The resurgence of continental air defense includes new interceptors, improved avionics and weapons, better warning and attack assessment, and much more.

The Return of Air Defense

BY DAVID F. BOND

Bear hunting, 1980s style. An F-15 from the 57th Fighter Interceptor Squadron at NAS Keflavik, Iceland, armed with live AIM-7 Sparrow missiles, escorts a Soviet Tu-142 Bear-G away from a sensitive area (left). Bear intercepts are almost a game, albeit a deadly serious one, as the Soviet bombers fly close enough to US areas to alert the interceptors, but not close enough to violate US airspace.

THE AIR Force, in the midst of what will turn out to be a decade of modernizing its continental air defense forces, is finding out that it acted none too soon. An equally modernized Soviet threat, of cruise missiles as well as bombers, will put a premium on pushing air defenses outward and engaging enemy forces farther and farther from their targets in the United States. The capabilities offered by the US modernization may make the difference between credible air defenses and a perception—perhaps the reality—of vulnerability.

The US has come full circle from the late 1960s, when more than 2,500 interceptor aircraft defended against what came to be regarded as a threat of diminishing size and priority. This assessment has not changed fundamentally. The Strategic Defense Initiative is ample evidence that the Defense Department is putting much more of the nation's technical ingenuity and resources into defenses against heavy ICBMs. One year's worth of SDI budget proposals would pay for much of the Air Force's planned continental air defense interceptor and radar modernization—perhaps all of it, depending on how the costs are allocated. The challenge of detecting and intercepting bombers or even cruise missiles represents only a fraction of the challenge of SDI. But the air defense modernization now under way is nevertheless wide and deep. It will reshape US forces, tactics, and capabilities into the next century.

The US moved in the second half of the 1970s to introduce the cruise missile into the strategic equation that the Soviet Union must solve, and in 1981 it restored the B-1 bomber to its strategic force plans. The Soviets have moved in parallel. The US fielded 1,500-mile-range AGM-86B air-launched cruise missiles (ALCMs) on B-52G and H bombers, and the Soviets countered with 1,800-mile-range AS-15 ALCMs on new-production Bear-Hs. The US deployed Tomahawk sea-launched cruise missiles, similar to the AGM-86B in size and range, and the Soviets responded by developing a submarine-launched variant of the AS-15 and a larger SLCM. As the Air Force fields the B-1B, it awaits the Soviet Union's Blackjack bomber, expected to be a bit larger and faster than the B-1B and with about the same combat radius. As the Air Force develops SRAM II, a successor to the AGM-69A SRAM (short-range attack missile), the Soviets replace the slower AS-3 air-to-surface missile with the supersonic AS-4.

Different Defenses

The two nations defend against these similar threats differently. The US has put a greater percentage of its strategic nuclear weapons on bombers than the Soviet Union has. The Soviets must defend a greater area with longer borders. In addition to strategic bombers based in the US, the Soviets must consider US and allied tactical aircraft deployed in Europe, which can reach their ter-

ritory and that of their allies. As in other missions, the Soviets seem to add new weapons to their force structure without retiring old ones. Whatever the reasons, Soviet air defense forces are numerically staggering. There are more than 10,000 Soviet air surveillance radars and about 2,250 interceptor aircraft dedicated to strategic defenses, with 2,100 more interceptors available if needed. The Soviets also rely heavily on surface-to-air missiles, weapons that have no place in defending the US. They have more than 9,000 strategic SAM launchers and continue to develop new missiles and improve existing ones.

