community Staff, CIA; and Colonel Wofford, USAF (Ret.), a distinguished aviator and AFA Life Member.

ed the **Mississippi State Convention** in Biloxi, Miss., with State President Henry W. Boardman presiding. Lt. Gen. Thomas J. Hickey, USAF Deputy Chief of Staff for Personnel, was the guest speaker for the evening banquet, at which AFJROTC students were honored and the Keesler Chorale presented a program of patriotic music.

The **Arkansas State Convention** was held in Blytheville, Ark., with CMSAF James C. Binnicker as the banquet's guest speaker. National President Jack C. Price also participated in the program. At the banquet, Jacksonville High School's AFJROTC was honored as the Outstanding Arkansas AFJROTC, and Delta Composite Squadron 02099 from West Memphis was honored as the Outstanding Arkansas CAP Squadron. Other honors were presented to Cadet Col. William C. Murphy (University of Arkansas), Outstanding Arkansas AFROTC Cadet of the Year; Kris Mayer

Aerospace education was the theme of the Tucson (Ariz.) Chapter's twenty-ninth Annual Air Force Appreciation Luncheon. Among the more than 300 guests were (from left) Mary Sue Keith; Sam E. Keith, Jr., AFA Chairman of the Board; Julie Stoddard; Bruce R. Stoddard, National Under-Forty Director; Thomas W. Henderson, National Director; Barbara Henderson; Kay Chapman; and Gerald S. Chapman, National Vice President (Far West Region).

At the New York State AFA Convention, National Director William C. Rapp (left) and John Siedlicki (center), President of Bell Aerospace Textron, presented the Bernt Balchen Award to Arthur Middleton Young. In 1942, Mr. Young was hired by Bell Helicopter Division to develop his design for a two-blade, see-saw rotor with a gyro stabilizing bar. Mr. Young's design became standard in all single-rotor Bell helicopters, including the Model 47, which now ranks as the world's most-produced helicopter.

(University of Arkansas), Outstanding AFROTC Angel Flight Person of the Year; MSgt. Mark A. DeJesus (Little Rock AFB), Outstanding ANG Enlisted Man of the Year; and CMSgt. Robert Wright (Eaker AFB), Arkansas AFA Man of the Year. Lt. Col. Thomas Robertson (Eaker AFB) received the Arkansas AFA State President's Special Award.

Texas State President Dan Heth presented numerous awards during the **Texas State Convention,** held in South Padre Island. Lt. Gen. Robert Oaks, USAF, Commander of Air Training Command, was the luncheon speaker; National President Jack C. Price spoke at the evening banquet. Convention participants also included Sam E. Keith, Jr., AFA Chairman of the Board; Oliver Crawford, National Vice President (Southwest Region); and all twenty Texas chapter presidents.

John E. Kittelson, National Vice President (North Central Region), and George Christensen, State President, presided over the **North Dakota State Convention** in Grand Forks. Convention activities included a briefing on the B-1 and tours of the aircraft and the Center for Aerospace Studies. National President Jack C. Price was guest luncheon speaker; Gen. John L. Piotrowski, USAF, Commander in Chief of US Space Command and Commander in Chief of North American Aerospace Defense Command, spoke at the evening awards banquet held at the Grand Forks AFB NCO Open Mess. General Piotrowski's address dealt with the DoD budget, the costs of "peace with freedom," and the intricacies of interaction among his commands and other USAF commands, the US Navy, the US Army, and the US Drug Enforcement Agency.

The Panhandle (Tex.) Chapter held its Annual Awards Banquet in Amarillo with a large group of AFA members and supporters in attendance. Shown about to bestow AFA and AEF awards at the banquet are, from left, Wanda Jones, Chapter Vice President for Aerospace Education; Barry Smith, Chapter President; and Guy Leach, Chapter Secretary.

