in the defense. The F-14 and F/A-18 are roughly equivalent in rate of acceleration, but the F-14 has a substantial advantage in maximum speed. 14/ Moreover, the F-14 carries the Phoenix missile, which can be fired at a range of 50 nautical miles against up to six targets simultaneously, or at 100 nautical miles against a single target. The F/A-18's Sparrow missile has a range of about 25 nautical miles against a single target. 15/ In addition, the AWG-9 radar on the F-14 has an advertised range of 170 nautical miles against bombers, allowing the operator time to select targets and assign missiles to them before reaching the launch point. 16/ The F/A-18 radar has a much shorter range. Finally, the ability to engage multiple targets at longer range allows each F-14 to cover a wider attack corridor, reducing the number of interceptors required to cover an attack along several axes simultaneously.

The long-range capability of the F-14 would be very useful in certain circumstances--for example, on carriers operating close to highly defended areas within the Soviet Union (such as Murmansk or Vladivostok), where large numbers of capable bombers would pose a continuing threat over an extended period of time. This sort of threat might, however, tax or even overwhelm several squadrons of F-14s, and exhaust their supplies of Phoenix missiles in short order.

On the other hand, the F/A-18, carrying the Sparrow F and M models and perhaps a new medium-range missile in the late 1980s or early 1990s, will have more capability in fleet air defense than the F-4 now has. Also, the lower capability of the F/A-18 in fleet air defense relative to the F-14 may not always be critical. The F-14 is designed to deal with the most demanding air threats, especially the Soviet Backfire bomber. Using the F/A-18 to fill out the fighter force would leave five carriers with a reduced capability in this respect, although they would still be very capable against lesser threats. Indeed, if the Navy

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14/ The F-14's maximum speed is 2.4 Mach compared with 1.8 Mach for the F/A-18; see Congressional Research Service, Fleet Air Defense: A Naval Problem, Report 79-259F (September 1979).

15/ Congressional Research Service, F/A-18 Hornet.

16/ Congressional Research Service, Fleet Air Defense.

was fighting in an area far from Soviet bases, or against a much less capable foe, the F/A-18 with Sparrow and Sidewinder missiles would have substantial capability.

Then, too, operating policies and distribution of aircraft could be instituted that would minimize the effect of the degradation in fleet air defense capability brought about by use of the F/A-18. Carriers, which often operate in pairs, could be teamed so that one always had F-14s. Alternatively, the Navy could distribute F-14s so that every carrier had at least one squadron. While either alternative would provide all battle groups some F-14 capability against a threat that included some of the most capable Soviet aircraft, it would not suffice against relatively large numbers of them. The overall capability of each battle group and of the entire Navy to perform fleet air defense, as measured in F-14 flight hours per month, would be degraded.

Another advantage of the F/A-18 is that when assigned to fighter squadrons it could be used to augment attack forces. A carrier with two F/A-18 fighter squadrons would have 24 more aircraft capable of dropping bombs than other carriers would have. This would mean a relative improvement in the capacity to deliver bombs to a target area--an improvement of up to 75 percent depending on the attack force (see Figure 4).

Costs

Buying F/A-18 fighters to meet remaining fleet demands would be substantially less costly than buying F-14s. The long-run procurement cost of buying enough F-14s to equip ten squadrons would be $11.2 billion. Adding 248 F/A-18s to the end of the present F/A-18 program would cost $4.2 billion, about one-third as much. (If the F/A-18 was not procured as the replacement for the A-7E, then the total buy of F/A-18s would be smaller and the unit cost of the 248 aircraft would be higher. The cost would then be $4.4 billion rather than $4.2 billion.)

Costs of owning and operating the aircraft (life-cycle costs) are not evaluated in this report. But since the two aircraft have equal service lives of 15 years, the procurement costs appropriate to a calculation of life-cycle costs are those shown here. Over the 15-year period, the F/A-18 force would cost about $1 billion less to operate.

Figure 4.

Range of Improvement in Bomb Delivery Capacity from Adding 24 F/A-18s to a Carrier Air Wing, at Various Distances to Target

Procuring the F/A-18 for these ten squadrons would not only reduce long-run costs, but would also save a total of $5.8 billion over the next five years. This is because F-14 procurement would be terminated in 1983, but procurement of the F/A-18 over the five years would not increase above currently planned levels because the program is already at efficient procurement levels. Thus, while $5.8 billion would be avoided in 1983-1987, the added cost of the extra F/A-18s would not be incurred until after the five-year period. This also means that the Navy would procure 142 fewer fighter aircraft over the next five years under this alternative than it would under its current plan. If the F/A-18 were not bought as the replacement for the A-7E, the five-year savings would be only $1.3 billion, but more fighters would be bought in five years under this option than under the Navy's fighter option.