By contrast, the Air Force counts on superior equipment and modernization as it plans and carries out the continental air defense mission. With the E-3 Airborne Warning and Control System (AWACS) fleet limited in numbers and shared with other, worldwide missions, the service is establishing a network of over-the-horizon backscatter (OTH-B) radars to extend surveillance as far as 2,000 miles beyond US borders. Unable to use OTH-B facing north because of polar atmospheric conditions, the US and Canada, linked through the North American Aerospace Defense Command (NORAD), are replacing the thirty-year-old Distant Early Warning (DEW) Line radars with the new North Warning System (NWS). The Federal Aviation Administration will gather and share with the Air Force data from an upgraded Joint Surveillance System (JSS) of long-range radars along the border of the continental US. And in a remarkable infusion of modern hardware into the interceptor forces, the Air Force will modify 270 of its F-16A and B multirole aircraft for Air National Guard fighter-interceptor squadrons currently equipped with F-106s, F-4s, and unmodified F-16As.

The F-16 program is estimated to total $633 million, not counting the cost of the aircraft being modified or the new-production F-16s that will replace the ones being shifted to air defense from other Tactical Air Command forces. The Air Force established the program in November 1986, after choosing it over two new-production aircraft options judged to be far more expensive—purchase of F-20 aircraft or F-16Cs adapted for air defense. The modification plan had the additional advantage of modernizing the forces losing aircraft to the Guard—they will get new, current-model F-16s—as well as the Guard itself.

The Air Force will buy F-16 air defense equipment kits from the producer of the aircraft, General Dynamics Corp., and install them in the F-16As and Bs at Ogden Air Logistics Center, Utah. This work will be made to coincide with previously scheduled operational capability upgrades (OCUs) and other engineering changes. The F-16 OCU program includes provisions for the AIM-120A Advanced Medium-Range Air-to-Air Missile (AMRAAM), additional capacity for the avionics computer, a mission data load capability, low-altitude flight improvements, and updated avionics software.

Improved Radar

A principal item in the air defense kit is a continuous wave illuminator to be added to the antenna of the aircraft's Westinghouse APG-66 radar. The change will enable the radar to illuminate targets for AIM-7 Sparrow air-to-air missiles. Current F-16s lack a radar missile. F-16C/Ds and suitably modified A/Bs will be able to use AMRAAM when the new missile is available, but the air defense F-16s will get an AIM-7 capability as well. As scheduled originally, AMRAAM was to have been available by now as Sparrow's successor. The air defense kit also includes an interface unit compatible with the infrared-guided Sidewinder missile as well as Sparrow and AMRAAM.

In another radar modification, the APG-66 will get a software change to improve its ability to detect and track small targets, such as cruise missiles, and a cockpit switch to engage it. A high-frequency radio, an identification, friend or foe (IFF) system, a drag chute, and a night identification light will be installed, and avionics

Air defense interceptors, like these McDonnell Douglas F-15 Eagles from the 5th Fighter Interceptor Squadron at Minot AFB, N. D., are kept on five-minute alert to launch and chase away or—if need be—shoot down any intruders into US airspace. Air defense units frequently rotate fighters to other bases so that greater coverage can be provided.

The shape of air defense to come: The General Dynamics F-16 was chosen last year as the Air Force's new interceptor to replace the F-106s and eventually the F-4s now used. This F-16 is armed with two AIM-9 Sidewinder missiles and four AIM-120 AMRAAM missiles, which will replace the AIM-7 Sparrow.

reliability improvements will be made. Development of a Joint Tactical Information Distribution System (JTIDS) variant with size and weight reductions for F-16 use is a NATO codevelopment initiative, so no AWACS data link is in the current F-16 air defense plan.

General Dynamics is scheduled to deliver a prototype air defense modification kit to the Air Force in February 1988 for installation and testing in an F-16A flight-test aircraft. The Air Force is to begin installing production kits in F-16s at Ogden ALC in October 1988. The modification will continue through February 1991.

When the Air Force conducted its air defense aircraft competition, the average ages of F-106s and F-4s in fighter-interceptor squadrons were twenty-six years and twenty years, respectively. There were three F-15 fighter-interceptor squadrons in the active forces, averaging 8.3 years of age, and this brought the average for all air defense aircraft down to 19.5 years. Five- to ten-year-old F-16s were picked for the air defense modifications.