Chapter Activities

AFA's twenty-first California chapter, the **Bakersfield Chapter,** was re-

At its thirtieth Annual Awards Program, the Billy Mitchell (Wis.) Chapter presented the Billy Mitchell Award to Maj. Gen. James C. Wahleithner, Commander of Air Force Reserve's 4th Air Force, headquartered at McClellan AFB, Calif. From left: Col. Leonard J. Dereszynski, USAF (Ret.), the program's master of ceremonies; General Wahleithner; and Gil Kwiatkowski, Wisconsin State AFA President.

Coming Events

October 6–7, **Arizona State Workshop,** Tucson, Ariz.; October 20–21, **25th Annual Orientation of AFA State Presidents and National Directors,** Washington, D. C.; October 27, **Los Angeles Air Force Ball,** Los Angeles, Calif.; October 27–28, **North Central Regional Workshop,** Sioux Falls, S. D.; November 3–4, **Rocky Mountain Regional Workshop,** Colorado Springs, Colo.; November 17–18, **Southeast Regional Workshop,** Savannah, Ga.; December 5, **AEF Doolittle Salute,** Washington, D. C.; February 1–2, **TAC Symposium,** Orlando, Fla.; February 22–24, **AFA Board of Directors Meeting,** San Antonio, Tex.; April 7, **Iron Gate Salute,** New York, N. Y.; May 11–13, **New York State AFA Convention,** Rome, N. Y.; May 25–27, **AFA Board of Directors Meeting,** Colorado Springs, Colo.; July 13–15, **Pennsylvania State AFA Convention,** Philadelphia, Pa.; July 13–14, **Texas State AFA Convention,** Fort Worth, Tex.

cently chartered in Bakersfield, Calif., with John W. Postgate as President. The chapter has fifty-six members and was chartered through the support and hard work of George Estrella, California (South) Vice President. Mr. Price, National Vice President (Far West Region) Gerald S. Chapman, and California AFA officials participated in the chartering ceremonies.

The **General Charles A. Gabriel (Va.) Chapter** held its quarterly luncheon meeting recently, with Congressman Ben G. Blaz, a Republican Delegate from Guam, as guest speaker. Mr. Blaz, a retired Marine brigadier general, spoke of his experiences as the only retired general officer in Congress and as a member of the House Armed Services Committee.

Thunderbird Schedule

AFA chapters will be supporting the following Air Force Thunderbirds programs: October 1—Vance AFB, Okla.; October 7—Fort Huachuca, Ariz.; October 8—Cannon AFB, N. M.; October 14—Hammond, La.; October 15—Bergstrom AFB, Tex.; October 18—Laughlin AFB, Tex.; October 21—Charleston AFB, S. C.; October 22—Robins AFB, Ga.; October 28—NAS Point Mugu, Calif.; October 29—Edwards AFB, Calif.; November 4—Patrick AFB, Fla.; November 5—Tyndall AFB, Fla.; November 11—March AFB, Calif.; November 12—MCAS Yuma, Ariz.

The Riverside (Calif.) Chapter hosted this year's AFA Celebrity Golf Tournament, which raised $10,000 for the Morale, Welfare, and Recreation Program of the 22d Air Refueling Wing, March AFB, Calif. Col. Paul F. Gill (far left), Wing Commander, receives the check from (left to right) former Chapter President Monk Aamodt, current Chapter President Robert Parks, and Chapter Treasurer Ed Campbell.

Have AFA News?

Contributions to "Intercom" should be sent to J. R. "Doc" McCauslin, AFA National Headquarters, 1501 Lee Highway, Arlington, Va. 22209-1198. ■

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AIR FORCE ASSOCIATION

Pennsylvania AFA honored its Man of the Year, Frank Juliano, at the Pennsylvania State Convention. Shown at the awards banquet are, from left, newly elected State President Eugene Goldenberg, Mr. Juliano, and Lt. Gen. Claudius E. Watts III, Comptroller of the USAF, who was the convention's keynote speaker.

