low this precisely defined cut-off point should not have been released.

The precise effect of the DBS policy of releasing subpotent vaccines is hard to estimate but probably some 67 million doses of influenza vaccine were used in the United States during the 3 years covered by the GAO report. If half of these vaccines failed the DBS's own standards, and the cost to each recipient was $1 a head (a conservative estimate), then the DBS has allowed citizens to spend more than $30 million on subpotent vaccines.

On the question of efficacy of influenza vaccine, the GAO report records a difference of opinion between DBS officials, who estimate the vaccine is 50 to 60 percent effective, and studies conducted by the Center for Disease Control, one of which concluded the vaccine had "little if any effectiveness" and another that its efficacy was "20 to 25 percent at best."

The GAO auditors recommend in their report that the Secretary of HEW should require the NIH to establish milestones for implementing the efficacy provisions of the 1962 act and should monitor the NIH's progress in doing so. The report also advocates that the DBS should revise its philosophy of relying on the manufacturers to do the necessary tests. HEW should require the DBS to prevent vaccines from being released if either the manufacturers or the DBS shows the vaccines to be subpotent, the GAO report advises.

The fact that the GAO, not the NIH, discovered how the DBS went about certifying influenza vaccines raises the question of whether the NIH has exercised adequate supervision over the DBS. Not until last August, some 5 months after the DBS management had been crushingly overruled in a grievance hearing brought by Morris, formerly the DBS influenza control officer, did the NIH launch a formal inquiry to ascertain if all was well within the DBS. Despite the GAO report, however, NIH officials continue to maintain, as reported in *Science* (17 March), that Murray has a good record as a regulatory official.

Be this as it may, a committee chaired by NIH deputy director John F. Sherman has been appointed to search for a successor to Murray. The successor will assume office immediately rather than when Murray reaches mandatory retirement age in August 1973. NIH officials indicate that personnel problems in the DBS rather than any regulatory failing are the reason for this change.—NICHOLAS WADE

Navy F-14: New Fighter's Cost, Sophistication, Stir Controversy

Senate hearings are now in progress in advance of the fourth annual congressional debate over the future of the F-14, the Navy's costly, carrier-based, swing-wing fighter. The F-14 is intended to defend the fleet against air and missile attack, to provide aerial escort of carrier-based bombers, and to furnish air superiority over areas of ground combat. The Navy says the F-14 is essential to the national security. Others believe its contribution is out of line with its costs. The ostensible question before the Congress is whether to authorize procurement of 48 aircraft in addition to the 86 already funded. The underlying issue is whether limited government revenues should be spent here or elsewhere.

The F-14 controversy involves questions of cost, effectiveness, and need. Is the cost excessive? Are there more efficient means of protecting carriers from air attack? Is it more economical to use land-based bombers in situations where carriers might be employed, providing the F-14 were available for air defense? If so, should aircraft carriers be assigned a lesser role in the overall defense posture of the United States? Is the F-14 essential in order that certain commitments to allies be fulfilled? The argument is fueled by disparate estimates concerning the course of domestic and international affairs, military threats and capacities, and developments in science and technology.

So far, more than $2.5 billion has been appropriated for the F-14 program—$1.26 billion for research, development, testing, and engineering, and $1.47 billion for procurement. Eleven F-14's are in flying status, and 75 are in various stages of assembly.

By any standard, the F-14 is a major enterprise. It currently represents nearly 0.1 percent of the gross national product. It provides employment for at least 50,000 workers. It consumes approximately 1 percent of the entire Department of Defense appropriation, 3 percent of the total military procurement authorization, and about 7 percent of Navy procurement funds.

Support for the F-14 is shaky. Secretary of Defense Melvin Laird has expressed doubt. On 9 February, Senator John Stennis (D–Miss.), chairman of the Senate Armed Services Committee, stated his general concern that concentration on sophistication rather than numbers can leave American military forces inadequately equipped to perform their assigned missions.