The youth of the F-16s being added to the air defense forces and the advance in technology that went into their design and upgrade figure prominently in the plane's ability to do some of the things the Air Force will want increasingly to accomplish as the cruise-missile threat develops further. In particular, the service is expected to rely more and more on the use of austere forward operating locations in northern Canada to place its interceptors where they can engage bombers more quickly, before the bombers can launch their cruise missiles.

Stopping Them Early

Intercepting a Bear-H north of the Arctic Circle is a much more straightforward proposition than looking for its cruise missiles, provided that the interceptor can get to the Arctic quickly enough. The payoff in attacking a single weapon carrier rather than many weapons is increasingly applicable across service and mission lines. Navy plans for the outer air battle have centered for years on intercepting enemy aircraft at greater distances from the fleet, before they can launch antiship missiles. The SDI Organization has emphasized the leverage of engaging an ICBM in the boost phase of its flight, before it can dispense individual reentry vehicles and penetration aids.

In continental air defense, forward operating locations may be small civilian airports or bare bases. Their numbers and locations, chosen to cover major ingress routes for Soviet bombers, are classified. Detachments of fighter-interceptor squadrons deploy to them in exercises, and there is a constant tradeoff between training at them and exposing their locations to watching Soviets. Whether in training or during an alert, they are occupied only briefly. Planning for the specific locations to which aircraft would be deployed in an alert changes as assessments of the threat change.

Streamlining the Organization

Partly because modernization made it possible, partly because modernization demanded it, the Air Force has streamlined its air defense organization in recent years. There were several steps.

In 1983, the six remaining vacuum-tube-technology Semi-Automatic Ground Environment (SAGE) centers were replaced by four Joint Surveillance System Region Operations Control Centers. ADTAC (Air Defense, Tactical Air Command), which was part of TAC headquarters but functioned like a numbered air force, was responsible for air defense support (resource management, logistics, training, and the like). NORAD, which controlled operations, functioned through commanders of four continental US (CONUS) regions, which ran the ROCCs, and Canada and Alaska regions. The CONUS region commanders also headed air divisions responsible to ADTAC.

In December 1985, the TAC side was simplified with the reactivation of First Air Force to succeed ADTAC. Instead of acting like a numbered air force, ADTAC's successor really would be a numbered air force. The support chain of command ran from TAC through First Air Force to the four air divisions. The NORAD side wasn't changed.

In October 1986, First Air Force received an operational role when it became NORAD's CONUS region. NORAD's Canada and Alaska regions remained, but the four former regions in CONUS became air defense sectors in the newly unified CONUS region. The TAC side wasn't changed, so the air divisions now coincided with the air defense sectors.

In July 1987, TAC compressed First Air Force's four air divisions into two, each comprised of two sectors. The four TAC sectors are the same as NORAD's and coincide with the former air divisions.

F-15s, F-16s, and Canada's CF-18 interceptors are much better suited than the aircraft they replace to operations at austere locations with minimal facilities. Older aircraft need more support equipment and maintenance personnel, particularly in the cold weather and difficult conditions of the Arctic north. Even when they can be supported, their inherent disadvantages in reliability and maintainability make them less likely to generate the sorties necessary for success. The older planes are capable and are made to do what they must do—one of the first deployments to a forward operating location was by an Air National Guard detachment of F-106s—but the Air Force is counting on the newer ones to be able to do it faster, better, and more often. The more interceptors the Air Force can put in the air and the

longer it can keep them there, the more likely it is to succeed.

Beyond increased reliability and reduced support needs, the modern radars, weapons, and electronic counter-countermeasures of modern interceptors broaden the ways in which they can be used. In Copper Flag exercises against jamming penetrator aircraft and in other air defense exercises, the Air Force is developing tactics for using the new planes and is finding that the F-16 can use many of the tactics devised for the F-15. The newer aircraft are easier to fly and their equipment is easier to operate, so less-experienced pilots can fly them successfully and with increased safety.