The Navy would not, however, have to wait until the 1990s to equip its fighter squadrons with F/A-18s under this alternative, since these aircraft could be drawn from any part of the F/A-18 program. Doing so would, of course, delay delivery of F/A-18s for other purposes. At the production rates currently planned, adding 248 F/A-18s at the end of the buy would extend the program by about a year and a half.

In sum, this alternative would equip the remainder of the fleet with F/A-18 fighters at about one-third the cost of equipping them with F-14s. The F/A-18 is clearly less capable in the key role of fleet air defense. But it would have substantial capability in medium-threat areas, such as those in the Persian Gulf. Moreover, only about one-third of the fleet would have F/A-18s under this option; thus, battle groups containing two carriers could always be configured so as to have some F-14 aircraft.

APPENDIXES

APPENDIX A. A CALCULATION OF THE EFFECTIVENESS OF CARRIER-BASED ATTACK FORCES

This appendix describes the methodology used in calculating the total number of pounds of bombs that a carrier-based attack force can carry into a target area during a 12-hour operating day. It combines a calculation of the number of sorties that can be flown to a specific range with the payload that can be carried to that range by each attack aircraft type. The methodology does not take into account the accuracy with which bombs are delivered (although it could be modified to do so in a straightforward manner), or other characteristics that would enter into a judgment of the relative merits of different forces. In this application it has not included in-flight refueling, but that should not affect the relative rankings of aircraft types.

RANGE/PAYLOAD

Data shown in Table A-1 for the F/A-18, A-6E, and A-7E were supplied by the Navy. Data on the A-7X were supplied by

TABLE A-1. RANGE TO WHICH SPECIFIC LOADS CAN BE CARRIED BY AIRCRAFT FLYING A HIGH-LOW-HIGH MISSION PROFILE (In nautical miles)

Load a/	F/A-18	A-6E	A-7E	A-7X
4 Mk-83	706	1,000	793	880
6 Mk-83	630	950	635	767
9 Mk-83	495	775	435	
12 Mk-83	359	600	200	

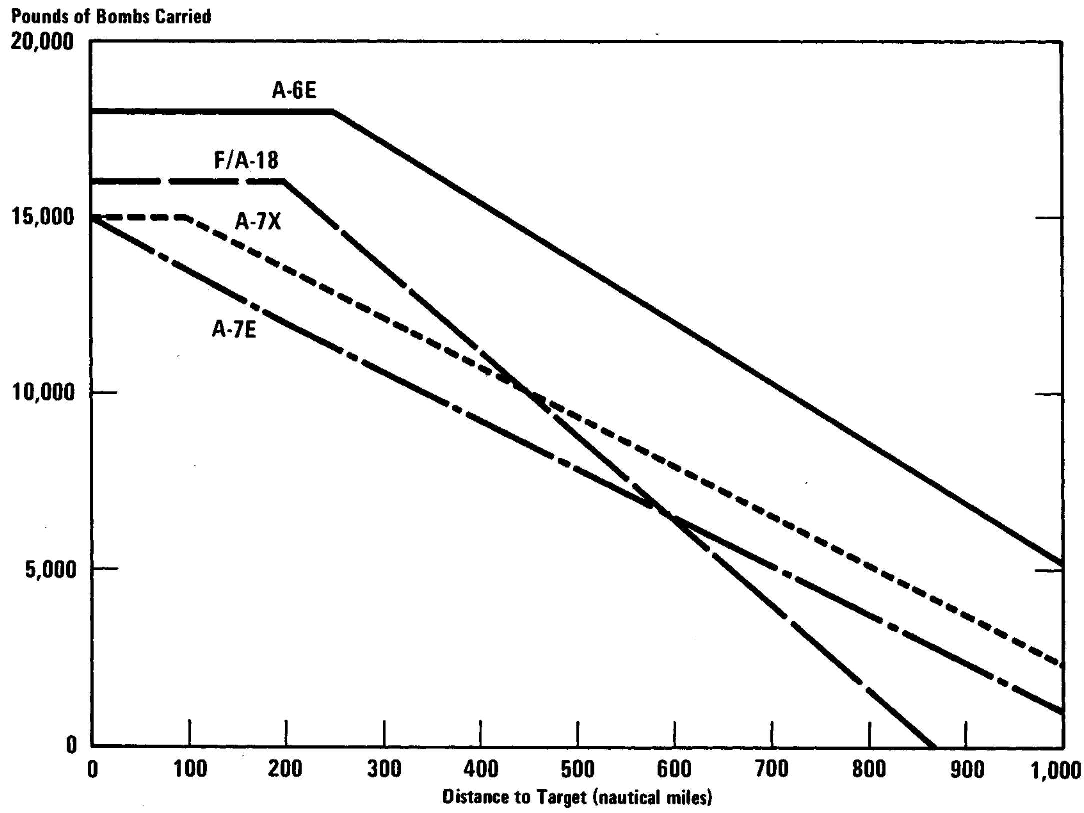
NOTE: External fuel as needed, external tanks dropped when empty. Low leg: five minutes at maximum power without after-burner.