The Senate Armed Services Committee tactical airpower subcommittee last week started hearings for the purpose of determining what the Navy's procurement plans were and how much the program was likely to cost. There is some concern that, if costs rise, appropriated funds will be used to procure a smaller number of aircraft than that specified in the original budget request. Senator William Proxmire (D–Wis.) has recommended that Members of Congress for Peace through Law, a bipartisan group of 30 senators and 97 congressmen, focus on the F-14 as one of four major weapons programs that should be cut back or terminated.

Adding to congressional and Executive skepticism is diminished public patience with cost overruns, delays, and technical problems inherent in undertakings of this type. In consequence, the F-14 is being pursued in an unsympathetic climate, where a lapse in management, design, or workmanship causing cost growth or a plane crash can lead directly to termination of the program.

The previous attempt to develop an aircraft to provide fleet air defense ended in failure with the cancellation

Table 1. Program costs (in billions of dollars), including research and development. Per plane costs (in millions of dollars) are in parentheses.

Source and date of estimate	Program costs		
Total number of planes produced	313	469	722
Department of Defense, January 1968		$5.9 (12.6)	
Department of Defense, August 1969			$8.36 (11.6)
Department of Defense, April 1971	$5.2 (16.7)	$7.2 (15.4)	$9.8 (13.6)
Critics' projection,* March 1972	$6.2 (19.8)	†	†

* Projected costs assume contractors will be required to absorb cost growths and the contracts will be modified accordingly. † The situation is insufficiently defined to permit a meaningful estimate. Ultimate costs will depend on terms of a contract which is yet to be negotiated.

of the F-111B, the carrier-based version of the TFX. The prime function of the F-111B was to serve as a launching platform for the long-range air-to-air Phoenix missile, which is designed to intercept bombers or missiles targeted at surface naval vessels. The F-111B was abandoned because weight grew during the development process to the point where the plane was too heavy for the decks, catapults, and arresting gear of standard aircraft carriers.

When it became apparent that something different would be required for fleet air defense, the Navy was authorized to undertake development of a new aircraft. The design benefited from lessons learned in the F-111 program. The result is the F-14, which is supposed to be an air superiority fighter equal to any that might be encountered during the next decade. A major design objective is to enable the F-14 to carry six Phoenix missiles without sacrifice in fighter characteristics. The plane will also be adaptable for use as a carrier-based bomber.

From the taxpayer's perspective, the most striking aspect of the F-14 is likely to be the cost of each plane, variously estimated between $14 and $20 million. The precise amount depends upon assumptions concerning the number of aircraft to be built, the likelihood that serious systems problems are encountered, and whether contracts are modified to take into account cost increases incurred since the program was initiated. In any event, each F-14 will cost three to five times as much as an F-4 Phantom, the most versatile combat aircraft now operated by the Navy. The price tag of the F-14 will be about 16 times the cost of the MiG-21, which is the best general-purpose fighter in widespread use by the Russians and their allies.

The basis for the cost differential between the F-4 and F-14 is, in part, the F-14's greater size, swing-wing, and extensive use of titanium in the air frame. The F-14's engines are at least four times as costly as the F-4's. The F-14's navigation and fire control systems are more sophisticated. As compared to the F-4, the F-14 is designed to require fewer maintenance hours between missions. Finally, F-14 research and development costs (totaling more than $1.4 billion) will be amortized over a much smaller number of aircraft than was the case with the F-4.

The performance of the F-14's now in flying status has led the Navy to believe the aircraft will meet or exceed its requirements. The existing aircraft (designated F-14A) are equipped with the Pratt and Whitney TF-30-P-412 engine, an outgrowth of the engine planned for use in the F-111B. The original intent was to build not more than 67 F-14A's. All subsequent aircraft (designated F-14B) were to be equipped with a higher thrust, lighter weight engine that would add considerably to performance. This engine, the F-401, is being developed by Pratt and Whitney. It is behind schedule and its cost has grown significantly. As a result of these troubles, current plans call for procurement of the F-14A until such time as the performance of the F-401 is proved, possibly December of this year. The Navy is optimistic that the F-401's problems will be solved. But some of the skeptics are not so sure. They say that costs may very well increase to the point where the engine will be too expensive for use in the F-14. The impact upon the F-14 program of further delays or cost increases in the F-401 is unclear.

