AUGUST 1990/$2

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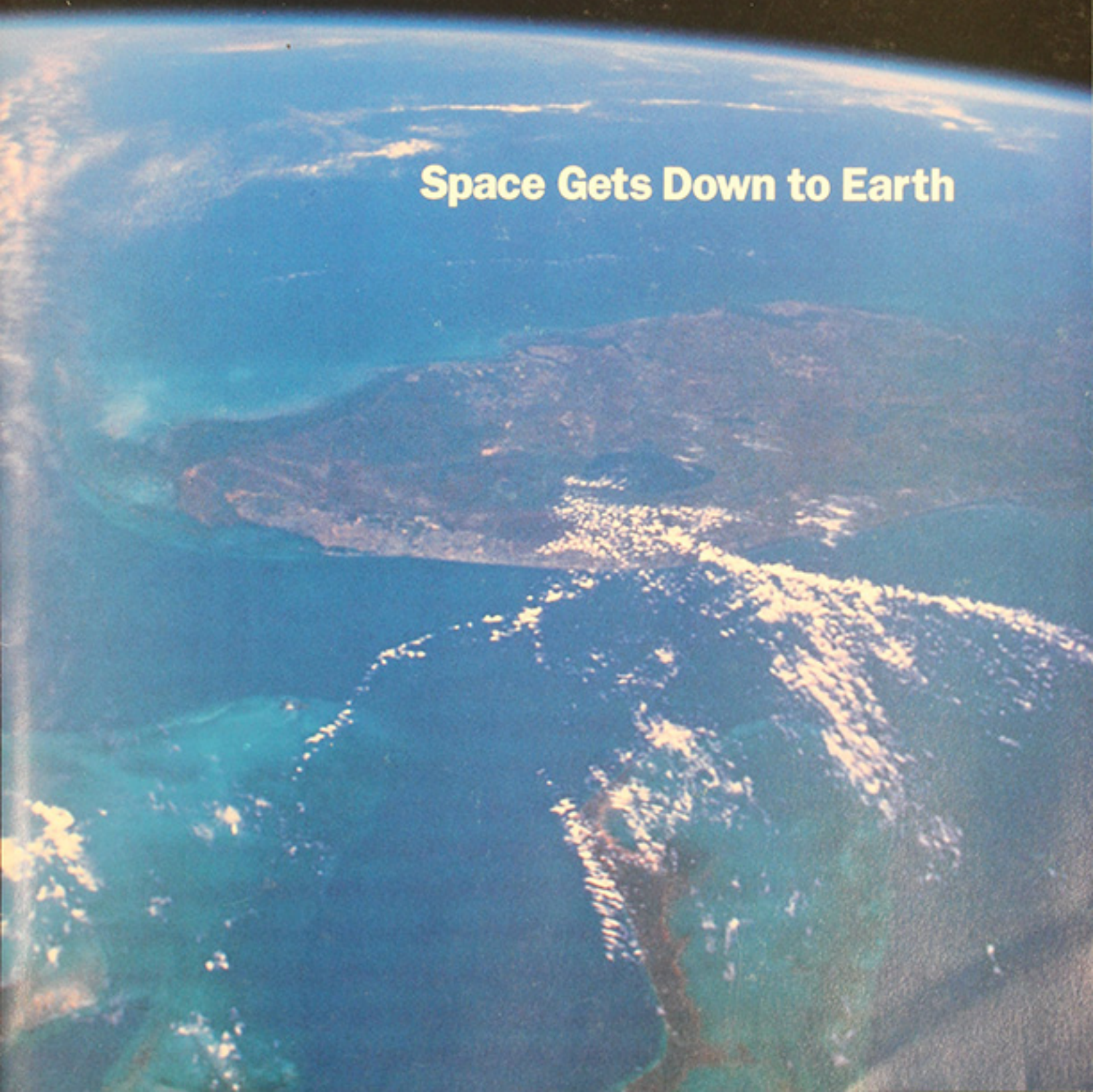

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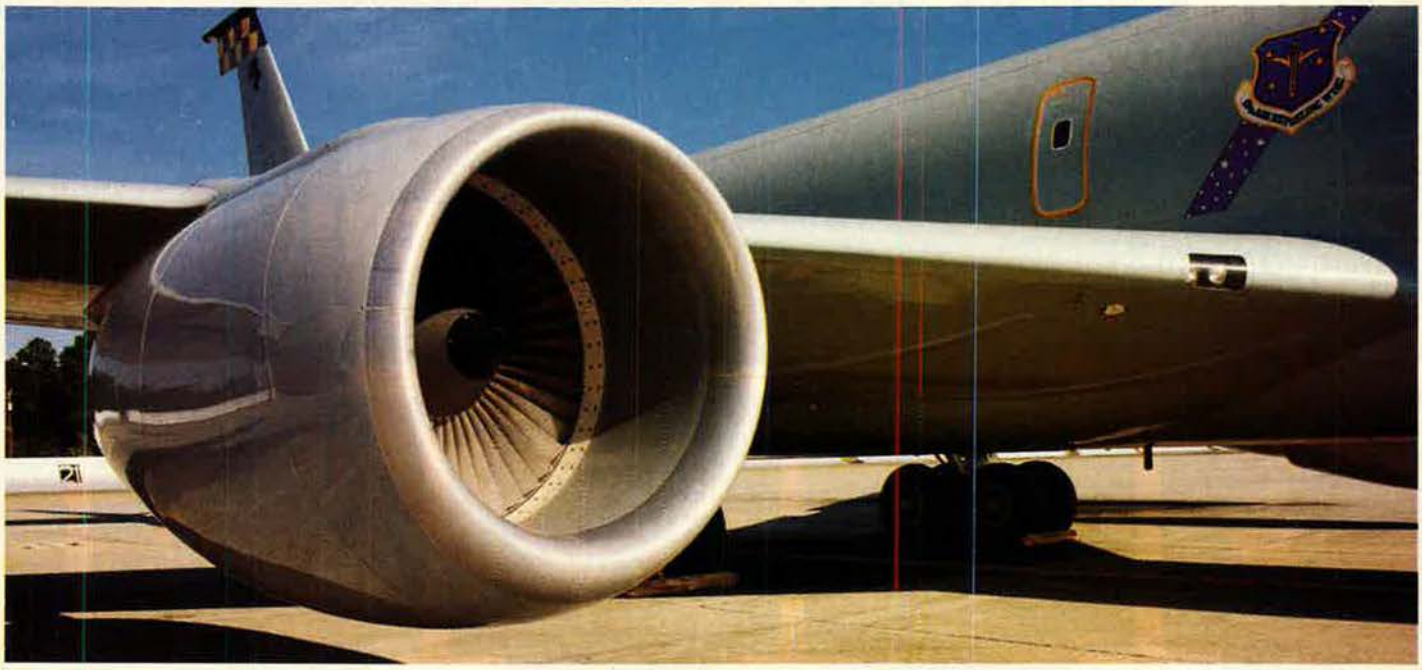

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AUGUST 1990
VOLUME 73, NUMBER 8

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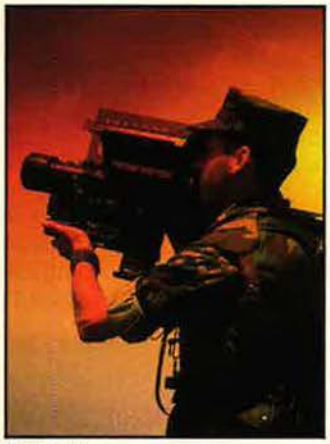
Space Gets Down to Earth



Page 44

About the cover: Viewed from space, the Florida peninsula is framed by the rim of Earth and the Bahama Banks in the foreground. Also visible are Cape Canaveral, Lake Okeechobee, and Miami.

Departments

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Editorial

By John T. Correll, Editor in Chief

In the Name of Integrity

THE Great Reprogramming Flap failed to generate much excitement when it rose out of the political muck last February 26. How could anything so procedural and dull-sounding possibly be very important?

The specific news was an announcement by Rep. Les Aspin (D-Wis.) that his House Armed Services Committee would not consider a Pentagon request to transfer some money—the total amount to be spent was never in question—from one defense budget account to another.

The yawning stopped, however, long before the flap ground to a halt 102 days later. By then, it had created hardship and career uncertainty for 210,000 military members and recruits, who awaited the outcome in suspense as the months rolled by.

Had the impasse continued a few days more, the Department of Defense would have begun terminating 90,000 enlisted and officer accessions, involuntarily separating 40,000 active-duty members, freezing 50,000 promotions, and delaying 30,000 change-of-station moves.

We should remember the Great Reprogramming Flap, not only as a case study in how government is not supposed to work but also because conditions are ripe for a repeat performance next year.

According to Mr. Aspin, the trouble all started last fall when the politicians were negotiating Fiscal Year 1990 budget reductions to meet limits imposed by the Gramm-Rudman-Hollings deficit reduction act.

The Bush Administration—unlike the Reagan Administration before it—did not declare ahead of time its intent to shield military personnel somewhat by absorbing heavier reductions in other defense budget accounts. The maneuver effectively limited the number of line-item reductions the Administration had to concede in its negotiating.

When Congress and the Administration reached a compromise on FY 1990 outlays, everyone recognized that the military personnel account was seriously underfunded. Congress said in November that it expected the Pentagon to send up a request to shift money from other defense accounts to cover the shortfall for military personnel.

That reckoned without Mr. Aspin, who sprang his surprise in February with almost five months of the fiscal year elapsed. He accused the Administration of "playing chicken" with the budget process, daring Congress to disallow an adjustment that the Administration deliberately did not seek earlier. He dug in his heels, and the 102-day crisis began.

This political game, played for 102 days to defend "the integrity of the budget process," touched the lives of 210,000 military members and recruits.

There was an element of truth in Mr. Aspin's accusation. The Administration was playing power games—but so was Congress, and the troops were caught in the middle. The *casus belli* got a little fuzzy at times. In April, Mr. Aspin's focus turned to "acceptable bill payers." If programs of his choosing were cut, the savings could be reprogrammed into the personnel account, apparently without harm to orderly procedure. In June, he again stated the issue as one of principle, specifically "the integrity of the budget process."

The budget process is manipulated regularly by all political sides and has never functioned in pure form. It does not have enough integrity to warrant a defense on principle. As for integrity in the line-item review, Congress balked last year—mostly for reasons of pork-barrel politics—at a long list of reductions proposed by the Pentagon.

This was a raw contest of political wills. The personnel account was an arena of convenience, and the 210,000 people unfortunate pawns in a game. In a white paper released March 14, the Air Force Association called it "the game that nobody wins."

The whole sorry business finally came to an end June 7 with a compromise engineered by Speaker of the House Thomas Foley (D-Wash.). That averted a crisis, but some harm was already done.

When the nation finishes cutting the defense program to its heart's content, the motivation and morale of the force that remains will be vitally important. Basic to that, the troops must believe the system that sustains them is fair and reasonable. The spectacle we have just witnessed undermines that confidence.

This fall, the government faces budget reduction pressures more intense than last year's. The conditions that set up the Great Reprogramming Flap of 1990 are still present.

Hard times often require hard decisions. In the days ahead, actions that cause difficulty or hardship for military people may be unavoidable. If so, a government truly committed to integrity will do its utmost to behave with consideration and decency. When the nation's leaders yield instead to the temptation of power struggles and gamesmanship, we all lose. ■

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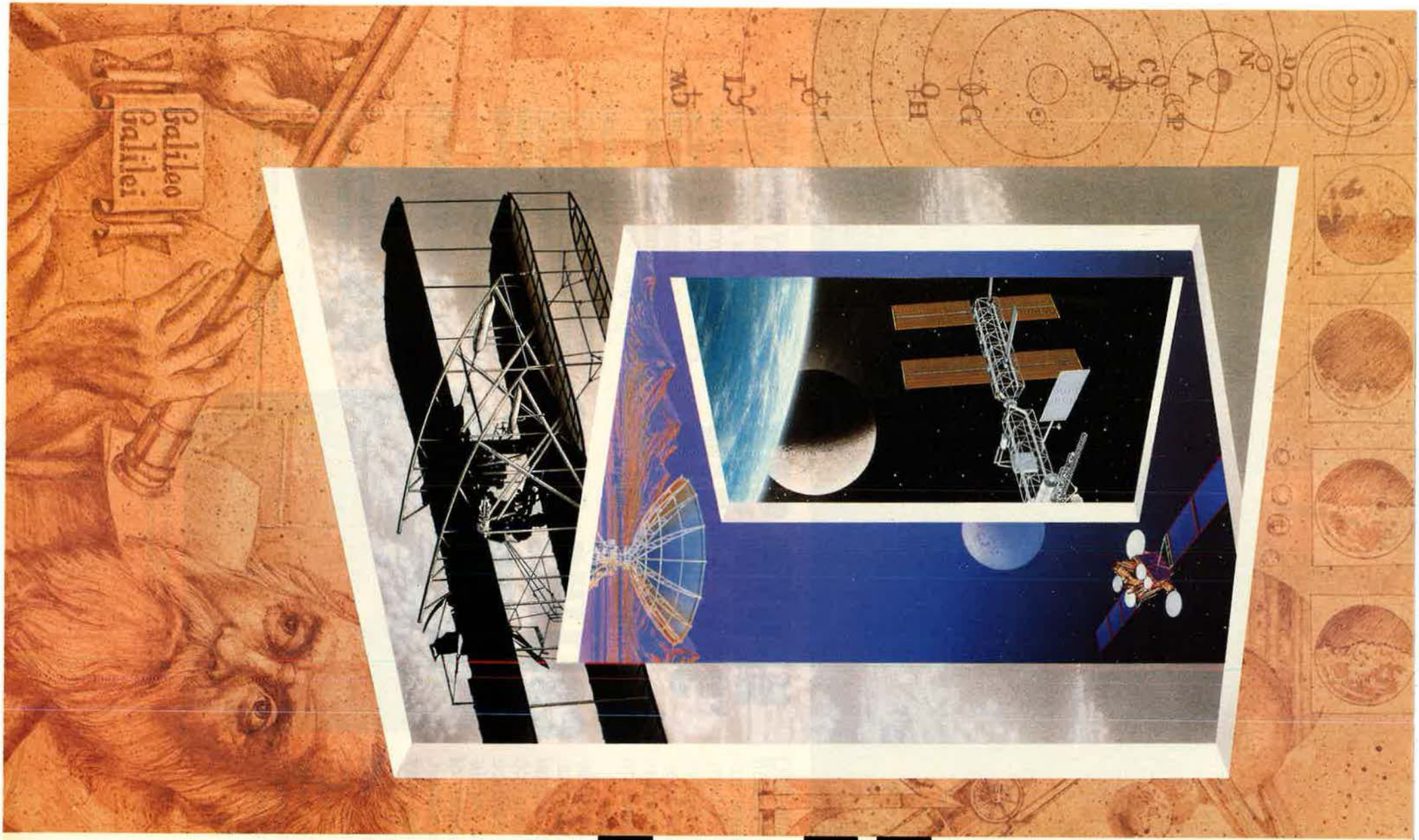

evolution

Change is constant. Depend on it.

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The aerospace industry is evolving also. Redirecting strategies and resources. Forming new alliances. And sharing knowledge to create new opportunities.

For the thousands of men and women at Ford Aerospace, our company is evolving, too. We are ready for the challenge. Managing our diversified programs in space systems, satellite and ground communications, information systems and electronics. Leveraging technologies to provide real value where it counts. Continuously improving.

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Letters

An Important Capability

Congratulations to AIR FORCE Magazine for the interesting and informative articles on special operations and low-intensity conflict that were printed in the June issue. I applaud the insight used in detailing aspects of this component of our nation's armed forces.

The changing world situation has indeed required the Pentagon to alter its focus toward greater emphasis on training and equipping our elite forces. The headline [of the article] "Low Intensity—High Priority" *[by Robert S. Dudney, p. 30]* accurately reflects this sense of direction.

In the early 1980s, Congress, thanks mainly to the efforts of the late Rep. Dan Daniel (D-Va.), wisely became more attentive to the growing need for special operations capabilities. As a result, Congress passed legislation creating the US Special Operations Command (USSOCOM), now headquartered at MacDill AFB in Florida. The legislation also created the position of Assistant Secretary of Defense for Special Operations and Low-Intensity Conflict, now filled by James Locher. Mr. Locher has worked astutely with the legislative branch as we try to ensure that USSOCOM has the resources to plan and execute its mission. In the House Armed Services Readiness Subcommittee, we will maintain our efforts to see that special operations forces are properly funded and able to continue the great strides that have been made in these capabilities in recent years.

Thank you for your attention to the increasing role of special operations forces. AIR FORCE Magazine has provided an excellent perspective for its readers on this important defense capability.

Rep. Earl Hutto (D-Fla.)
Armed Services Committee
US House of Representatives
Washington, D. C.

Misplaced Reliance

I would like to congratulate AIR FORCE Magazine for its emphasis on low-intensity conflict (LIC) and special operations in the June issue. Both topics have tended to be ignored, given the past preoccupation with nuclear and conventional threats and responses. Nevertheless, the articles underscore the fact that despite the current interest in LIC, the focus on its nature and the means of meeting its challenges is, at best, blurred and, at worst, erroneous.

"Low Intensity—High Priority" provides a fine overview of the major characteristics of low-intensity conflict—its protracted nature, the importance of political considerations, etc.—but then follows a common fallacy by concentrating on high-technology responses to a form of politico-military conflict that calls for a delicate balance of psychological, social, and economic measures in conjunction with a military presence to meet challenges in an unstable political environment.

Furthermore, too much emphasis is placed on sophisticated weapon systems that may be too expensive, difficult to maintain, or not suited to meet the requirements of Third World armed forces. Ospreys and a new generation of hardware for special operations may be essential to direct action by US forces, but are they suitable for a conflict where AK-47s and handheld missiles may represent the balance of power? Highly complex weapon systems and support equipment developed under the auspices of the Special Operations Research, Development, and Acquisition Center have their place in the LIC arena, but a discussion of the vital role of the USAF Special Operations School to train personnel in the art of unconventional warfare, psychological operations, cross-cultural affairs, and foreign internal defense should have been included in the article. In the long term, it is not high technology, but the ability of advisors to help train, organize, and motivate indigenous personnel that will determine the outcome of the conflict.

I am fearful that General Milton is right on the mark when he notes that the development of LIC doctrines and capabilities may have become "the means to certain budgetary ends." *[See "Viewpoint: The Low-Intensity Decade," June 1990 issue, p. 98.]* As the Soviet nuclear and conventional threats rapidly recede, each service is competing for scarce resources by defining its own expanded roles in LIC and, more specifically, in the "war on drugs."

The latter preoccupation is particularly vexing, given the fact that, until recently, counternarcotics was not included either as an aspect of low-intensity conflict or under the umbrella of special operations. Military doctrine driven by budgetary competition has led to a situation where the US military finds itself increasingly involved both domestically and overseas in what should primarily be a police function.

Prof. Stephen Sloan
University of Oklahoma
Norman, Okla.

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

The Simulator's Uses

In 1970, when I was an Air Force forward air controller (FAC) attached to the Military Assistance Command Vietnam, Studies and Observation Group, we routinely used a device that was similar in purpose to the "return-fire" simulator mentioned in the article "Low-Intensity—High-Priority." The apparatus was called Nightingale, and it was a flexible plastic lattice with an assortment of pyrotechnics wired onto it. Once lit, it would continue to explode for five to seven minutes, sounding exactly like a firefight. We used them to make the North Vietnamese think we had put a team into one landing zone

while we actually used another, as a decoy for a retreating team, and to keep enemy troops occupied after we exfiltrated a team from a jungle landing zone. . . .

We also found another use for Nightingales that some readers may find amusing. Another FAC and I were passing through Cam Ranh Bay in the summer of 1970. Much against our wishes, we ended up spending the night when our transportation broke down. Our only clothes were what we were wearing—jungle fatigues. We went to the officers club to eat dinner and were told we couldn't eat there while wearing jungle fatigues. (Club policy required 1505s or appropriate civilian clothes.) We protested, explaining we had no other clothes and would leave as soon as we were finished, but it did no good. Cursing the mentality of the Cam Ranh Bay rear-echelon types, we left quietly, found another place to eat, and decided to get our revenge later.

We did. At 0200 the next morning, we returned with a Nightingale, lit the fuse, and threw it behind the officers club. All hell broke loose as sirens wailed and the entire base went into a full-out red alert against what seemed to be a Viet Cong sapper attack. As we snuck back to our quarters for some sleep, we couldn't help smiling and wondering if the senior leadership at Cam Ranh Bay were wearing 1505s or jungle fatigues as they hunkered down in their bunkers for the rest of the night.

Lt. Col. Gary L. Dikkers, USAF
Commandant
USAFE Air Ground Operations School
Sembach AB, West Germany

"Jet War" Omissions

Philip Farris's article "Jet War" in the June 1990 issue was interesting and informative. Another aviation first connected with the Korean conflict deserves attention. Most people think that the aerial refueling of aircraft was first used in the Vietnam conflict, but the procedure was first used under combat conditions in Korea.

In June 1951, an Air Materiel Command KB-29M hose-type tanker, with a Strategic Air Command (SAC) crew from the 43d Air Refueling Squadron (ARS), Davis-Monthan AFB, Ariz., deployed to Yokota AB, Japan, for Project Hightide, a test of probe-and-drogue refueling for the Korean theater. This KB-29M plus two others added later formed Detachment 3, 91st Strategic Reconnaissance Squadron, assigned to the Far East Air Forces (FEAF) Bomber Command. On July 6, 1951, the original KB-29M delivered to Yokota conducted the first in-flight refueling under combat conditions by refueling four RF-80s flying a reconnaissance mission over North Korea. Eight days later, on July 14, the first KB-29P flying boom refueling took place over enemy territory when an RB-45C was refueled over North Korea. The SAC B-29P had deployed from Barksdale AFB, La., to Yokota AB in early summer and was assigned to Detachment 2, 91st SRW.

On September 28, 1951, two KB-29Ms of the 43d ARS refueled an RF-80 six times over Korea. This mission established a flight-endurance record for jet aircraft of fourteen hours and fifteen minutes and earned two combat sortie credits for the refuelers. One month later, on October 29, the first midair refueling of F-84s during combat occurred when three KB-29Ms, temporarily deployed to Taegu, Republic of Korea, refueled eight Thunderjets.

The tankers also helped rescue a downed pilot in the water near Wonsan Harbor on November 3, 1951. The SAC KB-29Ms were supporting F-84s on a bombing mission. By providing additional refuelings, the refuelers kept the F-84s airborne long enough to provide air cover until the pilot was rescued.

Lt. Col. David W. Harvey,
AFRES
Bolingbrook, Ill.

Disappointing Coverage

As a reader of your well-thought-out magazine, I enjoy the stories and how much detail they contain. I must, however, express my displeasure with your coverage of Operation Just Cause. I am a senior airman in the 180th Tactical Fighter Group, Ohio ANG, Toledo Express Airport, Ohio. A small group from my unit (myself not included) was manning the second half of a four-week rotation at Howard AFB, Panama. During their deployment, they provided the close air support needed on many occasions during Just Cause.

Every time I pick up an issue of your magazine that has words of praise for certain units, but never mine, I get furious. I don't understand how you can forget a group of people who served their country so bravely. To top it all off, I picked up your June issue, and what do I see? A comparison between the C-141 and the C-17 *[see "Airlift for the Next 'Just Cause,'" by Gen. H. T. Johnson, p. 42].* If you have time to compare two planes in something that is already over, then I would suspect that you had time to recognize the only Air National Guard unit to see combat in the 1980s or, possibly, the 1990s. I would surely hope that you recognize all participants who put their lives on the line.

SrA. Scott Donnelly, ANG
180th TFG
Toledo, Ohio

Exceptional Women

Three cheers to AIR FORCE Magazine for having the objectivity and sensitivity to print "Women in Combat" *[by Brian Green, June 1990 issue, p. 76].* I'm impressed that the author is bold enough to air an issue that, while receiving wide attention in the civilian media, is seldom publicly and forthrightly broached within the inner sanctum of the military community.

Many American citizens long to serve their country; some in an ultimate (combat) capacity. The "exceptional women" (Green's words) are especially entitled to do so.

Kudos to the Air Force for setting the standard among the services for integrating women—but don't stop the progress at ninety-seven percent. That's not good enough for flying—or fighting—and it doesn't hold for equality, either. Open all the doors to opportunity for our American servicemen and -women.

Capt. Mary K. Matthews,
USAF
State College, Pa.

Almanac Errors

We are disturbed by two errors in the May 1990 AIR FORCE Almanac edition of your magazine:

- The caption on p. 95 is incorrect. The A-10 is the only aircraft in that photo assigned to Third Air Force.
- The Seventeenth Air Force chart on p. 95 incorrectly lists the 38th Tactical Missile Wing as the 38th Tactical Fighter Wing.

Please set the record straight.

Doug Moore
Hq. USAFE
Ramstein AB, West Germany

Almanac Clarification

The statement [in "Famous Firsts Among US Bombardment Units"] that on June 18, 1965, twenty-seven B-52s from Andersen AFB, Guam, conducted the first USAF heavy bombing mission of the Vietnam War is not entirely accurate. Actually this first combat mission was flown by thirty B-52 aircrews, consisting of ten cells (three aircraft per cell), with the 7th and 320th Bomb Wings each providing fifteen aircraft.

Unfortunately, three aircraft from the 320th did not reach the target area. Two B-52s collided in the pre-

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Letters

strike refueling area, and one B-52 did not complete in-flight refueling and was forced to land at Kadena AB, Japan. The remaining twenty-seven aircraft reached the target area. However, one aircraft could not release its internal weapons due to a malfunction of the bomb bay doors. . . .

The failure of three launched aircraft to successfully reach the target area centered on the prestrike refueling tactic. For the majority of crews it was the first attempt at multiple track refueling (five parallel tracks), conducted under radio silence and during the hours of darkness. All thirty crews performed with the dedication expected of SAC combat-ready crews and thirty, not twenty-seven, aircrews should be recognized as contributing to this first B-52 strike.

Lt. Col. William E. Mulcahy, USAF (Ret.)
Daly City, Calif.

A Team Effort

I just read the article titled "Bombology" *[by James P. Coyne, June 1990 issue, p. 64]* and was truly impressed with the facts, figures, and historical data that Mr. Coyne used. I am, however, disappointed by the slant he gave it.

There are a number of comments about pilot duties and several references to aircrew tasks, but there is only one specific reference to the weapon system officer (WSO) in the entire six pages. The F-15E is a two-man aircraft. Getting its weapons to the target and the aircraft home again, in the environment it was designed for, is a team effort. This article glossed over the WSO contributions.

Someone not knowing any better could infer that the WSO is just there to respond to directions—no original thoughts allowed—and to log the kill when the pilot blows up the bad guys. The aircrews know that this is not the case, and I hope you do too. . . .

William R. Toombs
Ladson, S. C.

The Caproni and the B-2

The beautifully restored World War I Caproni bomber, recently placed on display at the USAF Museum *[see "Aerospace World," June 1990 issue, p. 27]*, is said to be the first strategic bomber. The political atmosphere in this nation may well cause the B-2A to be the last.

The "Aerospace World" item on p. 26 of the May issue about the crew positions on the B-2A is remarkable in detailing the similarity of the B-2 to the Caproni. The B-2A has two crew members: the "pilot" in the left seat who flies the aircraft and a "mission commander" in the right seat who is dual-qualified as pilot and navigator/weapon system officer. Although the Caproni also had gunners, it was flown by the copilot in the left seat and the pilot in the right seat who also aimed the internally loaded bombs with an externally mounted bombsight.

Col. Byron Lee Schatzley, USAF (Ret.)
Beavercreek, Ohio

Icebound P-38s

In reference to your June 1990 issue article "Squadron in the Ice," by C. V. Glines, I would like to point out that the six P-38Fs were part of the 94th "Hat in the Ring" Fighter Squadron (1st Fighter Group) of Capt. Eddie Rickenbacker's World War I fame.

On the Bolero mission, July 1942, they were known as "Tomcat Green" and "Tomcat Yellow" flights. I was in "Tomcat Black" flight, and we successfully made the flight from Bluie West One, Greenland, to Reykjavik, Iceland, on that same day, July 15, 1942.

All the rest of the 94th's pilots and P-38s arrived safely in England. We were awarded the Air Medal for participating on this mission. . . .

If the Greenland Expedition Society is successful in excavating those P-38s and B-17s, now under 260 feet of ice, after forty-eight years, we believe it will be one of the best news stories of this century.

Jack Ilfrey
20th Fighter Group Association
New Braunfels, Tex.

In "Squadron in the Ice," C. V. Glines stated: "The 97th's Group Commander was Lt. Col. Paul W. Tibbets." He was never the CO of the 97th. Cornelius W. Cousland was the commander during this period.

J. R. Boyd
Greensboro, N. C.

• *Mr. Boyd is correct in stating that Paul Tibbetts never commanded the 97th. According to documents sent in by Mr. Ilfrey, however, it would appear that Tibbetts did command the detachment from the 97th that was sent on this mission.*—THE EDITORS

Duckworth Gratitude

Forty-eight years later, C. V. Glines in "Duckworth's Legacy" *[see May issue, p. 178]* has let me know how fortunate I was to be a member of Class 42-I at Columbus Army Flying School.

With no basis for comparison, I assumed our instrument flying instruction at Columbus was typical for multiengine aircraft pilots-to-be.

Mr. Glines's article prompted me to look at my Form 5. Total pilot time at Columbus was 78:10; instrument time, 11:30; Link time, 17:15.

Twenty-seven of us from 42-I were assigned to Army Air Forces School of Applied Tactics at Orlando, Fla., where we received operational training in P-70s with radar observers as night fighter crews. By May 1943, most of us were in England as crews in the first four American-trained night fighter squadrons, the 414th, 415th, 416th, and 417th. By this time, flying on instruments was second nature.

In addition to the thorough foundation in instrument flying, another facet of our Columbus training was very helpful. The Curtiss AT-9 we flew there had similar flying characteristics to the Bristol Beaufighter, which all four squadrons received in England. The 416th later exchanged their Beaufighters for Mosquitoes. My squadron, the 417th, received P-61s (minus the fifty-caliber turrets that were going to B-29s) in February and March 1945.

More than I realized until reading Mr. Glines's article, I may be here to write this letter because Colonel Duckworth had the vision to see what we needed.

Lt. Col. C. Richard McCray, USAF (Ret.)
Walworth, N. Y.

A Tough Call

In this era of budgetary cuts, the Air Force has had to make some very tough calls. One of the toughest was to eliminate the Air Force Intelligence Agency's Soviet Awareness Program. The program was created in 1976 at the direction of USAF Chief of Staff Gen. David C. Jones, who perceived a need to educate the rank and file of the Air Force about the Soviet Union. Certainly, there were—and still are—many misconceptions about the Soviet Union and its goals, capabilities, and mindset. . . . The Soviet Awareness Program has sought to dispel these misconceptions and become, as one directive put it, the "focal point for disseminating information about how the Soviets think [and] why they think so differently from us, to eliminate prejudice, uninformed opinions, faulty perceptions, and . . . to substitute these with the hard facts about the Soviet people."

By the 1980s, the Soviet Awareness Program had earned a reputation for being one of the finest programs of its kind, and audiences had grown to include all of the services within DoD, as well as CIA, DIA, NSA, FBI, and State Department personnel. The program was also taken to Latin America, where the briefings were presented in Spanish. Wing Commanders at most bases elected to take advantage of the unclassified program that Soviet Awareness had developed, providing a chance for the local civilian population to learn about the Soviet Union and also gain an understanding of the USAF mission.

Over the past fourteen years, the Soviet Awareness Program presented over 12,000 one-hour briefings to audiences ranging from ROTC cadets to cabinet members. A remarkable statistic, considering that at no time did the team have more than twelve members. . . .

To all present and former team members: Congratulations on a job well done.

Maj. Donald J. Hanle, USAF
Bolling AFB, D. C.

Washington Watch

By James W. Canan, Senior Editor

"Normalizing" Space

Top Air Force leaders are sold on space as a "core" mission. The time is coming when USAF units will routinely have specialists wise in the ways of space.

The Air Force is intent on "normalizing" space operations. This means launching and operating its space systems as matter-of-factly and purposefully as it does its aircraft and treating those systems as workaday warfighting tools, not as showpieces in the sky.

There has been a lot of talk in recent years about the need for normalization. The space policy that the Air Force announced at the beginning of 1989 called for it and set the stage. Now there are strong signs that it is coming to pass.

Among them:

- Fighting forces have a growing hunger for services from space *[see "Space Gets Down to Earth," by James W. Canan, p. 30, and "The Army and Navy in Space," by Richard H. Buenneke, Jr., p. 36]*—surveillance, reconnaissance, communications, navigation, weapons targeting and guidance, warning of attack, threat assessment, and weather analysis and forecasting.
- Air Force Space Command, USAF's warfighting command for the so-called "fourth combat medium" above the atmosphere, has proved its adulthood. It is seen as increasingly capable of launching and operating the space systems that provide such services, is being given wider license to do so, and is bullish.
- The corporate Air Force means business about giving space its due. All other reasons for the rise of space in USAF's scheme of things flow from this one. Top-of-the-line Air Force uniformed and civilian leaders seem sold on spacepower as an indispensable element of airpower, have taken to treating the two as one, and have a no-kidding commitment to space as a "core mission"—the key to the future—for USAF.

Big changes are in store for the Air Force as a result of its ever-sharper accent on space. For one thing, the time is coming when air units will routinely include specialists wise in the ways of space.

The idea of transfusing the flying force with such specialists has been tried and is beginning to catch on. When it becomes standard practice, the Air Force will have gone a long way toward fulfilling a major space-policy goal: "integrating spacepower throughout the full spectrum of Air Force capabilities."

Gen. Michael J. Dugan, who succeeded Gen. Larry D. Welch as Air Force Chief of Staff on July 1, seems certain to lead the way. His actions of recent years, as a three-star on the Air Staff and then as a four-star operational commander in chief, indicate that space operations will continue to flourish under his touch from the top.

General Welch, recently retired from USAF, teamed with Edward C. Aldridge, Jr., then Secretary of the Air Force, in co-writing Air Force space policy, which postulates that "spacepower will be as decisive in future combat as airpower is today." General Dugan was present at the creation of that policy and was instrumental in putting it into play at the Pentagon and in the field.

As Air Force Deputy Chief of Staff for Plans and Operations (DCS/XO), General Dugan encouraged operational commands to enlist the on-the-spot services of Air Force Space Command experts in space systems and operations. He remained true to form after taking command of US Air Forces in Europe as a four-star in mid-1989. Right off, he asked Air Force Space Command to send him specialists to educate his USAFE planners and operators in the whys and wherefores of space systems and operations.

At the time, Air Force Space Command was headed by Lt. Gen. Donald Kutyna, now the four-star commander in chief of unified US Space Command and North American Aerospace Defense Command (NORAD). He welcomed General Dugan's request, because, as he put it then, "all operational commands need to know what's in space so they can use it, and we [Air Force Space Command] need to get our people cross-matrixed into those commands."

Lt. Gen. Thomas S. Moorman, Jr., who took over for General Kutyna at Air Force Space Command earlier this year, is following through. Says he, "I am committed to getting space-knowledgeable people into the operational commands, to infuse them with 'space thinking.' But it's a two-way street. We in this command need to become conversant with what the other warfighting commands need in the way of data from space."

General Moorman adds: "Space can help all of us do a better job. This becomes absolutely critical at a time of smaller forces."

Soon after getting squared away at Air Force Space Command, General Moorman began meeting with his counterparts in other operational commands, starting with Tactical Air Command, to discuss how they might employ space-based wide-area surveillance systems for their special purposes. He also created the Space Applications Division in AFSPACECOM to spread the word on what space can do for the other commands. "I'm seeing a lot of evidence that space is being taken very seriously in the Air Force," General Moorman declares.

Air Force doctrine, now being updated in conformance with the changing times, is studded with such evidence. It reportedly underscores, more strongly than ever, the importance of space in the Air Force's operational scheme of things, as a place where the Air Force should feel right at home in applying "aerospace power."

As DCS/XO, General Dugan put his stamp on that doctrine. The job of updating it fell to an XO directorate. That job has since been shifted from XO at the Pentagon to Air University at Max-

well AFB, Ala., but its overseer is the same. Air University is commanded by Lt. Gen. C. G. "Chuck" Boyd, Jr., who was General Dugan's two-star deputy of plans at the Pentagon and who declared in those days, "I cannot think of the future of the Air Force without thinking about space."

Giving space operations bigger play in doctrine, which has been defined as USAF's bridge from the past to the future, is no mere academic exercise in warlike wordsmanship.

"It's enormously important," asserts Martin C. Faga, Assistant Secretary of the Air Force for Space. "Getting space beyond the stage of being seen as just a support service, to where it becomes accepted as a key part of Air Force force structure, requires that development [incorporation in doctrine]."

While at USAFE, General Dugan made a point of discussing Air Force space operations and aspirations with Mr. Faga on several occasions and will almost certainly continue the practice as Chief of Staff. He will have plenty of kindred spirits on hand. By all accounts, his interest in space is shared by a growing number of Air Force leaders, including the current DCS/XO, Lt. Gen. Jimmie Adams, who has restructured his shop to sharpen its focus on space.

"I think the importance of space is now being seen more clearly at senior levels of the Air Force and by senior operational commanders," Mr. Faga says.

Why? "Because we are being challenged to think hard about the nature of the military threats and the military forces that will be required to meet them through the 1990s and beyond. As a result, all force elements are being reviewed afresh, and space capabilities, which are relatively recent, are seen in fuller perspective and are better appreciated for it."

He continues: "What's clear is that space will be a bigger part of the Air Force by any measure—the number of people devoted to it, the size and significance of the mission, the budget. Perhaps most important, space will reach the status where everybody in the Air Force will see it as integral to all operations and will list space systems right along with aircraft and missiles as things we routinely build and operate."

Infusing operational commands with space experts would be a big step in that direction. There is talk of creating permanent slots for such specialists in those commands, rather than detailing them on a temporary basis. Sooner or later, some planners predict, each air wing will have its own complement of space-savvy technicians who know how to retrieve and use data from assorted satellites on orbit.

It may be stretching a point to expect that space specialists will become so pervasively organic to air units. Giving local air commanders too much control of space systems designed for operations of global or hemispherical scope could bring more confusion than coherence to combat forces. Moreover, such decentralization, easily overdone, would be perceived as an unacceptable erosion of Air Force Space Command's overall control of space assets.