Bulletin Board

Information on **Lt. John D. Logan,** who crashed into Mount Holyoke while serving at Westover AFB on May 27, 1944. **Contact:** Col. Gordon A. Summers, USAF (Ret.), 2324 Indian Trail, Topeka, Kan. 66614.

Information on the whereabouts of **Lt. Robert Jackson,** who served as a copilot on the B-17 "HOLeY Joe" and was stationed at Foggia, Italy, in August 1944. **Contact:** Col. John W. Foster, USAF (Ret.), 3103 Tamarac Dr., Holiday, Fla. 34690.

Information on graduates of **Air Academy High School** class of 1960. **Contact:** Bill Mansmann, 6274 Lakewood Rd., Parker, Colo. 80134.

Boys Home of the South seeks donations of old or new **books** on battles or biographies of World War II leaders. **Contact:** Charles W. Aiken, Boys Home of the South, P. O. Box 8818, 226 Pendleton St., Greenville, S. C. 29604.

Serious patch collector with USAF, USN, USMC, ANG, and AFRES fighter and attack squadron **patches** desires to trade for all foreign fighter and attack squadron and aircraft special patches. **Contact:** Ralph Koslin, 3525 Sage, Apt. 1502, Houston, Tex. 77056.

Seeking permanent **location for public display** of archives of 483d Bombardment Group (H) of World War II. **Contact:** Ralph Simpson, P. O. Box 15573, Richmond, Va. 23227.

Information on **CMSgt. Robert L. Hill** of Michigan, who died in Vietnam on October 18, 1966. Also interested in any Air Force or aircraft **patches** or stickers. **Contact:** Peter Marshall, 17 Glenrose House, 2 Benhill Wood Rd., Sutton, Surrey SM1 4HT, England.

Seeking information, photos, documents, etc., of the forerunner unit of FTD 907, which was active from 1968 to 1970 at Korat AB, Thailand, and was known as **FTD 907S. Contact:** MSgt. Stephen Anderson, 1321A Paradise Dr., APO San Francisco 96334-5000.

Information on the whereabouts of these Americans who served in **7 Squadron, RAF,** flying Lancasters: Lt. W. M. Bradford, Maj. L. R. Hall, Capt. W. J. Senger, and J. A. Zee. **Contact:** C. A. Negus, 26 Tapscott St., Tinana, Queensland 4650, Australia.

Information on members of the US **Army 9th Service Command** who oversaw German and Italian POWs at Camp Cooke, Calif., or its regional branch camps during 1944–46. **Contact:** Jeffrey Geiger, Western Space and Missile Center, Vandenberg AFB, Calif. 93437.

Information on the survivors of the following World War II fighter pilots: **Capt. Francis Lee Bailey, 1st Lt. Harold Byrd,** and **Capt. Robert Ebner. Contact:** Lt. Col. Wallace H. Little, USAF (Ret.), P. O. Box 751973, Memphis, Tenn. 38175-1973.

Information on whereabouts of a **John Blair** or a **John Bacon** who was stationed at Chaunte AFB, Ill., sometime between 1953 and 1956. **Contact:** Maj. Jim Thomas, USMC (Ret.), P. O. Box 21, Remington, Ind. 47977.

Seeking donation of aviation **patches,** especially from Army units or flight schools, for extensive patch collection displayed at Hickam AFB. **Contact:** SrA. Teddy J. Wykle, Jr., USAF, Det. 4, 20th Weather Sqdn., Hickam AFB, Hawaii 96853.

Would like to purchase three new full-color patches from the **319th Bombardment Wing** at Grand Forks AFB, N. D. Will pay cost of patches plus first-class postage. **Contact:** Richard Bitler, 13010 Canterbury Rd., Savannah, Ga. 31419.

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

Information on the whereabouts of **Pvt. Timothy Carney,** who was in B Battery, 6th Battalion, 62d Artillery, in Aschaffenburg, West Germany, in 1968–69. **Contact:** Nancy Lynch, 735 Hanworth Rd., Hounslow, Middlesex TW4 5PR, England.