On 15 February, in his annual statement on the Defense posture, Laird requested that $163 million be authorized to fund additional development and $570 million for procurement of 48 more aircraft. In making this request for the next installment, Laird appears to have adopted some of the skepticism long voiced by the F-14's critics: "The program has suffered to some degree from each of four factors that have created problems in weapons systems acquisition." He said these factors were (i) decisions to undertake an overly ambitious or unrealistic project; (ii) insufficiently effective Defense Department management; (iii) unrealistic cost estimates; and (iv) a defense industry suffering from management and financial problems.

The Secretary pointed out that, while a significant investment had already been made, the program would be continued only if he were convinced that the "F-14 will provide the capability that the Navy needs and at a realistic cost." He noted that the funds expended to date are nonrecoverable and that his decisions would be based "solely upon its [the F-14's] demonstrated effectiveness and not upon cost already incurred as a result of earlier decisions."

Grumman Asks Revision

He took note of the fact that the principal F-14 contractor, the Grumman Aircraft Corporation, had indicated its unwillingness to proceed with further work beyond that funded in fiscal year 1972. Grumman claimed its financial condition would be seriously jeopardized unless the contract was rewritten to provide a higher rate of compensation. Laird's response to this was that the existing contract was legal and Grumman was bound to proceed under its terms. Grumman argues that circumstances beyond its control have rendered previous cost estimates meaningless, and just grounds exist for formulating a new contract. According to the corporation, cost increases resulted from an unexpectedly high rate of inflation and unforeseen loss of other business. As a result of the latter, the F-14 project was called upon to bear a higher-than-estimated proportion of the corporate overhead. The F-14's critics suspected that a good part of the cost escalation resulted from the fact that Grumman bid unrealistically low in order to get the contract. Since Grumman would be hard put to absorb the several hundred million dollar loss it will incur if held to the present contract, it is likely that a way will be found to provide additional funds. The estimates in Table 1 give some idea of the magnitude of cost and its dependence upon the number of aircraft procured.

Cost discussions center around possible procurement levels of 313, 469, and 722 planes. The lowest number is that which appears in the current 5-year plan approved by the Secretary of Defense. It is also the minimum num-

ber Grumman would be asked to deliver under the current contract, which runs through fiscal 1976. The number 469 is used for purposes of making cost comparisons. It represents the quantity used as a base line in the original contract, which provided for a specified number each year, plus or minus 50 percent of that number. The Navy has a stated requirement for 722 aircraft—25 for each of 15 aircraft carriers, 250 for the Marines, and approximately 100 for training purposes. This number can now be purchased only after renegotiation of the contract. Some critics believe that a renegotiated price would be so high as to be unacceptable to the Department of Defense; therefore F-14 procurement would cease with termination of the present contract.

Proxmire Criticizes Cost

Senator Proxmire says the F-14 costs too much and that there are less expensive alternatives. He recommends dropping the requirement for one aircraft to serve both as a high-performance fighter and as a launch platform for the $250,000 Phoenix missile. He believes this would make it possible to develop a 15,000- to 20,000-pound fighter (versus the F-14's 40,000 pounds) in the $2.5- to $5-million range. Proxmire also believes that the new fighter should be equipped with guns and a modest air-to-air missile such as the $15,000 Sidewinder. He thinks that if long-range missiles are required for fleet air defense they should be based on ships and that, in any case, the Phoenix should be abandoned altogether. Others are more optimistic about the prospects for the Phoenix, but believe it should be carried aloft either by the carrier-based A-6 or by long-range, land-based aircraft loitering above the fleet.