As space gains acceptance and importance in the Air Force, this issue begs for resolution. Says Mr. Faga, "In our dealings with Space Command and with tactical users of space, questions come up regularly of how space should be used and by whom—Space Command or unit commanders."

One answer may lie in giving local and regional commanders "tasking control" of space assets on a selective basis—for example, letting them control some channels of communications satellites and lay claim to certain outputs of surveillance satellites according to their individual combat requirements.

Calls from combat commanders for space systems to give them a hand are becoming much more sophisticated as well as increasingly urgent.

Declares Mr. Faga: "The key things that field users need to know are what services are available to them from space and how confident they can be of actually getting those services when they need them. Many of the users' concerns about not having enough control of space assets are simply the result of our not having enough space assets. We can't give them all the services they would like.

"Naturally, they'd like all the capabilities they can get from space. But what's most important to them is to know *which* capabilities they can count on getting from space, so they can plan in advance on how to marry them to the capabilities they get from the [nonspace] assets they own."

Whatever organizational setups finally emerge for giving combat units better access to satellites, one thing is clear: operational commands will demand more and more services from space, and as they get it, space will become more thoroughly integrated in the Air Force.

Such integration takes several forms, and one of the most important is the shifting of responsibility for satellite-launching and satellite-control missions from the Air Force's R&D community to its operational community.

A hallmark event in this regard took place last May 9. The mission of managing the Global Positioning System constellation of navigation satellites on orbit was transferred from Air Force Systems Command's Space Systems Division to Air Force Space Command. Thus GPS *(see p. 30)* is now considered an operational program, no longer an R&D program, at a time when warfighting commanders on land, at sea, and in the air are clamoring for the extraordinarily accurate navigational data it offers them.

Shortly after taking control of GPS, AFSPACECOM contracted with Ford Aerospace Corp. to operate the command's far-flung network of satellite-control stations at Falcon AFB, Colo., Onizuka AFB, Calif., and eight "remote" sites around the world.

The operational outlook on space is by no means confined to Air Force Space Command. It is characteristic of the whole Air Force, starting at the top. Even the space researchers and developers reflect it. Operational considerations were not always paramount in decisions on how best to build, launch, and use all space systems. Now they most certainly are.

Lt. Gen. Donald Cromer, commander of Space Systems Division, emphasizes that such considerations "are uppermost in our minds as we design and bring on line new space systems. Before, we had an R&D view—build one, put it up, check it, fix it, and then build another one. Every one was looked on as a unique system. We were in no hurry.

"Now that has changed. We're concentrating on building into the systems all the capabilities required for them to become operational right after they're launched and on checking them out very rapidly once they're on orbit."

General Cromer describes the chief workaday requirements for today's space systems as "autonomy, reliability, and redundancy—all driven by operational considerations."

He declares: "Our operational orientation means always having new space systems available in the pipeline, always being able to launch on schedule and maintain robust capabilities on orbit. We're getting away from having to spend sixty days on the launchpad building up the boosters and putting the satellites on them."

The Air Force's goal, says General Cromer, is "to build systems so that they're ready to fly when they come out of the factory—to have to spend

no more than one day in driving them out to the pad, fueling them, and launching them."

What it all adds up to, the SSD Commander explains, is that "the launch-pad will become the end of the runway, which will be a lot different from what it is now—an extension of the factory."

The pad will be the domain of the flyer, not the developer. Air Force Space Command has been put in charge of military space-launch operations, formerly the province of AFSC's Space Systems Division. The mission transfer was announced in mid-June and will begin taking effect on October 1. AFSC will retain the responsibility for research and acquisition of space boosters and satellites. Both commands studied the ins and outs of the transfer issue and got together on it.

Far from having a "no hurry" attitude, Air Force Space Command is stepping on the gas. Its ultimate goal is to launch satellites like clockwork, on thirty days' notice.

The launch-mission transfer had long been championed by General Kutyna and his predecessor at US Space Command, Gen. John L. Piotrowski, Jr. General Kutyna repeated his case for it soon after changing commands earlier this year.

SSD's General Cromer, a member of the high-level panel that analyzed the launch issue, provides historical perspective. He claims that USAF's space-launch recovery program, undertaken with great urgency in the aftermath of the space shuttle *Challenger* disaster of January 1986, marked a turning point in the service's approach to space, orienting it more to operations than to R&D.

"The recovery program forced us to refocus on our space capabilities, on our need for robustness of systems and operations." General Cromer says. "It led to the space-user community replacing the space-development community in the driver's seat."

This is just fine with General Moorman, who moved to Air Force Space Command earlier this year from a top job in space systems acquisition at the Pentagon. Says he: "We're a command with a single focus—space operations. Because of this—and the technical competence of our people—I'm confident we'll do an exceptional job with launch."

He declares, "Launch transfer to this command is a natural outgrowth as we mature, normalize, and institutionalize space operations in the Air Force."

Air Force Space Command is being put in charge of space-launch operations for the same basic reason that the command was formed in the first place—because the nation is becoming more reliant on space systems for national security, and, correspondingly, the Air Force is concentrating harder than ever on its space mission.

AFSC—USAF's major command for research, development, and acquisition—has always managed launch activities for unmanned national security missions, NASA missions, and others. The Air Force created AFSPACECOM as its first operational command dedicated solely to space missions, in the mold of other commands long dedicated to air missions.

First, though, the new command had to come of age. Now it is nearly eight years old and has taken its place among the grown-ups. Mr. Faga contends that USAF's decision to transfer launch responsibilities "recognizes the increasingly operational nature of our space-launch programs and the growth and maturity of Air Force Space Command."

As to the broader import of the move, he notes that it "will further integrate space as a primary mission in the Air Force."

The changeover is scheduled to take place in a series of steps over several years, but it will give the Air Force a new look right off.

On October 1, Air Force Space Command will take control of all ranges and organizations involved in launching Defense Department satellites. Included are the Eastern Space and Missile Center and Eastern Test Range at Patrick AFB and Cape Canaveral AFS, Fla., and the Western Space and Missile Center and Western Test Range at Vandenberg AFB, Calif.

Patrick AFB itself and Cape Canaveral AFS will belong to AFSPACECOM instead of AFSC. Vandenberg AFB will remain a Strategic Air Command base.

Roughly 2,500 AFSC blue-suiters and civilians currently specializing in space-launch operations will be added to AFSPACECOM's 8,600-member work force.

Ownership of five launch systems will change hands at different times over several years, in the same way that ownership of aircraft systems is assumed by operational units. Air Force Space Command squadrons will take over Delta II and Atlas E operations right away on the east and west coasts, respectively. At Cape Canaveral AFS, an AFSC-AFSPACECOM combined "test force" will oversee the fledgling Atlas II program until testing is completed and AFSPACECOM takes over around the middle of next year.

At the outset, a similar dual-command test force will conduct big-bruiser Titan IV operations at Cape Canaveral AFS. AFSC will continue to activate Vandenberg AFB sites for Titan IV and Titan II launches. A combined test force will go into action there in 1992. Air Force Space Command squadrons are scheduled to take total control of Titan IV launch operations at Canaveral around August 1993 and of Titan II/IV launch operations at Vandenberg about four years later.

The changing of the guard will have "no significant impact on contractor activities," the Air Force says. Mr. Faga notes that "it will not bring many immediate changes in the way we do space launch." He also emphasizes that SSD's stewardship of launch activities has been salutary in recent times.

To Mr. Faga, the scorecard on such activities through the past twelve months or so—"sixteen successful flights"—signifies that "the Air Force entered the era of what we can truly call 'sustained space operations' in 1990." Those flights involved the Space Shuttle, Titan IV, Titan II, Titan 34D, Delta II, Atlas E, and Scout boosters and the Pegasus air-launched rocket.

Says Mr. Faga, "We have been successful in spreading our payload launch requirements across a fleet of diverse space-launch vehicles, launchpads, and support facilities. We are pleased with our resiliency and depth."

Mr. Faga looks ahead to what he believes will be "the space-oriented Air Force of the twenty-first century." He sees space as "no longer something special, something set aside" in the Air Force. He sees it, instead, as "moving closer to the center" of the service's affections and attentions.

At some point, he declares, "space will be seen as a core mission of the Air Force along with all others. We will be able to say that space is 'here' in the Air Force when most people in the Air Force come to hold that view."

The timing of that turning point "will depend on how successful space systems and operations turn out to be in terms of their application, not in technical terms," the Assistant Secretary for Space asserts.

The pace is picking up. ■

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By Brian Green, Congressional Editor

The Impact of Big Cuts

Secretary Cheney says the Pentagon might save $128 billion over five years by cutting force structure twenty-five percent, but congressional budget goals mean cutting 900,000 troops.

Responding to a congressional request for data on the impact of force cuts, Secretary of Defense Dick Cheney reported in June that reducing military strength by twenty-five percent would lead to a savings of some $128 billion over five years. To achieve the still-greater savings that Congress has called for in ongoing budget negotiations, it would be necessary to cut back by 900,000 active-duty and Reserve troops.

Cheney emphasized that he was not proposing such cuts, but rather furnishing the numbers that he had been asked to work up. Nevertheless, some Congressmen immediately began treating Cheney's report as a proposal and talking about which additional reductions might be possible.

The "illustrative" twenty-five percent force reduction would save about ten percent, or $128 billion, in budget authority when compared to the budget "baseline" (FY 1990 spending, plus inflation) established by the Congressional Budget Office (CBO). In outlays, the savings would be $103 billion.

The cuts studied by the Secretary include:

- A twenty-one percent reduction in military personnel—442,000 active duty and 260,000 in the Guard and Reserve. The civilian work force would drop by 145,000. The active-duty Air Force would decrease by 79,000 (about fourteen percent), the Air Guard and Reserve by 15,900.
- Elimination of eleven tactical air wings, down to twenty-five (from the present thirty-six).
- Deactivation of the five FB-111 fighter-bomber squadrons.
- Elimination of one of three B-52 squadrons designated for conventional missions. Strategic airlift squadrons would not be reduced.
- Reduction of Minuteman missiles from 950 to 500. All 450 Minuteman II missiles would be eliminated. This, according to Cheney, would coincide with the expected outcome of strategic arms-reduction talks.

Other services are also hit hard in the Cheney analysis. The Army would shrink by 224,000, falling from thirty-two divisions to twenty-two. There would be an additional reduction of 242,000 in Army Guard and Reserve forces. The Navy ship total would drop from 566 to 455, carrier battle groups from fourteen to twelve, and Navy personnel from 591,000 to 501,000. The Marine Corps personnel would be cut from 197,000 to 148,000.

Aircraft procurement assumptions in this breakdown reflect savings derived from cuts and delays decided earlier in a major aircraft review *[see "Capitol Hill," June 1990].* Despite this, aircraft procurement over the period of the analysis continues to grow, from $25.3 billion in FY 1991 to $38.7 billion in FY 1995. That is attributable to coming expenses for the C-17 airlifter, B-2 bomber, and the A-12 ground attack aircraft. Other procurement accounts decline dramatically.

No reductions were projected in R&D, "since research and development program requirements are not sensitive to force size."

By Cheney's reckoning, the defense spending level proposed in this year's Senate budget resolution would require $155 billion more in cuts than can be achieved with a twenty-five percent force reduction. It would necessitate a thirty-five percent force reduction—560,000 active-duty personnel, 360,000 in the Guard and Reserve, and 180,000 civilians.

The force-structure cut would have to be ten percent rather than five percent in FY 1991, a difference that concerns Secretary Cheney. "To the extent that [the] process of reducing personnel gets front-loaded [and] pushed into 1991 instead of spread out evenly over the next five years, we will . . . do serious damage to our capacity to manage that in an intelligent fashion," he said.

This year's House budget resolution, he said, would set up $208 billion in reductions beyond the twenty-five percent scenario. Achieving that would mean an overall fifty percent reduction in force structure. That translates to the release of 800,000 active-duty personnel, 520,000 Guard and Reserve personnel, 250,000 civilians, and the closure or realignment of one third to one half of all US military installations.

If the Pentagon is required to hold force-structure reductions to twenty-five percent and still meet the House and Senate budget goals, procurement and R&D would be savaged, Cheney said. This would force cancellation of between a third and a half of planned procurement of ships, tactical aircraft, tactical vehicles, and communications-electronics equipment. One third of all defense laboratories would be closed. Tactical R&D would be reduced twenty percent. All strategic systems except the B-2 Stealth bomber and the Trident missile would be canceled. SDI funding would remain at FY 1990 levels.

Some on Capitol Hill objected to the "modesty" of the ten percent savings identified by Secretary Cheney. Rep. Les Aspin (D-Wis.), Chairman of the House Armed Services Committee, argued that a twenty-five percent force cut could save from eighteen to twenty-seven percent in spending.

Among the alternatives identified by Aspin that would generate the high range savings: reducing active tactical air squadrons by fifty percent, skipping the next generation of force modernization, and cutting R&D by about forty percent. He also argued that much greater savings in overhead could be achieved.

An analysis by the Congressional Budget Office comes up with a potential five-year savings of twenty-three percent compared to its baseline budget. CBO assumes a twenty-five percent cut in Army divisions, aircraft, and ships. It envisions savings of $52 billion in operating costs and $32 billion in investment by FY 1995. ■

An innovative radar antenna that can look forward, back, or to the side virtually instantaneously may soon be performing reconnaissance for the U.S. Air Force. The electronically scanning antenna (ESA), built by Hughes Aircraft Company, can position its broader beam faster than conventional antennas because it is a phased-array radar antenna that scans the radar beam electronically instead of mechanically. As a result of four years of successful testing in Europe, during which time an ESA was mounted in a United States Air Force TR-1 reconnaissance plane, the Air Force plans to install ESAs in the U-2R and TR-1 aircraft of its advanced Synthetic Aperture Radar Systems - 2 fleet.

An improved flow of information between air defense command and control centers and surface-to-air missile systems will be one result of a new state-of-the-art communications link being designed by Hughes. The link, called the Intelligent Interface Processor, will provide the signal interface between AN/TSQ-73 surface-to-air missile control systems and fixed NATO Air Defense Ground Environment sites in West Germany, Italy, Belgium, and the Netherlands. With the new system, NATO commanders will be able to allocate targets to be engaged by missile batteries and still retain autonomy. Commanders will also be able to exchange target and status information currently available only through voice communications.

An improved sight stabilization system will significantly increase first-round hit probability for tank gunners. The two-axis stabilized head mirror for the U.S. Army's M1A2 Abrams tank is currently under development at Hughes. Current M1 tanks are equipped with a single-axis stabilized head mirror, which limits the gunner's ability to accurately sight and fire on moving targets when the tank is also moving. The new system is part of the Army's planned improvements for the M1A2. Hughes also produces the laser rangefinder and thermal imaging system for the current M1 tank.

A state-of-the-art, on-line computer graphics projector helps a computing company manage a network of 300 host computers. Seven Hughes-built Superprojectors operating around the clock in General Motor's Electronic Data System's (EDS) Information Management Center give more than 100 operators up-to-date network status reports (operation bulletins, maps) and other network management information. Additionally, it provides a visually dramatic presentation of EDS services to its customers. The Superprojectors, connected via a standard RS232 bus to display-generating computers, project images with resolutions in excess of 1,000 TV lines onto 14- by 16-foot screens. The projectors use liquid crystal light valve technology developed by Hughes for displaying information in military command and control centers.

A new hydrogen maser "atomic clock" combines a compact size suitable for space applications with the highest long-term stability ever reported for this type of device. Developed and built by Hughes for the U.S. Navy, the fully automated frequency standard is about 10 times more stable than currently-used cesium beam devices. Atomic clocks use the resonance frequency of an atom to provide a precise measurement of time, but use of hydrogen maser clocks in space has been limited due to their bulkiness. Other Hughes-built atomic clocks are being developed for use in the Defense Department's NAVSTAR Global Positioning System.

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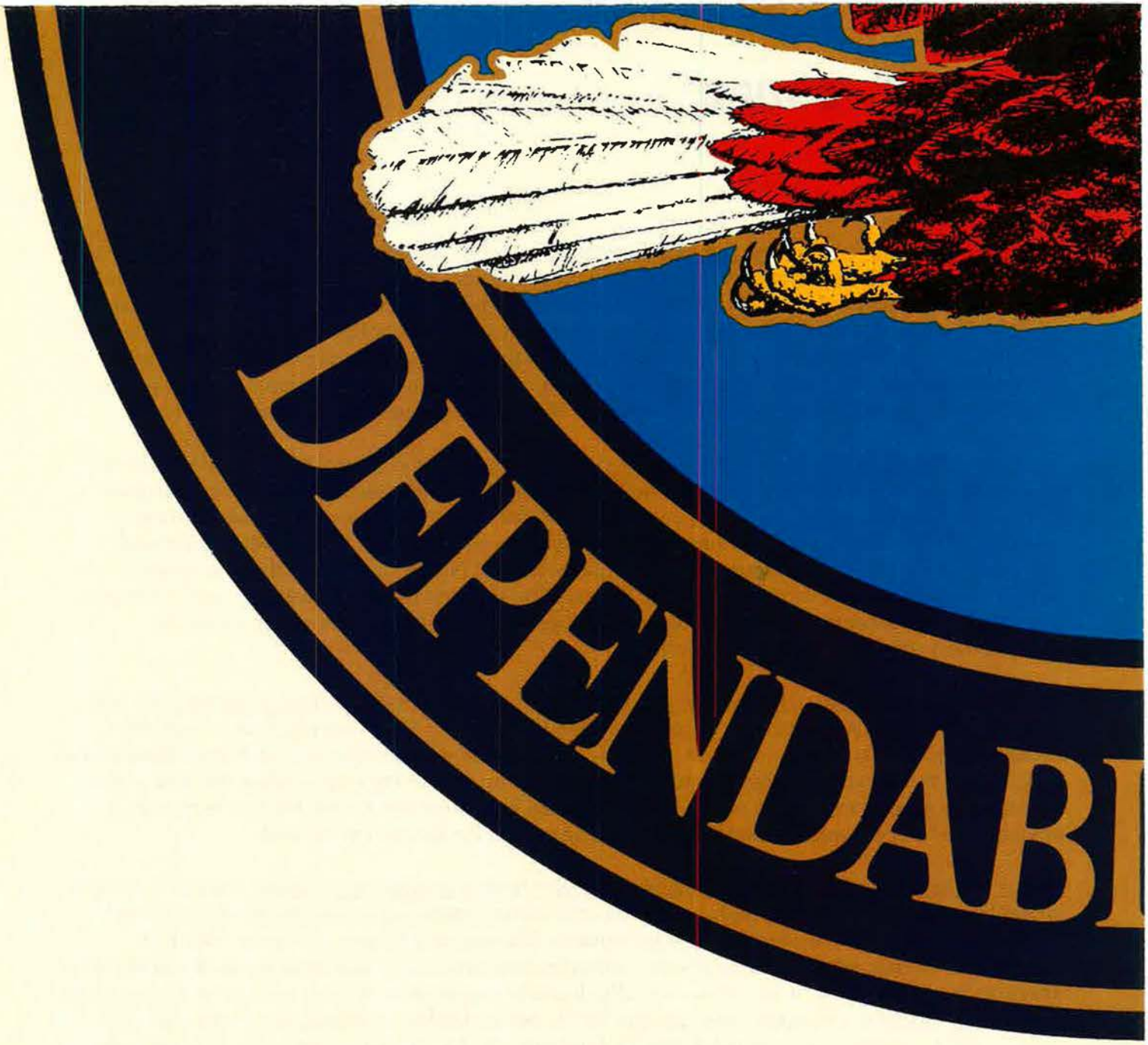

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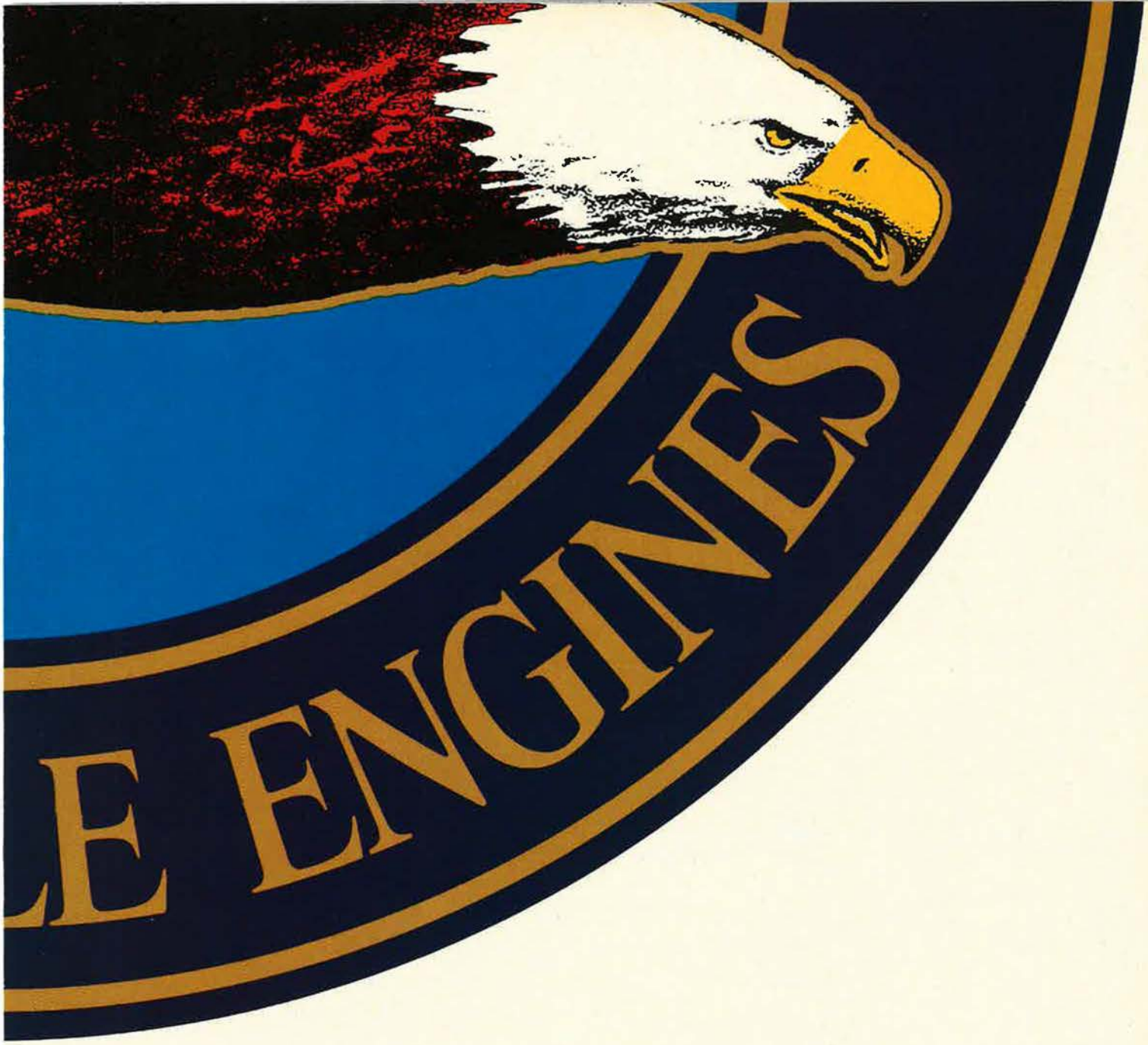

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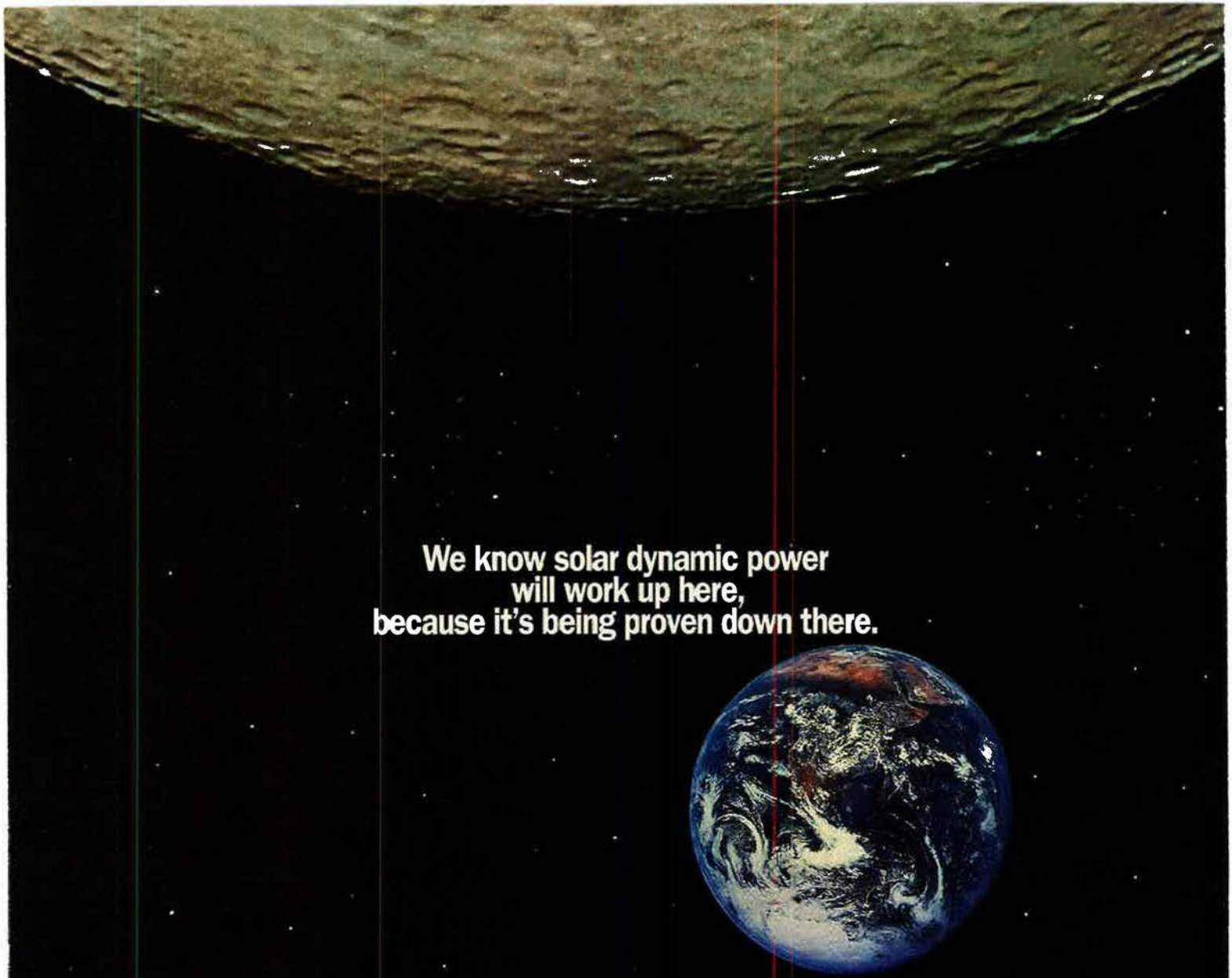

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Allied Signal *Aerospace*

Aerospace World

By Jeffrey P. Rhodes, Aeronautics Editor

★ Citing concerns from Energy Secretary James Watkins and the directors of the nation's three nuclear weapons laboratories, Secretary of Defense Richard Cheney ordered the removal of the AGM-69A Short-Range Attack Missile from Strategic Air Command's fleet of bombers sitting on ground alert on June 8. The grounding order will be in force at least until a special inquiry into safety of the nuclear-tipped missiles is completed.

The laboratory directors said in congressional testimony several weeks earlier that inadvertent aircraft fires could detonate the explosives used to initiate a nuclear explosion or the AGM-69's solid rocket propellant and release fissionable plutonium in the missile's W69 warhead (between 175 and 200 kiloton yield) into the atmosphere. The safety of the warhead on alert missiles was reviewed in the summer of 1989, and based on that review, some SRAM handling procedures were modified as an additional safety precaution.

The supersonic AGM-69s can be carried on B-1B, B-52G/H, and FB-111A aircraft. The fourteen-foot-long missiles have a range of about 100 miles when launched from high altitudes. Boeing built 1,500 SRAMs between 1972 and 1975. A replacement for the AGM-69A, the Boeing AGM-131A SRAM II, is now in development and is expected to be fielded by 1993.

★ A C-141 crew from the 63d Military Airlift Wing at Norton AFB, Calif., claimed top honors at Military Airlift Command's worldwide competition, Airlift Rodeo, held in early June at Pope AFB, N. C. This marked only the second time in the eleven-year history of the competition that a crew flying the Lockheed jet transport has won the event, and the 63d MAW crew was also the first active-duty contingent to win since 1983.

Second place in the competition went to Israel, whose C-130 crew calls Base 27 home. The Israelis also took the Best C-130/C-160 Aircrew and Best Foreign Aircrew honors. Third place went to the 145th Tactical Airlift Group, the Air National Guard unit based in Charlotte, N. C.

Other events and winners included Best C-141 Aircrew and Best C-141 Accuracy Landing—446th MAW (Reserve Associate), McChord AFB, Wash.; Best C-141 Maintenance and Best C-141 Pre-Flight—62d MAW, McChord AFB, Wash,; Best C-141 Post-Flight—443d MAW, Altus AFB, Okla.; and Best C-141 Engine Running On/Offload (ERO)—514th MAW (Reserve Associate), McGuire AFB, N. J.

Best C-130/C-160 Assault Landing—928th Tactical Airlift Group (AFRES), O'Hare Air Reserve Forces Facility, Chicago, Ill.; Best C-130/C-160 Maintenance—United Kingdom, RAF Lyneham; Best C-130/C-160 Pre-Flight—36 Squadron, RAAF Richmond, Australia, and United Kingdom, RAF Lyneham (tie); Best C-130/C-160 Post-Flight—911th TAG (ANG), Greater Pittsburgh IAP, Pa.; and Best C-130/C-160 ERO—130th TAG, Yeager Airport, Charleston, W. Va.

Best Combat Control Team and Best Drop Zone Establishment—1723d Combat Control Squadron (Red), Hurlburt Field, Fla.; Best Combat Leadership—Ciet 340, Toulouse, France; Best Tactical Infiltration and Best Cross-Country Run—501 Squadron, Montijo, Portugal; Best Joint Airdrop Inspection—167th TAG, Shepherd Field, Martinsburg, W. Va., and 317th Tactical Airlift Wing, Pope AFB, N. C. (tie); Best Combat Endurance Run—435th TAW, Rhein-Main AB, West Germany; and Best Transportation Team—317th TAW, Pope AFB, N. C.

In all, twenty-eight US teams (including two from the Marine Corps) and a record eleven foreign teams competed in the event, which features all aspects of the airlift mission.

★ The number two Grumman X-29A Forward Swept Wing technology demonstrator has exceeded expectations so far in its high angle of attack (AOA), or high alpha, test program

Air Force Gen. H. T. Johnson (center), commander in chief of US Transportation Command and Military Airlift Command, greets a foreign team chief on the Pope AFB, N. C., flight line prior to the opening ceremony of Airlift Rodeo '90, MAC's airlift competition. With General Johnson is Army Lt. Gen. Carl Stiner, who was then the XVIII Airborne Corps commander.

The number two Grumman X-29A Forward Swept Wing demonstrator has performed well in its high angle of attack test program now taking place at Edwards AFB, Calif. The aircraft is identical to the first X-29 except for some instrumentation changes and the addition of a fin-mounted spin recovery parachute. The X-29 high alpha test program is scheduled to continue into 1991.

now going on at Edwards AFB, Calif., according to Grumman and Air Force officials. The plane has been flown forty-four times since May 1989 and has demonstrated good controllability at high alpha without the use of wing leading edge flaps and without thrust vectoring.

On the flights so far, the airplane reached an altitude of 50,200 feet and a speed of Mach 1.47 and pulled 6.4 Gs. On one flight, the X-29 flew at a minimum speed of eighty knots, and it briefly reached an AOA of sixty-five degrees. The aircraft has also been put through 3-G maneuvering while at a thirty-five-degree AOA.

On these flights, the aircraft has exhibited good controllability to an AOA in the mid-forty-degree range and good roll characteristics in the twenty-five-degree to forty-degree AOA range, but at about forty degrees the wing rock that was predicted in wind-tunnel tests begins to appear. The plane's triple-redundant digital flight-control system, which has been "tuned" to correct for this motion, is doing its job.

A second part of this second phase of the X-29 program is to assess the military utility of high angle of attack. These tests will show what tactical maneuvering advantages high alpha offers and if there are any critical limitations. The tests also will provide data to calibrate future designs and will help in building a high-alpha database to help define agility.

Agility is an increasingly important consideration in tactical air combat situations. Lt. Col. William Gotcher, the Air Force X-29 program manager, says that agility is needed to enhance "point and shoot" characteristics of fighters; to generate fast transients that are quick and unpredictable, allowing pilots more time to make decisions; and to offset enemy designs that are faster and/or stealthy. He says that the capability to maneuver at high AOA could be the difference in killing or being killed in an air engagement.

The X-29 program is funded through 1991, but the Air Force, NASA, and the Defense Advanced Research Projects Agency are evaluating future uses for the two aircraft. One possibility is to test the use of vortex pneumatic control, or blowing air (and not a reaction control jet) from vents, to point the nose of the aircraft. Without any system installed, the X-29's nose starts to "wander" at AOAs of approximately fifty degrees. Accurate nose pointing could be a critical factor in a one-on-one engagement at slow speeds.

Since the X-29 program began in 1974, the total cost has only been approximately $250 million in direct funding from the government (USAF, NASA, and DARPA) and Grumman. The first X-29, which holds the record for the most flights by an X series aircraft (242), had been in storage since 1988, but it was recently brought back to flight status in order to show it publicly at the US Air and Trade Show in Dayton, Ohio, and the annual Experimental Aircraft Association fly-in at Oshkosh, Wis.

★ **HONORS—Capt. Kenneth Brown,** an F-16 acceptance pilot for the Air Force's Contract Management Division, **was awarded the Air Medal in early June for saving an F-16** last November. Taking off from the General Dynamics facility in Fort Worth, Tex., Captain Brown was flying at 40,000 feet and a speed of Mach 1.6. While performing an engine check, Captain Brown realized he had lost control of the engine when he pulled back on the throttle and it became loose. Ruling out other airfields because of high winds at one and proximity to populated areas at others, Captain Brown decided to return to Fort Worth. With ten minutes of emergency power left and a twelve-minute flight to the runway that is shared with Carswell AFB, he gained altitude to glide in and circled back. The runway was closed because of another pilot's emergency, but was cleared just in time for Captain Brown to land safely.

Lt. Col. John Numoto and SMSgt. John Everett were named the Air Force Reserve's Individual Mobilization Augmentees of the Year in late May. By coincidence, both men are assigned to Edwards AFB, Calif. Colonel Numoto, the IMA to the 6500th Air Base Wing vice commander, was cited for his leadership in supporting space shuttle landings, on-scene disaster response, and base planning for exercises. Sergeant Everett, an IMA aircraft maintenance superintendent assigned to the 6515th Logistics Test Squadron, was cited for creating operating procedures to improve maintenance quality. The annual award is sponsored by the Reserve Officers Association and recognizes IMAs for their leadership abilities, self-improvement efforts, and contributions to the Air Force Reserve.

The late **Maj. Gen. Benjamin D. Foulois,** the third US military airplane pilot and the first Signal Corps dirigible pilot, **was honored with a monument at his birthplace in Washington, Conn.,** on May 25. The Judea chapter of the Daughters of the American Revolution, noting that the town had no tribute to its famous son, erected the bronze and granite memorial outside of what is now Parks Drug, the building where General Foulois was born on December 9, 1879. In 1910, then-Lieutenant Foulois was told to take the Signal Corps's

only airplane to Fort Sam Houston, Tex., and teach himself to fly. He served as Chief of Army Air Service in France during World War I and as Chief of Air Corps from 1931 to 1935. He died in 1967 and was buried in his hometown.

★ **PURCHASES—Lockheed** received a $2.36 million San Antonio Air Logistics Center contract on June 5 **to develop and install a prototype missile defense system on two C-5 transports.** The project, called Pacer Snow, will include Tracor AN/ALE-40 flare dispensers and a Honeywell AN/AAR-47 missile warning system. The modified C-5s will be tested at Eglin AFB, Fla., and Holloman AFB, N. M., by the Air Force Special Missions Operations Test and Evaluation Center. The first installation is to be completed by August, with the second aircraft to be modified by November of this year. Under a separate San Antonio ALC contract, Lockheed is also installing new, safer interior panels on all of the C-5s. The new panels are a composite honeycomb structure of phenolic glass preimpregnated materials covered with a decorative laminate. There are 250 panels of various sizes and shapes in the interior of each C-5.

Bechtel was awarded a $100 million Martin Marietta subcontract **to modify Launch Complex 40** at Cape Canaveral AFS, Fla., **so it can be used to launch Titan IV boosters.** The contract calls for the demolition of existing facilities to accommodate construction of a new mobile service tower, an umbilical tower, an air-conditioning shelter, and a number of other pad structures. Now only capable of being used for Titan III launches, the modifications to Launch Complex 40 will give the Air Force its second Titan IV pad on the east coast. Work is scheduled to be completed in 1992.

Under a proposed Foreign Military Sales program announced May 25, **Italy will buy two McDonnell Douglas/British Aerospace TAV-8B Harrier II trainers.** The $111 million deal calls for the aircraft, one spare Rolls-Royce F402-RR-408 engine, logistics support, and training equipment. The sale is the first step in a larger effort to equip the Italian Navy with a vertical/short takeoff and landing capability for its through-deck carrier, the *Giuseppe Garibaldi*. The Italian Parliament first had to repeal a 1923 law that prohibits its Navy from operating fixed-wing aircraft, but the body recently approved the purchase of eighteen Harriers, including the two TAV-8Bs. The US, Spain, and Italy are working toward a memorandum of understanding to develop a new version of the plane, called a Harrier II Plus, which will use the Hughes APG-65 radar found on the F/A-18. The US Marine Corps has a requirement for a radar-equipped Harrier, but budget pressures may force Spain and Italy to develop the Harrier II Plus and then have the Marines make a follow-on purchase. Another possibility is to retrofit the radar onto existing Marine AV-8Bs.