Information on **Wilfred J. Halpy** or any other SSgt. Liaison Pilot assigned to the 125th Liaison Squadron, 77th Reconnaissance Group, based at Abilene AAF and Alamo Field, Tex. between April and July 1943. **Contact:** Wilfred A. Halpy, 15 Jennie Circle, Agawam, Mass. 01001.

Seeking donation of military **patches,** especially from bases in the Spokane, Wash., area. Will pay postage. **Contact:** Timothy L. Mattson, 1646A Commanders Dr., Spokane, Wash. 99204.

Information on **Burl Eldon Rice,** who was a member of USAF based at Newbury in Berkshire, England, from about 1955 to 1959. **Contact:** Charlotte Rice, 12 Penrhyn Crescent, East Sheen, London SW14 7PF, England.

Information on the whereabouts of **Robert Patch,** who served at RAF Greenham Common, UK, in 1963, or of his acquaintances **Chuck Cozgrove** and **Tom Green. Contact:** Teresa Hazel, 7 Church Rd., Harefield, Middlesex UB9 6DW, England.

For a book on fighter pilots who escorted bombers on their raids into German-occupied Europe during World War II, any information, memoirs, or photographs from your **ETO experiences. Contact:** Philip Kaplan, 916 15th St., No. 4, Santa Monica, Calif. 90403.

Former members of the **409th Bomb Group (L)** are invited to join the 409th Bomb Group Assn. **Contact:** Thomas R. Sammons, 216 S. Jones Blvd., Las Vegas, Nev. 89107.

Information on anyone who was stationed in the **Cairns-Mareeba-Atherton area** in North Queensland, Australia, in 1942 and stayed at the Imperial Hotel in Cairns during their leave. **Contact:** Ann Suranyi, 2 Dougan St., Ashfield 2131, Australia.

I would like to buy an old **9th Fighter Squadron** "Flying Knights" patch, and/or correspond with veterans of the 49th Fighter Group, 5th AAF. **Con-**

tact: Richard L. Doerner, 719 N. Walnut St., Reedsburg, Wis. 53959.

Information on the whereabouts of **TSgt. Thomas Howard Cook,** USAF, who lived in San Jose, Calif., in 1973. **Contact:** V. M. Jones, 53 Kingsland, Holyhead, Anglesey, N. Wales LL65 2SP, UK.

For an oral history of the air war during World War II, any information from **Americans who flew with the RAF** or USAAF in Europe. Also information from anyone who worked in the American aircraft industry during the war. **Contact:** Edward Smithies, 130 Clarence Gate Gardens, Glentworth St., London NW1 6AN, England.

Information on the **two pilots of Airacobras** that crashed into the sea on the same day at Sandgate, Queensland, Australia, sometime between March and May 1942. **Contact:** Grace Beecher, Pearl Haven, 13 Oxford St., Joyner, Queensland 4500, Australia.

I am attempting to compile a complete listing of all **Tactical Unit Identifiers** (tail codes) of all USAF units in Southeast Asia from 1965 to 1975. Particularly interested in tail codes assigned to Air Commando (later Special Operations) units. **Contact:** MSgt. Steven D. Herberth, USAF (Ret.), P. O. Box 5537, Reno, Nev. 89513-5537.

For a book on **Arthur Godfrey,** information on his aviation activities. Also, a copy of a 1950s Eastern Air Lines film, titled "Flying With Eastern" or something similar. **Contact:** Lee R. Munsick, Regina Place & Harriet Dr., Whippany, N. J. 07981.

The Vietnam War Studies Association of Spain is interested in **Vietnam War experiences** of all those who participated. **Contact:** Oscar Camargo, C/Serrano, 46-1ª, 28001 Madrid, Spain. ■

Unit Reunions

Narsarssuak AB
Personnel who served at Narsarssuak AB, Greenland (Bluie West 1) will hold a reunion May 17–20, 1990, in Reno, Nev. **Contact:** Art Turner, 10218 Willowick Lane, San Antonio, Tex. 78217.