Identifying the Penetrators

Unless the US is unambiguously at war, air defense commanders demand certainty in identifying potential threats. With radars as one source of data, the confirmation usually has to be a pilot flying an interceptor. While the F-106 performs well at high speed and high altitude, the F-15 and F-16 have broader envelopes and are better suited in this respect for the tactical warning and attack assessment that are required of interceptors. New equipment will contribute also—the air defense F-16's high-frequency radio, for example, will enable a pilot flying over Greenland or northern Canada to communicate with NORAD in Colorado or continental US (CONUS) region commanders at Langley AFB, Va. The F-15 and F-16 flying envelopes also are better suited to the peacetime air defense missions of enforcing the sovereignty of US and Canadian airspace, assisting in drug interdiction by law enforcement authorities, and helping lost pilots or disabled aircraft.

The two principal air defense radar system programs, NWS and OTH-B, are intended to give air defense forces by the early 1990s an ability they have never had before—the ability to detect bomber attacks on North America soon enough, and at a distance great enough, for well-placed interceptors to challenge them before they can launch cruise missiles against strategic targets in the US. Further, the Air Force believes OTH-B will be capable against the cruise missiles themselves or can be made capable against them, even though it was designed to detect and track aircraft.

OTH-B high-frequency radar transmissions are bounced off the ionosphere to cover sectors of a circle at

Lt. Col. Richard E. Coe is an old-hand interceptor pilot, having been a commander of the 5th FIS. Now at the Pentagon, Colonel Coe is shown mounting an F-15 at Langley AFB, Va.

Up From Knobville

Lt. Col. Richard E. Coe, former Commander of the 5th Fighter-Interceptor Squadron, an F-15 unit at Minot AFB, N. D., and currently Chief of the Weapon Systems Branch, Tactical Division, DCS/Plans and Operations, Hq. USAF, fields questions on air defense.

- *On exercises:* "We run some very, very stringent exercises, NORAD-generated exercises. They're both real-time operational and computer-generated. For example, what if you have a guy who throws a satchel charge in your generator? . . . Well, we do these [things] to ourselves when we exercise. We destroy parts of the system. We knock out command and control. We go from the region operations control center being nonfunctional [to the point where] the fighter squadron has to go . . . autonomous and fight the war by itself. The squadron commander at Base X has to talk to the squadron commander at Base Y. We have built these different ways of communicating, and we go all the way down to using the phone lines if we have to. In the end, we use radios, phone lines, we use anything we can get our hands on. . . ."
- *On engaging cruise missiles instead of aircraft, if need be:* "We practice that. One of the targets that we use is the 'state-of-the-art' T-33, which is a low observable, 'very low.' Although it's not as small as a cruise missile, we've been using it for a long, long time as a target . . . so our pilots have been practicing tactics and radar discipline that put us on the leading edge of all this. When we started worrying about an ALCM, it was kind of like, OK, it's a smaller T-33, and we just don't have two lieutenants in it."
- *On pilots and controllers:* "At the same time we were [modernizing equipment], we built a very robust and strong career field for radar controllers, which includes the people who work the scopes in the regional ops control centers [as well as] the AWACS controllers. . . . There had always been a very close camaraderie between the pilots and the controllers, and I think it's building even more and more because we each begin to understand the other, and understand that there's a symbiotic relationship between the two, and also a force-multiplier effect if we use the controller properly."
- *On the need for aircraft and equipment that operate well in cold weather:* "Let's face it. . . . The quickest route to the United States is not through Texas, not through Mexico. It's going to come through Canada, or it's going to come through Alaska, or it's going to come through the Northeast United States."
- *On the F-106 Delta Dart:* "It was a grand old lady. It just got very old. There are probably a lot of guys out there who would still like to be flying that grand old lady, because it was a nice airplane. It was a real Cadillac."
- *On the F-106's "very manual" radar:* "They kept adding things to the -106. It wasn't that when it was built in 1959 it went out and sat on the ramp and didn't do anything. In fact, they added knobs in some of the strangest places. You would try to find them at night, and it was knobville inside. There were knobs all over the place. . . . It had great capability, but it required numerous switch changes to do some of the things that an F-15 or an F-16 will do automatically for you. The F-15 and the F-16 are heads-up systems that the pilots can work with very few switch changes. They've given us a tremendous increase in capability, and they've made it much simpler to acquire targets."