In an FMS purchase announced May 24, **Spain will buy an unspecified number of Texas Instruments AGM-88** High-Speed Antiradiation Missiles **(HARMs)** for employment on its EF-18 (F/A-18) aircraft. This is the first year of a multiyear procurement effort managed through the US Navy. Deliveries are to begin in early 1992. Spain is the second NATO government to buy HARMs. West Germany, the other foreign buyer, announced on May 15 that a series of three operational test and evaluation HARM firings at the Naval Weapons Center at China Lake, Calif., were all complete successes. The missiles were launched from Panavia Tornado IDS (Interdictor/Strike) aircraft.

Boeing received a $181 million Air Force Systems Command's Aeronautical Systems Division (ASD) contract in April **to proceed into full-scale development of the tactical version of the AGM-131 SRAM II** (Short-Range Attack Missile II). The new variant, to be designated AGM-131B, will first be integrated onto the F-15E, with possible later integration on F-111s, Tornados, and F-16s. Flight tests on an F-15 are expected to start in 1992.

NASA terminated the Orbital Maneuvering Vehicle program on June 7 as the result of budget pressures and a lack of near-term requirements for the "space tug." The OMV, scheduled to make its first flight in 1995, would have been a reusable, remotely controlled, low-Earth-orbit, free-flying vehicle capable of carrying out a wide range of on-orbit satellite servicing and retrieval missions. The only existing requirements for the OMV are to reboost the Hubble Space Telescope and the Advanced X-Ray Astronomy Facility, both of which can be done in the near-term with space shuttle crews. TRW had been working on the OMV under a $700 million contract.

In the famous World War II photograph at left, Supreme Allied Commander Gen. Dwight D. Eisenhower talks with 1st Lt. Wallace Strobel (wearing the number 23) of Company E, 502d Parachute Infantry, 101st Airborne Division, at RAF Greenham Common, England, prior to the D-Day invasion. In the photo on the right, John Eisenhower (General Eisenhower's son) meets a slightly older Mr. Strobel at Greenham Common this past June as current members of the 101st look on. Many of the soldiers are wearing the Combat Infantry Badge on their blouses, likely earned for service in Operation Just Cause.

August Anniversaries

• *August 20, 1910:* Army Lt. Jacob Fickel fires a .30-caliber Springfield rifle at the ground while flying as a passenger in a Curtiss biplane over Sheepshead Bay Track near New York, N. Y. This is the first time a military firearm has been discharged from an airplane.

• *August 15, 1935:* Famed pilot Wiley Post and humorist Will Rogers are killed in a crash of the hybrid Lockheed Orion-Explorer shortly after takeoff near Point Barrow, Alaska.

• *August 13, 1940: Adlertag* (Eagle Day), the start of the Luftwaffe's all-out effort to destroy the Royal Air Force, fails to accomplish its goal. The Germans win the day, though, as thirteen Spitfires and Hurricanes are shot down and forty-seven RAF aircraft are destroyed on the ground. The Luftwaffe loses forty-six aircraft as the Battle of Britain begins in earnest.

• *August 6, 1945:* At 8:15:17 a.m. local time, Maj. Thomas Ferebee toggles "Little Boy," the world's first atomic bomb, from the bomb bay of the B-29 *Enola Gay* over Hiroshima, Japan. When the uranium bomb explodes forty-two seconds later, the blast instantly destroys 62,000 of the 90,000 buildings in the city. Three days later, the crew of *Bock's Car* drops the "Fat Man" plutonium bomb on Nagasaki.

• *August 8, 1945:* Scientists at NACA's Langley Memorial Aeronautical Laboratory in Hampton, Va., speculate in a newspaper story about the possibility of an atomic aircraft engine powered by a "fuel supply the size of a brick with sufficient power to fly around the world many times."

• *August 8, 1955:* Prior to release from its B-29 carrier aircraft, the Bell X-1A research aircraft suffers a crippling explosion over Edwards AFB, Calif. NACA pilot Joe Walker escapes unharmed, but in order for the B-29 crew to land safely, the X-1A has to be jettisoned and is destroyed.

• *August 20, 1955:* Air Force Col. Horace Hanes, flying a North American F-100C, sets a class straight-line speed record of 822.26 mph on a fifteen-kilometer course over Edwards AFB, Calif.

• *August 16, 1960:* At an altitude of 102,800 feet over Tularosa, N. M., Air Force Capt. Joseph Kittinger makes the ultimate leap of faith. In the four and one half minutes between when he steps out of the balloon's open gondola and when his chute deploys, he free-falls 84,700 feet and reaches a speed of 614 mph. Captain Kittinger lands unharmed thirteen minutes and forty-five seconds after jumping. This marks the highest jump and longest free-fall ever recorded.

• *August 21–29, 1965:* The Gemini 5 crew of Air Force Lt. Col. Gordon Cooper and Navy Lt. Cmdr. "Pete" Conrad carry out the US's first long-duration spaceflight, ending one orbit short of eight full days.

• *August 24, 1965:* The 100th Boeing LGM-30B Minuteman I intercontinental ballistic missile test launch is successfully carried out from Vandenberg AFB, Calif., by a crew from the 341st Strategic Missile Wing at Malmstrom AFB, Mont. The launch is observed from space by the Gemini 5 crew.

• *August 24, 1970:* Two Air Force crews complete the first nonstop transpacific helicopter flight as the crews land their Sikorsky HH-53Cs at Da Nang AB, South Vietnam, after a 9,000-mile flight from Eglin AFB, Fla. The crews were refueled in flight by crews flying Lockheed HC-130 tankers.

• *August 20, 1975:* The Viking 1 mission to Mars is launched from Cape Canaveral AFS, Fla., on a Titan III booster. The spacecraft enters Martian orbit on June 19, 1976, and the lander, which takes soil samples and performs rudimentary analysis on them, soft-lands on July 20th.

★ **DELIVERIES**—The first phase of the **Unisys-designed and installed Strategic Air Command Intelligence Network** (SACINTNET) **went on line** in May. The first operational intelligence network based on Fiber Distributed Data Interface Technology, SACINTNET offers SAC commanders and the US intelligence community a faster (data rates of up to 100 million bits per second), more reliable (available 99.99 percent of the time), and secure means to communicate intelligence data. The first phase, called the "system-high" mode, allows users access to classified data, but all users must be cleared to the highest level of classification processed on the system. The second, or "compartmented," mode will segregate user access depending on clearance level and should be operational later this year. Unisys has a $10 million, eight-year contract for installation and operation of SACINTNET. The system was completed using commercially available cable, processors, and work stations.

The **Wright Research and Development Center,** the research arm of ASD at Wright-Patterson AFB, Ohio, opened its **new facility that will use** computerized axial tomography, or **CAT scans, to inspect materials for manufacturing, assembly, or service-induced flaws** on June 1. The two CAT systems (similar to those in hospitals) in the $4 million facility will allow scientists to inspect aircraft and missile hardware internally without having to dismantle the component. The facility will also be used to identify other ways to use CAT technology and create new capabilities through system and data analysis modification.

★ **MILESTONES**—When they took off at Pease AFB, N. H., on June 1, the two 509th Bomb Wing crews were flying General Dynamics FB-111As. When they landed later that day at Cannon AFB, N. M., those same crews were flying F-111Gs, as **Strategic Air Command had turned over the first pair of FB-111s to Tactical Air Command.** Except for one minor internal modification, the aircraft are the same—the change in designation results from the change in ownership. SAC will turn over all fifty-nine of its FB-111s (two other aircraft are used for test) to TAC by the first quarter of 1992. Pease will close on January 1, 1991, and the 509th BMW, whose World War II predecessor dropped the atomic bombs on Japan, will be deactivated. The 509th BMW's twenty-seven other FB-111s will be delivered to Cannon later this year. The wing's KC-135 tankers will be reassigned to other units. Plans for the 380th BMW at Plattsburgh AFB, N. Y., SAC's other FB-111A unit, have not been revealed publicly.

The May 22 flight of the **McDonnell Douglas F-15 S/MTD** (Short Takeoff and Landing/Maneuvering Technology Demonstrator) came to an abrupt end, as the **aircraft's crew landed in less than 1,650 feet** with the aid of its Pratt & Whitney-developed two-dimensional, thrust-reversing engine nozzles. Normal landing distance for an F-15 is approximately 4,800 feet. The crew, company pilot Larry Walker and Air Force Maj. Erwin "Bud" Jenschke, Jr., made the historic landing after a one-hour flight at the Air Force Flight Test Center at Edwards AFB, Calif. For short landings, the engine exhausts are blocked, forcing the efflux to vent through louvers at the top and bottom of the nozzle. On touchdown, the louvers direct the flow forward, providing full reverse thrust to reduce ground roll. On the May 30 flight, the modified F-15B's brakes failed on landing, but the crew was still able to stop in less than 2,000 feet.

One of the most visible symbols of the cold war, **Checkpoint Charlie,** was

abolished on June 21. The white, prefabricated guard shack on Friedrichstrasse in West Berlin was hoisted by a crane and trucked off to a museum as Secretary of State James A. Baker III, the foreign ministers of the three other Allied powers, and the foreign ministers of East and West Germany looked on. Erected on August 21, 1961, in response to East Germany's building the Berlin Wall to choke off a flood of refugees to West Berlin, Checkpoint Charlie was the scene of the cold war's only direct confrontation in Europe. On October 27–28, 1961, ten American and ten Soviet tanks faced off 100 yards apart after the East Germans had tried to control US diplomats and soldiers entering East Berlin. The Soviets backed down, and the US tanks were removed shortly afterward.

The **Rafael Industries AGM-142A Have Nap standoff missile completed its Initial Operational Test and Evaluation launches** by scoring two direct hits in two late May tests at Eglin AFB, Fla. In the first test, the TV-guided missile was launched at high altitude from a B-52G. The AGM-142 then flew a ballistic profile and destroyed a simulated surface-to-air missile site. On the second test, the 3,300-pound missile hit a stationary F-102 target on the ground. Martin Marietta recently entered a coproduction agreement with Rafael, the Israeli developer of the AGM-142, which is also called Popeye.

Another Air Force Systems Command's Munitions Systems Division project, the **GBU-15-I glide bomb, scored a direct hit in its first guided development flight** on May 18. Released from an F-4 flying at Mach 0.85 at an altitude of 5,000 feet over the Eglin range, the plane's weapon system officer guided the bomb 6.5 miles to a twenty-foot by twenty-foot, reinforced concrete target. The GBU-15-I (for "Improved") combines the accuracy of the GBU-15 with the penetration capability of the improved 2,000-pound BLU-109/B iron bomb.

Eleven Rockwell B-1B crews from the 96th Bomb Wing's 337th Bomb Squadron scored a combined .99 damage expectancy rate during flights made on May 26 as part of the wing's yearly Operational Readiness Inspection. The damage expectancy rate is believed to be the highest ever recorded during a Strategic Air Command ORI. The rate is based on four categories (aircraft generation, weapon system reliability, probability of penetration into enemy airspace, and probability of damage), with 1.0 being a perfect run. Only a maintenance problem that delayed one takeoff prevented a perfect score. Wing officials were quick to credit the wing's maintainers and tanker crews for their critical roles in the bomber crews' success.

The **Boeing MH-47E Chinook Army special operations helicopter made its first flight** on June 1 from the factory at Ridley Township, Pa., to the company's flight test center in Wilmington, Del. Boeing test pilots Ron Mecklin and John Tulloch crewed the twin-rotor helicopter on the flight. The test program for the modified CH-47Ds will continue until November, when the aircraft will be turned over to the Army for follow-on testing. The Army has ordered eleven production MH-47Es and has an option on thirty-nine more. *[See "Aerospace World," February 1990 issue, for more details on the MH-47E.]*

Entertainer **Bob Hope embarked on his fiftieth USO tour** on May 2. The nine-day tour took the comedian's entourage to Germany, England, and the Soviet Union. A C-141B crew from the 437th Military Airlift Wing at Charleston AFB, S. C., and a StarLifter crew from the Air National Guard's 172d Military Airlift Group at Jackson, Miss., flew the group to Europe. Mr. Hope has been performing for US service members since May 6, 1941, when he and a group of Hollywood performers went to March Field, Calif., to do a radio show. He made the first of his famous Christmas tours to entertain troops in 1948, when Secretary of the Air Force Stuart Symington asked him to go to Berlin to entertain troops involved in the Berlin Airlift. Over the years, he has become the United Services Organization's ambassador of goodwill as he has entertained soldiers, sailors, and airmen all over the world.

★ **NEWS NOTES**—The **Air Force will soon complete tests of a reengined Lockheed TR-1A reconnaissance aircraft.** The General Electric F101-GE-F29 engine used in the program is a derivative of the F118-GE-100 engine used in the Northrop B-2 Stealth bomber. The new engine is in the 19,000-pound-thrust category, which offers 2,000 more pounds of thrust than the old and increasingly unsupportable Pratt & Whitney J75-P-13B powerplant currently in use on the TR-1s. The lighter-weight GE engine will allow the aircraft to reach operational altitudes above 80,000 feet and will increase the plane's range by more than fifteen percent. The test

program was funded for 100 hours of flight time ($20 million in both FY 1989 and FY 1990) and is being conducted at the Air Force Flight Test Center at Edwards AFB, Calif. The Air Force wants to reengine up to forty aircraft in the TR-1/U-2R fleet, but no money has yet been budgeted. If approved, the reengine effort could begin as early as 1992.

After eighteen months of negotiations involving two governments and a dozen agencies, examples of two of the missiles banned under the Intermediate-range Nuclear Forces Treaty, **a US MGM-31 Pershing II and a Soviet SS-20, now stand side by side in the National Air and Space Museum** in Washington. The INF Treaty Protocols allow each side to retain up to fifteen disarmed missiles for display. The Army agreed to give the museum two Pershing IIs in order for a trade to be worked out, but details of the swap

Displayed together in the National Air and Space Museum's Milestones of Flight Gallery are examples of two of the missiles destroyed under the Intermediate-range Nuclear Forces Treaty. At left, the three-warhead Soviet SS-20; on the right, a single-warhead US MGM-31 Pershing II. A similar exhibit will soon open in Moscow. US Air Force C-141 crews were tasked with taking the display Pershing II to Moscow and bringing the SS-20 back to the US after negotiations for the swap were worked out.

Senior Staff Changes

RETIREMENTS: M/G Hugh L. **Cox** III; B/G Peter D. **Hayes;** M/G Donald A. **Logeais;** M/G John C. **Scheidt,** Jr.

PROMOTIONS: To be **Lieutenant General:** Ronald R. **Fogleman.**

CHANGES: L/G Joseph W. Ashy, from Vice Cmdr., Hq. TAC, and Vice CINC, USAFLANT, USLANTCOM, Langley AFB, Va., to Cmdr., Hq. ATC, Randolph AFB. Tex., replacing L/G (Gen. selectee) Robert C. Oaks . . . **L/G Thomas A. Baker,** from Cmdr., 7th AF, PACAF; Dep. CINC, UN Cmd. Korea; Dep. Cmdr., US Forces Korea; and Cmdr., ROK/US Air Component Cmd., Combined Forces Cmd., Osan AB, Korea, to Vice Cmdr., Hq. TAC, and Vice CINC, USAFLANT, USLANTCOM, Langley AFB, Va., replacing L/G Joseph W. Ashy . . . **B/G Lawrence E. Boese,** from Cmdr., 318th AD, and Kaiserslautern Mil. Community Cmdr., Hq. USAFE, Ramstein AB, West Germany, to DCS/P&P, Hq. USAFE, Ramstein AB, West Germany, replacing B/G Lawrence P. Farrell, Jr. . . . **B/G Lawrence P. Farrell, Jr.,** from DCS/P&P, Hq. USAFE, Ramstein AB, West Germany, to Dep. Dir., Prgms. & Eval., DCS/P&R, and Chairman, PRC, Hq. USAF, Washington, D. C., replacing B/G (M/G selectee) Eugene E. Habiger.

M/G (L/G selectee) Ronald R. Fogleman, from Dir., Prgms. & Eval., DCS/P&R, and Chairman, Air Force Board, Hq. USAF, Washington., D. C., to Cmdr., 7th AF, PACAF; Dep. CINC, UN Cmd. Korea; Dep. Cmdr., US Forces Korea; and Cmdr., ROK/US Air Component Cmd., Combined Forces Cmd., Osan AB, Korea, replacing L/G Thomas A. Baker . . . **B/G (M/G selectee) Eugene E. Habiger,** from Dep. Dir., Prgms. & Eval., DCS/P&R, and Chairman, PRC, Hq. USAF, Washington, D. C., to Dir., Prgms. & Eval., DCS/P&R, and Chairman, Air Force Board, Hq. USAF, Washington., D. C., replacing M/G (L/G selectee) Ronald R. Fogleman . . . **Col. (B/G selectee) Henry M. Hobgood,** from Ass't for Gen. Officer Matters, DCS/Personnel, Hq. USAF, Washington, D. C., to Dir., Manpower & Org., DCS/P&R, Hq. USAF, Washington, D. C., replacing M/G Paul E. Landers, Jr. . . . **B/G (M/G selectee) Ronald W. Iverson,** from Vice Cmdr., AFMPC, and Dep. Ass't DCS/Pers. for Mil. Pers., Randolph AFB, Tex., to DCS/Ops., and Staff Dir., Ops., PACOPS, Hq. PACAF, Hickam AFB, Hawaii, replacing M/G Donald Snyder.

M/G Paul E. Landers, Jr., from Dir., Manpower & Org., DCS/P&R, Hq. USAF, Washington, D. C., to Cmdr., 21st AF, MAC, McGuire AFB, N. J., replacing retired M/G Donald A. Logeais . . . **B/G Kenneth G. Miller,** from Cmdr., Contract Mgt. Div., AFSC, Kirtland AFB, N. M., to Cmdr., Def. Contract Mgt. Region, DLA, Los Angeles, Calif. . . . **M/G Donald Snyder,** from DCS/Ops., and Staff Dir., Ops., PACOPS, Hq. PACAF, Hickam AFB, Hawaii, to Dep. CINC, Hq. USSOCOM, MacDill AFB, Fla., replacing retired M/G Hugh L. Cox III . . . **Col. (B/G selectee) Richard T. Swope,** from IG, Hq. PACAF, Hickam AFB, Hawaii, to Cmdr., 318th AD, and Kaiserslautern Mil. Community Cmdr., Hq. USAFE, Ramstein AB, West Germany, replacing B/G Lawrence E. Boese.

AFRES CHANGE: B/G Robert A. McIntosh, from Cmdr., 10th AF, AFRES, Bergstrom AFB, Tex., to Cmdr., 10th AF, AFRES, Bergstrom AFB, Tex., and Reserve Forces Policy Board.

SENIOR ENLISTED ADVISOR (SEA) CHANGES: CMSgt. Nicholas L. Lewis, to SEA, Hq. AFTAC, Patrick AFB, Fla., replacing CMSgt. Dennis D. Corbiser . . . **CMSgt. Russell N. Moffett,** to SEA, Hq. AFCOMS, Kelly AFB, Tex., replacing CMSgt. Glenn H. Lewis . . . **CMSgt. James R. Robertson,** to SEA, Hq. AFSOC, Hurlburt Field, Fla.

SENIOR EXECUTIVE SERVICE (SES) CHANGES: William O. Berry, from Physiologist (GM-15), Dir., Life Sciences, AFOSR, Bolling AFB, D. C., to Dir. of Life Sciences, AFOSR, Bolling AFB, D. C., replacing Robert K. Dismukes . . . **Jack B. Davis,** to Dep. Ass't Sec'y, Readiness Support, OSAF, Washington, D. C. . . . **Robert C. Majors,** from Dep. Cmdr., Std. Sys. Ctr., Gunther AFB, Ala., to Automated Info. Sys. Prgm. Exec. Officer, AFPEO, Washington, D. C. . . . **Gene L. Mortenson,** from Dep. Dir., Maintenance, Directorate of Materiel Mgt., Ogden ALC, Hill AFB, Utah, to Dep. Dir., Materiel Mgt., Directorate of Materiel Mgt., Ogden ALC, Hill AFB, Utah, replacing Louis K. Dumas . . . **Michael P. Reardon,** to Dep. Ass't Sec'y, Reserve Affairs, OSAF, Washington, D. C. . . . **Earl W. Rubright,** from Ass't Dir., Space and Strat. Sys. (GM-15), Ass't Sec'y of the Army (Research, Dev. and Acq.), to Scientific Advisor, Hq. USCENTCOM, MacDill AFB, Fla, replacing William G. Lese. ■

were not completed until last December. C-141B crews based at McGuire AFB, N. J., took the Pershing II to the Soviet Union and brought the three-warhead SS-20 back to the US after the exchange took place at Sheremetievo Airport in Moscow on May 17. The SS-20, which is actually a factory reject (the Pershing II is a training missile), was then brought back to the US and trucked to Washington. The Treaty Protocols allow for the other side to inspect the displayed missiles periodically to verify that they are still inoperable, so the exact map coordinates of the museum—38° 53′ 16.95″ N/77° 01′ 09.94″ W—had to be determined and given to the Soviets. An accompanying exhibit, funded by System Planning Corp., explains the Treaty. A similar missile display is scheduled to open in Central Armed Forces Museum in Moscow in the near future.

The **second phase of the flight-test program for the Northrop B-2 bomber was completed on June 13.** The plane then entered a scheduled three-to-four month layup to prepare it for low-observable characteristics testing this fall. The sixteenth flight of the bomber was carried out by Air Force Lt. Col. John Small and Col. Frank Birk. During the two hour and thirteen minute flight from Edwards AFB to Palmdale, Calif., the crew continued flight envelope expansion and made one aerial refueling. The bomber has now flown more than sixty-seven hours. The thirteenth flight (May 22) was made by Northrop pilots Cal Jewett and Leroy Schroeder and lasted more than five hours. An indication of a flight-control problem ended the fourteenth flight (June 1) after just over one hour, but a three-hour flight on June 2 accomplished the previous day's goals. Air Force Lt. Col. Tom LeBeau and Mr. Schroeder crewed both flights.

Recent happenings in the space-launch world: The Air Force successfully launched its second **Martin Marietta Titan IV** on June 8. The launch, made from Launch Complex 41 at the Kennedy Space Center in Florida, boosted a classified payload believed to be an electronic intelligence satellite. The first Titan IV was launched from Cape Canaveral last year. On May 9, an LTV Scout rocket successfully boosted two Defense Advanced Research Projects Agency Multiple Access Communications Satellites **(MACSATs)** into orbit. The MACSATs have data store-and-forward capabilities, and they can interrogate and collect data from unattended sensors. Finally, the Roentgen Satellite **(ROSAT)** was successfully launched from Cape Canaveral atop a McDonnell Douglas Delta II booster on June 1. The satellite, a cooperative effort between the US and West Germany, is designed to conduct a six-month study to chart X-ray-emitting sources in the visible universe, followed by a detailed study of approximately 1,000 of the anticipated 50,000 to 100,000 sources that will be detected. On-orbit verification of the satellite will take two months.

Sandia National Laboratory in Livermore, Calif., **has developed a battlefield reconnaissance artillery shell.** The Video Imaging Projectile (VIP), a 155-mm artillery round, contains a Lucite window that reflects a narrow field of view onto a photodiode in the shell. The photodiode converts the light images into a continuous electrical signal that is then transmitted to a ground receiver. A microcomputer is used to convert the data into a picture. The VIP is simple, inexpensive, and provides real-time data to field commanders. The VIP has the same range as a regular 155-mm round.

The first McDonnell Douglas C-17A transport was removed from its tooling fixture and lowered onto its own wheels on June 30. Removal of the aircraft from its specially constructed, automated fuselage/wing alignment system was accomplished on schedule. Mission computer software was delivered in mid-June, and the critical design review of the electronic flight control system was recently completed.

The **Korean War Veterans Memorial Fund** reports that it **is halfway to its goal of raising $11 million** to build the monument to America's "forgotten war." The new memorial, to be built across from the Vietnam Veterans Memorial in Washington, D. C., will be 120 yards long and forty yards wide. It will consist of thirty-eight figures (roughly the size of an infantry platoon) representing members of all US services (to include members of various racial and ethnic groups), Republic of Korea soldiers, and troops from the other countries that made up the United Nations forces. Additionally, a mural will depict the troops and events of the Korean War. The Memorial Fund group must raise the remaining funds by the end of October 1991 in order to begin construction and meet congressional deadlines for memorials erected in the District of Columbia.

★ **DIED**—Retired **Lt. Col. Gerald O. Young,** one of twelve Air Force winners of the Medal of Honor in Vietnam, of cancer at his home on Guemes Island, Wash., on June 6. He was sixty-one. On November 9, 1967, then-Captain Young maneuvered his HH-3E rescue helicopter to a hillside near Khe Sanh to pick up five survivors of an Army reconnaissance unit that had been ambushed. His Jolly Green Giant took a direct hit and crashed. Suffering from severe burns, Captain Young rescued one man from the wreckage and hid him in the bushes. He then lured the North Vietnamese away from the crash site, so the others could be rescued. Captain Young evaded capture and was himself rescued seventeen hours after the crash. He later served at the Air Force Academy, was instrumental in setting up the forerunner to the Air Force Mast program (which provides helicopter assistance to civilian highway patrols), flew with the 1st Helicopter Squadron (which performs VIP transport) at Andrews AFB, Md., and served as Air Attaché to Colombia. He retired in 1980.

★ **UPDATE**—At a Pentagon press conference on May 31, it was announced that **Secretary of Defense Richard Cheney is satisfied the Air Force did not withhold information or intentionally try to mislead him about the attack** made by two F-117A Stealth fighter pilots **on the barracks at Rio Hato during Operation Just Cause,** the US military action in Panama last December. An investigation of the incident was conducted by Air Force Inspector General Lt. Gen. Bradley Hosmer, and his analysis cites a problem in reporting procedures and states that many of the reports that reached senior Air Force officials were incomplete. The compartmentalized secrecy that still surrounds many aspects of the F-117 was a contributing factor in the miscommunications. Steps are now being taken to improve the reporting process in future actions. *[For more on the attack, see "The Black Jet," July 1990 issue.]* ■

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TEST PILOTS GIVE HIGH MARKS TO THE V-22.

Four V-22 aircraft have flown a combined total of more than 160 hours.

The first government flight evaluation of the V-22 Osprey has been completed. Three Marine Corps test pilots evaluated the aircraft during thirty flight hours.

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A JOINT SERVICE PROGRAM

OSPREY UPDATE

NO. 1 JUNE 1990

The emphasis is on how space assets can help operational forces with communications, navigation, intelligence, and more.

Space Gets Down to Earth

By James W. Canan, Senior Editor

IN military circles, space is losing its high-flown, R&D aura and is taking on a down-to-earth, operational look. Warfighting commanders are fast becoming sold on space systems. From Panama to the Persian Gulf, those systems have shown their stuff in support of combat forces under fire.

As space's stock goes up, all the services want more say in space policy and operations *[see "The Army and Navy in Space," page 36]*. Each has its own space command, and all belong to the unified US Space Command. But the Air Force holds sway. It builds, launches, and operates the great bulk of national security satellites, is the service most closely identified with space, and intends to keep it that way.

There are many recent examples of the value of space systems, particularly of "multiuser" satellites operated by the Air Force for itself and the other services. One case in point was the Navy's use of USAF-operated Global Positioning System navigation satellites in the Persian Gulf.

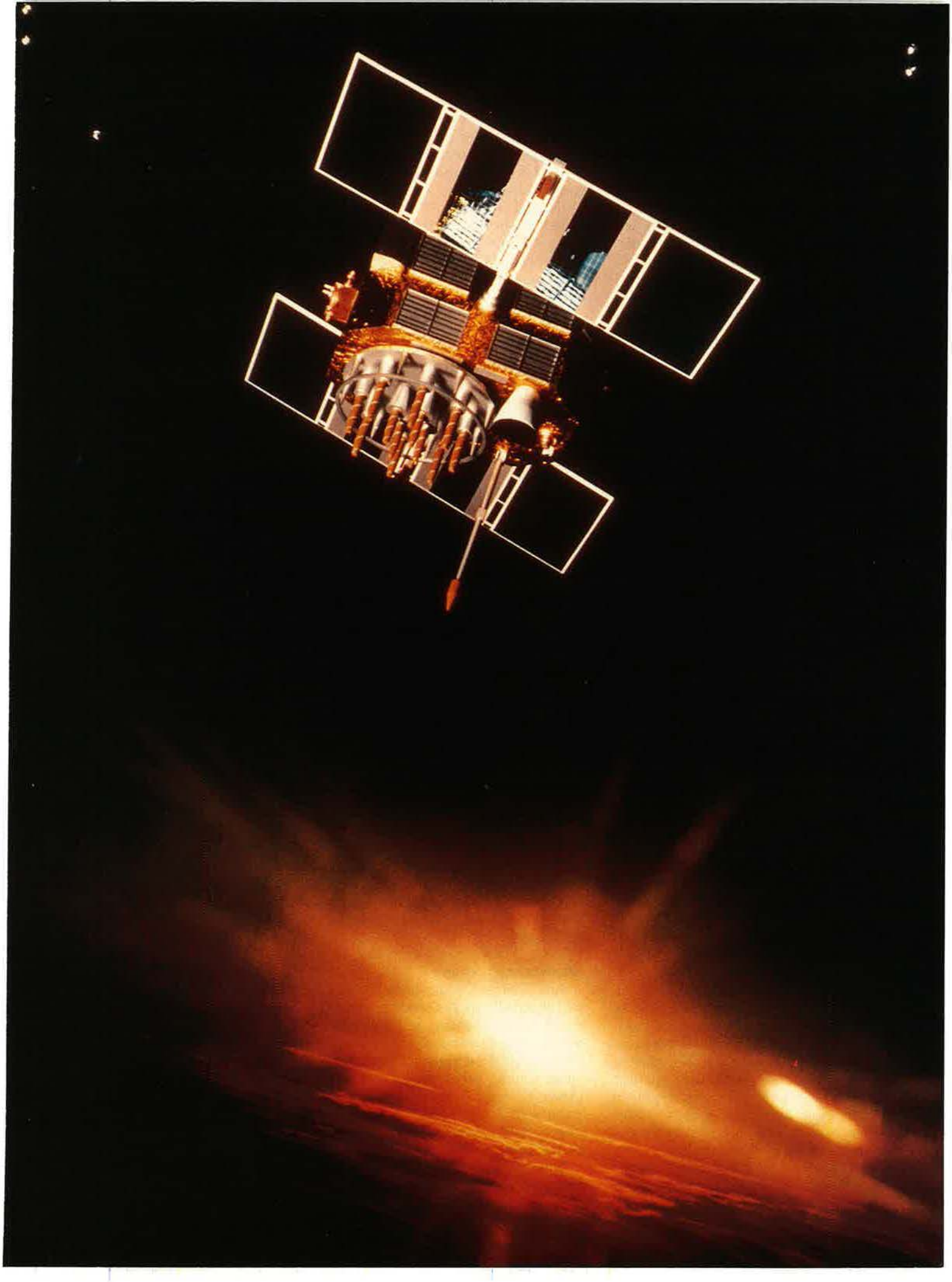
Assigned to clear the Gulf of tanker-menacing Iranian mines, the Navy borrowed GPS receivers from Air Force Space Command, installed them on minesweepers, and tapped into the half-formed GPS constellation on orbit. The navigation satellites enabled the minesweeper skippers to know the exact whereabouts of their ships on the move, around the clock, within a radius of sixteen meters. This made it possible for the ships to sweep assigned sectors of the Gulf on precisely delineated tracks, with no misses and no overlaps. Such sure-handed sweeping would have been impossible with the Navy's old-standby Transit navigation satellites still serving the fleet. Their position-fixing accuracy is measured in miles, not in meters.

Martin C. Faga, Assistant Secretary of the Air Force for Space, notes that the Navy never returned the GPS receivers. "That's fine by us," he adds. "We're glad they kept them. The Navy is buying into the GPS system, in any case."

Mr. Faga emphasizes that the Air Force is not trying to deprive the other services of their fair shares of US space operations. "Everybody understands that each service

The Air Force oversees and operates nine-tenths of all US military space systems.

—Photo by Erik Simonsen



should operate its own space systems for its unique purposes," he says. "but most multiuser systems have been—and should continue to be—operated by the Air Force."

The Air Force oversees and operates nine-tenths of all space systems devoted to US military purposes. This goes a long way toward explaining why approximately nine-tenths of all space-experienced military personnel in the entire Department of Defense wear Air Force blue, and why USAF's space budget grows, in absolute and relative terms, every year.

Of all the services and NASA too, the Air Force is by far the biggest spender on space. In the current fiscal year, the US space budget stands at $31 billion. The Defense Department's share is $18 billion. The Air Force accounts for about eighty percent of that—roughly $14.5 billion—and for almost half of the NASA-enfolding national total.

"Money talks," Mr. Faga declares. "We have the money in our budget and in our longer-range program planning to advance the systems that the users are calling for, or that the Air Force thinks will be needed in the future. The Air Force takes very seriously its role as the principal provider of space systems for the nation's defense. We intend to put our experience, infrastructure, and fiscal resources toward maintaining the best space capabilities in the world."

What the Air Force hopes to do in space is tied into its perception of what space can do for the Air Force.

Seeds of Power

The Air Force sees space as the seedbed of the "global power" that the service, in its drive for strategic and tactical preeminence, proposes to provide national command authorities in years ahead.

Air Force Secretary Donald B. Rice gets to the heart of the matter. Calling the Air Force the "aerospace service" and space "the natural extension of the Air Force's operating medium," Dr. Rice declares, "Until the modern age, surface forces were the dominant means of ensuring America's security. Now aerospace power has inherited a large share of that role."

At a time of shrinking forces and budgets, and facing the prospect of fewer forward bases and wider-ranging, farther-reaching deployments, USAF is intent on exploiting the force-multiplying, global-coverage advantages uniquely offered by space-based systems.

Lt. Gen. Thomas Moorman, commander of Air Force Space Command, declares, "We're going to be all the more dependent on space systems for global support in the 1990s. They will become increasingly important as force-multipliers."

Why? Says General Moorman, "In a multipolar world, a world of diverse threats, our demands for global information will be much more intense. The forces we deploy will require the traditional kinds of support: communications, navigation, intelligence, weather reports. We'll have fewer places overseas from which to collect that kind of information. But space systems will be on the scene, already there, everywhere, to provide it."

Some such systems are designed to give forces on the fly "situational awareness" on whatever scale is required—global, regional, or local. Others are designed to help those forces get to the fight and wage it with utmost efficiency. Notable in this regard are navigation satellites for aircraft and for unmanned "smart" munitions, such as the long-range standoff missiles now catching on in the Air Force as mainstay nonnuclear, tactical weapons for future years.

The many force-enhancement applications of space systems showed up in Operation Just Cause. General Moorman calls that US combined-arms operation in Panama late last year "a microcosm" of space systems contributing to combat as they would on a larger, more remote military stage.

Showcasing Space

Just Cause was a showcase for just about all types of space resources. A remote-sensing satellite provided US commanders with the big picture. GPS satellites made it possible, among other things, for aircrews to zero in on air-evacuation points and airdrop and pickup zones. Soldiers toted GPS terminals in backpacks.

Navigation satellites and a weather satellite made it possible to provide crews of all aircraft—tankers, airlifters, gunships, fighters, and reconnaissance, electronic-warfare, and command-and-control platforms—with optimum flight paths. Some air routes were reordered as a result. One hilltop airstrip was shunned after icing conditions showed up in images sent to Earth by a weather satellite on the watch for temperature gradations among other things.

Communications satellites made everything work. As space buffs like to point out, the single most important military function of space systems, as constituted today, may be to provide satellite links for battlefield and combat-zone communications, thereby surmounting line-of-sight limitations and vastly extending the ranges of voice and data transmissions crucial to command and control.

"Due to our communications satellites, our forces at the tip of the sword are never out of touch," Secretary Rice declares.

In the Panama operation, Navy Fleet Satellite Communications (FLTSATCOM) UHF satellites and USAF-operated Defense Satellite Communications System (DSCS) SHF (super-high frequency) satellites were the major players. General Moorman reports that Just Cause "used an awful lot of the DSCS resource—that is, the two DSCS birds—over that part of the world."

Some time after the successful completion of Just Cause, Mr. Faga, representing the space side of the Air Force, visited Army Lt. Gen. Carl Stiner, field commander of the operation, who has since added his fourth star and been tapped to head the US Special Operations Command. Mr. Faga expected General Stiner to typify the tough combat commander in displaying little understanding of, or appreciation for, the contributions of nonshooting space systems to the successes of his troops.

"Great Support"

To Mr. Faga's delight, the General greeted him with enthusiasm, gave him an autographed picture with the message, "thanks for the great support in Just Cause," and told him, "I can't go to war without space systems."

Of all such systems, the GPS sat-

ellites have probably made the biggest impact on the broadest scale. Secretary Rice reports that "a GPS-equipped RC-135 cleaned up in last year's SAC bombing and navigation competition. It hit every checkpoint within three seconds. Its accuracy was so good that SAC may not let GPS-equipped planes compete again until the whole fleet is equipped."

There are thirteen GPS satellites on orbit. It will be three more years until the GPS constellation is filled out, for full-time global coverage, with twenty-one operational satellites and three spares in varied spacetracks. The full-up system is expected to enable its Air Force, Army, and Navy users to plot their positions within ten meters under all circumstances.

The partial GPS constellation now in space provides limited, although unprecedented, coverage.

A two-dimensional position fix, such as that of a tank moving on land, requires simultaneous reception of signals from three GPS satellites. Such coverage is available, depending on the positions of users, only from fourteen to twenty-two hours a day. Round-the-clock, round-the-world coverage is expected to be available in a year, as the constellation continues to form.

Three-dimensional position-fixing—for example, the location and altitude of an aircraft in flight—requires reception from four GPS satellites at the same time. This service is currently available to users from nine to seventeen hours a day. Full-time, three-dimensional, global GPS coverage will be at the disposal of all users everywhere in mid-1993 if the constellation is filled out on schedule.

US warfighting CINCs can hardly wait. As General Moorman says, "They realize the tremendous force-enhancement value of GPS." This is why the CINCs petitioned, two years ago, to have the Air Force add three satellites to the originally planned twenty-one-satellite constellation. They were concerned about the coverage gaps, however slight, that the smaller constellation would have left in certain places on and above the planet.