a/ The Mk-83 is a 1,000 pound bomb.

Vought Corporation, which manufactures the A-7E and has defined the A-7X. The data along with maximum payloads obtained from Jane's All the World's Aircraft, 1980-81 were used to produce Figure A-1. The data point for the A-6E carrying four Mk-83 bombs appears somewhat inconsistent with the rest of the data, and was discarded. For the purpose of this analysis, it was assumed that a payload could take on any value between zero and the maximum. In reality, this is not true as bombs come in discrete sizes, and limitations on the numbers that can be carried dictate which payloads are possible. Taking this into account would not alter the trends observed in the calculation; it would simply yield less regular curves with more "wiggles."

Figure A-1.

Range/Payload Comparison of Four Attack Aircraft Forces



NOTE: Hi-Lo-Hi mission profile, no refueling, external fuel as needed, empty tanks dropped.

SORTIE GENERATOR

This part of the calculation draws heavily from the methodology and data developed in the Center for Naval Analyses (CNA) study CNS 1110. 1/ A carrier is assumed to conduct flight operations for 12 hours, and then cease operations. Extension of operations for about one hour to allow recovery of aircraft launched earlier in the day was permitted. Individual deck cycles are either 1.75 hours or 2 hours, and are of constant length throughout the day. During a cycle aircraft are first recovered (except, of course, during the first cycle), then moved, fueled, armed, and launched. At least five launch slots in each cycle are assumed to be devoted to aircraft other than attack aircraft. Attack aircraft are operated either in single cycles or in multiple cycles (that is, remaining in the air for more than one full cycle and being recovered during the next available recovery period). Cycle length was based upon a round trip at 400 knots plus 30 minutes for miscellaneous activities such as grouping while in the air.

The first step in calculating the number of sorties was to count the number of aircraft available for the first cycle. All available aircraft were assumed launched up to the maximum for the cycle; those not accommodated were assigned to the second launch. Since no aircraft were recovered during the first cycle, two launches were made with a suitable delay between. Aircraft launched at the beginning of the first cycle were recovered at the beginning of the second (if on single cycle), while those launched at the end of the first cycle were recovered at the beginning of the third. Available launches were apportioned among attack aircraft types in proportion to the total number of aircraft of each type available for launch. The number of aircraft available for the first cycle was dictated by overall operational readiness rates as supplied by the Navy:

A-7E	54 percent
A-6E	52 percent
F/A-18	66 percent

A7-X availability was assumed to be the same as A-7E availability. This is consistent with contractor statements.

1/ William B. Buchanan, and others, Sea Based Air Platform Cost/Benefit Study, Center for Naval Analyses (January 1978).

All aircraft returning at the beginning of a cycle and not in need of repair were launched at the end of the cycle, and all aircraft repaired during the day were assigned to the next cycle as they became available. 2/ Following the CNA methodology, it was assumed that in all cases 75 percent of the aircraft returning from a mission could be turned around for the next launch after fueling and arming; the other 25 percent needed repair. The mean time to repair was taken to be about three cycles regardless of aircraft type. It was assumed that one-fourth of those in need of repair needed minor repair only and would be available after missing one cycle. Similarly, one-fourth were assumed irreparable during the 12-hour day. One-fourth were assumed ready for the third cycle following the one in which they were initially not ready, and the other fourth were ready for the fourth cycle following the one in which they were initially not ready. Thus, of those aircraft that returned at the beginning of the second cycle in need of repair, 25 percent would be ready for the third cycle, 25 percent for the fifth cycle, and 25 percent for the sixth cycle; 25 percent were lost for the day. This methodology was also applied to those aircraft that were not mission-capable at the start of the day; of those, 25 percent would be ready for cycle 2, 25 percent for cycle 4, and 25 percent for cycle 5.