Ravens
Members of the Ravens (Project 404) will hold a reunion October 27–29, 1989, at Randolph AFB, Tex. Air America and enlisted personnel are also welcome. **Contact:** Jim "Raven 21" Baker, P. O. Box 27418, Panama City, Fla. 32411-7418. Phone: (904) 234-8426.

Rocket Propulsion Laboratory
The Air Force Rocket Propulsion Laboratory will hold a reunion November 3–5, 1989, in Lancaster, Calif. **Contact:** Beth A. Douthett, 3165 S. Batavia, Las Vegas, Nev. 89102. Phone: (702) 876-3718.

8th Attack Squadron
Members of the 8th Attack Squadron, 3d Bomb Group (World War II), will join the 89th Squadron for a reunion on May 9–13, 1990, at the Red Lion Inn in Colorado Springs, Colo. **Contact:** Andrew H. Weigel, 2512 Fairmount St., Colorado Springs, Colo. 80909. Phone: (719) 632-8576.

22d Bomb Squadron
The 22d Bomb Squadron, 341st Bomb Group (World War II), will hold a reunion October 16–20, 1989, at the El Dorado Hotel in Reno, Nev. **Contact:** W. E. McDowell, 15601 S. E. 42d Place, Bellevue, Wash. 98006. Phone: (206) 641-4650.

462d Fighter Squadron
Members of the 462d Fighter Squadron, 506th Fighter Group, will hold a reunion May 3–6, 1990, in Orlando, Fla. Members of the 457th and 458th Fighter Squadrons are also welcome. **Contact:** Edward F. Bahlhorn, 7485 Center Parkway, Sacramento, Calif. 95823. Phone: (919) 428-8469.

751st AC&W Squadron
The 751st Aircraft Control and Warning Squadron will hold a reunion April 19–22, 1990, in Dayton, Ohio. **Contact:** Guy L. Palumbo, 7614 Springvale Dr., Louisville, Ky. 40241. Phone: (502) 423-9518.

Buffalo Squadron No. 1
For the purpose of planning a reunion next year, Buffalo Squadron No. 1 would like to hear from former members of the Civil Air Patrol who served in the Buffalo, N. Y., area, especially those who served during World War II.
Please contact the address below.

1st Lt. David J. Albanese, CAP
Buffalo Squadron No. 1
Civil Air Patrol
233 Normal Ave.
Buffalo, N. Y. 14213

Class 50-C
For the purpose of organizing a reunion, I would like to hear from members of Pilot Class 50-C.
Please contact the address below.

George E. Martz
7440 N. Shadeland Ave.
Suite 150
Indianapolis, Ind. 46250
Phone: (317) 841-8988

3080th ADG
I would like to hear from anyone assigned to the 3080th Aviation Depot Group at Loring AFB, (formerly Limestone AFB, Me.) between 1952 and 1956 who would be interested in holding a reunion.
Please contact either of the addresses below.

Silas C. "Gus" Gustafson
New Sweden, Me. 04762
or
Bernie Giangiordano
207 S. Fairview Ave.
Upper Darby, Pa. 19082
Phone: (207) 896-5813 (Gustafson)
(215) 789-7393 (Giangiordano)

Readers wishing to submit reunion notices to "Unit Reunions" should mail their notices well in advance of the event to: "Unit Reunions," Air Force Magaine, 1501 Lee Highway, Arlington, Va. 22209-1198. Please designate the unit holding the reunion, time, location, and a contact for more information.

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6. Up to five visits per year for each insured person to Marriage and Family Counselors under conditions defined by CHAMPUS.

And the New 'Expense Protector' Benefit

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 can mean significant savings to you and 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 1/800/858-2003.

Who Is Eligible?