GPS is a prime example of a subtle but profound shift in the way commanders have come to regard space systems in general—not just as stand-apart, above-the-battle force multipliers, but as organic to the fray, undeniably integral to forces and weapons.

GPS satellites may not shoot, but they make a tremendous difference in the effectiveness of the troops and things that do. The navigational, position-fixing precision provided by the satellites translates into "orders of magnitude increases in the accuracy" of forces equipped with GPS receivers, says an Air Force planning document, and, thus, into unheard-of capability for concentrating firepower and making it count.

Commanders now regard space systems as integral to forces and weapons.

In some of tomorrow's standoff weapons, GPS guidance may be combined with inertial guidance. Such weapons may include cruise missiles, submarine-launched ballistic missiles, and long-range tactical standoff missiles, as well as the aircraft, ships, submarines, and land vehicles that launch them.

The partial GPS constellation now in space has performed well enough to leave "no doubt that GPS will revolutionize the way we fight future conflicts in all domains," General Moorman declares.

Receivers Galore

That future is nearly here. The services are expected to possess about 25,000 GPS receivers by the turn of the century, with all Army line units and Air Force and Navy combat aircraft and ships plugged into the system. Aircraft receivers will allow for right-on-the-money, all-weather close air support, battlefield interdiction, and offensive counterair operations.

"We're seeing the rapid proliferation of GPS terminals in all sorts of platforms already, and it marks the beginning of something big," says Lt. Gen. Donald Cromer, commander of Air Force Systems Command's Space Systems Division. "GPS will permit changes in air and ground tactics, in planning and scheduling missions, in air refueling, special operations, and more. GPS terminals are going into special operations aircraft. They'll enable special ops forces to operate in a much different manner, to take troops in and extract them with great precision."

New weather satellites—state-of-the-art systems emerging from the Defense Meteorological Satellite Program—are as vital as any, because, notes General Cromer, "weather is a big factor in any military operation."

"Tactical terminals for weather satellites are proliferating," he says. "Local commanders and theater commanders are getting them. The Marines are getting them now. The DMSP satellites can do many things, [such as] provide very accurate data on ice states, sea states. They have a big effect on flight plans, on air refueling routes."

A weather satellite makes a complete polar orbit of the Earth in 101 minutes, surveying forty million square miles with every revolution, and "downlinks" much of its collected imagery in real time.

Dr. Rice singled out such satellites in making the point that "space systems offer range," an attribute that, according to him and like-minded Air Force leaders, sets the Air Force apart from the other services.

"To be a twenty-first-century superpower, the US needs the ability to help friends and quell enemies within hours," Dr. Rice continues. "Only with aerospace forces can you concentrate and reconcentrate power that quickly. The cutting edge of global reach is aerospace technology."

There is a school of thought that believes such technology may have been carried to extremes in one of USAF's favorite space-systems-to-be—the Military Strategic and Tactical Relay communications satellite. The Milstar program has been criticized, even in some Air Force

circles, as being too complex and too costly. Critics propose turning to simpler, lighter, more "launch-responsive" satellites for tactical communications at the beck and call of field commanders.

The Air Force admits that the Milstar program is very expensive and is, as Mr. Faga says, "modestly over budget." But USAF is hanging tough with the program. It has nothing against so-called "lightsats" and believes that much good can come from them, but it warns against regarding them as future substitutes for Milstar or for the currently deployed DSCS II and DSCS III satellites.

Communications satellites are of top rank in military significance. The Air Force estimates that about ninety percent of all US overseas military communications are now routed through space, in contrast to something like seventy-five percent only five years ago. Thus communications satellites have life-or-death importance in support of the long-haul deployments and operations seen ahead for US forces.

Cost Concerns

Concerned about the whopping cost—roughly $1 billion per satellite-plus-launcher—of the Milstar program, the Air Force recently took another hard look at it and came away more determined than ever to see it through. Intent on fostering global airpower, USAF is unwilling to do without the highly advanced capabilities that Milstar would contribute to the cause.

Given its global responsibilities and aspirations, the Air Force covets Milstar as the means of making certain that its combat aircraft and units can keep in touch with one another and with commanders at all levels, at all times, anywhere in the world. Such ubiquitous connectivity is now the name of the game.

Milstar is designed for the long haul in more ways than one: for robustness, survivability, and security of communications. It will feature crosslinks, an attribute lacking in other communication satellites and one that could well save the day for forces in combat in faraway places.

Currently deployed communications satellites have their ups and downs. They serve only to relay communications from ground station to ground station. To reach some military arenas around the world, a broadcast may have to go from Earth to space and back again several times.

The speed of such communications is not the issue. Security is. If ground stations were taken out during armed conflict, their interlinked communications satellites would be left empty-handed on orbit.

Milstar satellites would change all that. They would be switchboards, not just relay stations, in the sky. Computers on each satellite could be reprogrammed by ground controllers to reroute broadcasts via alternate ground stations or through other Milstar satellites. Moreover, Milstar's extremely high frequencies, augmented in transmission by sophisticated counterjamming techniques, would be almost impossible to disrupt.

The Milstar system is also designed to surmount a major problem that plagues US armed forces in joint operations—their inability to talk to one another, caused by incompatible communications equipment and techniques. That problem was egregiously evident during the Grenada operation of 1983 and somewhat noticeable again in Just Cause.

Each of the services is developing Milstar terminals to be universally capable of communicating with one another—Navy ship with Air Force plane, Army van with Air Force reconnaissance aircraft, or whatever.

Secretary Rice makes it clear that the Air Force is prepared to spend whatever it takes to put Milstar into play, which should happen fairly soon. The first Milstar satellite is taking form. TRW's payload has been integrated with prime contractor Lockheed's space vehicle, or satellite bus.

Now it appears that the warfighting commanders are doing for Milstar what they did for GPS—exerting what is called "operational pull" on the program.

"I'm optimistic about Milstar," General Moorman declares. "The CINCs have come on line to say how important it is to them. They say they need the flexibility it will give them to communicate through all phases of combat and the assurance that they'll be able to communicate through all kinds of conflict, strategic and tactical. It's an enormously complicated system because it has to be."

Air Force power-projection plans also hinge on full-time, real-time surveillance of enemy air deployments, something that can be done only from space. Such capability will become all the more necessary, in USAF's view, as the US withdraws forces from overseas and must figure on sending them back if the shooting starts. The idea is to be able to let them know what they will be up against when and after they get there.

The Air Force has settled on space-based radar as the answer. General Moorman rates USAF's proposed program for producing SBR as "the most important new start that we could have. There is nothing that we need more than space-based, wide-area surveillance."

The Navy, anxious to detect air threats to the fleet at long distances, agrees. But the Navy is pushing for less expensive and, according to USAF, less capable infrared surveillance satellites instead. At this writing, the issue is before the Defense Acquisition Board.

In a philosophical sense, the main point in the debate over space-based surveillance systems is not that the Air Force or the Navy is correct, but that both are now convinced of the need for such systems to give tactical and strategic commanders a god's-eye view of all things on the move in the air. Not long ago, the Air Force doubted that it could afford such systems, no matter how much it might like to have them. Now it has become convinced that it cannot afford to go without them.

To the Air Force, the allure of space can only grow stronger. Says General Cromer, "Our dependence on space for our warfighting capabilities is growing every day, because our space systems have demonstrated that they are extremely capable.

"GPS and communications satellites are good examples. As we get into future systems, such as wide-area surveillance, they will bring whole new dimensions to our ability to execute our wartime missions, and, hence, they will increase our dependency." ■

USAF Space Systems Checklist

Compiled with the assistance of Space Systems Division, Air Force Systems Command

Expendable Launch Vehicle Programs

Titan IV
Development and acquisition of the Air Force's heavy-lift vehicle for shuttle-class payloads. Launch sites at Cape Canaveral AFS, Fla., and Vandenberg AFB, Calif. (when completed), will provide launch capability of ten launches per year. Maiden launch occurred June 14, 1989. **Status:** Production. **Contractor:** Martin Marietta.

Delta II
Acquisition and launch support of medium launch vehicle. Currently used for launching Navstar GPS, SDIO experimental payloads, and commercial payloads. **Status:** Operational. **Contractor:** McDonnell Douglas.

Atlas II
Development and acquisition of a medium launch vehicle. Initially to be used for communications satellite launches such as SATCOM, NATO IV, and other payloads. **Status:** Development. **Contractor:** General Dynamics.

Titan II
Modification of Titan II ICBMs into expendable launch vehicles. Initial conversion contract is for fourteen Titan IIs. The first two have been launched successfully. The Titan II was also used for the NASA Gemini program. **Status:** Production. **Contractor:** Martin Marietta.

ALDP
Advanced Launch Development Program, formerly Advanced Launch System (ALS), is designed to develop a variety of new launch vehicles and launch technologies to put payloads into orbit at a fraction of current costs. ALDP is looking at ways to make the launch business as routine as that of a long-haul trucking company. **Status:** Research. **Contractors:** Boeing Aerospace, General Dynamics, Martin Marietta.

Pegasus
Development and acquisition of a small launch vehicle in conjunction with DARPA. Pegasus is unique because it is launched from an aircraft rather than from a normal launch complex. Primarily for experimental payloads and low-Earth-orbit satellites. Maiden launch occurred April 1990. **Status:** Development. **Contractors:** Orbital Sciences Corporation (OSC), Hercules.

Taurus
Development program of a more powerful version of Pegasus using a Peacekeeper first-stage addition. Taurus, however, will be ground-launched from regular launch complexes and may also be used to test a quick-readiness, mobile launch facility. **Status:** Development. **Contractor:** OSC.

Interspace Transfer Vehicles

Inertial Upper Stage
IUS was developed to provide highly reliable two-stage vehicles to boost satellites into geosynchronus orbits. Used for military and NASA payloads, including the Magellan and Galileo interplanetary missions for NASA. **Status:** Operational. **Contractors:** Boeing Aerospace, United Technologies Chemical Systems Division, Rockwell International.

PAM-D II
Payload Assist Modules (PAM) are solid fuel boosters capable of moving satellites from low-Earth orbit to higher orbits, including geosynchronous. They are currently used to boost Navstar GPS into a 10,900 nautical mile, twelve-hour orbit. **Status:** Operational. **Contractor:** McDonnell Douglas.

Centaur
The Titan IV/Centaur upper stage is a modified Centaur-G Prime with high-energy cryogenic propellants and multiple restart capability. It will be the most powerful upper stage in the US inventory. **Status:** Development. **Contractors:** Martin Marietta, General Dynamics.

Satellite Programs

Defense Satellite Communications System
DSCS is a worldwide satellite network providing secure voice and high data rate communications for DoD, US State Department, and other US government users. DSCS III satellites are larger and provide increased capability and longer on-orbit life spans. **Status:** Operational. **Contractors:** General Electric, TRW, Hughes Electronics Dynamics Co., Aerospace Corp.

Defense Meteorological Satellite Program
DMSP spacecraft are designed to satisfy military requirements for worldwide weather information. The data help identify and track severe weather systems, such as typhoons and hurricanes. **Status:** Operational. **Contractors:** GE Astronautics, Aerojet Electrosystems, Hughes Aircraft.

Air Force Satellite Communications System
AFSAT provides high-priority command and control communications for US strategic forces. System is integrated into other spacecraft. **Status:** Operational. **Contractor:** Classified.

Milstar
The next generation of military satellite communications to provide worldwide, jam-resistant, survivable communications capability for national command authorities and US military forces using EHF and UHF systems. **Status:** Development. **Contractors:** Lockheed Missiles and Space Co., TRW.

NATO III
System provides military and diplomatic communications for NATO forces through a network of ground, airborne, and shipborne communications that are interoperable with DSCS. **Status:** Operational. **Contractors:** Ford Aerospace, Aerospace Corp.

Navstar GPS
Navstar Global Positioning System (GPS) will provide twenty-four-hour, all-weather, worldwide, space-based radio navigation capabilities. GPS will provide military and civilian users with extremely accurate three-dimensional position information. Military users will be able to get position information to within sixteen meters, civilians to within 100 meters. **Status:** Fully operational in mid-1993. **Contractors:** Rockwell International (Block I & II), General Electric (Block IIR).

Space Test and Transportation Program
STTP sponsors spaceflights for DoD experimental payloads that do not have dedicated spacecraft. Experiments may be flown on small boosters or the shuttle. STTP also manages DoD-dedicated payloads aboard NASA's shuttle. STTP has cooperative programs with both NASA and DARPA. **Status:** Research. **Contractor:** None.

Defense Support Program
DSP is a surveillance satellite designed to provide early warning of ICBM launches. **Status:** Operational. **Contractors:** TRW, Aerospace Electro Systems.

Strategic Defense Initiative Organization Programs

Boost Surveillance and Tracking System
BSTS is a space-based sensor system being developed to replace the Defense Support Program (DSP). BSTS is also being designed to meet requirements for the boost-phase sensor element of the multitiered Phase One Strategic Defense System. The BSTS mission is to detect, track, count, and identify the type of hostile ballistic missiles in an attack. **Status:** Development. **Contractors:** Lockheed Missile and Space Co., Grumman Aerospace.

Space Surveillance and Tracking System
SSTS is a space-based system using state-of-the-art technology to track space objects. It is a key element in the Phase One Strategic Defense System. SSTS provides tracking during the critical post-boost and mid-course flight phases of hostile ballistic missiles, a process critical to the successful employment of ground- and space-based weapons designed to negate these targets. **Status:** Development. **Contractors:** Lockheed Missile and Space Co., TRW.

Brilliant Pebbles/Space-Based Interceptor
Both Brilliant Pebbles and Space-Based Interceptor (SBI) programs are designed to intercept and destroy ICBMs before the warheads become active or reenter the atmosphere during a nuclear attack. Both programs are similar, with SBI being a somewhat larger vehicle. SBI is being phased out with SDIO's choice of Brilliant Pebbles as the primary system. **Status:** Development. **Contractors:** Various.

Starlab
The Starlab program is a proof-of-concept demonstration of acquiring, tracking, and laser-designating a ground-launched rocket from an orbiting platform. It will also supply key visual, IR, and UV data required for other SDI programs. Starlab will be carried by the shuttle in early 1992 as a Spacelab mission. **Status:** Development. **Contractors:** Lockheed Missile and Space Co., Kaman Aerospace Corp. ■

The other services have aggressive agendas in space and want their own systems up there.

The Army and Navy in Space

By Richard H. Buenneke, Jr.

EVEN as the Air Force moves to strengthen its hand in space, other services are pushing hard to grab a piece of its action.

The Army and Navy are pursuing ambitious space agendas, pressing for their own space systems to enhance the combat powers of terrestrial forces. Unwilling to wait for USAF's multiservice spacecraft, they propose building satellites and ground terminals tailored to specific demands of land and naval warfare.

The newcomers in space maintain that their moves are aimed at making sure that their wartime space-support needs are met. Given space systems' mounting value as force multipliers, they argue, theater commanders must be sure they will get strong wartime backing.

For US Space Command, this is a top priority. The unified command, created in 1985 to oversee the three services' space commands, wants to improve space support for the full range of tactical and special operations combat units.

The growing assertiveness of USSPACECOM and its Army and Navy components foreshadows a shift in the distribution of space roles and missions. In fact, it may mark the end of the Air Force's thirty-year dominance of policy and programs. Since 1961, USAF systems have provided surveillance, warning, communications, and weather support for all three services.

Evidently, Washington policymakers welcome this change. Defense Secretary Dick Cheney has ordered a major review of space activities, to be performed by a new Defense Space Council. Congress also supports changing space responsibilities. No less a figure than Sen. Sam Nunn, the Georgia Democrat who chairs the Armed Services Committee, calls for more "creative competition."

What accounts for the pressure to break up the Air Force's near-monopoly on space? The answer, say officials, is a mixture of bureaucratic bottlenecks and technological advances.

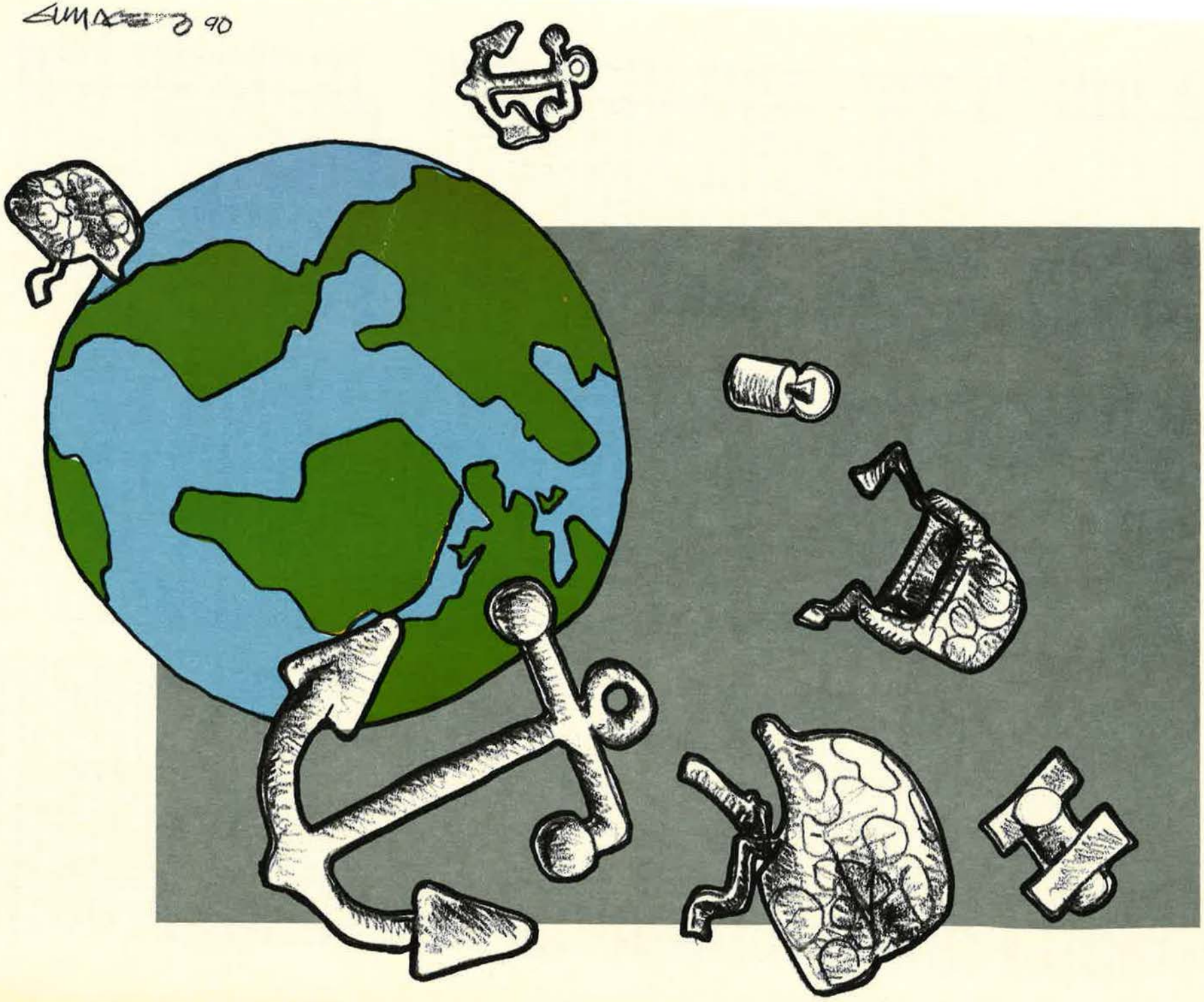
In a new report, the Washington-based Center for Strategic and International Studies (CSIS) leveled harsh criticism at the Pentagon's space bureaucracy. "The problems are not a lack of technological capability," charged CSIS, "but frequently ones of distribution, classification, and a lack of confidence."

Experts maintain that, due to the high cost and extreme complexity of space systems, only the most critical US military units receive extensive space support. Space data are reserved for top commanders, nuclear targeting staffs, and intelligence organizations. Tight secrecy surrounds "national" reconnaissance and signal intelligence systems. The take from these satellites, controlled by a bureaucracy of CIA and military intelligence services, is mostly off-limits to tactical forces.

Slow-Moving Imagery

Army and Navy officers complain that restrictions on such data make it difficult to transmit imagery quickly to the field. Naval officials recall that photos used to plan the 1986 raid on Libya were hand-carried from the US to the Mediterranean, a trip that took three days. "That," quips a Navy space planner,

—Illustration by Guy Aceto



"is the state of the art for the battlefield commander, folks."

Tactical commanders also fear that, in a crisis or major conflict, the system of US spy satellites will be commandeered by top political leaders and Strategic Air Command. Air Force civilians say they have developed procedures to avoid this, but tactical commanders distrust these assurances.

Even the Air Force's Gen. John L. Piotrowski, the recently retired USSPACECOM commander in chief, was frustrated by inflexibility and unresponsiveness in the space force. In general, he argued, the Air Force had put too many eggs in too few baskets.

"Current US systems are a fragile, thin blue line—a thin blue line that is not sufficiently backed up by on-orbit spares or a rapid replenishment capability," General Piotrowski warned in 1988. "In time of crisis or conflict, these systems would not be sustainable." The blunt warnings are echoed by General Piotrowski's successor, Gen. Donald J. Kutyna, also an Air Force officer.

At the same time, new advances in technology have convinced more and more service officials that next-generation satellites could revolutionize tactical warfare.

The biggest advance in tactical space support may come from electro-optical sensors. Based on the same technology employed in home video cameras, these sensors can provide "near real-time" images of enemy forces.

Moreover, images from electro-optical satellites can be combined with data from other satellites. Signals intelligence and infrared sensors in high orbit can pinpoint enemy radars, command posts, and missile launch sites. Advanced radar imaging systems can track targets hidden by clouds or darkness.

3-D Databases

When satellite data are merged with terrain data from civilian Landsat and SPOT satellites, fused images can give Army and Marine commanders a detailed portrait of any battlefield or beach anywhere on the globe. These data can be transformed into three-dimensional databases for mission-rehearsal simulators.

Electronic maps based on space data can increase the firepower of conventional cruise missiles, which could be guided to targets by signals from Navstar Global Positioning System satellites and could perform tasks now assigned to nuclear weapons.

The job of ensuring that these breakthroughs are fully exploited falls to US Space Command. Established in 1985, the unified command is responsible for providing space support to all US terrestrial forces. USSPACECOM recently conducted a comprehensive study of military boosters, satellites, and ground terminals. This "Assured Mission Support Space Architecture" effort included participants from field commands and service planning staffs. The command hopes the study will produce a coherent roadmap for space acquisition by all three services.

The Army and the Navy, rather than merely complaining, have embarked on major space programs. With relatively modest budgets, and in tandem with the Defense Advanced Research Projects Agency and private space entrepreneurs, they are pursuing an array of innovative concepts for tactical space support.

The Army is engaged in a steady, deliberate expansion of its space capabilities.

Since its troops are relatively unfamiliar with space support, Army Space Command (ARSPACE) is spending a good deal of time demonstrating satellite technology to airborne, armored, artillery, and infantry units during field exercises.

Working with the Army Space Institute, a branch of the Army's Training and Doctrine Command, ARSPACE encourages soldiers to seek ways to integrate space systems into Army combat plans. Results from the demonstrations can help the Space Institute establish requirements for small, mobile terminals.

Insights from field demonstrations also help the Army see to it that joint satellite programs don't ignore the unique needs of ground warfare.

Giving a soldier a GPS receiver is one of the fastest ways to teach him or her about space. Instead of fumbling with charts and compasses, units can use handheld receivers to plot their course or aim artillery. "The infantry won't get lost anymore," jokes Col. Ronan Ellis, ARSPACE commander.

In another demonstration, soldiers get a chance to try out meteorological satellite receivers. These systems can provide an airborne commander with vital information on weather conditions in his drop zone.

Colonel Ellis says airborne troops could send back to reinforcing units "Eyewitness News" reports about facilities and battle damage. These video images, combined with satellite-relayed voice and fax transmissions, could help reinforcements pack the right equipment.

In another ARSPACE demonstration, troops analyze terrain features on a minicomputer work station. This commercial system could pave the way for an integrated terminal that fuses terrain, weather, and intelligence data into three-dimensional images.

To help plan for worldwide Army deployments, ARSPACE is setting up space support cells at corps and division headquarters in the US. The first of these cells will open this year at Fort Bragg, N. C., home of the 82d Airborne Division.

When divisions deploy overseas, they could get their space support from regional space support centers. These centers will build on Defense Satellite Communications System control centers operated by ARSPACE.

No Olive Drab Spacecraft

The command, which will grow to some 440 military and civilian personnel by 1992, hopes to move into other military space missions. ARSPACE is developing plans to operate a battery of ground-based antisatellite weapons developed by the Army's Strategic Defense Command. ARSPACE works with USSPACECOM and Strategic Defense Command to develop operational plans for ground-based ballistic missile defenses.

The Army's space advocates aren't racing to develop olive drab satellites. For the most part, the Army is willing to let the Air Force run programs that satisfy the ground service's needs.

With the Navy, however, the story is far different. That service, though it still desires the savings that can be achieved in joint programs, also thinks single-service satellites are sometimes required.

For the most part, the Navy has relied on Air Force satellites. Until recently, its own satellite program was limited to research payloads and two small constellations of navigation and ocean-surveillance satellites, with the Air Force performing the bulk of the advanced work. "Our idea of a joint program," jokes one Admiral, "is one the Air Force pays for and the Navy uses."

The growing importance of space, however, has made the Navy restless. Carrier battle groups increasingly depend on satellite communications and weather and surveillance reports. The Navy complains that Air Force satellites are expensive and designed primarily for apocalyptic scenarios of strategic nuclear war.

Navy officials cite Milstar as one example of a satellite system poorly suited to tactical needs. The Navy had hoped to use Milstar to replace its Fleet Satellite Communications (FLTSATCOM) system. FLTSATCOM is a key part of ship-to-shore and surface battle group communications, but the system's UHF channels are increasingly vulnerable to enemy jamming.

Big Bird, Big Bucks

Milstar's extremely high frequency channels are virtually jam-resistant. A cost of a billion dollars per satellite, however, has convinced the Navy that there won't be enough Milstars. "Even with a full constellation of ten satellites, Milstar will only provide forty-one percent of total validated requirements, mostly on carriers," says Vice Adm. Jerry Tuttle, head of space and electronic combat programs. "Milstar's a big bird that costs big bucks."

To make up for the shortfall created by Milstar's limited capacity, the Navy is purchasing its own satellite system—the UHF Follow-On. When deployed in the mid-1990s, the UHF Follow-On birds will mesh with both FLTSATCOM and Milstar terminals.

The UHF Follow-On showed the Navy's willingness to innovate. When it wanted ten satellites, the Navy went straight to commercial communications satellite builders. The result was a program with twice the capacity of its USAF predecessor and a lower cost.

Navy officials are also challenging Air Force plans for a wide-area surveillance satellite. For years, USAF space officials have sought a network of large, orbiting radars. This system would provide global surveillance of any aircraft larger than a fighter under any weather conditions.

Air Force plans for the space-based radar constellation were sidetracked when the Navy submitted a competing proposal. The Navy's system, based on the concept of infrared sensors, would not be able to spot aircraft flying under clouds, but it would be able to detect heat plumes of conventional and stealth aircraft during high-altitude cruise operations.

Pentagon and congressional officials, though mindful of the superiority of the Air Force system, nevertheless are intrigued by the low cost and reduced risk of the Navy's system. Rather than approving a demonstration of space-based radar, Congress told the administration to put on hold all wide-area surveillance programs until the Pentagon conducts a review of both concepts.

Navy officials also believe that small, less costly spacecraft can perform a wide range of missions. Dubbed "spinsats" (single purpose inexpensive satellites), they could carry optical or radio sensors to detect and track aircraft and ships. Other versions could be equipped with microwave and laser radar sensors to provide oceanographic data for antisubmarine warfare.

Navy space experts suggest that spinsats could provide battle groups with their own satellite constellations. Instead of waiting months for the Air Force to launch a large payload, the Navy could put a spinsat in orbit within hours of a call-up. Once in orbit, the satellites would be controlled directly by carrier task forces—circumventing the centralized space bureaucracy.

Last year, a study by the National Academy of Sciences concluded that the Navy will need its own anti-satellite weapons if it is to control the seas during the twenty-first century. The Navy lost out to the Army in a bid to develop a new ASAT. However, new technologies developed by the Strategic Defense Initiative could permit ASAT deployments on a new class of guided missile submarine.

Now that the programs are under way, say Navy space advocates, the sea service needs to get serious about integrating space into its force planning. "We have let others do the R&D that we should be doing," says William E. Howard III, science advisor to the Naval Space Command, "and they are not giving us what we need."

Beyond their in-house efforts, the Navy and Army are monitoring results of the Defense Advanced Research Projects Agency's small-satellite research program. In April, DARPA launched its first "lightsat" on a Pegasus air-launched booster. Future flights of Pegasus and a larger, ground-launched Taurus booster will carry a wide array of communications and surveillance payloads.

Though DARPA and the Navy have taken the lead, USAF also is at work on small satellites. This marks a shift in position for the Air Force, which until very recently questioned the cost-effectiveness of what it called "cheapsats."

Air Force System Command's Space Systems Division (SSD) is sponsoring studies of "reserves"—responsive replacement vehicles. SSD, which is due to take over DARPA's Pegasus booster program next year, says standardized lightsats could serve as the low end of a "high-low mix" of satellites.

"The mindset has changed a lot in a year, when fatsats were good and leansats were bad," says Brig. Gen. Esker Davis, a Reservist specializing in mobilization planning for Air Force Space Command at Peterson AFB, Colo. "The ability of small satellites to do incredible missions is being accepted." ■

Richard H. Buenneke, Jr., Washington-based editor of Military Space Newsletter, *has covered space and defense issues for more than five years. This is his first article for* Air Force *Magazine.*

New options are coming in mission rehearsal, networking, and low-level flight training.

Three Tracks for Simulation

By Peter Grier

Sophisticated simulation technology permits greater readiness at lower cost. Here, a Marine Corps pilot lands a simulated aircraft on a simulated assault ship.

THE B-2 bomber is expensive, so when the stealthy planes become operational, they will get special treatment. Crews won't just take them out and fly them for everyday training, as they do with most other aircraft. Each crew will get only two B-2 training flights per month, compared to five for a B-1B crew.

Even though there will be fewer training flights, however, the Air Force expects that the B-2 fleet and its crews will be in a high state of readiness. In fact, Strategic Air Command plans to keep fifty-five percent of B-2s on alert, far higher than the B-1B's alert rate of about ten percent. The key to achieving this, say SAC officials, is that each B-2 crew will "fly" five times each month in a highly sophisticated B-2 weapon system trainer. Says Gen. John T. Chain, Jr., SAC commander in chief, "I think the [B-2] force will be extremely well-trained, because the modern simulators are very good."

As the case of the B-2 makes clear, simulators are emerging as a critical factor—and a hot defense acquisition area—for the US armed forces in the 1990s. As budgets grow tighter, threats more diverse, and weapons more complex, simulators are emerging as a cost-effective readiness tool and a target of opportunity for contractors.

Not that the simulator business is about to explode. Market analysts expect simulator expenditures to level off or perhaps decline slightly. That, however, is a performance that few segments of the defense budget can expect to match nowadays. "The training budget will be, by and large, intact," says Mark Lawrence, a Prudential-Bache Securities analyst who tracks the simulator industry.

The awesome complexity of next-generation aircraft and sensors will force pilots to spend increasing amounts of time in simulators, honing their skills. Even if funds for flying hours were unlimited, simulation still would be needed.

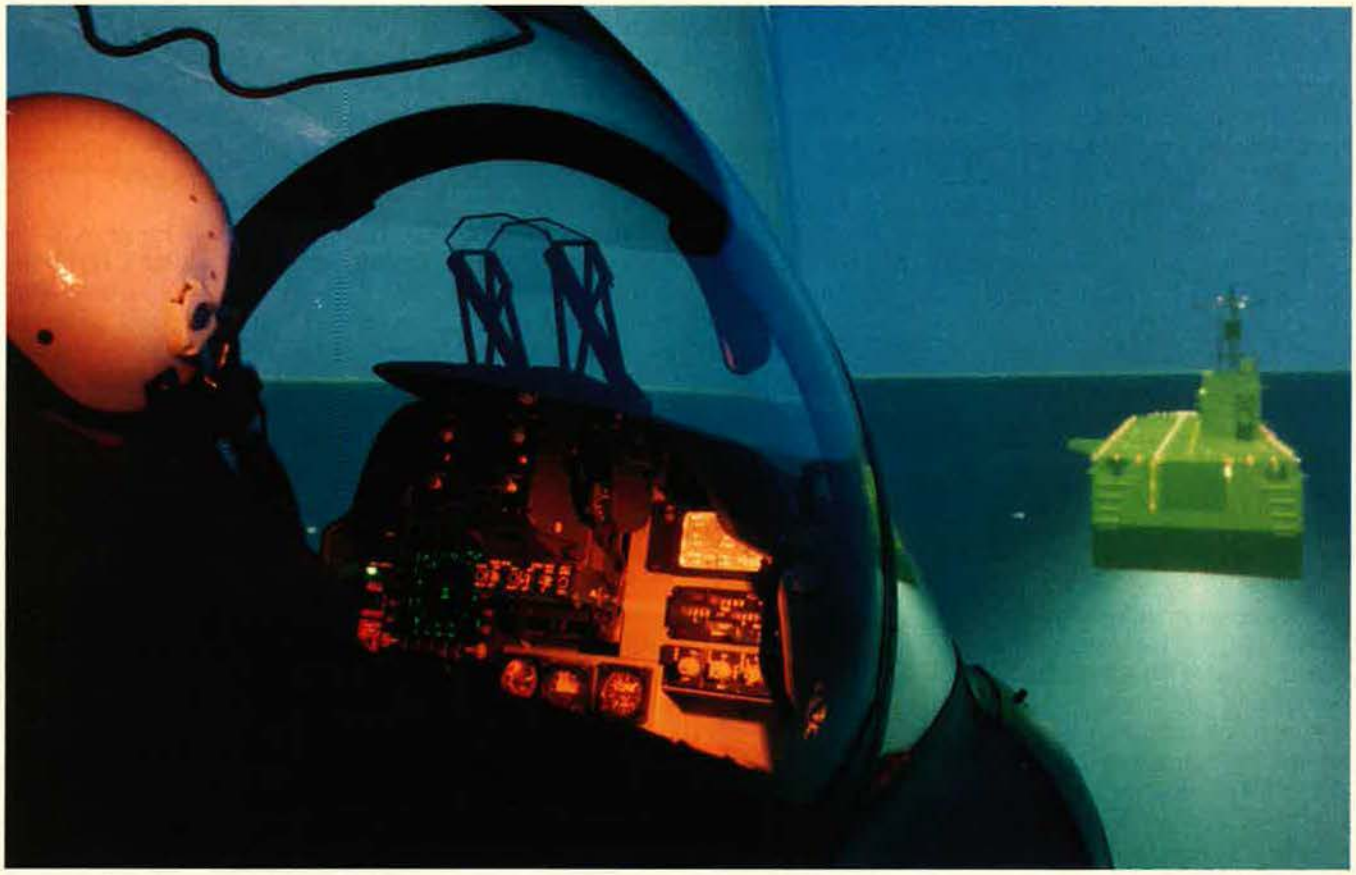
The LANTIRN (Low-Altitude Navigation and Targeting Infrared for Night) system shows why that is so. Attacking targets at night in poor weather—the mission of LANTIRN-equipped aircraft—is always dangerous. It's especially difficult in the single-seat F-16, with the pilot cycling from a head-up, out-the-window position to a head-down look at his sensors. Repeatedly practicing this operation on the ground before trying it in the air makes sense: It is safe, cost-effective, and efficient.

"When you've got an airplane system worth multimillion dollars," remarks Gary Ebert, a top official for training systems at Air Force Systems Command's Aeronautical Systems Division (ASD) at Wright-Patterson AFB, Ohio, "you want to make good use of your hours in the air."

The Advanced Tactical Fighter (ATF) and other new fighters will still have the general hierarchy of cockpit procedures trainers, weapon systems simulators, and other training systems, says Mr. Ebert. But, he adds, "you'll probably see us relying more heavily on part-task trainers than in the past."

As advanced part-task trainers proliferate, reports the ASD official, the Air Force might well rethink its traditional hierarchical approach to ground training.

The microminiaturization of com-



puting power that made LANTIRN and other new weapon systems possible is now driving the revolution in simulator technology. Scene capacity—the ability to reproduce photographic textures—is improving greatly. Image brightness, long a problem, is being pushed along with research on helmet-mounted displays and area-of-interest focus.

New technology is making possible an array of simulator applications.

Consider this scenario: Air Force F-111s are ordered into action against a Third World nation. The planes get airborne quickly. En route, a satellite downlink feeds them a digitized picture of the target from a Defense Mapping Agency database. Crews rehearse the mission on simulation-capable cockpit displays. First they practice individually. Then they switch to network mode, where they see and react to each other's actions on their screens.

This flexible simulation technology doesn't exist yet, but much of it is fast approaching maturity. Claims Dan Eliason of BBN Corp. in Boston, Mass., "Transmitting simulation data to actual aircraft en route to training or target area is something that hasn't been solved—but will be shortly."

Whether the services are ready or not, simulators will soon be able to do things once thought possible only in live training, if at all. The scenario described above demonstrates three: mission rehearsal, networking, and low-level flight simulation.

Specific Mission Practice

Air Force officials and their counterparts in the Army and Navy show increasing interest in simulators' ability to practice specific missions with visual representation of the area of ingress and egress. In basic form, the capability already has arrived. The Air Force has awarded the first aircrew training system contract to contain a requirement for mission rehearsal: the C-17 ATS (advanced training system), won by McDonnell Douglas. Training systems for the new Navy A-12 Avenger II will likely include such a requirement. The Army approach is hinged to Simnet, the experimental warfighting simulation network whose development is sponsored by the Defense Advanced Research Projects Agency (DARPA).

Like the buzzword "C^{3}I," the phrase "mission rehearsal" is hard to define. Quick change of simulator scenes is one part: The Air Force requires the C-17 system to prepare and display a new database scene within forty-eight hours. The base must show an area of ten nautical square miles around the target and include low-level entrance and exit corridors and detailed runway pictures.