ranges between 500 miles and 2,000 miles. Targets within this surveillance area reflect the radar signals back up to the ionosphere, where they are bounced back to the OTH-B receiver. The Air Force plans four OTH-B systems, facing east, west, and south. An East Coast system, in use now and to be fully available next year, and a West Coast system, under construction for 1990, will monitor the areas in which Bear-Hs are known to have practiced attack runs up to their cruise-missile launch points. A third system is planned for coverage to the south to monitor SLCMs launched within the 500-mile minimum range of the coastal systems. A fourth installation, in Alaska, is to watch the Aleutians.

NWS, which uses conventional radars, was chosen for surveillance directly to the north because the aurora borealis interferes with OTH-B signals. By 1992, the thirty-one-year-old, deficient, hard-to-maintain DEW Line radars are to be replaced by NWS, which consists of thirteen minimally attended long-range (200 miles) radars from Alaska's Seek Igloo system and thirty-nine unmanned short-range radars. NWS and Seek Igloo coverage will link up with the OTH-B systems to provide a circle of surveillance around North America.

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The Air National Guard plays a big role in air defense. Although more units are converting to the F-16, the F-4 Phantom II is still the Guard interceptor mainstay. This F-4C is from the 123d Fighter Interceptor Squadron at Portland IAP, Ore., and in a previous life, this Phantom was used as a MiG hunter.

The Cruise-Missile Problem

OTH-B capabilities against cruise missiles are suspect because the system's performance against small targets falls off at frequencies below about fifteen megahertz (MHz). The OTH-B systems are operated in six bands between five MHz and twenty-eight MHz, but the ionosphere fails to reflect higher-frequency transmissions when temperatures are low and during times of low sunspot activity. OTH-B performance against cruise missiles will be tested this winter when a drone modified to have a signature similar to that of the AS-15 is flown against the East Coast system.

The Soviets, themselves experienced with OTH-B technology, may be able to predict statistically how the performance of the system would decrease as targets get smaller and as atmospheric conditions worsen. Advocates of the US system believe, however, that they couldn't predict performance specifically enough, for a specific date and time, to launch missiles against the US with confidence.

If OTH-B is judged to be deficient in this winter's cruise-missile tests, the Air Force will be able to double the East Coast system's sensitivity by increasing the size of its receiving antenna array to match that of the West Coast installation. Other hardware and software improvements under consideration for development could double sensitivity several times over if needed. Increasing the sensitivity of the system would increase its capabilities against small targets.

Air Force leaders acknowledge that all of their current and planned radar systems will be vulnerable and might be among the first assets lost in an attack on the US. They note, however, that even in this case the system still would have contributed to its main job, warning of an attack, and that to neglect defenses against bombers or cruise missiles is to invite an attack by such forces.

Satellite-based warning systems—which might or might not be less vulnerable than large radar installations on the ground—aren't realistic alternatives to OTH-B or NWS. The Air Force has said that a space-based radar test satellite is a prospect for the year 2000 and that an operational constellation couldn't be available before 2005. Space-based infrared coverage, which could be obscured by cloud cover, is a late-1990s prospect. The Teal Ruby satellite experiment, intended to demonstrate IR sensor capabilities, was scheduled last year, but was delayed because of the Shuttle *Challenger* accident. Satellite systems are considered to be part of the Air Defense Initiative, seen as a high-technology counterpart to SDI against air-breathing rather than ballistic missile threats. ■

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