1. All AFA members under 65 years of age wh are currently receiving retired pay based upo their military service and who are eligible fo benefits under Public Law 89-614 (CHAMPU their spouses under age 65 and their unmarri

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 outpatient 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 outpatient 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 inpatient 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!

dependent children under age 21, or age 23 if in college.

2. All eligible dependents of AFA members on active duty. Eligible dependents are spouses under age 65 and unmarried dependent children under age 21 (or age 23 if in college). (There are some exceptions for older age children. See "Exceptions and Limitations.")

Renewal Provision

As long as you remain eligible for CHAMPUS benefits and the Master Policy with AFA remains in 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 for which treatment has been received during the 12-month period prior to the effective date of insurance until the expiration of 12 consecutive 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 incapacitated and if they are insured under CHAMPLUS® on the date so declared. Coverage 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 _____ (Month/Day/Year) Current Age ____ Height ____ Weight ____ Soc. Sec. No. _____

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

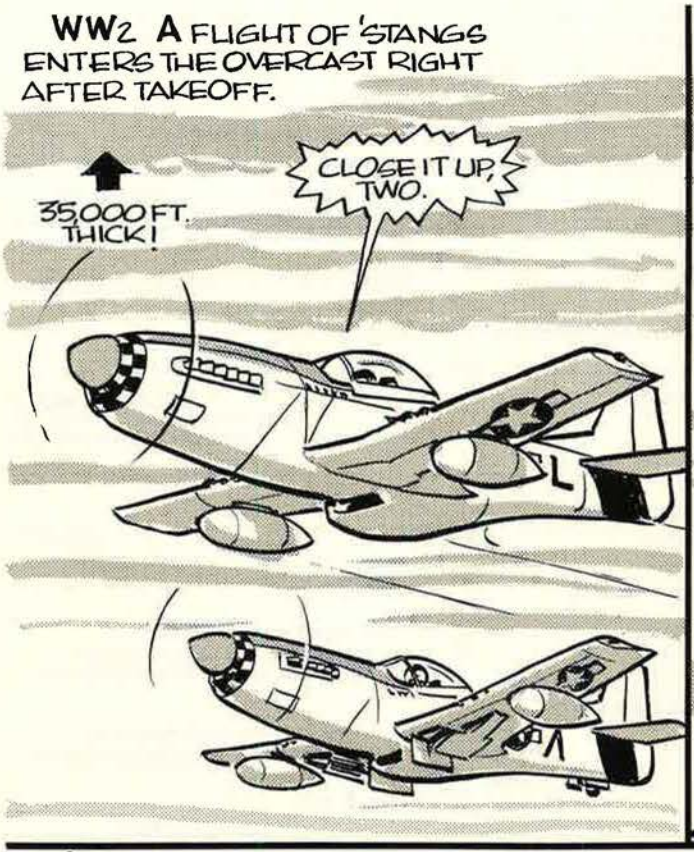
Form 6173GH App.
10–89

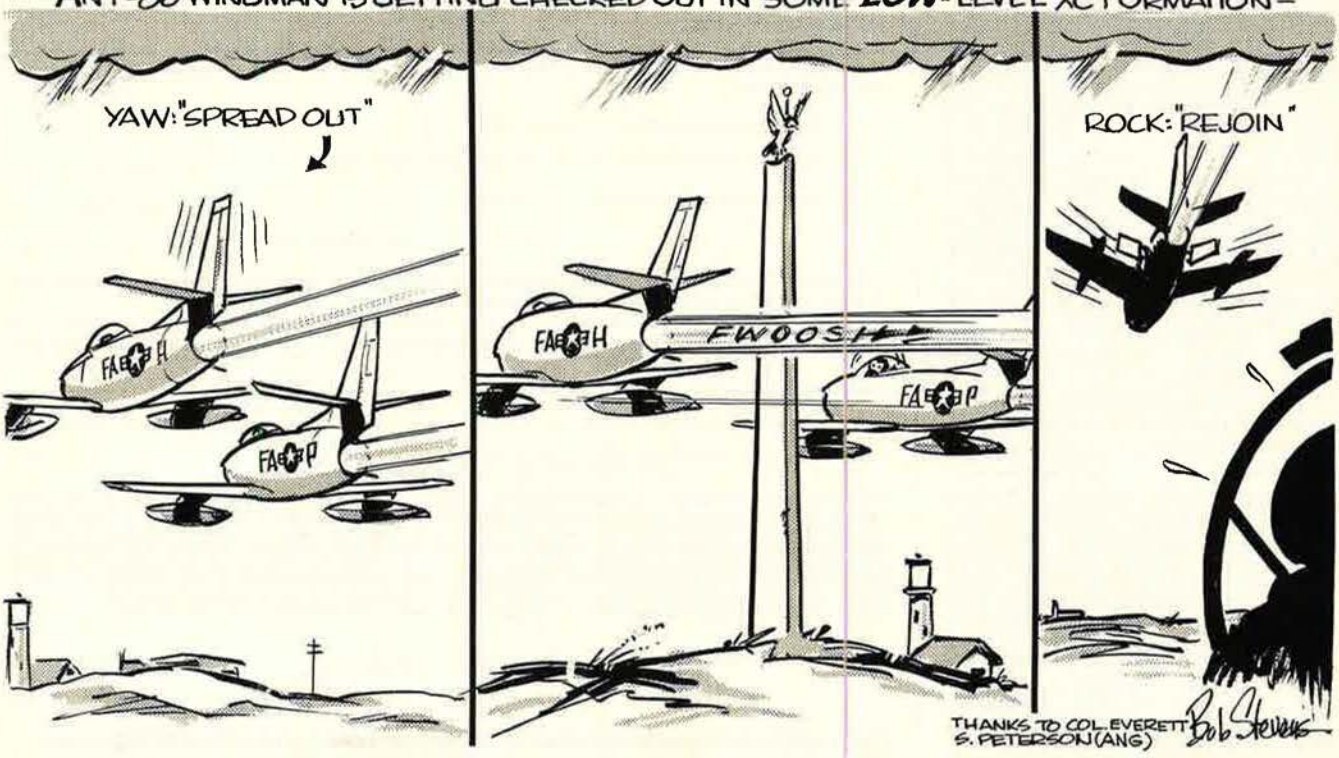