Handling information from all manner of sources, including secret reconnaissance satellites, is another challenge. "You have to convert data that has been acquired through strange and mysterious means," says Wayne Calhoun, director of marketing for McDonnell Douglas Training Systems. "You have that digitized, then electronically converted to visual presentation."

Special operations is an area of major emphasis for mission rehearsal. USAF's coming Special Operations Forces Aircrew Training System—one of the most complex advanced training systems ever developed—will include mission-

rehearsal features far beyond those of the C-17 ATS. Service officials think of mission-rehearsal training devices as being sophisticated part-task trainers. They may have only rudimentary cockpit depiction but extremely high-fidelity visual systems.

US Special Operations Command at MacDill AFB, Fla., is developing advanced mission-rehearsal gear as part of the Special Operations Forces Planning and Rehearsal System (SOFPARS). Only a technology demonstration project, SOFPARS is intended to produce simulators deployable with commando teams and enable practice of both ground and flight operations.

The technology, notes a report of the Electronic Industries Association, will be awesome. "For instance," says EIA's study, "what would you see if you were driving down a particular street? What would you see if you looked at the side of this building? Where is the door that you want to go through? Obviously, a very detailed, photo-based rehearsal system is required."

Training Together

For decades the US military has had plenty of simulators to teach skills to individuals. Technologists now are looking to break this mold and tie simulators into interactive training networks. After all, combat—even air-to-air combat—is rarely a series of one-to-one fights. It's a group effort.

"There's an increasing recognition and desire to do something about the fact that when teams of people get together, they don't always know what to do," says Ron Hendricks, senior vice president of business development for CAE/Link.

Simnet, an Army/DARPA program, is a big reason for this new thinking. Under Simnet (Simulator Networking), contractors BBN and Perceptronics have tied together some 250 combat vehicle and aviation simulators at eleven locations in the US and Europe.

This network gives the Army the capability to fight daily interactive combined-arms battles up to the battalion level. Red and Blue teams can be patched together at some distance from each other, with aviation support units at third locations. Each operator of a Simnet display sees the same battlefield.

Simnet has focused industry's mind on the network idea and shown that there are relatively inexpensive ways of solving linkage problems. CAE/Link joins an AH-64 Apache combat mission simulator, an AH-1 Cobra flight and weapons simulator, and two UH-60 Black Hawk flight simulators at Fort Rucker, Ala. GE Simulation and Control Systems links an AH-64 simulator with generic fighter, transport, and tank simulators at its new Daytona Beach, Fla., lab.

The Army is plunging enthusiastically into networking. Other services are lagging. "The Air Force is reluctant to grab on to it," says Mr. Eliason, BBN's Simnet manager. "They've not acknowledged the need for training that requires multiple participants."

Tactical Air Command is more interested in preventing aircrew accidents through practice on expensive, high-fidelity simulators, says Mr. Eliason. Simnet-style networked training devices cost only about thirty percent as much as such full-up simulators. Networking would be particularly valuable for training in close air support, a mission TAC is frequently accused of neglecting.

However, the Air Force is at the forefront in one network technology: compatibility of simulator databases. Up to this point, defense contractors each have developed their own methods of generating simulator visuals. Simply making sure that the visual display in one simulator type matches a radar image has been a problem.

The lack of interchangeable databases from different contractors—a waste of resources and an impediment to networking—hasn't escaped USAF's notice. ASD's Project 2851 is an effort to develop standard, compatible digital databases for visual generation by the early 1990s.

Though initially only Air Force systems will benefit, all services will use the 2851 product library. ASD's modular design fits this plan.

US Special Operations Command is developing advanced simulators that will enable both ground and flight operation practice. Networking permits different kinds of simulators in different locations to interact in the same training exercise. Above, a simulation on Special Operations Forces' MH-53J weapon system trainer.

"If you had a rain element with one simulator," says ASD's Mr. Ebert, "you could use it on another."

Low-Level Flight Simulation

For NATO, increasing opposition to low-level fighter training in western Europe poses a major problem. Front-line pilots need constant practice flying at altitudes of only 100 to 500 feet. NATO aircraft in West Germany must observe, in most areas, a minimum altitude of 500 feet. Limits on low-level flying can only get more restrictive, and the push is on for new and better simulation of this mission.

Currently, the Air Force does little low-level training in simulators, though F-15 and F-16 training devices have some low-level capability. The F-15E weapon systems trainer, for example, permits fly-by-sensor, nighttime, low-level simulation. It lacks a full-field-of-view system needed to represent daytime flights.

Visual systems must improve in power and realism if there is to be adequate low-level capability. One approach under study at CAE/Link hinges on a helmet-mounted display. Rather than surround a pilot with a dome on which visuals are projected, CAE/Link system designers use fiber-optic funnels to generate pictures a few inches from a pilot's eye. Requirements for projector and computational power are thus greatly reduced. CAE is installing this technology on Panavia Tornado aircraft training systems for low-level capability.

Another approach uses more traditional displays and a helmet-mounted instrument that detects eye movement. Wherever the pilot looks, the simulator concentrates its power to produce high-resolution imagery. The rest of the field of view is kept at low resolution.

The Aeronautical Systems Division is now analyzing United States Air Forces in Europe's training requirements to see what they need in the way of low-level equipment. Says Mr. Ebert, "We are looking to support USAFE specifically."

Such specialized applications are the growth areas of the simulator market. The market for traditional simulator devices will see somewhat less action. Purchase of these is closely tied to purchase of new aircraft, and the B-2, ATF, and ATA are among the biggest targets for cuts in the current budget wars.

"Cautiously optimistic" is the phrase used by many simulator industry executives. The consensus is that they may escape the big percentage cuts imposed on other hardware accounts. "[In the] worst case, it will stabilize," says John Wohler, director of business development at BBN. "It may even grow."

Prudential-Bache's Mr. Lawrence predicts that, by 1992, the overall military training budget will be thirty-five percent higher than in 1987. He sticks by that forecast. For contractors, that's his good news. His bad news is that any firm that wants a piece of the pie will have to fight to get it. "The aggressiveness of the competition in the US market is intense," says Mr. Lawrence. "I don't expect that to lighten up in the foreseeable future."

CAE/Link is the biggest player in the training systems business. It got that way through acquisition. In July 1988, the Toronto-based CAE bought Singer's Link defense simulation business for $500 million. General Motors' Hughes Aircraft has moved into training systems in a big way in recent years, buying Rediffusion and Honeywell's Training and Control Systems division, and is now nipping at CAE/Link's heels. Aggressive bidding won Hughes the Air Force C-141 training system contract in 1988, for instance.

McDonnell Douglas Training Systems is also an up-and-coming player. Mr. Lawrence calls the company "a fierce number three." McDonnell Douglas fought a tough battle to win the prized C-17 training contract.

One CAE/Link advantage is the experience of its Canadian parent firm in the European market, as evidenced by its Tornado low-level simulation contract. The international simulation market is likely to grow faster than its US counterpart, reports a survey of European training officials conducted by Letter Perfect, a Washington area defense research firm. NATO nations show great interest in networking and part-task training, according to the survey.

Buy Through the Prime

One trend that doesn't please US simulator firms is the growing Pentagon tendency to acquire training systems through its prime airframe contractors. One case in point: The Army's Light Helicopter (LH) competition. On the Boeing/Sikorsky "First Team," Link is a subcontractor supplying the training system. For the McDonnell/Bell "Super Team," McDonnell Douglas's Training Systems Division is providing simulators and designing other services.

ATF simulators will also be bought through the prime, though Air Force officials say they analyze each weapons procurement on its own and that "buy through the prime" isn't necessarily the wave of the future for service simulators.

Concurrency is the reason for this procurement approach. Recent programs such as the UH-60 Black Hawk and the B-1B suffered delays in simulator production and consequent loss of training momentum. By making the prime contractor responsible for providing the simulation contractor with technology changes and other data, officials figure they can get simulators developed and produced faster.

For simulator firms, working through the prime presents problems. First, they have to hitch their wagon to a potential loser. Second, the prime may not be interested in simulators and training technology. Given a fixed-price development contract, as with ATF, primes might decide to pour money into the airframe and skimp on simulators, in the belief that it's aircraft performance that will win the day, whatever procurement officers say.

"I totally disapprove of it," says one industry official of buy-through-the-prime practices.

In any case, simulators are destined to become parts of a fully integrated approach to training. Absolute realism may be less important than the ability to network, change databases quickly, and rehearse missions. ■

Peter Grier is a Washington-based defense correspondent for the Christian Science Monitor. *His by-line last appeared in* Air Force *Magazine with "Policing the Treaties" in the June 1990 issue.*

The criticism sort of tapered off when Stinger mopped up the Soviets in Afghanistan.

Stinger Proves Its Point

By Colleen Nash, Associate Editor

For years, the Stinger antiaircraft missile looked like a dud, the embodiment of excessive weapons complexity. Its guidance system demonstrated poor results in some early tests. Its firing sequence seemed extraordinarily confusing. Its cost was great.

That is how things looked until 1986. In that year, the shoulder-fired missile with the bad reputation reached the Afghan guerrillas. In quick time, Stingers swept Soviet aircraft from the Afghan skies. The guerrillas began to move at will. Soon the Red Army's Afghan expedition was finished.

The US Army, in an exhaustive review, concluded that the guerrillas fired a mere 340 Stingers but destroyed 269 aircraft—a shootdown rate of seventy-nine percent. "Stinger was the war's decisive weapon," claimed the Army. "It changed the nature of combat."

Indeed, since Afghanistan, Stinger no longer serves as an example of weaponeering run amok but of almost unalloyed success. Further, the story of Stinger dramatizes the benefits that can come when the Pentagon stays with a troubled but promising weapon long enough to let it mature.

The Stinger is a $3.3 billion program. At present, US services have bought approximately 29,000 of the weapons, and there are plans to buy another 16,000-plus by 1992. In addition, foreign sales are expected to generate production of about 4,000 weapons.

The mature Stinger is a marvel of aircraft-killing efficiency. Primary components include a missile, disposable launch tube, reusable gripstock, battery coolant unit (BCU), and Identification, Friend from Foe (IFF) system.

One person can carry and fire the Stinger. The soldier hoists the thirty-five-pound weapon on his shoulder and aligns the sight on a target. He "interrogates" the aircraft with the IFF system, which emits a telltale signal. The soldier depresses the impulse generator, releasing the BCU's argon gas that cools the weapon's infrared (IR) seeker. When the seeker's tone tells the gunner that the seeker has locked on the aircraft, he uncages the gyro, leads the target, and fires. Assuming the target is within Stinger's range, the entire process takes less than ten seconds.

When the missile has traveled a safe distance from the gunner, a fuze timer ignites the flight motor, accelerating the missile to supersonic speed. The missile makes a beeline for the plane's exhaust plume, but just before impact, Stinger's advanced guidance systems take over. Sensing the rate of change in energy, Target Adaptive Guidance (TAG) circuitry steers the missile away from the plume and leads it to the aircraft's fuselage.

The missile hits with the force of a midsize car traveling sixty miles per hour.

A Compelling Idea

The lightweight, portable Stinger, built by General Dynamics Corp., was designed to permit a specially trained army foot soldier to provide air defense at the forward edge of a battle area. The concept behind Stinger, says GD Vice President for Stinger Bill Leonard, was simple and compelling: "having one man defeat a very expensive as well as very lethal attacking aircraft."

It had been tried before. GD's

—Photo by Erik Simonsen

first man-portable air defense system (MANPADS) was the Redeye missile. Yet, as Redeye went into production in 1966, the Army and GD already were at work on a successor. They recognized that Redeye was limited and that the next-generation weapon would have to be much faster. Improved Soviet countermeasures meant that the new weapon had to have a far more sophisticated seeker.

Stinger promised major improvement over Redeye. For one thing, the older weapon had no ability to defeat countermeasures, and Stinger did.

Moreover, Redeye was a "revenge" weapon. It could only home in from the rear on the hot exhaust metal of an enemy aircraft. Thus, a gunner had to wait until after an aircraft had flown by—and perhaps unloaded its bombs—before he could be sure that the missile's seeker would sense the hot metal and engage the target. Stinger's improved passive homing infrared seeker, coupled with TAG, meant that it could take on fast-moving, low-level aircraft flying in a multitude of directions—incoming, crossing, and outgoing. Its all-aspect engagement capability enabled defense of a greater area; Stinger's engagement envelope is nine times larger than Redeye's.

Stinger also had greater speed. Equipped with a dual-thrust rocket motor, Stinger was nearly twice as fast as Redeye.

Stinger Gets Stung

For all its promise, the Stinger program got off to a slow, inauspicious start. General Dynamics kept the program going as a company-funded effort, but actual engineering development did not begin until 1972. It continued for five years. Stinger's performance was disappointing during the first guided tests conducted at the White Sands Missile Test Range, N. M., in 1974. Problems with the infrared guidance system and escalating costs drove Army Missile Command (MICOM) to ask Ford Aerospace to develop an "Alternate Stinger" system.

For General Dynamics, this was a wake-up call. GD engineers went back to the drawing board and scrubbed the missile's design. In the process, they eliminated fifteen percent of its electronic parts, thereby reducing costs while improving reliability. They also developed a new, improved gripstock.

The changes worked. In the next round of operational tests in 1975, Stinger began to exhibit much-improved scores. By early 1976, the Pentagon had become convinced that Stinger's guidance problems had been resolved. Development of the Alternate Stinger was canceled. In 1979, after a total of 130 test-round firings staged to validate Stinger's design, the Pentagon gave GD the green light to begin production.

Stinger's problems, however, were far from over. It was first deployed with Army forward maneuvering elements in Europe in 1981. Fresh concerns about the missile arose a few years later.

The General Accounting Office, Congress's watchdog agency, weighed in with a critical report in 1984. By 1985, an element in the Army itself was slamming the missile. The Army Research Institute (ARI), in a highly critical report, charged that the weapon was "un-

necessarily difficult" to use. The study pointed out that a soldier would have to undertake a sequence of eighteen distinct steps to ready the weapon for firing—a task that was viewed as being too complex for the average soldier.

Critics pounced. Stinger was too heavy, they said, and the troops got too tired lugging it around. The warhead was too small. In short, Stinger became a symbol of high-tech weapons-making gone haywire.

"The criticisms that befell Stinger were something that we expected," says GD's Mr. Leonard. "There was genuine concern at the time about human factors in weapon design and about soldiers who had a high-school diploma or less keeping pace with high-tech hardware."

Many of the criticisms, however, seemed ill-founded or greatly exaggerated. Mr. Leonard says that some had a rather utopian flavor. "It's always very easy to say, 'Wouldn't it be easier if the soldier didn't have to carry a thirty-pound weight but only a twenty-pound weight?'" says the GD official. "If we could have made Stinger lighter at the time, we certainly would have."

As for the infamous eighteen firing steps outlined in the Stinger operator's manual, Mr. Leonard observes that they included such steps as "open box and remove weapon." In reality, says one experienced Stinger gunslinger, USAF Col. Gene Tucker, "it boils down to five or six essential actions you might need to take to engage the target."

For one Army officer involved in the Stinger controversy, the 1985 ARI criticism had a huge blind spot. "The 1985 report deleted one important fact," says he. "After you perform the eighteen steps, Stinger kills the airplane. End of argument."

Mujahedeen Success

It was the Afghan *mujahedeen* who demonstrated the validity of that statement. The first US delivery of Stingers to rebel forces came in September 1986. The impact was felt almost immediately. The Moslem guerrillas promptly shot down a pair of Soviet "Hind" helicopters.

Unofficial reports began to trickle in about the little missile's big successes. In mid-1989, the Army released an official tally: Even counting misfires and gunner errors, the rebels had destroyed 269 out of the 340 Soviet aircraft they shot at. Ninety percent had been fired at crossing targets, ten percent against incoming targets, and a handful against outgoing aircraft.

"Before Stinger," states the Army report, "Soviet fixed- and rotary-wing aircraft always won the day." After its appearance on the battlefield, enemy flight operations ceased completely for a month. "When flying resumed," the report adds, "Stinger continued to kill despite flares and procedural countermeasures."

The Afghan resistance employed Stinger in a variety of ways. Techniques, says the Army report, included "ambushing transiting aircraft along known flight routes, shooting cargo aircraft landing or taking off at bases, and using ground ambushes to draw close support aircraft into Stinger's envelope."

In response to this new, threatening weapon, Soviet pilots began to fly their aircraft very low, which exposed them to other dangers such as small arms ground fire and accidents, or very high, which greatly undercut the accuracy and thus the effectiveness of their bombing. Stinger's range is classified, but it probably is about three miles. The Army's after-action report observed that, when flying in interdiction or close support missions, Soviet attack aircraft dropped their bombs from altitudes exceeding 10,000 feet.

Despite the Soviet Hinds' excellent countermeasures, such as infrared jammers, engine-exhaust suppressors, and flare dispensers, the heavily armored helicopters began flying only night missions, in hopes of avoiding an encounter with the Stinger. Soviet helicopters and low-flying bombers virtually disap-

Stinger is much more than a shoulder-fired missile. In this artist's concept of a typical air cavalry engagement, two AH-64 Apaches equipped with Air-to-Air Stingers (ATAS) provide counterair capability while other Apache crews attack ground targets.

peared from daytime skies. Freed from the threat of air attack, the *mujahedeen* began to move men and supplies more effectively.

Why It's Hot

In the aftermath of its success in Afghanistan, Stinger is now much in demand around the world (see box). Nations seeking to purchase the system point to a number of specific attributes.

- *High accuracy.* In more than 1,000 fly-to-buy test firings, Stinger has exhibited a success rate approaching ninety percent. Some officials claim that Stinger might even be reasonably effective against low-flying cruise missiles.
- *Fire-and-forget capability.* Army reviewers claim that the *mujahedeen*'s use of British Blowpipe missiles was not effective. One reason may be that a Blowpipe gunner must guide the missile all the way to impact. By contrast, Stinger's gunner can fire and take cover, without the missile losing its lock on the aircraft.
- *Mobility.* At thirty-five pounds, Stinger is especially suited to transport by small army ground units.
- *Ease of use.* Stinger is issued as a certified round that requires no field maintenance or field testing.
- *Reasonable cost.* The unit flyaway cost of the Stinger Basic model used in Afghanistan is approximately $50,000.

The US Army, Navy, Air Force, and Marines all use the same weapon in a variety of roles. A 1989 GAO report said that "the missile configuration bought by the other services is exactly the same as the Army's version, and so commonality is 100 percent among service participants." Its IFF is compatible with US/NATO equipment.

Stinger can be installed on almost any platform. Integrated with helicopters, it becomes the Air-to-Air Stinger (ATAS). In conjunction with the Army's High Mobility Multipurpose Wheeled Vehicle, it is the Pedestal-Mounted Stinger/Avenger, used to counter fixed-wing aircraft attacking targets in the rear of a division.

The US Navy uses Stinger on ships having little or no air defense capability or to swiftly augment the defensive strength on those that do. Stingers, for example, were deployed aboard Sixth Fleet warships off Lebanon in the mid-1980s to give added protection against fixed-wing and rotary-wing terrorist attacks and on ships on duty in the Persian Gulf during the Iran-Iraq war. The Air Force uses the missile for air base defense.

Who Has the Stinger?

Country[1]	Service	Model
Afghanistan	*Mujahedeen*	Basic (FIM-92A)
Angola	UNITA guerrillas	Basic
Bahrain	Army	Basic
Chad	Army (limited numbers)	Basic
Denmark	Army	POST (FIM-92B)
France	Army (limited numbers)	Basic
Greece	Army	POST
Iran[2]	Revolutionary Guards Corps (limited number)	Basic
Israel	Army	RMP (FIM-92C)
Italy	Army	Basic
Japan	Army, Air Force	Basic
Netherlands	Army, Navy, Marine Corps	Basic/POST
Nicaragua	Contra guerrillas	Basic
Pakistan	Army	Basic
Qatar[2]	Army	Basic
Saudi Arabia	Army	Basic
South Korea	Army	Basic
Switzerland	Army	RMP
Turkey	Army	Basic/POST
UK	Special Air Service (limited number)	Basic
US	Army, Navy, Marine Corps, Air Force, Special Forces	Basic/POST/RMP
West Germany	Army, Navy, and Air Force	Basic/POST/RMP

[1]On order or in service.

[2]Obtained illegally or indirectly.

Source: *Jane's Land-Based Air Defence*, 1989–90.

New Model, New Concerns

Production of the Stinger Basic model and improved Stinger POST (Passive Optical Seeker Technique) model ended in 1987. Last June, the contractor began deliveries of an improved Stinger, the Reprogrammable Microprocessor (RMP) version.

Stinger-RMP can be reprogrammed to counter evolving countermeasures threats. With Stinger-RMP, fielded hardware can be upgraded with the latest software by a simple change of a module in the gripstock. The object is to extend the Stinger's useful service life. The foreign-sales version of RMP does not include a module and has Stinger POST-equivalent capabilities.

Raytheon Co. is the second source for production of Stinger-RMP. The firm recently won a contract to produce 1,383 of the latest missiles.

With Stinger's success has come problems. Because of its proven performance, it has become a weapon much coveted by Third World countries and subnational terrorist groups. Already, Stingers have fallen into the wrong hands. Iran is said by US officials to have obtained a few. Early this year, federal agents set up a sting operation using a borrowed Stinger as bait, capturing suspected members of the Irish Republican Army. The suspects had tried to purchase the weapon for $50,000.

In light of the potentially huge threat that the missile could pose to civilian airliners, the United States is taking steps to prevent unauthorized use of Stingers. One plan under consideration calls for equipping new Stingers with built-in security devices, the disabling of which will require access to secret and ever-changing codes.

Such steps make it abundantly clear that no one worries any longer that the Stinger is too complex to be effective. ■

The Malmstrom missileers take home the Blanchard Trophy for 1990.

Olympic Arena

By Jeffrey P. Rhodes, Aeronautics Editor

SHARP rivalries sometimes flare at Olympic Arena, Strategic Air Command's annual competition to decide which strategic missile wing is best overall. Last year, the 351st SMW from Whiteman AFB, Mo., beat out the 341st SMW from Malmstrom AFB, Mont.

"We lost by one point," recalls one 341st SMW missileer, 2d Lt. Larry Eiman, "and we were really put out about that. We were determined not to let that happen again."

They didn't. This year, in another down-to-the-wire contest between the two, the "First Aces" of Malmstrom edged out Whiteman's "War Chiefs," winning by thirteen points. It marked the third time in Olympic Arena's twenty-three-year history that the Montana wing recorded the top score and, with it, won the Blanchard Trophy.

Olympic Arena 1990 was, as always, a gathering of the best of the best from SAC's intercontinental ballistic missile (ICBM) community. From top to bottom, the competition held in May was fierce. In fact, the gap between first and sixth place teams came to fewer than 100 points.

For Air Force crews, Olympic Arena also brings lasting benefits. "With the crews, there is a natural exchange in a situation like this," says Maj. Mike Glaspy, SAC project officer for Olympic Arena '90. "They go back and think about what they saw, and the word gets out to the crew force. Somebody always comes up with a better idea."

Col. Edward L. Burchfield (left), Commander of the 341st Strategic Missile Wing, hoists the Blanchard Trophy with Gen. John T. Chain, Jr., SAC Commander in Chief. In 1990, the 341st won the Olympic Arena competition for the third time.

The annual meet, held at Vandenberg AFB, Calif., features three intense days of competition. From SAC's six ICBM wings come the top missile launch crews, maintainers, security police, civil engineers, and communicators.

The rivalry between Whiteman and Malmstrom provided extra incentive for the 351st and the 341st SMWs. Col. Edward Burchfield at Malmstrom and Col. Thomas Kuenning at Whiteman, the respective wing commanders, once served together as missileers. Friendly sparring between the two officers is common, but the entire units were involved this time.

A Team Approach

"The competition is a total team effort," says Sgt. Keith Jennings, a pneudraulics maintenance team member from Whiteman. "Everybody has to pull his weight. No one group can carry the team, and just one minor error can sway the outcome."

The 3,100 possible points available to each wing in the competition are weighted toward operations and maintenance (1,200 points each). Those are the prime jobs associated with the LGM-30F/G Minuteman and LGM-118A Peacekeeper ICBMs. Groups such as security police, civil engineers, and communications specialists have vital support roles and contribute heavily (a possible total of 700 points) to a wing's score at Olympic Arena.

In the operations area, four two-missileer crews take part in one ninety-minute warfighting scenario. This takes place in the missile procedures trainer, which simulates the underground launch-control center. The exercise tests the crews' ability to follow checklists, handle unusual situations, correct malfunctions, and launch missiles. A major part of the scored simulator ride is knowledge and demonstration of Emergency War Order (the US nuclear warfighting plan) procedures.

"Everybody is given the exact same scenario within the configuration of their weapon system," says Major Glaspy. "We have to tweak the scenario a little to make it compatible between the Minuteman II [LGM-30F] and Minuteman III [LGM-30G] systems, though." The two have modest differences in de-

Olympic Arena '90 Scoreboard

Unit	Base	Operations (1,200 points)	Maintenance (1,200 points)	SP (300 points)	CE (200 points)	Communications (200 points)	Total (3,100 points)
341st SMW	Malmstrom AFB, Mont.	997	1,077	296	190	192	2,752
351st SMW	Whiteman AFB, Mo.	1,038	1,118	246	188	149	2,739
321st SMW	Grand Forks, AFB, N. D.	984	1,093	251	175	187	2,690
44th SMW	Ellsworth AFB, S. D.	968	1,086	270	172	190	2,686
91st SMW	Minot AFB, N. D.	1,009	1,085	230	191	161	2,676
90th SMW	F. E. Warren AFB, Wyo.	969	1,076	245	180	189	2,659

sign, but are essentially the same in procedures.

The 90th SMW at F. E. Warren AFB, Wyo., operates two different missiles, Minuteman III and LGM-118A Peacekeeper. The 90th SMW's crews are divided evenly between the two missiles. From day to day, the wing follows the same procedures as any other wing, only it does so with different missiles, notes Major Glaspy. The 90th SMW doesn't bring a Peacekeeper maintenance team, because there are no similar units against which they could compete.

Four of the thirteen standard missile maintenance shops are represented in the competition. Three separate two-person teams compete in the areas of pneudraulics (hydraulics and compressed air systems), power-refrigeration-electric (PREL) generation, and electromechanical systems. The performance of a three-person munitions maintenance team is also counted in the maintenance scoring. Each of the four teams is required to troubleshoot, fix, or replace an item within its specialty.

Seven-member security police teams competed in three areas. The first exercise involved an attempt by a "terrorist" group (members of the SAC Elite Guard, plus staff SPs and evaluators) to force entry into a launch facility (a missile silo) opened for maintenance. The teams were graded on their response to the raid.

Another SP event graded combat marksmanship of the team. The SPs employed all weapons (M16 rifle, M60 machine gun, and M208 grenade launcher) on the range. The last exercise was a confidence course where the times of six of the seven runners counted for points.

The final competition areas involved civil engineering teams and communicators. CE teams had to repair the launch facility C-ring, a metal ring holding a work cage that provides access to a missile. Several wings had civilian competitors in this event. The communications specialists had to check, troubleshoot, and repair a UHF receiver.

Throughout, events are timed and arbitrary limits are established. "If everybody is perfect, there is no winner," Major Glaspy observes. "However, being correct is the most important thing."

Training and Benefits

In the past, some missile wings sent what amounted to professional teams to Olympic Arena. The same people seemed to turn up at every competition. "The crew force had some complaints about the competition," notes Major Glaspy. "The line crew member didn't have much of a chance to compete."

Three years ago, SAC instituted a random crew selection policy for the competition. Each wing now submits fifteen crews for selection, and SAC officials pick which crews will compete. This year, the number one and number eleven crews on each list were chosen. This method provides two crews, and the individual wings still get to choose two of their "elite" crews for the competition.

"This method is more representative of the crew force," says Major Glaspy. "We get to see a crew dog [what the crews call themselves], rather than an instructor. It is a quick snapshot, and it gives us an idea of what the knowledge and training level is, although [we see it] in a sterile environment."

Selection of the teams for the other areas were left to the discretion of the individual wings. Some wings made the troops take a written test and undergo a performance exercise, while others went through an evaluation board. In almost every case, all participants were volunteers.

Once the units were selected, SAC limited training to the thirty days prior to the competition. Although determining the training regimen was left up to the wings, every team in every event worked six days a week to prepare. Operations teams were required to sit two alerts during their training in order to ease the scheduling burden on the rest of the wing.

The benefits from Olympic Arena are both tangible and intangible. The most tangible was the discovery by one team that an error existed in the missile technical data. This was corrected at once. Because time is so critical in the competition, the Malmstrom pneudraulics team sat down and was able to cut a thirty-three-item checklist down to just nineteen items.

"We found a better, easier, and faster way to do it for the competition," says Sgt. Thomas Young, one of the 341st SMW competitors. "What we found is that it would work after the competition, too." Those are the discoveries that benefit the entire missile force. ■

Today's US fighters will have been on duty a long, long while by the time the ATF arrives.

General Welch's Warning

GEN. Larry Welch, as he wrapped up his four-year term as USAF Chief of Staff, issued a tough warning about possible shifts in tactical airpower: At the end of the 1990s, just before the Advanced Tactical Fighter enters service, the Soviet Union might catch up to the US in fighter prowess.

"If the Soviets field their [next-generation] fighters on the current projection," the retiring Chief maintained, "we're going to have a couple of years . . . when we're going to be very uncomfortable with the balance." He referred not to numbers, but to technological sophistication, an area in which the US always has led.

The Air Force won't field significant numbers of ATFs until 2001. The Navy's carrier-based variant of the ATF will take even longer to deploy. In a June 8 session with Washington defense writers, General Welch emphasized that the period of maximum risk would occur "toward the end" of ATF development late this decade.

"The Air Force F-15 and Navy F-14 will have been performing the air-superiority mission for more than twenty-five years," said General Welch, who retired on June 28. "That's a hell of a long time to stretch the capabilities of an aircraft in the most demanding tactical air role"—air superiority.

Intelligence agencies report that the USSR is developing advanced successors to the MiG-29 and Su-27, but deployment dates are unknown. The level of risk, said General Welch, "depends on how fast they actually develop and deploy their advanced aircraft."

In 1986, the year General Welch became chief, USAF active-duty strength topped out at 607,000. Since then, he noted, the service has lost 63,000 members and thirty-one tactical squadrons. What will the force look like in 1995? Here is the General's prediction:

- Tactical fighter forces will "probably be twenty to twenty-five percent smaller than we had envisioned three or four years ago," about twenty-eight or twenty-nine active and reserve tactical fighter wings.

All F-4s, active and reserve, will be gone, and A-7s will be nearly so. A-10s will be in "low-intensity force" roles.

Mainstays of the tactical force will be F-15Es and F-111s for interdiction, the F-15C/D and the proposed F-15F—"as it comes on board"—for air-to-air combat, "A-16s" for close air support, and the F-16 as the multirole fighter.

Multirole F-16s will fill "ten to eleven" of the wings. The mix in the rest of the force will remain about the same. USAF wants a new multirole fighter, but "it's a concept, not a program."

- Strategic forces, as a result of the START Treaty, will see increased reliance on bombers and less reliance on ballistic missiles. Even so, "you will see a bomber force significantly smaller than we had envisioned in 1986." Instead of 400 aircraft, the force will probably number around 275. Included in the mix will be seventy-five B-2s, ninety-seven B-1s, and eighty-five B-52H cruise-missile carriers. The need for the B-2 is acute. By the end of the 1990s, if B-1s were used on B-2 routes, "losses would be very, very high."

Heavily MIRVed ICBMs, such as the ten-warhead Peacekeepers, will be a "principal target" for reductions in a second round of START talks, which "everyone" expects to ensue. Thus there will be "even fewer" ICBMs than the modest number today.

- Strategic airlift "will be even more important" than it has ever been, the result of losses of forward bases. There will be a "significant" reduction of Air Force and Army bases over the next five or six years, placing a greater premium on quick response with US-based forces.
- The Air Force will have "a continued commitment to high-quality people," but will have to work hard to attract, retain, and motivate them. The size of the force, which will be about 530,000 by September 1991, could drop as low as 460,000 by the mid-1990s. That figure "assumes that world events continue to unfold as they are now."
- "Really effective standoff munitions" are rapidly becoming a reality for the conventional forces and will mark a "significant" change in the nature of the Air Force in years to come. The service is now beginning to field the technologies that will permit it to deploy effective standoff weapons. Such weapons "are now becoming a reality rather than a hope."

The retiring chief indicated that the Air Force, and all other services, will have to make do with current equipment for some time. Said General Welch, "In the environment we're operating in, you're going to see damn few new starts for a while." ■

Gallery of West European Airpower

By John W. R. Taylor and Paul Jackson

Bombers and Maritime

Mirage IV-P

The Mirage IV was developed as the quick-reaction manned component of the French nuclear deterrent triad of strategic bombers and silo-based and submarine-launched ballistic missiles. Dassault scaled up its delta-wing Mirage III fighter airframe and installed tandem seats for a two-man crew, a large circular radome for ground mapping radar under the center fuselage, and a pair of uprated Atar turbojets. The 62 production Mirage IV-As 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. 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 takeoff 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. Later, 12 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 May 1, 1986, followed by 2/9-2 *Bretagne* (each now with 7 aircraft). Two other aircraft are allocated to the OCU, CIFAS 328 *Aquitaine*, at Bordeaux. The underground Hq of the bomber force is at Taverny, near Paris. A reserve war Hq is located inside Mont Verdun, near Lyon.

Contractor: Dassault 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.

Albatross (HU-16B)

In 1961, Grumman developed a 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.

Mirage IV-P, French Air Force

Atlantic, Italian Air Force

D.3B Aviocar, Spanish Air Force (Paul Jackson)

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 October 21, 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 ESM 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. The first of 42 was delivered to 23 Flottille at Lann-Bihoué on October 26, 1989. Reequipment of 24 F at the same base will follow; 21 F and 22 F at Nimes-Garons will be converted between 1996 and 2001. 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: Dassault 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, or two Exocet missiles. Underwing pylons for two AS 30 or Martel missiles.

Aviocar (C-212)

Specially equipped versions of the CASA C-212 Aviocar STOL utility transport have been delivered for military duties. Nine Srs 100/200s were ordered by the Spanish Air Force for search and rescue missions (Spanish designation D.3B), 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 21 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.

Buccaneer

The heavily area-ruled Buccaneer began life as a naval aircraft, designed specifically to exploit the vulnerable gap beneath hostile radar defenses by delivering its nuclear weapon at speeds around Mach 0.9 at extremely low altitude. The prototype, flown for the first time on April 30, 1958, and early production Buccaneer S. Mk 1s had Gyron Junior turbojets. The switch to Rolls-Royce Speys offered a 30 percent increase in thrust and reduced fuel consumption, and these engines became standard in Buccaneer S. Mk 2s 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 anti-radiation antiship missiles on wing pylons, plus an additional 510 gallon fuel tank in the bomb bay door. The balance comprised non-Martel S. Mk 2As.

Today, four 2As and 44 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

Gulfstream III, Danish Air Force

Nimrod MR. Mk 2, Royal Air Force (Paul Jackson)

were updated by British Aerospace in 1987–90 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 33,000 lb, gross 62,000 lb.

Performance: max speed 668 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.

Two F27 Maritimes of the Royal Netherlands Air Force are assigned to non-NATO duties in the Netherlands Antilles.

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 Narssarssuaq, Greenland. Special features include a cargo door on the starboard

P-3C Orion, Royal Norwegian Air Force

side, forward of the wing. Texas Instruments APS-127 sea surveillance radar, and Litton 72R INS. The Italian Air Force has two Gulfstream III VIP transports.

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

The airframe of the Nimrod maritime patrol aircraft 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. They equip four squadrons of No. 18 Group of Royal Air Force Strike Command. Of these, No. 42 is based at St Mawgan in Cornwall, England. Nos. 120, 201, and 206 are at Kinloss in Scotland. The remaining 11 were allocated to the later-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 Arcturus (CP-140A)

Standard shore-based antisubmarine and maritime patrol aircraft of the US Navy since 1962, the P-3 also flies in the insignia 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.

No. 221 Squadron of the Spanish Air Force, at Jerez, has five of the seven P-3Bs (Spanish designation P.3) that were operated formerly by No. 333 Squadron of the Royal Norwegian Air Force. In their place, No. 333 now flies four of the latest Update III P-3Cs for its primary task of detecting Soviet submarines leaving Northern Fleet bases in the Murmansk area from its base at Andøya, in the far north of Norway. 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 have been 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 the first had received a major retrofit and detection sensors upgrade by Lockheed. Funding is awaited for modification of the remaining five which, designated P-3P, will 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 are also to be added, making the P-3Ps comparable to a P-3C Update II.5. They are operated by No. 601 Squadron at Montijo. 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, for operation as unarmed economic zone patrol aircraft under the designation CP-140A Arcturus. *(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)

First flown in XS2F-1 prototype form on December 4, 1952, this veteran piston-engined aircraft continues to perform shore-based maritime duties with the Turkish Air Force. About 15 S-2A/E Trackers are operated on antisubmarine patrol by No. 103 Squadron, 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 withdrew the last of its Trackers from economic zone patrol and utility roles on April 1, 1990. *(Data for S-2E.)*

Prime Contractor: Grumman Corporation, USA.

Power Plant: two Wright R-1820-82WA piston engines; each 1,525 hp.

Dimensions: span 72 ft 7 in, length 43 ft 6 in, height 16 ft 7½ in.
Weights: empty 18,750 lb, gross 29,150 lb.
Performance: max speed 253 mph, search speed 161 mph, service ceiling 22,000 ft, range 1,150 miles.
Accommodation: crew of three or four.
Armament: 2.75 in rocket packs, torpedoes, depth bombs, and bombs.

Fighters

F-4 Phantom II

Four NATO air forces in Europe continue to deploy the Phantom II as first-line combat equipment. The Royal Air Force has four air defense squadrons, all under NATO command. No. 56 at Wattisham in England, and Nos. 19 and 92 at Wildenrath in West Germany, have FGR. Mk 2s (F-4Ms), 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 look-down/shoot-down 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 AMRAAMs. A further 40 F-4Fs, serving in the fighter-bomber role, are undergoing partial update.