The Navy counters that criticisms of the F-14's cost-effectiveness are misconceived—that those who claim a simple fighter will do the job are basing their assertions on faulty analyses. Actually the nature of the cost-effectiveness debate is such that the lay observer is likely to be convinced by the last expert he hears. An independent opinion on the matter of the F-14 vis-à-vis the alternatives requires familiarity with esoteric details of aircraft performance, carrier operations, and aerial combat.

For example, at square one, the Navy says the F-14 is a fighter equal or superior to any that might be encountered. The critics respond that the proper comparison is on an equal cost basis; for example, one F-14 versus four F-4's, or one F-14 versus 16 MiG-21's. In a letter appearing in the 10 January 1972 issue of *Aviation Week and Space Technology*, a veteran F-4 pilot wrote: "One F-14 versus a squadron of MiG-21's is a poor bet for the U.S. Navy." Proponents of the numbers argument say that if four F-4's outperform one F-14 then four F-4's are a better buy.

The Navy retorts that in most situations carrier aircraft will be outnumbered. Therefore it is necessary to pack the highest performance into the limited number of planes that can be accommodated on a carrier's deck. If there is room for 25 fighters, it is better that they be F-14's that F-4's, even though the latter might cost one-third as much. The critics reject the argument, claiming total fighter strength per aircraft carrier would be greater with the smaller fighters. This, they say, is because carriers could handle a larger number of smaller aircraft and because these, as a consequence of their relative simplicity, would be easier to maintain and therefore would be more available for missions. The Navy says that F-14's do not require that much more deck space and that, in spite of greater complexity, they are designed to require less maintenance time. And so on.

The cost-effectiveness dialogue is not only inconclusive, it also tends to obscure the real issue: the likelihood of situations in which the F-14 would be essential for fleet air defense. If possession of the F-14 does indeed make a big difference, the cost differential between a unit price of $15 million and $20 million is small potatoes in comparison to what is at stake. In fact, some substantial portion of the disagreement about cost-effectiveness stems from the disparate underlying assumptions concerning the nature of future conflicts and of the aircraft-carrier mission.

With regard to the future, it is generally agreed that aircraft carriers will not survive for long in a nuclear war; whatever role they might play would not be substantially enhanced by the F-14. Similarly, for purposes of showing the flag (as in the recent dispatch of the nuclear carrier *Enterprise* to the Bay of Bengal), F-4's on a flight deck 100 miles offshore should do the job as well as F-14's. In Vietnam-like conflicts fleet air defense can be accomplished by less costly means and, what is more important, the massive retaliation likely to be called forth by the destruction of all or part of a $2 billion carrier task force acts as a powerful deterrent to attack.

The dispute centers on a possible scenario in intermediate situations, where the availability of the F-14 would make a difference in the outcome of the conflict. One such scenario, according to the Navy, is a nonnuclear war with Russia—one in which the F-14 would be crucial if U.S. and allied surface naval forces were to be capable of surviving a high-intensity air and missile threat. The critics say such a conflict is exceedingly unlikely and that, even if it were to occur, the F-14 would not be able to save the carriers or other surface naval forces from a determined attempt to destroy them; a carrier task force could be incapacitated cheaply in terms of the damage inflicted.

Complex Interactions

As with other weapons system controversies, this one begins with a consideration of calculable factors and drifts toward inconclusive disputation over intangible effects and broader issues involving interactions between politics, military science, technology, and economics. A judgment that the F-14 program should or should not proceed rests on beliefs or feelings about a series of intangibles: what the next decades hold; where the threats are likely to lie; and the distribution of resources among the sectors competing for them. In one view, the F-14 will play an important role in the national defense. In the opposing view, it is irrelevant to the problems of the real world; limited defense dollars should be spent in a more effective fashion.

There are signs that within the next year a decision will be made about the future of the program. Termination would signal a more restricted role for naval aviation than is deemed prudent by Navy planners. It remains to be seen whether this would initiate a retrenchment of American commitments, a sensible adjustment to the realities of the nuclear age (as the critics claim), or both.—HENRY R. MYERS

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