Application must be accompanied by a check or money order. Send remittance to: Air Force Association, Insurance Division, 1501 Lee Highway, Arlington, VA 22209-1198

Bob Stevens'

"There I was..."

GOOD FLIGHT LEADERS ARE USUALLY PRETTY TERSE ON THE RADIO. (ANY MESSAGE OVER 10 WORDS IS A SPEECH.) SOME LEADERS REMAIN SILENT and LET THEIR AIRCRAFT DO THE TALKING... THESE TWO EXAMPLES ARE LIGHT-YEARS APART.





Innovation

WE MAKE HOUSE CALLS.

As with any maintenance program, the bulk of the time spent on a down plane is spent in diagnosis.

That's why Sanders' automated test systems are invaluable. Completely automatic and programmable, these units can cut diagnostic time down to minutes. Like a private robotic physician, they can even be programmed to analyze the idiosyncrasies of individual aircraft: fighters, bombers, transports, and helicopters.

Used in a regimen of preventative maintenance, our test systems can run an aircraft's defensive systems through a complete range of simulated threats on the flight line, in the hangar or at depot levels.

The benefit is self-evident: full mission readiness.

Sanders
A Lockheed Company

NATION'S MILITARY LEADERS AGREE ON URGENT NEED FOR NEW DIRECT-DELIVERY AIRLIFTER.

In the view of the Commanders-in-Chief, as stated in congressional hearings, the C-17 represents a major way to achieve the strategic and tactical airlift our armed forces require.
The C-17 is starting production. When operational, it will be supporting the CINCs in their national defense missions.

McDONNELL DOUGLAS

TOP PRIORITY

C-17

"C" as in CINC's