The other two 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.)*
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 July 30, 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 southern flank they are flown by Squadrons 341 and 343 of the Hellenic Air Force, and Squadrons 133, 151, 152, and 153 of the Turkish Air Force. The Royal Netherlands Air Force now has only one squadron (No. 316) of Canadian-built NF-5As, others having re-equipped with 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, although its F-5As and F-5Bs have received improved avionics and self-protection systems for wartime air defense duties with AIM-9L Sidewinders, or ECM support with external jamming pods. *(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-4J Phantom II, Royal Air Force (Paul Jackson)

NF-5A, Royal Netherlands Air Force

F-16A Fighting Falcon, Royal Norwegian Air Force

CF-18A, Canadian Forces (WO Vic Johnson)

F-16 Fighting Falcon

On June 7, 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 75 for the Royal Norwegian Air Force. 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 are receiving 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, 314, 315, 322, and 323 of the RNLAF; and 331, 332, 334, and 338 of the RNoAF.

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 Ankhialos, where two squadrons have been 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 formed in 1989–90. Portugal will receive 17 F-16As and three F-16Bs to reform No. 201 Squadron at Monte Real. *(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 19,020 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 reequipped with the twin-engined F/A-18 rather than the single-engined 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. By comparison with the US 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 former Phantom squadrons of 12 Wing, at Torrejón AB, had also converted to EF-18s by mid-1990. *(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 reequipped. The Hellenic Air Force has two fighter-bomber squadrons of F-104Gs with 116 Wing at Araxos, plus considerable reserves. The Turkish Air Force has seven squadrons of F-104Gs and two-seat TF-104s (Nos. 161, 162, 163, 131, 182, 192, and 193), plus one air defense squadron of F-104Ss (No. 191) 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 153 Italian Air Force F-104s have been undergoing a major weapon system update since 1986, bringing them up to F-104S ASA *(Aggiornamento Sistemi d'Arma)* standard. This includes installation of an FIAR R21G/M1 Setter look-down/shoot-down 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, as an alternative to the very similar Sparrows, which accounted for the "S" in the aircraft's designation. The 100th ASA conversion was completed in February 1990. *(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-four years after the first flight of the Mirage III prototype, this delta-wing fighter remains in first-line service with the air forces of France and Spain, for 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

F-104S ASA, Italian Air Force (Paul Jackson)

Hawk T. Mk 1A, Royal Air Force

Mirage 2000EGs, Hellenic Air Force

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 but are being updated locally with an in-flight refueling probe, APQ-159 radar, AYK-1 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; bombs or rocket packs underwing, for ground attack missions.

Mirage F1

The basic Mirage F1-C, first flown in prototype form on December 23, 1966, is primarily 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 includes a HUD and Cyrano IV-M multifunction radar with a high degree of resistance to ECM. In addition, many F1-Cs have an in-flight refueling probe, under the designation F1-C-200. Squadrons equipped with F1-Cs are 3/5 *Comtat Venaissin* at Orange (reequipping with Mirage 2000Cs); 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. Fifty-five Mirage F1-Cs replaced in the air defense role by Mirage 2000s will be converted to F1-CT standard for attack duties, with upgraded radar, INS, F10M ejection seats, RWR, and air-to-surface weapons.

The Hellenic Air Force has two squadrons of Mirage F1-CGs, Nos. 334 *Thalos* and 342 *Sparta*, currently at Tanagra but scheduled to transfer shortly to Hiraklion and Skiros. 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: Dassault 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 December 18, 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. However, it is equally suitable for reconnaissance, close support, and low-altitude attack missions in areas to the rear of a battlefield. The French Air Force plans to acquire 169 air-superiority Mirage 2000Cs and 23 Mirage 2000B two-seat trainers, of which funds for 146 and 23, respectively, had been committed by FY 1990. A strike/attack version, the Mirage 2000N, is described separately.

From airframe No. 38, Mirage 2000Cs have a more powerful M53-P2 engine and RDI pulse-Doppler radar. Deliveries of initial production M53-5/RDM aircraft began in 1983, to 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 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 February 6, 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, took place in 1988–90. *(Data for Mirage 2000C.)*
Contractor: Dassault 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 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 170 Tornado ADVs (plus the prototypes) 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 required, 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 November 20, 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, Nos. 11, 23, and 25 at Leeming, and No. 43 at Leuchars. One further Squadron, No. 111, will form at Leuchars in late 1990. *(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 16,520 lb st.
Dimensions: span 45 ft 7½ in spread, 28 ft 2½ in swept; length 61 ft 3½ 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 implemented in 1989–92 includes 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.

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 46.5, 23.8, 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 May 15, 1984, and the first Italian production aircraft on May 11, 1988.

Italian requirements are for 187 single-seat AMXs to re-equip eight squadrons. Two batches totaling 80 aircraft (plus 34 for Brazil) are on firm order. The two-seat AMX-T, of which 51 are required by Italy, is to be delivered initially in training configuration, but may be adapted for other roles requiring two crew. As a G91T replacement, it will be operated by No. 60 Wing at Foggia for advanced training.

On January 1, 1989, 103 Squadron left its G91Rs at San Angelo and transferred to Istrana, where it reequipped with AMXs as part of 51 Wing. Next to reequip will be 28 Squadron (RF-104G) at Villafranca, followed by 14 Squadron (G91R) at Rivolto and 132 Squadron (F-104G) at Villafranca. Nos. 13, 101, and 102 Squadrons are also to convert to the AMX, including probably a version equipped with Grifo radar, for which Aeritalia, Aermacchi, and FIAR signed a joint venture agreement in 1990.

Contractor: AMX International (Aeritalia, Aermacchi, Embraer).
Power Plant: one Rolls-Royce Spey Mk 807 turbofan; 11,030 lb st.
Dimensions: span 32 ft 8½ in (over missiles), length 44 ft 6½ in, height 15 ft 0¼ in.
Weights: empty 14,638 lb, gross 28,660 lb.
Performance: max speed Mach 0.86, service ceiling 42,650 ft, combat radius 328 miles lo-lo-lo with 6,000 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 Soúda, they retain the folding wings and 15,000 lb st nonafterburning Allison TF41 (Spey) turbofan of the US Navy's A-7E on which they are based, but have no in-flight refueling capability. They were followed by five two-seat TA-7Hs.

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. No. 304 has a detachment in the Azores, and will move there completely by 1992. *(Data for A-7P.)*

Contractor: Vought Corporation, USA.
Power Plant: one Pratt & Whitney TF30-P-408 nonafterburning 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.

Alpha Jet, Luftwaffe (Paul Jackson)

TA-7H Corsair II, Hellenic Air Force (Paul Jackson)

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, alongside the RF-35s of 729 Squadron. Half of the Draken force will be withdrawn in 1993–95, leaving a dual-role attack/recce squadron to continue until the year 2000.

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

The Italian Air Force continues to operate one squadron (No. 14) of G91R/1 series aircraft, 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. 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

AMX, Italian Air Force

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. Ex-German Alpha Jets have been requested as replacements. West Germany retains more than 20 G91R/3s and two-seat G91Ts 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 December 27, 1966. Over the next ten years, 20 preseries and 45 production G91Ys were built for the Italian Air Force. They currently equip Squadrons 101 and 13, the latter with a primary antishipping 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, Italy, and ARGE-91 consortium, Germany.

Power Plant: one Fiat-built Orpheus 803 nonafterburning 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 August 31, 1966. Deliveries of production Harriers to the Royal Air Force's No. 233 OCU at Wittering in the UK began in April 1969, and at its peak the aircraft equipped four squadrons. 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 the OCU, 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. The last Harrier GR. 3 squadron of RAF Germany (No. 4) is converting to Harrier GR. Mk 7s in 1990.

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 5/7

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 original 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 November 5, 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 Harrier IIs 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 redeclared to NATO with GR. 5s in October 1989, followed by No. 3 in Germany this year. The last 34 RAF aircraft are being built to "night attack" standard, with the designation GR. Mk 7. Their equipment includes GEC Avionics FLIR, new Smiths head-up and head-down displays, and cockpits compatible with night vision goggles. GR. 7 delivery will begin shortly to No. 4 Squadron in Germany. 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 have been 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.

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 six squadrons of Jaguar As in No. 7 Wing at St Dizier, and No. 11 Wing at Toul, plus Jaguar A/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 *Alger* 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.)*

Harrier GR. Mk 5, Royal Air Force (Paul Jackson)

Harrier GR. Mk 3, Royal Air Force (P. J. Cooper)

Jaguar GR. Mk 1, Royal Air Force (Paul Jackson)

Mirage 5BA, Belgian Air Force

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

This tandem two-seat attack aircraft is in service with Squadrons 1/4 *Dauphiné* and 2/4 *Lafayette* at Luxeuil, replacing two Mirage IIIE squadrons of No. 4 Wing that have been responsible for "prestrategic" missions carrying AN 52 tactical nuclear bombs. A third squadron, EC 3/4 *Limousin*, became operational at Istres on July 1, 1990, carrying conventional armament in the overseas rapid deployment role.

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 180, of which 132 are scheduled to be funded by the end of FY 1990. These include the first 57 Mirage 2000N' aircraft, intended primarily for nonnuclear attack roles, and lacking ASMP capability. 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 antiairfield JP233s.

RAF GR. Mk 1s are to undergo a midlife update, involving the Marconi RWR and Sky Shadow EW jamming systems, GEC Avionics Spartan terrain-referenced nav/terrain-following system, an updated weapons control system, new Ferranti HUD, and Smiths color CRT head-down display. The first upgraded aircraft, designated Tornado GR. Mk 4, is expected to fly in late 1991.

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, which, like German squadrons, can carry antiairfield MW-1s. 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 four air forces and the German Navy.
Contractor: Panavia Aircraft GmbH (BAe, UK; MBB, Germany; Aeritalia, Italy).
Power Plant: two Turbo-Union RB199 Mk 103 afterburning turbofans; each 16,075 lb st.
Dimensions: as Tornado ADV, except length 54 ft 10¼ in.
Weights: empty 31,065 lb, gross more than 61,730 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.

Reconnaissance and Special Mission Aircraft

Andover R. Mk 4 and E. Mk 3

An Andover C. Mk 1 transport/communications aircraft of the RAF's No. 60 Squadron, based at Wildenrath, West Germany, returned to service in January 1990 after conversion to R. Mk 4 standard with vertical cameras in the fuselage. This aircraft is used within the Berlin corridors and control zone, replacing two Pembroke C(PR).

TR.12D Aviocar (ECM version), Spanish Air Force (Paul Jackson)

C-135FR, French Air Force (Ivo Sturzenegger)

RF-35 Draken, Royal Danish Air Force (Paul Jackson)

Mk 1s. The six Andover E. Mk 3s of No. 115 Squadron are C. Mk 1s modified for radar calibration and special duties. *(Data generally as for Andover C. Mk 1 transport.)*

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, including a blunt nose radome and fintip pod, 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 similar C-212s (designated TR.12D) 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.)*

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 reengining them with CFM56 turbofans, and the last updated aircraft rejoined the three squadrons of the 93d Bombardment 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

A few Canberra PR. Mk 9s of No. 1 PRU, with cameras and infrared linescan in their belly, form the only dedicated strategic photoreconnaissance 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.
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)

Six Canadair Challenger 600s are employed on electronic support and training missions by No. 414 Squadron of the Canadian Forces. Equipment includes an ALQ-502 radar jammer, ALE-502 chaff dispenser, spectrum analyzer, and communications jammers. Another was delivered to the Aeronautical Engineering and Test Establishment at Cold Lake, Alberta, as a test-bed for developing such future military applications as maritime reconnaissance. Canadian Forces designation is CE-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.

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 30, under the designation UD.13, the surviving 23 of which are to be converted to CL-215T standard with two 2,380 shp PW123AF turboprops. 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, Bombardier 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 will operate four Dash 8M-100s with No. 402 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-3D Sentry AEW. Mk 1, Royal Air Force

E-3A/D/F 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. 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 this year. The RAF aircraft are scheduled to become operational with No. 8 Squadron at Waddington on July 1, 1991, under the designation E-3D Sentry AEW. Mk 1; the French E-3Fs are assigned to Unité de Détection Aéroportée 2/290 at Avord. Both the E-3D and E-3F have an in-flight refueling probe; the RAF aircraft are fitted additionally with wingtip Loral 1017 Yellow Gate ESM pods. *(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. If, as expected, Orpheus is withdrawn in April 1993, with no funding available to replace it, 306's aircraft will 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 40 kW 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 of the Luftwaffe operates seven sweptforward-wing Hansa Jets for ECM training. Features include a cylindrical nose radome and a boat shape fairing under the rear fuselage.

G222RM, Italian Air Force

F-16A(R) Fighting Falcon, Royal Netherlands Air Force (Paul Jackson)

Nimrod R. Mk 1P, Royal Air Force (Paul Jackson)

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

Five Royal Air Force Hercules (including four C. Mk 1(K) tankers and a C. Mk 1) have been fitted with Orange Blossom 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 Vinten 401 infrared linescan system.

Mirage 5BR

The Belgian Air Force's tactical reconnaissance unit is No. 42 Squadron, equipped with 18 remaining 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 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 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 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 also have Mystère-Falcon calibration aircraft in service.

Contractor: Avions Marcel Dassault-Breguet Aviation, France.
Power Plant: two General Electric CF700-2D2 turbofans; each 4,500 lb st.
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 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, carrying four flight crew and 20 systems operators. 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. All three were fitted with in-flight refueling probes between 1982 and 1988, so becoming Mk 1Ps. *(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 conversion of some of the transports 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 FTB 337 G militarized versions of Cessna's "push and pull" twin-engined light aircraft, for counterinsurgency, photo-

graphic 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 noncombat missions.

RF-4 Phantom II

Four of America's European allies continue to operate reconnaissance versions of the Phantom. The Luftwaffe 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. Eight ex-USAF RF-4Cs (CR.12s) serve in 12 Wing of the Spanish Air Force. *(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 has about 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 3d 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. They will be replaced soon by AMXs.

Shackleton AEW. Mk 2

The five surviving Shackletons of the RAF's No. 8 Squadron, based at Lossiemouth in Scotland, continue to provide vital airborne early warning coverage for UK airspace until they are replaced by E-3D Sentries on June 30, 1991. The first of 12 Shackleton AEW. Mk 2s flew on September 30, 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 equipment. This includes AN/APS-20F search radar 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, West Germany, the RAF's No. 2 Squadron was the first to equip with a cameraless reconnaissance version of the Tornado IDS, designated GR. Mk 1A, with which it became operational in 1990. No. 13 Squadron formed at RAF Honington, in the UK, in January 1990. Identifiable by a small underbelly blister fairing to the rear of the laser rangefinder pod, this aircraft has a Vinten sideways looking IR system, Vinten 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 Luftwaffe is receiving 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 is 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 provides 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.)*

RF-4E Phantom II, Luftwaffe (Paul Jackson)

VC10 K. Mk 2, Royal Air Force (Paul Jackson)

Victor K. Mk 2, Royal Air Force (Paul Jackson)

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)* 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 antennas above the forward fuselage, a retractable ventral Thomson-CSF radome, and slender wingtip pods with UHF/DF blade antennas. *(Data as for Transall C-160 transport.)*

TriStar Tankers

The Royal Air Force purchased six Lockheed L-1011-500 TriStar airliners from British Airways and three from Pan Am for conversion into in-flight refueling tankers. The first four aircraft were modified 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 313,300 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 have been fitted to two of the four K. Mk 1s by early 1991. Conversion of the six ex-BA aircraft was done by Marshall of Cambridge. The three ex-Pan Am aircraft will become TriStar C. Mk 2(K) tanker/passenger transports, with only standard TriStar fuel tanks of 213,240 lb capacity 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 24,470 gallons, and the K. Mk 3 a capacity of 26,455 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 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 1(K)s 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.

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

The 14 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 Andover E. Mk 3 and R. Mk 4 are listed under *Reconnaissance and Special Mission Aircraft. (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.
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 four NATO air forces besides USAF. Those of the Canadian Forces, designated CC-137, 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 has modified 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. Italy is converting four ex-airline 707s to tankers for delivery in 1990–91, the contractor being Aeronavali.

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.

CC-137 (Boeing 707), Canadian Forces

CC-115 Buffalo, Canadian Forces

G222 (with C-130), Italian Air Force

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-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 36 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 27 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.

Transall C-160

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 and 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 24,600 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 first NATO military operator was the Spanish Air Force, which 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 has funded two in FY 1990, and plans to order six more in FY 1991. Deliveries begin later this year. Turkey has ordered 52 to replace veteran C-47s, 50 to be built locally by TUSAS.
Contractor: Aircraft Technology Industries (Airtech: CASA, Spain, and IPTN, Indonesia).
Power Plant: two General Electric CT7-9C turboprops; each 1,870 shp.
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 Friendship 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

The G222 equips two of the three transport squadrons of the Italian Air Force in its standard general purpose form. 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 Luftwaffe 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 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. Four and a half squadrons of the French Air Force, and six squadrons of the Luftwaffe, 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 1(K), 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

The French Air Force continues to operate this veteran helicopter, which first flew in prototype form 35 years ago. 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, but replacement by MDH 500s has begun. *(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.

Alouette III, Royal Netherlands Air Force (Paul Jackson)

BO 105 CB, Royal Netherlands Air Force (Paul Jackson)

CH-113 Labrador, Canadian Forces (WO Vic Johnson)

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.

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. RAF Chinooks will be upgraded to HC. Mk 2 standard in the early 1990s, gaining all major features of the CH-47D, some of which have already been installed. *(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.

Chinook HC. Mk 1, Royal Air Force (Paul Jackson)

Ecureuil 2

The French Air Force is acquiring 50 of these twin-turbine light helicopters for surveillance of strategic military bases and other support duties. The first six are AS 555F$_1$s, as described below. The remainder, delivered from January 1990, are AS 555ANs, 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 20 mm gun and 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. Four serve with 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.

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: 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 two 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.

Hughes 300, Spanish Air Force (Paul Jackson)

Puma HC. Mk 1, Royal Air Force (Paul Jackson)

CH-136 Kiowa, Canadian Forces (WO Vic Johnson)

Sea King Mk 43, Royal Norwegian Air Force

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 have been supplemented by 14 Bell 206B JetRanger IIIs (CH-139s) for pilot training since 1981. Eight of the CH-139s have been upgraded recently for service with the UN in Central America. The Hellenic Air Force uses two 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.

MD 500

Delivery began in May 1990 of 50 MD 500 light helicopters, built under license as NH-500Es, to replace the aging Bell 47s of the Italian Air Force's helicopter school at Frosinone.
Contractor: Agusta SpA, Italy.
Power Plant: one Allison 250-C20B turboshaft; 420 shp.
Dimensions: rotor diameter 26 ft 4 in, length of fuselage 23 ft 11 in, height 8 ft 2 in.
Weights: empty 1,441 lb, gross 3,550 lb.
Performance: max speed 160 mph, service ceiling 16,000 ft, range 320 miles.
Accommodation: pilot and six passengers.

Puma

Pumas serve 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 $330S_1$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 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 but have undergone progressive updating. From 1991 onward, six Canadian Sea Kings will be converted to CH-124B standard, with a new tactical navigation system, acoustic processor, internal MAD, and passive (replacing active) sonar. *(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.

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 and SAR, 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 liaison and 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 18 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.)*

UH-1N (CH-135), Canadian Forces (WO Vic Johnson)

Wessex HC. Mk 2, Royal Air Force (Paul Jackson)

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.

ALARM (on Royal Air Force Tornado IDS)

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, initially on Tornado GR. Mk 1s of No. 9 Squadron, which are assigned to a pathfinding role.

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 14 ft 1½ in, body diameter 9 in, wing span 2 ft 5 in.
Weight: 584 lb.
Performance: range 28 miles.

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 prefragmented 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 30L

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.

AS 30L (on Mirage 2000)

Propulsion: two-stage solid-propellant rocket motor.
Guidance: preguidance 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) is primary armament of the French Air Force's Mirage IV-P strategic bomber and Mirage 2000N attack aircraft, and is replacing 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-12)

Developed originally for the US Navy, Bullpup began as a simple weapon built around a standard 250 lb bomb. The pilot steers 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-88)

America's HARM (High-speed AntiRadiation Missile) has been ordered by the Luftwaffe, 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.

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 Tornados of the Italian Air Force, 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 initial 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 intervals between rounds. There is no minimum launch speed; maximum is more than 805 mph IAS.

The Magic 2 all-sector version is operational on Mirage 2000 aircraft of the French and Hellenic air forces. It has a more sensitive infrared seeker with head-on capability and improved IRCCM, including flare rejection, and can be slaved to the launch aircraft's AI radar as an alternative to autonomous operation. It has been fired successfully from an F-16 flying at Mach 1.3 at 20,000 ft, during an 8.7*g* turn. 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 Magic 2.)*
Contractor: SA Matra, France.
Propulsion: single-stage solid-propellant rocket motor.
Guidance: infrared homing.
Warhead: high-explosive type; weight 28.6 lb. Impact and RF proximity fuzes.
Dimensions: length 9 ft 0¼ in, body diameter 6¼ in, wing span 2 ft 2 in.
Weight: 198 lb.
Performance: cruising speed above Mach 2, range 1,640 ft to 6.2 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.

HARM (AGM-88) being launched from a Luftwaffe Tornado

Kormoran

Magic (R.550)

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. Radar 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 34 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 system.
Warhead: high-explosive type, shaped charge; weight 125 lb. Impact fuze.
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 arms 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 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 under the wings of 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.
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: 585 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.

Maverick (AGM-65)

Super 530 and Magic (R.550)

Sea Eagle (on Buccaneer) (Paul Jackson)

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 21 lb.
Dimensions: length 9 ft 5 in, body diameter 5 in, fin span 2 ft 1 in.
Weight: 192 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 and Phantom FGR. Mk 2.
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 continuous rod 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 25 miles.

Sidewinder AIM-9P on wingtip and AIM-9L on wing pylon

Sparrow (AIM-7) (Paul Jackson)

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. ■

The Chart Page

Edited by Colleen A. Nash, Associate Editor

The Twenty Most Critical Technologies

and Major Long-Term Goals for the S&T Program

Goal	Strategically relocatable targets	Force projection/rapid deployment	Defense against ballistic missiles	On-demand space asset deployments	Antisubmarine warfare	Worldwide, all-weather C³/surveillance	Signature management	Close combat/air defense	Brilliant weapons	Reduced support requirements	Personnel reduction	Affordable/producible weapon systems
High-Priority, Most Pervasive Technologies												
Composite materials	●	●	●	●	●	●	●	●	●	●	●	●
Computational fluid dynamics				●	●			●				●
Data fusion	●		●	●	●	●				●	●	
Passive sensors	●		●		●	●		●	●			
Photonics						●			●			●
Semiconductor materials and microelectronic circuits	●	●	●	●	●	●	●	●	●	●	●	●
Signal processing	●		●	●	●	●			●		●	
Software producibility	●	●	●	●	●	●	●	●	●	●	●	●
Enabling Technologies												
Air-breathing propulsion		●		●			●	●		●		●
Machine intelligence and robotics				●				●	●	●	●	●
Parallel computer architecture				●		●			●	●		
Sensitive radars	●		●		●	●		●	●			
Signature control	●		●		●		●					
Simulation and modeling		●				●		●		●	●	●
Weapon system environment	●	●	●		●			●	●			
Emerging Technologies												
Biotechnology materials and processes										●	●	●
High-energy-density materials			●	●				●		●	●	●
Hypervelocity projectiles			●					●	●			●
Pulsed power			●					●				●
Superconductivity			●		●	●				●		

DoD annually identifies for Congress the technologies that are most essential to "the long-term qualitative superiority of US weapon systems." The Pentagon has grouped the technologies into three categories.

Source: The Department of Defense Critical Technologies Plan, 1990.

The Defense Science Board thinks there is a better way to track weapon requirements, effectiveness, and costs.

Improving Systems With Simulators

IN 1985, when the Army's Sergeant York Division Air Defense system finally began operational tests, the Pentagon got an unpleasant surprise. It discovered that the DIVAD couldn't engage new Soviet helicopters firing standoff weapons from six kilometers away, as it was required to do, but only those at a range of four kilometers or less.

Pentagon officials felt they had no choice but to pull the plug on DIVAD, even though $1.2 billion had been spent. The Pentagon could prevent such surprises, claims a new report prepared by a task force of the Defense Science Board, if it would make more extensive use of computer modeling and simulation early in the life of the program.

In the case of DIVAD, the Army in the 1970s estimated that Soviet helicopters would have a firing range of three kilometers. During DIVAD development, the US estimate of Soviet ranges rose continually. Due to the inflexibility of the acquisition process, however, the Army made no corresponding changes in DIVAD design, and soon it was too late to do so. The DSB report argues that simulations could identify this type of problem early, before a weapon design is so far along that fixing it is prohibitively expensive. Simulations can determine whether a design can handle an upgraded threat and what is the best measure of effectiveness.

Writes retired USAF Brig. Gen. Robert Duffy, chairman of DSB's Task Force on Improving Test and Evaluation Effectiveness: "The use of models and simulations can amplify and expand our understanding of system and mission requirements, system effectiveness, and costs resulting from acquisition decisions."

Of course, modeling and simulation have been Pentagon acquisition tools for many years. Simulation is already used in everything from operations research, which lays the groundwork for new military products, to war-gaming formulas, which are the basis for final operational tests. But the last few years have seen an explosion in the computer and networking technologies which are the foundations of simulation. As it becomes more sophisticated, more flexible, and cheaper, simulation will surely play an even greater role in weapons buying, concludes DSB.

Specifically, the DSB recommends:

- Top-level Defense Department promotion of simulation as a weapons evaluation tool and reduction of procurement rigidity.
- Establishment of an evaluation framework early, so that operational test officials can be brought in on the ground floor.
- Early resort to extensive simulations to isolate, identify, and quantify potential problem areas.
- Construction—as soon as possible—of mockups laying out the critical man/machine interfaces for every weapons program.

Modeling and simulation, says the study, "could be more effectively applied to provide more illumination early in the acquisition process, to provide more flexibility in the middle of the acquisition process, and to provide more consistent utility evaluation throughout the entire acquisition process."

Already, there have been some success stories. The USAF-Army Joint STARS airborne radar program has made good use of simulation, says DSB. Simulations have been set up to determine how sensitive the radar must be to pick up many moving targets on the ground while keeping confusing "ground clutter" to a minimum. Operational tests to validate simulation data are planned.

"It is this concept for simulation that we think should be stressed," says the DSB study. "Namely, as a focusing mechanism for running expensive but very useful operational tests, as early on during the development process as we can, rather than waiting those six to ten years for the independent test to be the first crack at understanding whether the systems we are building have utility or not."

The DSB Task Force stopped short of recommending that an independent office be established to manage simulations. But its members did admit that for many in the Pentagon, simulation has a credibility problem. As simulations grow larger and more complex, notes the study, ensuring their reliability becomes more important. ■

—Peter Grier

Spending on reconnaissance and surveillance is high. A new study predicts the trend will continue for years.

Surveillance Stays Strong

THE Pentagon in 1990 will spend $6.9 billion for major reconnaissance and surveillance systems. In 1995, even after five more years of savage cuts to the defense budget, outlays in this sector will have declined only slightly, to $6.3 billion. The Air Force will be spending $3.8 billion, about the same as it spends today.

All signs indicate that the market for this type of equipment will hold up well, say Frost & Sullivan, Ltd., private analysts, in a new, 392-page forecast. Spending won't be immune to cuts, the company notes, but "neither is it likely to drop sharply." In fact, the need for such systems will grow as the USSR modernizes strategic forces and Washington seeks means to verify arms agreements.

The Frost & Sullivan study, "US Market for Military Reconnaissance and Surveillance Systems," predicts the bulk of expenditures in 1995 will go to space systems ($2.6 billion) and airborne systems ($1.8 billion). Some $1.1 billion will go to development, and $800 million will go to modest ground- and sea-based upgrades. Frost & Sullivan's projections for the Air Force include:

• *Airborne Systems.* The US will devote major expenditures to improvement of the USAF E-3 Airborne Warning and Control System (AWACS) fleet. "The military requirement for the E-3 missions is well established," maintains the study, "and is not expected to be diminished by any foreseeable arms reduction."

From a level of $133 million in 1989, spending on AWACS upgrades will rise to $200 million in 1995. Advanced development work on airborne radar technology for an AWACS follow-on aircraft is under way. The analysts don't expect funding before 1995.

The Air Force/Army Joint STARS system, funded at $254.9 million in 1989, is to grow to $479 million in 1995. The decision to begin production could take place in FY 1991, with significant procurement funding beginning in FY 1992. The airborne system is designed to locate and track moving ground vehicles.

The Tactical Air Reconnaissance System (TARS) combines electro-optical sensors and signal processors for use on manned or unmanned air vehicles (UAVs). The study projects healthy funding of TARS and the associated Joint Services Imagery Processing System.

With regard to Unmanned Air Vehicles, the report forecasts funding of $205 million in 1995, up from $90 million today.

• *Space Systems.* In 1995, spending for space reconnaissance will be the largest component of the market. Outlays will remain at today's levels. World political change, reductions in forces, and arms talks will intensify the need for such satellites. With KH-12 satellites, whose real-time downlink and other features mark a "new phase" in space reconnaissance imagery, emphasis will be on exploitation and dissemination of data.

The Defense Support Program (DSP) will continue as the key system for ballistic missile surveillance and warning, at least through the 1990s. The Air Force is procuring five more DSP satellites. In 1992, USAF will initiate procurement of three more DSP craft.

Late in the decade, DSP spacecraft will be replaced by the Boost Surveillance and Tracking System (BSTS) satellite, developed under the Strategic Defense Initiative but now a USAF program. On-orbit demonstration of a developmental BSTS is slated for 1995, with significant production funding to follow.

The Defense Meteorological Satellite Program (DMSP) probably will continue with evolutionary modifications to the Block 5D-3 satellite. DMSP development also focuses on a more advanced Block 6 satellite, though delivery has slipped from 1998 to 2002.

The US will continue to procure the Nuclear Detonation Detection System and deploy it on Global Positioning System spacecraft. Procurement of new sensor packages for GPS replenishment satellites and ground and airborne terminals is expected.

Congress in 1990 zeroed funds for the Space-Based Wide Area Surveillance (SBWAS) program, which USAF hopes will be a system of space-based radars. Even so, "there is substantial backing [in Congress] for establishing the foundation for a future system."

• *Ground Systems.* The Air Force will continue to build a technology base for the Advanced Tactical Radar system. The Army/USAF Joint Tactical Fusion (JTF) program will be pursued. Also in the near term, USAF will make upgrades to the NORAD Cheyenne Mountain Complex and expand the Over-the-Horizon Backscatter radar system and Ballistic Missile Early Warning System. ■

Reviews

By Jeffrey P. Rhodes, Aeronautics Editor

Affording Defense, by Jacques S. Gansler. A milestone work on the subject of defense reform, this book, based on extensive research as well as the author's long experience in the defense industry and his service as Deputy Assistant Secretary of Defense, lists his proposals for revitalization and reform of the defense industry. The text focuses on three major problem areas: the changes in strategy and budgeting, shortcomings in the weapons acquisition process, and the defense industry's lack of weapons production at adequate quality and acceptable costs. Also examined are international political trouble spots, the defense industrial base, the processes other countries go through to defend themselves, and personnel issues. MIT Press, Cambridge, Mass., 1989. 417 pages with charts, notes, bibliography, and index. $24.95.

The Berlin Candy Bomber, by Gail S. Halvorsen. One of the Air Force's most successful "bombing" campaigns took place during one of the largest airlift operations in history. During the Berlin Airlift, the author, then a C-54 pilot, met some German children outside the airfield watching the airplanes. He gave them some chewing gum and made a promise to bring some more on his next trip. The next day, Lieutenant Halvorsen wiggled his plane's wings to let the children know he was back, and the crew dropped several packages, using handkerchiefs for parachutes. After further drops to more and more children, Operation Little Vittles was born. This book is the story not only of how Little Vittles started and grew, but also of the Airlift itself from a participant's perspective. An interesting read. Horizon Publishers, Bountiful, Utah, 1990. 210 pages with photos and notes. $12.95.

Chosin: Heroic Ordeal of the Korean War, by Eric Hammel. The epic battle and retreat under fire of the US X Corps from the Chosin Reservoir during the bitterly cold Korean winter of 1950 is a benchmark in courage. Seventeen Medals of Honor were awarded for actions there. After reviewing the outbreak of hostilities, the author moves right into the battle. Rather than just developing a historical narrative, the author interviewed participants to get a foxhole view of the fighting. The detailed text centers on small unit actions and moves rapidly from the front to headquarters to supply depots and hospitals, giving a real sense of the frenetic pace of the battle. There are no pictures in this reissue, but this is not a drawback because the text so vividly describes the fighting. Presidio Press, Novato, Calif., 1990. 457 pages with appendices, bibliography, and index. $24.95.

Fighting Words: The Correspondents of World War II, by Richard Collier. The day World War II started, it was an English reporter, Hugh Carleton Greene, who first called the Polish Foreign Office's press department to inform the Poles that their country was under attack. While they didn't always get that kind of spectacular scoop, the war correspondents, or "warcos," brought the war to the rest of the world. Roughly chronological, this overview of the Fourth Estate in the war is filled with anecdotes and excerpts from firsthand accounts by such well-known print and broadcast journalists as Edward R. Murrow, Margaret Bourke-White, and Ernie Pyle. In addition to dodging enemy bullets, these reporters had to fight the censors. This book details how these battles were won. St. Martin's Press, New York, N. Y., 1990. 230 pages with photos, bibliography, and index. $17.95.

Military Misfortunes: The Anatomy of Failure in War, by Eliot A. Cohen and John Gooch. Why is it that fortune in battle sometimes turns against one side and favors the other? With that question as their premise, the authors examine five military operations in this century in which the "heavy favorites" failed. Using a wide variety of source materials, the authors found three main types of misfortune—failure to anticipate (Israeli Defense Forces in the 1973 Yom Kippur War), failure to learn (American antisubmarine warfare in 1942), and failure to adapt (the British invasion at Gallipoli in 1915). The authors also assert that combinations of these factors have led to aggregate failure (the US Eighth Army's 1950 defeat in Korea) and to catastrophic failure (the French armed forces in 1940). The Free Press, New York, N. Y., 1990. 296 pages with charts, notes, and index. $22.95.

War Movies: A Guide to More Than 400 Films on Videocassette, by the editors of CineBooks. A videophile's dream come true, this book offers complete information on almost every war movie that is out on videocassette (both domestic and foreign) and even includes listings for films that only tangentially relate to war. Each entry gives the movie's title, year of release, production company, actors and their roles, a fairly detailed plot summary, production credits, the movie's Motion Picture Association of America rating, and a recommendation regarding the film's suitability for viewing by children. The book rates the movies on a one-to-five-star scale. The films are also cross-referenced by star rating and parental recommendation. New America Publishing, Evanston, Ill., 1990. 218 pages with information keys and indices. $8.95.

Other Titles of Note

The Development of Ballistic Missiles in the United States Air Force, 1945–1960, by Jacob Neufeld. A highly useful reference, this is a complete, detailed developmental history. Office of Air Force History, Washington, D. C., 1990. 409 pages with photos, appendices, notes, glossary, and index. $23.00.

German Aircraft of the Second World War, by J. R. Smith and Antony L. Kay. This volume is regarded as one of the best standard reference books and is now in its seventh printing. An encyclopedic compendium, the book covers all fixed-wing, rotary-wing, and experimental aircraft used by the Luftwaffe. The Nautical & Aviation Publishing Co. of America, Baltimore, Md., 1990. 745 pages with photos, drawings, and appendices. $38.95.

Jane's World Aircraft Recognition Handbook (Fourth Edition), by Derek Wood. The complete field guide to identifying almost every civil and military aircraft that flies. Chock-full of information, including sections on aviation basics. Jane's Information Group, Alexandria, Va., 1989. 598 pages with photos, diagrams, glossary, proficiency test, and index. $17.50.

War & Conflict: Selected Images from the National Archives, 1765–1970, edited by Jonathan Heller. This catalog-format book represents the best images from the Archives' holdings. It touches on every facet of war—people, scenes, battles, machines, and death and destruction. A well-crafted and impressive work. National Archives and Records Administration, Washington, D. C., 1990. 354 pages with photos, bibliography, and indices. $25.00.

IN VIDEO—"Disguises of War." Machiavelli said, "Though fraud in other activities be detestable, in the management of war it is laudable and glorious. . . ." This show, an episode of the PBS series "Nova," takes a look at the many forms of wartime "fraud," including camouflage in its many forms (such as a clear fabric covering on biplanes in World War I and the dazzle paint scheme used on ships), historical and current forms of decoys, and other means of confounding an enemy, including infrared, acoustic, and radar. 1989, black and white/color. Distributed by Vestron, Inc., Stamford, Conn. $29.98. ■

Veterans in Transition

The military's loss is the labor market's gain as able, well-trained people leave service.

By Amy D. Griswold

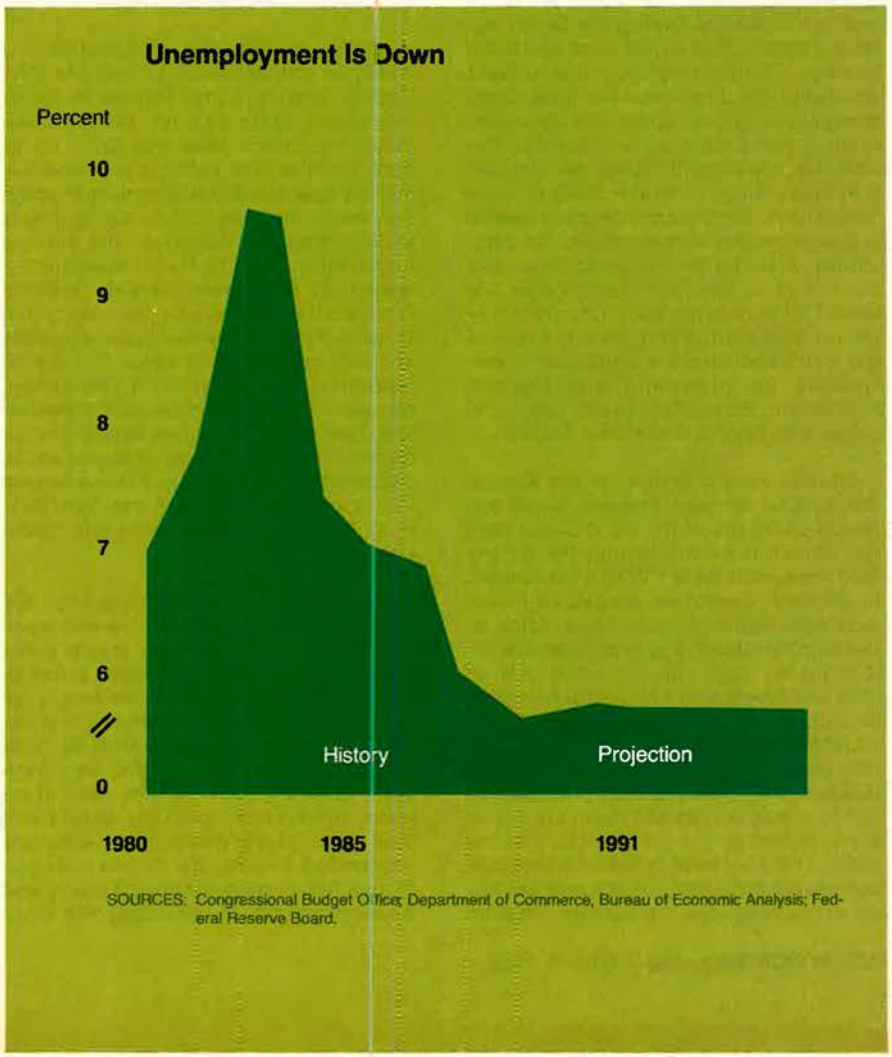
As the armed services shrink, an extraordinary number of military veterans are headed for the civilian labor force. In many instances, these are individuals the military would not be releasing if it had a choice.