After calculating the number of sorties flown during each cycle, the total number of sorties for the day was summed.

2/ A cycle is usually defined as beginning with a launch. The sequence is: launch; recover; move, fuel, and arm; launch; and so on. For convenience, this analysis has defined the cycle as beginning with recovery followed by moving, fueling, and arming aircraft, followed by a launch.

AIRCRAFT REQUIREMENTS FOR ONE CARRIER AIR WING

In addition to the aircraft assigned to the air wings--Primary Aircraft Authorization (PAA) or Unit Equipment (UE) aircraft--others are purchased for Fleet Replenishment Squadrons (FRS), RDT&E, pipeline, and peacetime attrition. The number authorized for FRS is generally a fixed fraction of PAA. These aircraft are used for training. The pipeline authorization is a fixed fraction of PAA plus FRS. Pipeline includes aircraft that are being repaired, along with others that have been repaired and will replace those going into repair. The number bought for RDT&E is generally independent of PAA and relatively small, so it will not be included in this accounting.

Table B-1 shows the data for calculation of the aircraft required for one air wing. Requirements for S-3A and ASW helicopters (other than PAA) could not be met unless new production is begun. Expansion could result in reductions in PAA of these types as existing inventories are redistributed. The number required is calculated from the expression N = PAA x (buy factor), where

$$\text{Buy factor} = \left(1 + \frac{\text{FRS}}{100}\right)\left(1 + \frac{\text{Pipeline}}{100} + 15 \times \frac{\text{Attrition}}{100}\right)$$

A 15-year buy factor is used here. Fifteen years is the service life of the F-14 and F/A-18, and less than the service life of the other aircraft. Buying N will provide enough aircraft to establish the air wing and replace attrition for 15 years. However, the value of the aircraft remaining at the end of 15 years will vary with aircraft type since they all have different service lives.

AIRCRAFT UNIT PROCUREMENT COSTS

Two alternative costs will be generated for the air wing shown above. The first will be based on the assumption that no

TABLE B-1. AIRCRAFT REQUIREMENTS FOR ONE CARRIER AIR WING

Aircraft	PAA	FRS (percent of PAA)	Pipeline (percent of PAA + FRS)	Yearly Attrition (percent of PAA + FRS)	15-Year Buy Factor
A-6E	10	25	29	2.5	2.08
F/A-18	24	25	12	3.5	2.06
F-14	24	25	18	3.6	2.15
E-2C	4	25	26	1.5	1.86
EA-6B	4	25	20	4.4	2.33
KA-6D	4	4	26	4.0	1.93
S-3A	10	25	12	1.3	1.64
SH-60	6	25	6	3.0	1.89

PAA: Aircraft assigned to the air wing.

FRS: Aircraft in Fleet Replenishment Squadrons (for training).

Pipeline: Aircraft in the repair pipeline.

$$\text{Buy Factor} = \left(1 + \frac{\text{FRS}}{100}\right)\left(1 + \frac{\text{Pipeline}}{100} + 15 \times \frac{\text{Attrition}}{100}\right).$$

new ASW aircraft are procured. The second will assume that the S-3 line is reopened, and that the SH-60 helicopter is procured as a carrier-based ASW helicopter. The SH-60B is the Navy's LAMPS MkIII ASW helicopter for use on surface combatants (cruisers, destroyers, and frigates). Table B-2 shows the unit costs that will be used in the analysis.

TABLE B-2. AIRCRAFT UNIT COSTS (In millions of 1983 dollars)

Aircraft	Unit Cost	Comments
A-6E	26.7	Unit cost at 12 per year. Continued procurement at 12 per year assumed. Current budget buys 12 per year, except 8 in fiscal year 1983 and 8 in fiscal year 1984 at $33.83 million per unit.
F/A-18	17.2	Average unit cost of last 665 aircraft. Average cost for full program is over $20 million.
F-14	43.32	Unit cost at 30 per year. Continued procurement at 30 per year assumed. Current budget buys 30 per year, except 24 in fiscal year 1983. 1983 unit cost is $48.22 million.
E-2C	53.8	Unit cost at six per year. Continued procurement at six per year assumed.
EA-6B	54.7	Unit cost at six per year. Continued procurement at six per year assumed.
KA-6D	28.7	$2 million conversion of existing A-6E plus replacement with a new A-6E. Since older airplanes are converted, this somewhat overstates the cost.
S-3A	43.4	Based on Navy and manufacturer estimates.
SH-60	13.4	Add-on buy at highest production rate.