The ongoing defense reductions are not driven completely by change in the world situation. The services have been ordered to cut back for budgetary reasons, and, as a consequence, they cannot keep some of their valuable manpower, trained and seasoned at considerable expense.

In June, the Department of Defense told Congress that it would explore the possibility of reducing military force strength by twenty-five percent over a period of six years.

Nathaniel Crook, the president of NATC Associates, a Pennsylvania firm that helps aerospace companies manage force reductions, compares today's military to a corporation that has just announced plant closings. Everyone knows the cuts will come, he says, but no one knows the full impact. The rate of departure from services has already begun to increase.

In Fiscal Year 1989, 43,590 people left the Air Force. Of that number, 16,234 were retiring after twenty or



SOURCES: Congressional Budget Office; Department of Commerce, Bureau of Economic Analysis; Federal Reserve Board.

more years in the service. The other 27,356 were younger, 17,708 of them first-termers.

As of May—with four months of the fiscal year remaining—the number of separating first-termers, 28,711, exceeds last year's total of nonretirement separations. Retirement and separation of experienced veterans brought the FY 1990 figure through May to 46,494.

Some civilian employers have already spotted this pool of military veterans as the answer to some urgent requirements. Others, says President Mike Tavenner of the employment firm Systec, need to learn that "the all-volunteer military force is better educated [and] better skilled than any other concentration of employable people in the world."

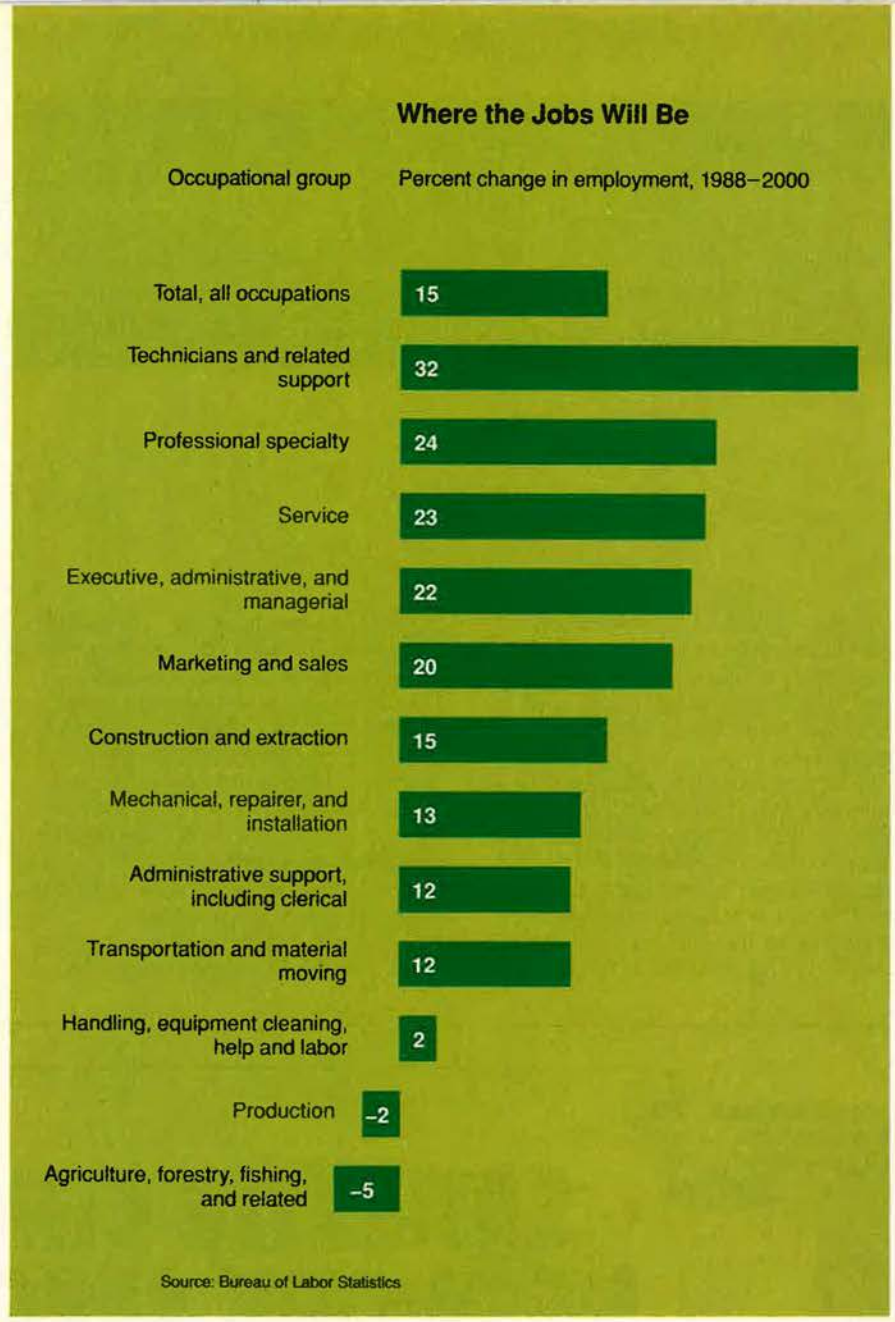
With demonstrated skills and work experience, veterans seem well positioned to succeed in today's civilian labor market, which is chronically short of talent in critical areas.

US unemployment, which in recent years has hovered at 5.3 percent of the labor force, is expected to remain at or around that so-called "near-full-employment" level for the rest of the century.

Compounding the shortage of talent is a major "skills gap," created by the increasing trend toward automation in major US industries. The General Electric light bulb plant in Winchester, Va., is a case in point. For its employees, the bulk of the work involves maintaining a raft of complex automated machines. Most of the GE "laborers" are skilled electricians, machinists, or mechanics. In the words of the Washington *Post*, "There is no longer any room for the unskilled, eighteen-year-old high school graduate in the American factory."

Veterans hold an advantage in today's market. "You hear a lot of complaints about the unskilled nature of the labor force," says Lt. Col. Harry Forbes, Air Force project officer for employment assistance efforts. "In the active-duty member, we have a dedicated, loyal, competent, well-trained person who is used to giving a day's work for a day's pay and who can take a ball and run with it."

Those with advanced skills are in highest demand. In fact, many of the skills most important in the military are precisely those in most critical demand in the economy. When they start to look around for jobs, say analysts, those veterans experienced in computers, telecommunications, electronics, and related high-tech areas will find job offers.



This group brings excellent management skills to the marketplace. More than any other group, they are accustomed to delivering results under great stress. Employers report that, by and large, veterans are intensely loyal and dedicated workers.

In educational attainment, veterans as a group far outpace civilians. Close to 100 percent of the enlisted force holds at least a high school diploma, and many have taken college-level courses or advanced military instruction. All officers are college graduates, and many hold advanced degrees. Both groups take full advantage of the military's emphasis on self-improvement to obtain further advanced degrees.

In the past, says Mr. Tavenner, "almost all the veteran candidates that we processed had already made a decision to seek employment outside of the military." That's changing as more and more veterans feel the pressure of the budget squeeze. For these servicemen and -women, the need to decide when and how to leave the military once seemed remote. "Now," says Mr. Tavenner, "someone else has made the decision for them."

Many industries stand to benefit from this influx of new talent if they can overcome the "language barriers" that make it difficult to translate military experience into civilian terms. "The sheer size of the military work force that is potentially available," says one employment analyst, "will present some different and challenging conditions for the transitioning military job-seeker."

Employment Outlook

The jobs will be there—but perhaps not exactly where you expect them to be.

To be successful in today's job market, experts report, retiring and separating military men and women must broaden their job search beyond the areas that served their predecessors.

In the past, defense industries have provided many separating military persons with an easy, seamless transition to the civilian market, but that may no longer be the case. Defense contractors are faced with the same pressures as the military and are also reducing their work forces.

Other areas, however, are promising. These include companies in the service sector, especially health care, finance, insurance, and real estate. Also attractive is the exploding field of computer technology and services. Marketing and retail services are growing and will provide an even larger share of new jobs in the years ahead. Public-sector jobs for local and state governments are also expected to increase.

US Bureau of Labor Statistics analysts predict that by the year 2000, eighteen million new jobs will be added to the US economy, with the service sector leading all other growth areas. Half of the new jobs will be added in the fields of retail trade, health services, and business services.

Where, specifically, will the most active employment centers be located? Studies indicate that most jobs will be found in or near major metropolitan areas, especially in the northeastern United States. Boston, New York, Washington, and Chicago

all have vigorous economies, though former high rates of expansion have leveled off somewhat over the past year. California's Silicon Valley, one of the hot spots of high technology, also is expected to show strong growth.

Even in aerospace, attractive jobs will still be available. However, the competition in the industry will be much fiercer than in past years. One indicator of this trend: The Aerospace Industries Association announced in March that employment in the aerospace industry fell from 1,318,000 in 1988 to 1,316,000 in 1989, the second straight year of decline. The slight numerical drop masks a major shift away from defense contracts and toward construction of commercial aircraft. The AIA survey showed an overall decline in aerospace industry demand for scientists, engineers, and specialized technicians.

How should separating or retiring military personnel find work?

One answer, say employment experts, is to look beyond immediate job experience to find the skills that are transferable to other areas and industries. For example, it is not necessary to remain in the combat arms field to use the management and supervisory skills developed in that profession. Those might be equally well applied in managing finance or retail enterprises.

Also look beyond the obvious prospects. Small businesses employ more people in this country than large corporations do. Job-placement specialists note that the temporary employment market has grown dramatically in recent years. This, say the analysts, could provide the veteran with more time to decide on a permanent career path, secure an income, and gain job experience, all without making a permanent commitment.

Service jobs tend to start at the low end of the wage scale, but managers do significantly better than the people they manage. Sales positions that pay on a commission basis allow people to control their level of income, says Mr. Tavenner.

In the manufacturing sector, experts predict a modest decline in factory jobs, the result of the shift from low-skill, low-pay manufacturing jobs to more highly skilled technical and management jobs. In fact, that is the trend throughout the economy. The expanding industries that are producing jobs need workers who have basic skills and the ability to absorb new technologies through retraining programs.

As an Aerospace Education Foundation study reported last fall, there is growing evidence of a skills gap for many industries. Education and employment are inextricably linked. Analysts expect the most impressive job gains in occupational groups requiring the most education or training.

Tom Collins, Assistant Secretary of Labor for Veterans Employment, maintains that higher skill requirements can translate into major opportunities for those separating from the armed forces. The trick will be to provide proper ways to link these veterans to potential employers.

Forging that link may be more difficult than it sounds. In spite of the low national unemployment figure, it is an average and does not present an accurate picture of the economy. While demand for highly skilled workers might be great in certain

parts of the nation, pockets of high unemployment exist in others.

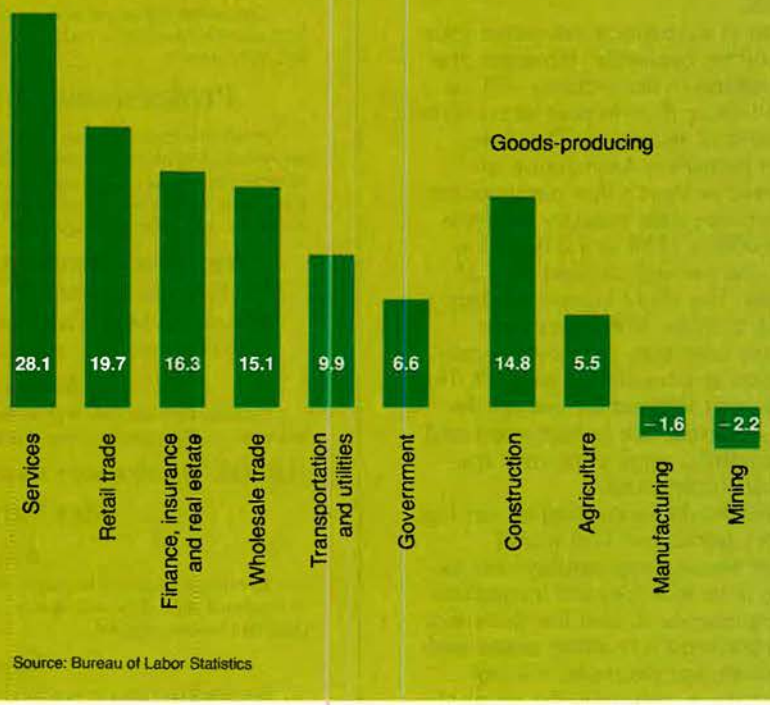
Investing in People, a report to the Department of Labor by the Commission on Work Force Quality and Labor Market Efficiency, puts the problem succinctly: "One perennial difficulty . . . is that the job vacancies and the unemployed workers are often in different parts of the country."

Mr. Collins also addressed this issue: "People needing jobs are frequently located in an area where the economy doesn't provide jobs, which suggests that the job-seeker should be a little more willing to move." Explains Systec's Mr. Tavenner, "the most mobile group is the most marketable group."

Even when prospective job-seekers know that most jobs are in cities and in the Northeast, that does not always translate to a willingness to move there, as these areas also tend to have the highest costs of living. Proposals have been floated to address this need, in particular to make sure that state employment programs can provide information on job openings in other states to job-seekers. Little action has resulted, however.

Some Industries Will Grow More Rapidly Than Others

Percent change in employment, 1988–2000



Source: Bureau of Labor Statistics

Help in the Search

Public and private programs may point the way toward the right job.

The serviceman or -woman frequently knows the exact date of his or her departure years in advance. Even so, finding civilian employment often is put off until the last moment, when it becomes a daunting task. Government and private employment specialists, however, point out that help is available in many forms.

Militran. Militran Employment Transition Service (formerly, Employment Transition Service, or ETS) is a private company that was formed in 1986 to help military personnel in their transition from military to civilian employment. Through agreements with several associations, including AFA, Militran provides an array of services, designed specifically to help "reduce the time, effort, and costs" of the job search.

Militran uses three major services to bring retiring or separating military personnel in contact with civilian employers who value their skills. Of these, the best-known is the series of Militran/NCOA job fairs, frequently held in cooperation with the US Department of Labor.

According to Lt. Gen. Edgar Chavarrie, the retired Air Force officer who serves as Militran's chairman of the board, the job fair is an old tool that is getting new attention these days. "They are good for the companies because they provide a

look at many job candidates at once," says the Militran executive. Further, he notes, they allow recruiters to determine instantly who is and is not qualified. The job fairs also give separating or retiring military personnel an opportunity to present themselves in person to the companies that interest them most.

Company representation at job fairs has changed in recent years, says General Chavarrie. Once most heavily attended by defense contractors, they now attract heavy participation from the nondefense sector. These companies have demonstrated a willingness to return again and again, says General Chavarrie, "once they see for themselves what kind of workers former military personnel are."

At the job fairs, Militran provides entry to its second employment technique. By filling out a "Mini-Résumé," the job-seeker can have his or her name and work background entered into a computerized database that translates military experience into civilian business terms.

This database is linked with HRIN, an on-line human resources information network that counts most of the *Fortune* 500 companies among its corporate subscribers. Corporate recruiters can call up résumés of qualified job candidates from this database. People who do not attend job fairs can still obtain a mini-résumé form at no cost by writing to AFA or to Militran *[see box]*.

A third service is the *Militran Jobs Digest,* seen as a useful tool for

For information on either the AFA/Militran Job Search Assistance Mini-Résumé or on AFA's résumé critique and preparation service, write to:

Air Force Association
Attn: Membership Services
1501 Lee Highway
Arlington, VA 22209-1198

For more information on the programs offered by Militran (ETS) write to:

Militran
1255 Drummers Lane
Suite 306
Wayne, PA 19087
(215) 687-3900

or

Militran
1511 K Street, NW
Suite 1000
Washington, DC 20005
(202) 347-0367

For information on the services of The Retired Officers Association, write to:

The Retired Officers Association
201 N. Washington St.
Alexandria, VA 22314
(703) 838-8117

For information on the services and programs offered by the Non-Commissioned Officer Association, write to:

NCOA
P.O. Box 33610
San Antonio, TX 78265
(512) 653-6161

FY 1990 Transition Assistance Program Test Sites

State	Location	Service
California	Camp Pendleton	Marines
Texas	San Antonio	Air Force
Virginia	Norfolk	Navy
Florida	Jacksonville	Navy
Georgia	Fort Benning	Army
	Fort McPherson	Army
Louisiana	Fort Polk	Army
Colorado	Fitzsimons AH	Army

FY 1990 Disabled Transition Assistance Program Sites

State	Location	Service
Texas	San Antonio	Air Force
Colorado	Fitzsimons AH	Army
Florida	Jacksonville	Navy

1990 Militran Job Fairs
(hosted by NCOA)

Date	Location
August 21	Colorado Springs, Colo.
September 26	Sacramento, Calif.
September 28	San Diego, Calif.
October 30	Fort Walton Beach, Fla.
November 2	Norfolk, Va.
November 20	Arlington, Va.
December 14	San Antonio, Tex.

The Department of Labor is jointly sponsoring the job fairs on September 28 and December 14.

evaluating employment possibilities in distant job markets. This publication is divided into two sections, covering the private sector and the federal government.

The first section is produced by a computer search of the want ads in sixty-two newspapers nationwide. Militran plans to expand the number of newspapers to eighty-two. A laser scanner device searches for specific words relating to specific jobs and skills, then reproduces the entire ad.

The second section lists all of the jobs in the federal sector. Both sections are organized by skill category rather than by geographic region or federal agency. It will be possible for someone leaving the military to look up his or her Air Force Specialty Code or the equivalent for the other services and find a listing of all the available jobs that need that particular skill.

Plans called for the first issue of the *Militran Jobs Digest* to appear August 1, with subsequent issues to be published every two weeks. Militran plans to make this resource available to base libraries accessible to departing military personnel.

AFA. In addition to the partnership with Militran for the Mini-Résumé database service, AFA's membership services department has recently begun a service to provide résumé preparation assistance for members. *[See p. 75 for where to obtain more information.]*

Transition Assistance Program. Shaping up as the centerpiece of the government's veteran-transition effort is the Department of Labor's Transition Assistance Program (TAP). In an agreement signed in May, the Labor and Veterans Departments have agreed to provide the Pentagon with transition services.

These take the form of three-day workshops taught by representatives from the employment commission of the particular state. The program is in a test stage now, with sites at eight installations in seven states. *[See chart above for locations.]* The Department of Labor plans to expand the program to twenty-eight bases in ten states in Fiscal Year 1991.

The program's goal is to provide service members with "sufficient vocational guidance to allow them to make informed career choices" before they leave active duty, according to Assistant Secretary Collins. The seminars include information on career decision-making, occupational and labor market data, tools needed to conduct a successful job search, and training programs. Service members who will be separating or retiring within 180 days are eligible to participate in the seminars.

A related program, administered through Veterans Department hospitals, attempts to help service members separated due to service-related disability. This program is called the Disabled Transition Assistance Program (DTAP), and it is being tested in three military hospitals, in Texas, Colorado, and Florida.

Both programs will be evaluated and the results reported to Congress in May 1992. The process/content evaluation, which addresses the training of the instructors, seminar materials, and information provided to participants, is under way, with the first in-process review due to be conducted this summer. A post-service longitudinal study will compare seminar participants with a

control group to determine the benefits of participating in the program. It will look at occupation, periods of employment vs. unemployment, salary, training, education, and other demographic information.

The Air Force's Colonel Forbes expects the TAP program to be expanded to all major installations in the continental US during the next fiscal year. "Congress is really pushing DoD to provide services," he says. "We're as anxious to do that as they are for us to do it."

TAP is not the only government program, however. Other resources already available include:

Base education offices. This outlet has many programs available to help people with the transition process. They can provide occupational guidance and counseling, interest and aptitude testing, and advice regarding educational courses needed to qualify for a particular job. Base education office personnel can also explain GI Bill and other benefits that are available to retiring or separating military members.

Family support centers. These centers (on bases where they exist) can provide excellent career advice, since they are heavily involved in the spouse employment program. In conjunction with that, they run courses in interviewing techniques and résumé-writing in which active-duty members may participate on a space-available basis.

Base libraries. These often concontain many how-to books on résumé-writing and interviewing, as well as statistical labor market information that people can use to their advantage.

The Air Force has combined these three resources, made the base education officer the focal point of the effort, and started a more vigorous advertising program to make people aware of what is already available. Colonel Forbes says that the Air Force hopes soon to include the civilian office in the effort, because the civilian personnel office can provide information on job opportunities in the federal sector.

The Air Force cannot endorse the activities of a private employment organization or association, but it does make brochures available at the base level. ■

By **John L. Frisbee,** Contributing Editor

A Rather Special Award

As the crippled B-17 neared its end, 2d Lt. David Kingsley faced a decision that would be immutable.

PLOESTI always will be a symbol of surpassing valor in air warfare. More Medals of Honor—seven in all—were awarded for extraordinary heroism over that Romanian city than for great deeds performed at any other USAAF target of World War II.

The Ploesti area was said to be the third most heavily defended in the European theater, and for good reason. Oil fields and refineries in and around the city provided from one quarter to one third of the petroleum used by Hitler's armed forces and industry.

The first large-scale (five B-24 groups) USAAF attack on Ploesti was on August 1, 1943 *[see "Valor: Into the Mouth of Hell," September 1988 issue]*. An estimated forty percent of refining capacity was put out of service, but at a terrible cost of men and planes. USAAF was not able to follow up decisively because of other commitments, including support of the imminent invasion of Italy. Ploesti was soon back on line.

In the spring and summer of 1944, however, Fifteenth Air Force opened a sustained campaign against oil targets, including Ploesti, "the premier oil target of the continent." Before the refineries around that city were shut down by bombing and the city captured by the Soviets, nearly 60,000 USAAF airmen had flown against those pinpoint targets, dropped some 13,000 tons of bombs, lost 350 heavy bombers, and left more than 1,000 airmen as POWs in Romania.

Fifteenth Air Force raids were considerably larger than the attack of August 1943. On June 23, 1944, in one of its major strikes, the Fifteenth sent 761 bombers to Romanian oil targets. In the nose of one 97th Bombardment Group B-17 was bombardier 2d Lt. David R. Kingsley, four days short of his twenty-sixth birthday. This was his twentieth combat mission, but not his first to Ploesti, where the flak was intense. German fighter pilots tenacious, and targets usually obscured by smoke generators. It would be his job to put the B-17's bomb load on an oil storage facility at Giurgiu, about seventy miles south of Ploesti.

As the bomber stream approached the city, the 97th Group broke off and headed for Giurgiu, which, not unexpectedly, was shrouded by smoke. On the bomb run, Kingsley's B-17 was knocked out of formation by flak hits, but was able to proceed alone to bomb its target. Unable to hold altitude, the damaged bomber fell behind its formation. The straggler was attacked viciously by three Me-109s, which further damaged the bomber and severely wounded the tail gunner. Lieutenant Kingsley was called to the radio compartment to administer first aid. He removed the wounded man's damaged parachute harness and flight clothing, managed to check the bleeding, and did what he could to alleviate the gunner's suffering.

David Kingsley chose to sacrifice his life to save a wounded comrade.

Could the B-17, torn by flak and raked by the Me-109s' 20-mm fire, make the 500-mile flight over Yugoslavia's 8,000-foot mountains to its base at Amendola, Italy? That question was answered as eight Me-109s bored in on the faltering bomber, wounding the ball turret gunner. With the B-17 now barely controllable and apparently about to break up, the pilot ordered his crew to prepare for bailout.

Kingsley immediately began helping the wounded crewmen into their parachute harnesses, but the tail gunner's damaged harness could not be found in the welter of debris and blood-soaked clothing and blankets. David Kingsley faced a fateful decision: Should he save himself by abandoning the wounded gunner, or give the man his chute harness at the cost of his own life? Lieutenant Kingsley chose the latter, fitting his harness to the injured man. Moments later, on the order to jump, Lieutenant Kingsley helped both wounded men to bail out through the open bomb bay. When last seen by surviving crew members, David Kingsley was standing alone by the bomb bay catwalk, awaiting the inevitable end. His body was later found in the plane's wreckage.

For the gallant sacrifice of his life to save another, 2d Lt. David Kingsley was awarded the Medal of Honor posthumously.

In four wars, fifty-eight men of the United States Air Force and its predecessors have earned the Medal of Honor. Their acts of phenomenal bravery generally have been done to complete a mission or to save others in exceptionally hazardous combat circumstances. It is doubtful that any paused to consider the odds, but in the great majority of cases there was a chance, however remote, of survival. David Kingsley made a conscious, irreversible, and total commitment that June day in 1944. His Medal of Honor, it would seem, was a rather special award of the nation's highest decoration for valor. ■

Viewpoint

By Gen. T. R. Milton, USAF (Ret.), Contributing Editor

Droning On

CFE picks up where MBFR—which never accomplished much—left off. Negotiations are complicated by factors remote from both arms control and defense.

Theologians and arms controllers have a few things in common; both deal in esoteric knowledge, and both must contend with the unverifiable. Both also contemplate the hereafter, although theologians seek to ease the path to it, while arms controllers hope to postpone it. To be fair, however, any comparison between these two is essentially specious, for arms control is a more superficial trade than theology.

The current Conventional Forces in Europe, or CFE, negotiations in Vienna are simply an extension of the Mutual Balanced Force Reduction (MBFR) talks which began in 1974. These proceedings, in turn, were the result of a June 1968 declaration by the NATO Council of Ministers, meeting in Reykjavik, on the need for mutual and balanced force reductions between NATO and the Warsaw Pact.

As the first step following the ministerial declaration, a working group made up of representatives from nations in the central region—the agreed-upon area of concern—was called into being. To the unconcealed fury of several ambassadors, I was made chairman of this polyglot group of second-tier diplomats, thanks to a bit of inside maneuvering on the part of Admiral Sir Nigel Henderson, who at that time was Chairman of the NATO Military Committee, and Secretary General Brosio. Their support notwithstanding, the idea of a military man—and an American at that—presiding over an arms-control group continued to offend some of the more sensitive types.

Early in our deliberations, it became obvious that the task assigned to us was a formidable one and that the working group would never be more than a debating society. Accordingly, I wangled a small staff from a few nations, concealed them at SHAPE, and appointed a choleric, one-armed German colonel, a veteran of Stalingrad, as their director. Starting from scratch, this staff group did a heroic job of producing the first database on both NATO and the Warsaw Pact.

Our report to the 1970 ministerial conference in Rome had mixed reviews. The British praised our effort, while future Secretary of State Henry Kissinger, at the time National Security Advisor, was less than enthusiastic, giving the impression that the United States had a more sophisticated approach in mind. Whatever that approach might have been, nothing ever came of it.

The years passed without visible progress. If, instead of Vienna, the talks had been held in Liverpool, or in one of the grubbier Belgian towns, they might have adjourned earlier, but it is difficult to see how much could have been accomplished. When the Warsaw Pact was a functioning organization, Soviet troops deployed in East Germany, Hungary, and Czechoslovakia were the essential factors in its cohesion. These deployments had become a way of life for the Soviet military. Housing, schools for the children—the support infrastructure for the Soviet forces in Pact countries—simply didn't exist in the USSR. Thus, so long as Soviet troops were comfortably planted on their allies' soil and had nowhere else to go, force-reduction talks were almost guaranteed to produce nothing.

When the Warsaw Pact collapsed, the Soviet troops were evicted—not negotiated—back to the Motherland. As we have learned from the public statements of senior Russian generals, the result has been chaos. In addition to a lack of housing and schools, there are no jobs for these displaced families. No wonder the Vienna talks stalled all those years. Now, the CFE talks, successor to MBFR, are stalled, ostensibly because of the German NATO question, but also because of the worry in Moscow over what to do with the troops that have been stationed in East Germany, in varying numbers, since 1945. They, too, have nowhere to go. An abrupt redeployment to the Soviet Union would further aggravate the desperate situation of the already homeless Red soldiery.

It is ironic that these MBFR and CFE negotiations have droned on over the years with no result, only to have both sides suddenly faced with urgent problems that have nothing to do with either arms control or prudent defense. The USSR is in a political and economic crisis, while the US has the mounting deficit, together with the savings & loan disaster, to make reduction in military expenses an imperative. A CFE agreement will give our side a graceful way to reduce our armed forces, but that same agreement will only add to the Soviet dilemma of what to do with any more returning troops.

If there is no CFE agreement soon, the US Army and Air Force may be forced to cut domestic forces in order to meet budget strictures, rather than take the cuts in Europe as planned. Should that occur, it will not only be an undesired result, but also a rueful commentary on the binding commitment the Army and Air Force have made over the years to NATO. The US Navy, ever canny when it comes to committing its forces, has never been as explicitly tied down, nor will it be affected by any CFE agreement.

Arms controllers will continue to plug away, officially oblivious, we can assume, to certain decisive factors—housing and other amenities for the Soviet forces stranded in a united, and we hope, NATO Germany, and the US peace dividend, however mythical, hopefully awaited by countless supplicants. ■

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  Chief of Staff, USAF
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☐ *Annual Reception @ $50 each*.....$ _____
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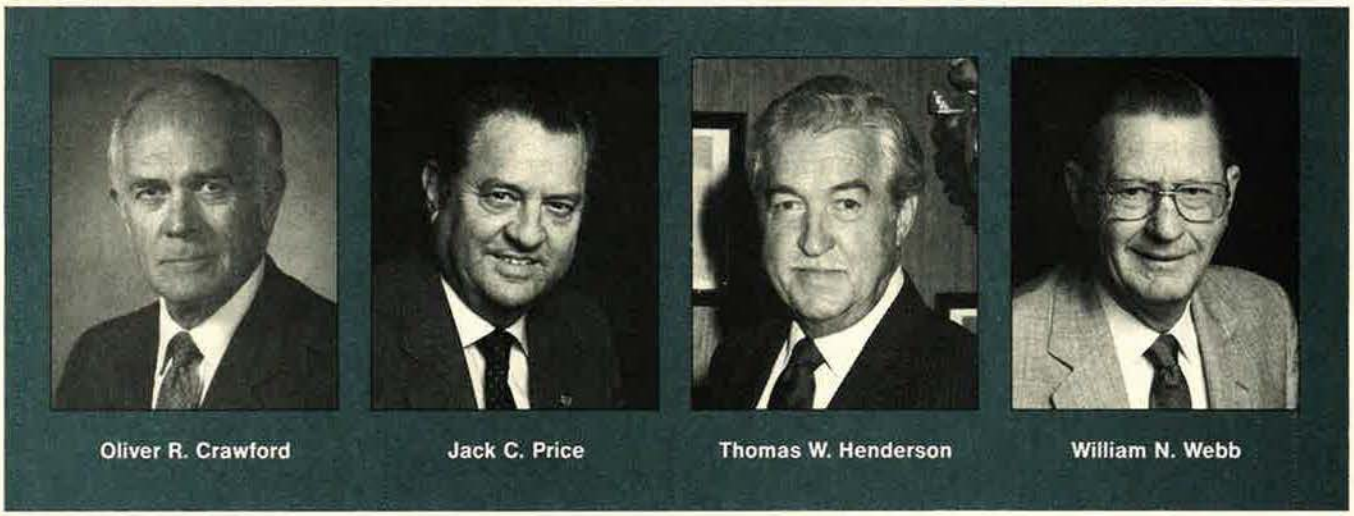
Total for separate tickets .....$ _____
Total amount enclosed .....$ _____

AFA/AEF Report

By **Daniel M. Sheehan,** Assistant Managing Editor

AFA Nominees for 1990–91

At a meeting on May 25 in Colorado Springs, Colo., the Air Force Association Nominating Committee selected a slate of candidates for the four national officer positions and the six elective positions on the Board of Directors that will be presented to the delegates at the National Convention in Washington, D. C., on September 17. The Nominating Committee consists of the five most recent past National Presidents, the twelve National Vice Presidents, and one representative from each of the twelve regions.



Oliver R. Crawford | Jack C. Price | Thomas W. Henderson | William N. Webb

Nominated for his first term as National President was **Oliver R. Crawford** of Austin, Tex. Mr. Crawford is President and Board Chairman of CTS, Inc., a Department of Defense services contracting firm headquartered in Austin. He is President and Chairman of CTS Nevada, headquartered in Las Vegas.

Mr. Crawford was born in Amarillo, where he attended public schools. He entered the US Army Air Forces in 1943 and served as a fighter pilot in World War II. He was in the Air Force Reserve until 1959. After attending Washington State University and South Texas College of Law, he began work with Time-Life Inc., a New York publishing firm with extensive holdings in Texas, where from 1956 to 1974 he was officer and director of several subsidiaries. He was on the Board of the First State Bank, Jasper, Tex., from 1959 to 1975.

Mr. Crawford, a recipient of many honors, is recognized in business and government as an outstanding leader and executive and internationally for his contributions to the scientific and business communities. He received the rank of brevet major general from the Air National Guard. While serving as President of Southern Forest Research Institute, he received from the President of West Germany the Commander's Cross of the Order of Merit, that country's highest nonmilitary honor and the peacetime equivalent of the Blue Max. He is in several volumes of *Who's Who* under different categories and in *Leading Men in the United States of America.*

Mr. Crawford has flown eighty-seven types of civilian and military aircraft, logging more than 12,450 flying hours in jet and propeller-driven aircraft. He flies his personal Aerostar and a World War II Curtiss P-40 fighter aircraft for the Confederate Air Force.

Mr. Crawford has served as member of the AFA Finance Committee, Texas State President, member of the Texas Executive Committee, Austin Chapter President, member of the Austin Chapter Executive Committee, and Trustee of the Aerospace Education Foundation (AEF). Today he is National Vice President (Southwest Region), a member of AFA Executive, Membership, and Resolutions Committees, and an AEF Trustee. He has received AFA's Presidential Citation, Special Citation, Exceptional Service Award, and Medal of Merit. He was AFA's 1989 Man of the Year and is a Life Member of AFA and an AEF Charter Sustaining Life Member.

Jack C. Price of Clearfield, Utah, was nominated for his first term as Chairman of the Board. At retirement, he was Deputy Director of Distribution for the Ogden Air Logistics Center, Hill AFB, Utah. He directed a large depot-level complex involved in wholesale and retail receipt, storage, issue, and shipment of material worldwide. He was responsible for quality control, packaging, inventory, and transportation. The Distribution Directorate has about 2,300 civilian and military personnel and is responsible for managing 400,000 items valued at $4.2 billion. Mr. Price controlled and managed an annual payroll of $58.5 million and facilities worth $100 million.

Mr. Price held several earlier man-

Charles A. Gabriel | H. B. Henderson | Frank M. Lugo | Thomas J. McKee | Mary Ann Seibel | Walter G. Vartan

agement positions at Ogden ALC. Included were posts as chief of Missile and Aircraft Systems Division in the Directorate of Maintenance; deputy chief of the Aircraft Division; chief of Navigational Instruments, Photographic, and Training Devices Division; and chief of the Missile Division.

Born in Iowa, he moved to Utah in 1953. He attended Weber State College in Ogden, where he majored in management logistics. Mr. Price served a six-year tour in the Air Force before and during the Korean War. He began his Civil Service career at Hill AFB in 1953.

Mr. Price has served on AFA's Executive, Finance, Resolutions, Constitution, and Organizational Advisory Committees. He has been National Secretary, National Vice President (Rocky Mountain Region), Utah State President and Vice President, Ute Chapter President and Vice President, AEF Trustee, and AEF Trustee Emeritus.

Today he is National President, Chairman of AFA's Executive Committee, a member of the Resolutions Committee, and an AEF Trustee. He holds AFA's Presidential Citation, Special Citation, Exceptional Service Award, and Medal of Merit. He is a Life Member of AFA and an AEF Charter Sustaining Life Member.

Thomas W. Henderson of Tucson, Ariz., was nominated for his first term as National Secretary. At retirement, he was an Arizona real estate broker. Born in Duluth, Minn., Mr. Henderson is a retired USAF colonel who saw ten years of overseas active duty, his last service being in Vietnam. He flew fifty missions as a B-24 commander in World War II. His assignments ranged from squadron commander to Air Staff at the Pentagon. Mr. Henderson holds a Bachelor of Science degree from the University of Maryland.

He is a Life Member of the Air Force Aid Society, Charter Member of the Air Force Academy Athletic Association, Charter Member of the Air Force Historical Foundation, member of the Vietnam Veterans of America, Charter Member of the National Aviation Hall of Fame, and Life Member of the Order of Daedalians.

Mr. Henderson has served as a member of the National Board of Directors, National Vice President (Far West Region), member of the Finance and Building Acquisition panels, Arizona State President and Vice President, and Tucson Chapter President, Vice President, and Secretary. Today he is on the National Board of Directors and Finance Committee and the Arizona AFA Executive Council. He has received AFA's Presidential Citation and Medal of Merit and twice received the Exceptional Service Award. He is a Jimmy Doolittle Fellow, a Life Member of AFA, and an AEF Charter Sustaining Life Member.

William N. Webb of Midwest City, Okla., was nominated for a fourth term as National Treasurer. He is an advisor in AFA matters for the commander of the Oklahoma City ALC.

Born in western Oklahoma, Mr. Webb completed schooling at Burns Flat, Okla. He attended Southwestern State Teachers College, Weatherford, Okla., in 1945. He moved to Midwest City in 1950 and began work at the Oklahoma City Air Materiel Command (now the Oklahoma City ALC), Tinker AFB. He began there as a warehouseman; on retirement in 1981 he was chief of the Management Organization for Distribution. Career responsibilities included accounting, manpower, funding, data systems, and engineering.

He joined AFA in 1960 and is a Life Member. He has been a National Vice President (Southwest Region), member of the Finance Committee for twelve years, Chairman of the Building Acquisition Committee, and AEF Trustee. Today he is Chairman of the National Finance Committee, Executive Committee member, State Treasurer, and member of the Central Oklahoma (Gerrity) Chapter and the Oklahoma Executive Committee. He has twice won AFA's Exceptional Service Award.

These individuals are permanent members of the AFA Board of Directors under the provisions of Article IX of AFA's National Constitution: John R. Alison, Joseph E. Assaf, David L. Blankenship, John G. Brosky, Dan F. Callahan, Robert L. Carr, George H. Chabbott, Earl D. Clark, Jr., M. Lee Cordell, R. L. Devoucoux, James H. Doolittle, Russell E. Dougherty, George M. Douglas, Joseph R. Falcone, E. F. Faust, Joe Foss, Barry Goldwater, John O. Gray, Jack B. Gross, George D. Hardy, Alexander E. Harris, Martin H. Harris, Gerald V. Hasler, John P. Henebry, Robert S. Johnson, Arthur F. Kelly, Victor R. Kregel, Curtis E. LeMay, Nathan H. Mazer, William V. McBride, J. B. Montgomery, Edward T. Nedder, J. Gilbert Nettleton, Jr., William C. Rapp, Julian B. Rosenthal, Peter J. Schenk, Joe L. Shosid, William W. Spruance, Thomas F. Stack, Edward A. Stearn, James H. Straubel, Harold C. Stuart, James M. Trail, A. A. West, Herbert M. West, and Sherman W. Wilkins.

The six people whose photos appear above are nominees for elected Directorships next year. Asterisks indicate incumbent National Directors.

***Charles A. Gabriel,** McLean, Va. Self-employed. Retired Chief of Staff, USAF. Former National Director, national committee member, and AEF Advisory Council member. Current National Director, national committee member, and Life Member of AFA.

***H. B. Henderson,** Ramona, Calif. Aerospace executive. Former National Director, National Vice President (Central East Region), national committee member, and State and Chapter President. Current National Direc-

tor and national committee member. Life Member of AFA.

***Frank M. Lugo,** Mobile, Ala. Educator. Former National Director, National Vice President (South Central Region), national committee member, State and Chapter President, AEF Trustee, and AEF Advisory Council member. Current National Director, national committee member, and AEF Advisory Council member. Life Member of AFA and AEF Charter Sustaining Life Member.

Thomas J. McKee, Arlington, Va. Aerospace executive. Former National Secretary, Under-40 National Director, national committee member, chapter officer, and AEF Trustee. Current National Secretary, national committee member, and AEF Trustee. Life Member of AFA and AEF Charter Sustaining Life Member.

***Mary Ann Seibel,** St. Louis, Mo. Administrator. Former National Director, Under-40 National Director, national committee member, and Chapter President. Current National Director and national committee member. Life Member of AFA and AEF Charter Sustaining Life Member.

Walter G. Vartan, Chicago, Ill. Graphic arts executive. Former National Vice President (Great Lakes Region), national committee chairman, State President, and Chapter President. Current National Vice President (Great Lakes Region) and national committee chairman. Life Member of AFA and AEF Charter Sustaining Life Member.

–Katie A. Storm

New Florida Chapter

The American public has long associated Florida's central Atlantic coast with moon shots and other glamorous space activity, so it is fitting that AFA's newest chapter, the **Spacecoast (Fla.) Chapter,** based in Titusville, reflects that image in its name. Florida State President Bill Bingham recently presented the Chapter's charter and installed the officers. Also on hand was National Vice President (Southeast Region) Roy Whitton. Lockheed employees J. B. Kump and John Glass assumed the posts of Chapter President and Vice President, respectively, and Jim Codd of General Dynamics and Tom Yensco of NASA filled out the board as Treasurer and Secretary. In keeping with the space theme, the Chapter heard a speech by Eastern Space and Missile Center Commander Col. John Wormington of Patrick AFB. The Colonel's speech discussed USAF's future in space and emphasized the need for an inexpensive, dependable means of delivering a wide variety of space cargoes. He is a veteran of space assignments, having previously served as the director of Space System's Division's Advanced Launch System effort at Los Angeles AFB, Calif.

Convention Schedule

The 44th Annual AFA National Convention and Aerospace Development Briefings and Displays will open Monday, September 17, at the Sheraton Washington Hotel in the District of Columbia with a keynote and awards ceremony. The theme will be "Year of Decision," and AFA is pleased to announce that there will be no increase in either single ticket prices or registration fee. A special theme for the Wednesday night dinner dance will be a tribute to the fiftieth anniversary of the Battle of Britain. The Membership Awards Program and Delegate's Reception will take place on September 17, and the Outstanding Airmen's Dinner occurs on September 18.

Congressional Address

In South Carolina, Rep. John M. Spratt, Jr. (D–S. C.), addressed a combined meeting of South Carolina AFA members and members of the Retired Officers Association at the Shaw AFB Officers Club. The Congressman, a member of the **Swamp Fox (S. C.) Chapter,** used his vantage as a member of the House Armed Services Committee to discuss what he sees ahead for the US military. He believes that a stable future for defense is possible but that cuts will be necessary, and he sees the budget deficit as a stronger impetus for defense cuts than the diminishing Soviet threat is.

Also in South Carolina, the **Ladewig-Shine Memorial Chapter** reaped a daily-double victory in the state awards. State President George Thom presented the award for Member of the Year to Steve Halpin, former Chapter President, and the Outstanding Chapter Award to Joe Ross, current Chapter President.

Spanning the Globe

Some AFA leaders made the trek from Texas to West Germany to examine the state of Base-Community relations there. While overseas, they visited with Mayor Peuter of the town of Hunsrück, West Germany, at nearby Wueschheim AB, home of the 38th Tactical Missile Wing. Civic leaders taking part in the trip included Oliver Crawford, AFA's 1989 Man of the Year and National Vice President (Southwest Region); his wife Nancy Crawford; Glenn Jones, Executive Vice President of Texas AFA and Advisory Council; Pat Gloff of LTV, Vice President (Administrative Support) of the Dallas Chapter; and Earl Bullock, Dallas Chapter Vice President (Government Affairs) and Clerk of Dallas County.

On the other side of the world, PACAF Commander in Chief Gen. Merrill A. McPeak invited members of the Hawaii Air Force Civilian Advisory Council and the Alaskan Civilian Advisory Board on a tour through Alas-

In June, AFA National President Jack C. Price and his wife Gretchen attended this year's Alaska State Convention in Fairbanks, home of AFA's Fairbanks Midnight Sun Chapter. Mr. Price has been nominated to be AFA's Chairman of the Board.

ka, Japan, and South Korea. The tour's purpose is to increase public awareness of USAF's roles and missions and its stewardship of national resources. One civic leader who gleaned a better understanding of USAF operations in the Pacific was Col. Tom Keeney, USAF (Ret.), **Hawaii Chapter** President, who serves as cochairman of the Air Force Civilian Advisory Council and manager of the Honolulu District Office of the Hughes Aircraft Co.

Chapter News

The **Greater Seattle (Wash.) Chapter** sponsored visits by the University of Washington AFROTC Detachment 910 Choir to the Washington State Veterans Homes in Retsil and Orting. The choir entertained the audience with a program of patriotic songs in an effort to let the veterans know that they are a valued and respected part of the community. Chapter Vice President (Veterans Affairs) John J. Billy helped make the program possible.

At Tennessee AFA's annual Awards Banquet, Dean Stone (left), editor of the Maryville-Alcoa Daily Times, received the Minuteman Trophy, the highest award given by the National Guard Association of Tennessee, from Col. Fred Forster, commander of Tennessee ANG's 134th Air Refueling Group.

White House Visit

Iron Gate (N. Y.) Chapter member Col. Richard Spaulding, USAF (Ret.), paid a visit to President George Bush in order to present him with a print of the painting "Bogey—3 O'Clock Low." The unusual painting, which depicts a TBF Avenger piloted by Lt. George Bush, USN, flying in the airspace between the White House and the Washington Monument, was crafted by Col. Jack McCoy, USAF (Ret.), a longtime friend of Mr. Spaulding who also was on hand for the presentation. The original was donated to the Air Force Art Collection.

The **Langley (Va.) Chapter** staged its twenty-fifth annual Salute to the Tactical Air Command for more than 500 AFA members and guests. Rep. Herbert Bateman (R-Va.), a USAF veteran whose district includes Langley AFB, addressed the assemblage, culminating a weekend of classified briefings, aerial demonstrations, sports, and much camaraderie in this yearly tribute to the men and women of TAC. Chapter President Dick Price introduced a number of those outstanding uniformed personnel and proudly cited the thirty awards given annually by the Chapter to honor the

individual professionalism and devotion to duty of TAC personnel. The Chapter's Community Partners lent strong support, and five of the Chapter's original members who attended that first meeting in 1964 were among the honored guests.

In a first for AFA, the **Tallahassee (Fla.) Chapter** got an insider's perspective on the condition of the People's Republic of China's military. Lieutenant Colonel Zhang of the People's Liberation Army Air Forces (PLAAF) and Senior Colonel Dou, Air Attaché to the People's Republic of China's Embassy in Washington, D. C., briefed the meeting on China's modernization plans, tactics, rank structure, and aircraft types. After the briefing, Chapter President Terrance Fregley accepted the Seal of the PLAAF from Colonel Dou. Among those in attendance were AFA National Director H. M. West; Col. Victor Williams and Capt. Jerry Sanders, Commander and Vice Commander of Florida State University's AFROTC Detachment 145; and members of the 125th Fighter Interceptor Group, located in Jacksonville.

Coming Events

August 3–4, **Louisiana State Convention,** England AFB, La.; August 4, **Indiana State Convention,** Indianapolis, Ind.; August 4, **Montana State Convention,** Malmstrom AFB, Mont.; August 10–11, **North Dakota State Convention,** Fargo, N. D.; August 17–18, **Wisconsin State Convention,** Milwaukee, Wis.; August 18, **Mid-America Ball,** St. Louis, Mo.; August 18–19, **Illinois State Convention,** St. Louis, Mo.; August 24–25, **Utah State Convention,** Hill AFB, Utah; August 25, **Minnesota State Convention,** Minneapolis, Minn.; August 24–26, **Nevada State Convention,** Las Vegas, Nev.; September 7–8, **Colorado State Convention,** Colorado Springs, Colo.; September 17–20, **AFA National Convention and Aerospace Development Briefings and Displays,** Washington, D. C.; October 13, **North Central Regional Workshop,** Bloomington, Minn.; November 17–18, **Southeast Regional Workshop,** Shaw AFB, Sumter, S. C.

Have AFA News?

Contributions to "AFA/AEF Report" should be sent to Dave Noerr, AFA National Headquarters, 1501 Lee Highway, Arlington, VA 22209-1198. ■

Bulletin Board

Seeking details of **current aviation organizations** for a directory scheduled for publication in 1991. **Contact:** Werner W. Hartman, 4793 Le Roy St., San Bernardino, CA 92404.

Seeking pictures and reminiscences of primary **flight training schools** from the World War II era. **Contact:** Richard M. Allen, 472 Spurlock St., Layton, UT 84041.

Seeking information on **Capt. Maynard Clark** (or Clarke), who was a member of Aviation Cadet Class 54-04 and was on a B-47 crew with the 19th Bomb Squadron, 22d Bomb Wing, at March AFB in 1956 or 1957. He was last seen at Tan Son Nhut AB, Vietnam in mid-1967. **Contact:** Maj. E. R. Leomazzi, USAF (Ret.), ASI, NM-21 AFJROTC, Clovis High School, 1900 Thornton, Clovis, NM 88101.

Seeking members of the **454th Bomb Group** who served in Italy during World War II, and who are not already members of the 454th Bomb Group Association. **Contact:** Ralph Branstetter, P. O. Box 678, Wheat Ridge, CO 80034.

Seeking information on **Vernon C. Blanke,** who was with the US Navy Scouting Squadron VS-54 on Guadalcanal in 1943. He later worked for the Southern Pacific Railroad; his last known address was in the San Francisco area. **Contact:** Robert L. Stix, 385 Underhill Rd., Scarsdale, NY 10583.

Seeking historical data, photographs, memorabilia, and other items pertaining to **Childress Army Airfield Bombardier School** from 1942 to 1946. **Contact:** Maj. Walter Lockhoof, USAF (Ret.), Childress County Heritage Museum, 210 3d St., NW, Childress, TX 79201.

Seeking **photographs of aircraft** and stations in Shropshire, England, during World War II, particularly P-38s and Spitfires. All material will be returned. **Contact:** Flight Lt. I. M. Pride, RAF, Schwanenberg, Shawbury, Shrewsbury SY4 4NW, England.

Seeking the whereabouts of people who were with the **3906th USAF Hospital** "Sidi Slimane" from 1961 to 1962. **Contact:** Maj. Clifford P. "Crash" Johnson, Jr., Rte. 2, Box 436-G, Warrenton, OR 97146-9708.

Researching the history of **German helicopter** development during World War II. I am especially interested in hearing from those who were at Ainring, Bad Tölz, or Zell-am-See in May 1945, when various helicopters were surrendered. **Contact:** S. M. Coates, 150 Uplands Rd., West Moors, Wimborne, Dorset BH22 0EY, England.

Seeking contact with anyone who heard a **Yank's "panic call"** on the radio in mid-December 1944. The transmission came from the London area (possibly Northolt), and one word was partially recognizable as "base." **Contact:** Lt. Col. Tom

Corrigan, USAF (Ret.), 3815 Somerset St., Colorado Springs, CO 80907-4844.

Seeking information on a B-17 called **"China Doll,"** which flew in the Central Pacific from 1943 to 1945. **Contact:** TSgt. Calvin W. Wood, USAF (Ret.), 39 Royal Rd., Battle Creek, MI 49015.

Seeking the whereabouts of **Harvey D. Wright,** a USAF pilot stationed in Munich in 1954. He often went skiing on weekends at St. Anton with Capt. Michael McDonough. **Contact:** Col. Russ Sturzebecker, USAF (Ret.), 503 Owen Rd., West Chester, PA 19380.

Would like to purchase a 3d Bomb Group flight jacket **patch** (Korea). **Contact:** John Dennis, 15215 Vollmer Rd., Black Forest, CO 80908.

Seeking the whereabouts of the following members of B-29 crew #63, 29th Bomb Group, 314th Bomb Wing, on Guam during World War II: **Norman Ellis, James S. Livingood,** and **Lawrence T. McConlogue. Contact:** Clem Heddleson, 9619 Carriage Rd., Kensington, MD 20895.

Nonprofit military aviation museum restoring an **AT-11 "Kansan"** aircrew training aircraft seeks information on these aircraft, used in Florida during World War II. **Contact:** Lt. Col. Henry L. Marois, Jr., USAF (Ret.), 360 Pinellas Bayway S., Unit E, Tierra Verde, FL 33715.

Seeking contact with anyone who knew **George Andrew Davis, Jr.,** a fighter ace in World War II and the Korean War, and a posthumous recipient of the Medal of Honor in the Korean War. **Contact:** Mel Stratton, Rte. 2, Box 331B, Hardy, AR 72542.

To commemorate its fiftieth anniversary, **Hq. 7th Air Force** is seeking personal accounts from past members of the unit, from its beginning in Hawaii in 1940 through Korea and Vietnam. **Contact:** Capt. Ron Joy, 7th Air Force Public Affairs, APO San Francisco 96570.

Seeking to purchase World War II **medals** for the European Theater, American Victory, occupation, air medal, etc. **Contact:** Lt. Col. Ed Lundak, USAF (Ret.), 801 Elmwood, Lincoln, NE 68510.

Seeking information on the **Azon bomb project** during World War II. **Contact:** David Friday, 731-D West Glenn, Auburn, AL 36830.

Seeking the whereabouts of **Maj. Gen. Larry Tibbetts,** whose last known address was at Lowry AFB, Colo. **Contact:** Rick Riggio, P. O. Box 3986, Fort Pierce, FL 34948-3986.

Seeking the whereabouts of **Werner Delbert** or **Delbert Werner,** also known as "Bob," who was stationed at Sculthorpe, Norfolk, England, in 1956 and 1957, then transferred to Wethersfield, England, in 1957 or 1958. **Contact:** C. E. Taylor, 17 Holworthy Rd., Cloverhill, Norwich, Norfolk NR5 9DG, England.

Seeking information on **Alfred Conradi,** who served with USAAF in the Pacific theater during World War II and was killed in action; especially seeking any details on his career and final mission. Also seeking theater-made **patches,** uniforms, and photos from World War II. **Contact:** George Dively, Jr., P. O. Box 10743, Alexandria, VA 22310-0743.

Seeking contact with **wives of military personnel** stationed in Vietnam or Thailand between 1964 and 1973, for a book on the subject. **Contact:** Cindi Noel, Director, Oral History Program, March Field Museum, March AFB, CA 92518-5000.

Seeking information, anecdotes, and photographs covering the presence of US personnel at **RAF North Luffenham** during the deployment of the 21st Heavy Glider Conversion Unit, General Aircraft Co. Hamilcars in 1943 and 1946, and the Thor Missile IRBM Hq. from 1959 to 1963. **Contact:** S. L. Gluning, Officers' Mess, RAF North Luffenham, Oakham, Leicestershire LE15 8RL, England.

Seeking information on **Willard Vernal Barnes,** who was stationed near Cheltenham, England, in 1954 and 1955. **Contact:** F. C. Hartland, 3 Lennox Close, Lordshill, Southampton, Harts., England.

Seeking information on the whereabouts of **Lt. Harry H. Spear** and **Lt. Arthur A. Amman, Jr.,** who were both B-25 pilots in the 489th Bomb Squadron, 340th Bomb Group, in Italy during World War II. **Contact:** Ezra L. Baer, 434 W. Patriot St., Somerset, PA 15501.

Seeking the whereabouts of **MSgt. Howard Patch** and **MSgt. Donald Wiester,** who served in Det. 3, 50th TFW, at Hopsten AB, West Germany, from 1968 to 1969. **Contact:** Robert Renner, 3444 Wellington St., Philadelphia, PA 19149-1629.

AFROTC Det. 420 of University of Minnesota-Duluth is seeking donations of the following **medals:** Medal of Honor, Distinguished Service Medal, National Defense Service Medal, Korean Service Medal, Vietnam Service Medal, and Republic of Vietnam Campaign Medal. **Contact:** Capt. Juan Torres, Jr., AFROTC Det. 420, University of Minnesota-Duluth, Duluth, MN 55812-2403.

Seeking contact with relatives of **Col. Jeredy A. Wright, Jr.,** who was shot down over North Vietnam on March 7, 1966. **Contact:** A1C William Atwood, Box 2262, APO New York 09123.

Seeking two **flight handbooks** for Douglas C-54, C-124C, and C-133 aircraft, for a book written from the standpoint of a flight engineer. **Contact:** Jack Sokoloff, Bldg. B-1, Apt. 403, 1690 NE 191 St., N. Miami Beach, FL 33179.

Seeking the whereabouts of **Lt. R. M. Meade,** an Army Air Corps pilot rescued about June 9, 1944, from the English Channel by HMCS *Lindsay,* a corvette. **Contact:** Ivan E. Chamberlain, 26 Dunraven Ave., St. Catharines, Ontario L2M 6A7, Canada.

Seeking the whereabouts of **Cpl. Robert Erwin Chesbrough,** who was based in Bournemouth, England, in 1945, teaching at an aeronautic school and who subsequently became a technician with the 46th Field Artillery Battalion, 5th Infantry Div., and was discharged from the Army in November 1945. **Contact:** Richards and Morgan Solicitors, 67 Southbourne Grove, Bournemouth, Dorset BH6 3RN, England.

Seeking the whereabouts of **Earle E. Ward, Jr.,** who was a B-17 bombardier with the 422d Squadron, 305th Bomb Group. **Contact:** Col. A. M. Lyon, 598 E. Club Blvd., Lake Mary, FL 32746.

Seeking information, photographs, and color slides of **Lockheed F-94 Starfire** aircraft in use in Air Defense Command, Far East Air Force, or the Air National Guard, for a book on the aircraft. All material will be returned. **Contact:** Larry Davis, Squadron/Signal Publications, 4713 Cleveland Ave., Canton, OH 44709.

Seeking information on a P-39 accident at Tonopah, Nev., on June 25, 1943, in which **2d Lt. Albert J. St. Germain** died. Need details of the accident and of Lieutenant Germain's experience. **Contact:** George D. Hnatusko, 1904 S. 11th St., Las Vegas, NV 89104.

Collector seeks contact with other collectors to trade **patches,** stickers, or K64 slides. **Contact:** Joel B. Paskauskas, 40 Hapgood Rd., Worcester, MA 01605-3803.

Seeking the whereabouts of **Capt. Dan Hill,** who was a B-24 pilot in the China-Burma-India theater. His last known address was at Westover Field, Mass., in 1945. **Contact:** Mrs. Robert A. Kiefer, 42 Meadowlark, Fairfield, PA 17320.

Seeking contact with **Lt. William J. Avery,** who was a basic pilot instructor at Greenville, Miss., in 1943 and an Air Force civilian contract pilot instructor in Florida in the 1950s. **Contact:** Lt. Col. Robert L. Alter, USAF (Ret.), Rte. 9, Box 236, Easley, SC 29640.

Seeking contact with former members of the **112th Tactical Reconnaissance Squadron,** 117th Tactical Reconnaissance Wing (later redesignated the 1st Tactical Reconnaissance Squadron, 1st Tactical Reconnaissance Wing), who were with the squadron in 1951 in Toul-Rosieres, France, or Wiesbaden, West Germany. **Contact:** Orvis M. Knarr, 8517 Brookridge Rd., Downers Grove, IL 60516.

Seeking technical drawings with dimensions and specifications or technical manuals on the World War II **PT-23 Fairchild** and Cessna T-50 or UC 78 model "Bamboo Bomber," also known as the "Bobcat." Seeking to restore these aircraft. **Contact:** George Lutheran, 4825 W. LaSiesta, Springfield, MO 65802.

Seeking the whereabouts of the following members of **Pilot Class 44-D,** Frederick AAF: August W. Turner, Dennis C. "Cotton" Tyllick, Eugene F. Leone, and Almon H. Kimball. **Contact:** S. J. Winkowski, 832 Prince St., Healdsburg, CA 95448.

Seeking information on **celebrities who served in the military** during World War II, Korea, or Vietnam. **Contact:** William R. Van Osdol, Ph.D., Professor, Special Education, Central State University, Edmond, OK 73034.

Researcher of USAF colors and markings seeks pre-1977 original slides of any USAF aircraft and helicopters. **Contact:** Terry Panopalis, 70 Gregoire, Candiac, Quebec J5R 5N5, Canada.

Seeking information on the whereabouts of **Larry Stone,** who was in the US Air Force, stationed at Fairford in Gloucestershire, England, in 1962. His last known address was in Kansas City. **Contact:** Tracy Wooldrige, 21 Orchard Close, Hardwicke, Gloucester, Gloucestershire GL2 6SZ, England.

If you need information on an individual, unit, or aircraft, or if you want to collect, donate, or trade USAF-related items, write to "Bulletin Board," AIR FORCE Magazine, 1501 Lee Highway, Arlington, VA 22209-1198. Letters should be brief and typewritten. We cannot acknowledge receipt of letters to "Bulletin Board." We reserve the right to condense letters as necessary. Unsigned letters are not acceptable. Photographs cannot be used or returned.—THE EDITORS

Unit Reunions

ASD Flight Control Lab
Members and friends of the Aeronautical Systems Division Flight Control Laboratory, a division of the Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio, are planning to hold a reunion September 19–20, 1990, in the Flight Control Facilities at Wright-Patterson AFB, Ohio. **Contact:** Max Davis or Charles Westbrook, WRDC/FIG, Wright-Patterson AFB, OH 45433. Phone: (513) 255-3110.

La Junta AAF Personnel
The Chamber of Commerce of La Junta, Colo., is holding a reunion September 7–9, 1990, for personnel who served at La Junta Army Airfield during World War II. **Contact:** La Junta Chamber of Commerce, P. O. Box 408, La Junta, CO 81050. Phone: (719) 384-7444 or (719) 384-8623.

McCook AAB
McCook Army Air Base personnel will hold a reunion September 28–29, 1990, at the Red Horse Motel in McCook, Neb. **Contact:** McCook Army Air Base Historical Society, P. O. Box 29, McCook, NE 69001. Phone: (308) 345-4234.

The Warning Star Ass'n
Members of the Warning Star Association will hold a reunion September 22, 1990, at the Hilton Airport Hotel in Fort Lauderdale, Fla. **Contact:** Laurie Haire, 9311 Orange Grove Dr., #307, Fort Lauderdale, FL 33324. Phone: (305) 938-9911.

Women's Army Corps
The Women's Army Corps Veterans Association will hold their convention reunion August 21–23, 1990, at the Mirage Hotel and Casino in Las Vegas, Nev. **Contact:** Gerry Gimbel, P. O. Box 44308, Las Vegas, NV 89116. Phone: (702) 452-3704.

Readers wishing to submit reunion notices to "Unit Reunions" should mail their notices well in advance of the event to "Unit Reunions," AIR FORCE Magazine, 1501 Lee Highway, Arlington, VA 22209-1198. Please designate the unit holding the reunion, time, location, and a contact for more information.

4th Emergency Rescue Squadron
Members of the 4th Emergency Rescue Squadron will hold a reunion October 17–21, 1990, in San Antonio, Tex. **Contact:** William "Mac" McGregor, P. O. Box 98, St. Germain, WI 54558. Phone: (715) 479-8801.

20th/81st Tactical Fighter Wings
Members of the 20th and 81st Tactical Fighter Wings will hold a reunion October 19–20, 1990, in Del Rio, Tex. **Contact:** CMSgt. Allan L. MacGillivray, USAF (Ret.), HCR 3, Box 59V, Del Rio, TX 78840.

21st Air Depot Group
Members of the 21st Air Depot Group will hold a reunion September 1, 1990, in Van Wert, Ohio. **Contact:** Jim Campbell, 20 Chelsea St., Staten Island, NY 10307.

22d Bomb Squadron
Members of the 22d Bomb Squadron, 341st Bomb Group, who served during World War II in the China-Burma-India theater will hold a reunion October 2–4, 1990, at the Hilton Hotel in Pittsburgh, Pa. **Contact:** David K. Hayward, 6552 Crista Palma Dr., Huntington Beach, CA 92647. Phone: (714) 842-8478.

25th Fighter Squadron
The 25th Fighter Squadron will hold a reunion in conjunction with the 14th Air Force Association Convention October 17–20, 1990, at the Clarion Hotel in New Orleans, La. **Contact:** Raymond M. Kaiser, 3512 Henican Pl., Metairie, LA 70003. Phone: (504) 887-2730.

27th Fighter-Bomber Group
Members of the 27th Fighter-Bomber Group will hold a reunion October 5–7, 1990, at the Menger Hotel in San Antonio, Tex. **Contact:** Lowell A. "Bull Dog" Smith, Diplomat Shores, 166 Sorento Dr., Leitchfield, KY 42754. Phone: (502) 242-7868.

28th Bomb Wing
The 28th Bomb Wing will hold a reunion September 6–10, 1990. **Contact:** George Ransom, P. O. Box 3092, Rapid City, SD 57709.

35th/319th Fighter Control Squadrons
Members of the 35th and 319th Fighter Control Squadrons, 13th Air Force, will hold a reunion September 12–15, 1990, at the Best Western New Tower Inn in Omaha, Neb. **Contact:** Kenneth "Bogie" Bogart, 512 W. Kirwin, Salina, KS 67401. Phone: (913) 823-3604.

Class 40-D
Members of Class 40-D will hold a reunion October 17–21, 1990, at the Hyatt Regency Hotel in San Antonio, Tex. **Contact:** Bruce Burgess, P. O. Box 34690, San Antonio, TX 78265-4690. Phone: (512) 655-4020.

40th Troop Carrier Squadron
Members of the 40th Troop Carrier Squadron will hold a reunion October 12–14, 1990, at the Marriott River Walk Hotel in San Antonio, Tex. **Contact:** Ray Kehl, 5100 John D. Ryan Blvd., #415, San Antonio, TX 78245.

Class 44-B
Members of Class 44-B (Freeman Field, Ind.) will hold a reunion October 4–7, 1990, in Naples, Fla. **Contact:** Robert L. Brown, 4424 Beechwood Lake Dr., Naples, FL 33962. Phone: (813) 775-4226.

81st Troop Carrier Squadron
Members of the 81st Troop Carrier Squadron and 732d Troop Carrier Squadron, 902d Troop Carrier Group, will hold a reunion October 27, 1990, at the Sheraton Wayfarer in Bedford, N. H. **Contact:** John L. Whenal, 36 Mill Rd., North Hampton, NH 03862. Phone: (603) 964-9564.

302d Tactical Airlift Wing
The 302d Tactical Airlift Wing will hold a reunion September 28–30, 1990, at the Holiday Inn in Fairborn, Ohio. **Contact:** Lt. Col. Bob Larkin, USAF (Ret.), 7991 Larkin Rd., Hillsboro, OH 45133. Phone: (513) 780-2664.

312th/316th Fighter Control Squadrons
Members of the 312th and 316th Fighter Control Squadrons will hold a reunion September 6–8, 1990, at the Brookhollow Holiday Inn in Dallas, Tex. **Contact:** Harold Salfen, 3841 Whitehall Dr., Dallas, TX 75229-2757. Phone: (214) 350-9688.

390th Bomb Group
The 390th Bomb Group will hold a reunion August 22–25, 1990, in Dayton, Ohio. **Contact:** G. K. Biel, P. O. Box 125A, Dayton, OH 45449-0125. Phone: (513) 433-4233.

452d Bomb Group
Members of the 452d Bomb Group will hold a reunion October 11–13, 1990, at the St. Anthony Hotel in San Antonio, Tex. **Contact:** John Witte, 625 S. 7th St., Richmond, IN 47374.

494th Bomb Group
Members of the 494th Bomb Group, 7th Air Force (World War II), will hold a reunion September 6–9, 1990, at the Marriott Hotel in Colorado Springs, Colo. **Contact:** Rusty Restuccia, 100 Willard St., W. Quincy, MA 02169. Phone: (617) 479-4678.

585th Bomb Squadron
The 585th Bomb Squadron will hold a reunion October 4–6, 1990, at the Daytonian Hilton Hotel in Dayton, Ohio. **Contact:** Tom O'Brien, 1907 Rio Vista Dr., Fort Pierce, FL 34949. Phone: (407) 465-7974.

2584th ABG
Memphis Air Force Reserve units, which include the 2584th Air Base Group, 319th Fighter-Bomber Wing, 445th Troop Carrier Wing, 919th and 920th Troop Carrier Groups, and the 701st and 702d Troop Carrier Squadrons, will hold a reunion September 29, 1990, in Memphis, Tenn. **Contact:** R. V. Quick, 2068 Firefly Cove, Memphis, TN 38119-5509. Phone: (901) 755-6219.

17th Bomb Wing
For the purpose of planning a reunion in 1991, I would like to hear from those who served in Korea in the 17th Bomb Wing, 5th Air Force. **Contact:** Lon D. Russell, 2401 E. Vanstory St., Greensboro, NC 27407. Phone: (919) 299-9779.

Bob Stevens'

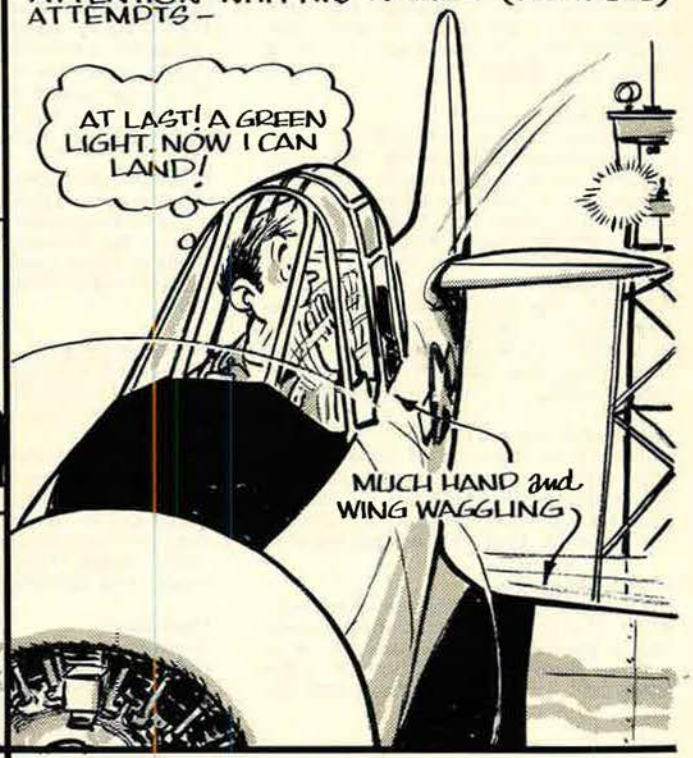
"There I was..."

OUR RECENT CARTOON ON "GUMP!" and COCKPIT DISCIPLINE BROUGHT FORTH A FLOOD OF LETTERS ON SIMILAR CADET FOUL-UPS (WELL... A COUPLE OF BUDDIES WROTE IN TO SAY, "THERE I WAS...").

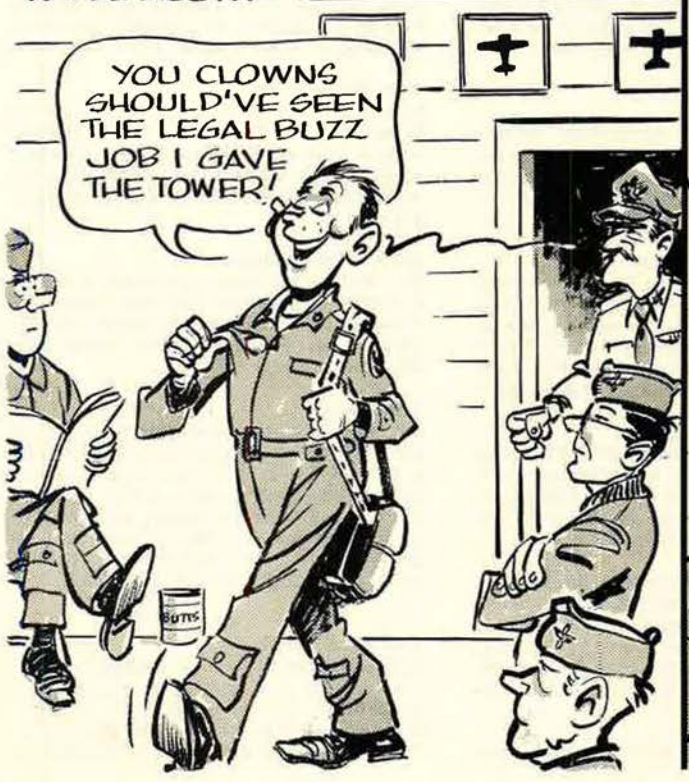
SCENE: ADVANCED FLYING SCHOOL BACK IN THE DARK AGES OF 1944. REMEMBERING HIS INSTRUCTOR'S ADMONITION TO "CHECK SIX" BEFORE TURNING, A GADGET (CADET) GETS HIS HEAD OUT-

P.S. IT WAS EASY TO LOSE GLASSES THIS WAY, TOO!

OUR HERO FINALLY GETS THE TOWER'S ATTENTION WITH HIS "NORDO" (NO RADIO) ATTEMPTS -



BACK IN THE READY ROOM, HOTSHOT IS ALL MOUTH-



From the front line to the bottom line, the A-7F will be right on the money.

This upgraded veteran will far outperform its predecessor. At half *the cost of any comparably equipped new aircraft.*

When America's defense planners needed a combat-proven, cost-effective attack airplane, LTV Aircraft Products Group had the answer—the A-7F. If selected for production, the A-7F will be quicker, more powerful, and developed exclusively for the ground support role at a significant cost saving. And the A-7F will come with a 4,000-flight-hour warranty that covers it for approximately 20 years of flying.

The prototype A-7F is currently undergoing flight testing at Edwards AFB.

The A-7F will have 50 percent more available power, for increased maneuverability. Improved lift and angle-of-attack performance. And a fivefold increase in acceleration that translates into greatly enhanced survivability. Low-altitude or night strikes would be no problem for the A-7F when equipped with advanced navigation and targeting avionics.

Because the A-7 is an already-existing asset, LTV's modernization program can deliver a proven performer at *half* the cost of any comparably equipped new aircraft. And that's important in today's budget-conscious defense environment.

From the runway to the balance sheet, the A-7F will be a remarkable aircraft. It proves that America can hold the line—in more ways than one.

LTV Aircraft Products Group

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

COUNTDOWN TO FIRST FLIGHT

History in the making:

Tooling fixtures removed June 30, 1990.

The C-17 stands on its own.

The proud team building the C-17 has recently moved this nation's newest airlifter from the giant steel tooling fixtures surrounding it during assembly. Now standing on its own landing gear for the first time, the C-17 is a dramatic display of American ingenuity at work.

Eighty-five hundred people—aircraft engineers, builders and support staff—have undertaken one of the most formidable tasks in the history of military airlift. Their dedication, patience and willingness to persevere in the face of any challenge are making it a success. Evidence of their achievement grows with each new milestone reached.

Its rugged landing gear will allow this new aircraft to land large payloads on remote airstrips around the world. Carrying over 80 tons, it will fly as far as 2,400 nautical miles without refueling —and land on a runway just 3,000 feet long.

Out of the joining tool now, this flexible airlifter is another step closer to first flight. And the dedicated team building it has another reason to be proud of their work.

MCDONNELL DOUGLAS

A company of leaders.