SOURCES: Department of Defense budget for fiscal year 1983, except for the F/A-18 which is taken from the December 1981 Selected Acquisition Report.

PROCUREMENT COST OF ONE CARRIER AIR WING

Table B-3 shows the costs of procuring one full carrier air wing, including FRS and pipeline aircraft, but excluding attrition aircraft.

In planning a program, the most economical approach is to buy all aircraft, including those for anticipated attrition, at high production rates, and then terminate production. For example, according to the program as specified in the December 1981 Selected Acquisition Report, the entire F/A-18 buy will be completed about six years after the beginning of large-scale

TABLE B-3. COST OF PROCURING ONE CARRIER AIR WING (In millions of 1983 dollars)

Aircraft	Number	Unit Cost	Total Cost
A-6E	17	26.7	454
F/A-18	34	17.2	585
F-14	36	43.3	1,559
TARPS a/	3	1.6	4.8
E-2C	7	53.8	377
EA-6B	6	54.7	328
KA-6D	6	28.7	172
Total with no new ASW aircraft			3,480
S-3A	14	43.4	607
SH-60	8	13.4	107
Total with all new aircraft			4,194

a/ Tactical Airborne Reconnaissance Pod System.

TABLE B-4. COST OF AIRCRAFT, INCLUDING ATTRITION AIRCRAFT, FOR ONE CARRIER AIR WING (In millions of 1983 dollars)

Aircraft	Total Aircraft Cost		Cost of Attrition Aircraft	
	Including Attrition	Without Attrition	Total	Average per Year
A-6E	555	454	101	6.7
F/A-18	852	585	267	17.8
F-14	2,235	1,559	676	45.1
TARPS a/	4.8	4.8	--	--
E-2C	400	377	23	1.5
EA-6B	510	328	182	12.1
KA-6D	222	172	50	3.3
Total with no new ASW aircraft	4,779	3,480	1,299	86.4
S-3A	712	607	105	7.0
SH-60	152	107	45	3.0
Total with all new aircraft	5,643	4,194	1,449	96.4

a/ Tactical Airborne Reconnaissance Pod System.

introduction into the fleet and will include substantial numbers of aircraft for anticipated attrition. 1/

Table B-4 extends Table B-3 to include the costs of attrition aircraft, including their average yearly costs. It is not

1/ Captain J.S. Weaver, F/A-18 program manager, as reported in Aerospace Daily (July 1, 1981). See Also Admiral T.B. Hayward, CNO, as reported in Sea Power (August 1981).

anticipated, however, that attrition costs will be spread evenly over the years of service.

OPERATIONS, MAINTENANCE, AND MANPOWER COSTS

Table B-5 shows the additional personnel that would be needed to man the squadrons in one air wing. This does not include other personnel on the carrier, or those billets associated with increasing FRS and pipeline inventories. Typical total manning of a Nimitz-class carrier is about 6,300.

Table B-6 lists the direct personnel and operation and maintenance costs for one air wing and the associated FRS expansion.

TABLE B-5. PERSONNEL NEEDED FOR ONE CARRIER AIR WING

Aircraft	Officers	Enlisted
A-6/KA-6	38	271
F/A-18	42	416
F-14	70	508
E-2C	29	141
EA-6B	27	167
S-3A	44	256
ASW helicopter a/	23	157
Wing Staff	10	7
Total	283	1,923

a/ SH-3 assumed.

TABLE B-6. OPERATION COSTS FOR ONE CARRIER AIR WING FOR ONE YEAR (In millions of 1983 dollars)

Aircraft	Personnel	Operation and Maintenance	Total
A-6/KA-6	11	23	34
F/A-18	4	40	44
F-14	6	51	57
E-2C	4	8	12
EA-6B	4	12	16
S-3A	6	21	27
SH-60	4	19	23
Total	39	174	213

COSTS OF FIGHTER AND ATTACK AIRCRAFT ALTERNATIVES

Fighter Alternatives

Table B-7 shows the number of F-14s or F/A-18s that would be required to equip ten squadrons.

The F/A-18s would be added to the end of the 1,366 programmed buy at $17.2 million per unit in 1983 dollars. The total cost would be $4.2 billion. They would be procured in fiscal years 1990 and 1991. If the F/A-18 was not procured as an attack aircraft, 28 fewer F/A-18s would be procured in 1986, which would be the last year of the program. If 248 aircraft for fighters were added to this truncated program, they would be procured in 1986 and 1987 at a total cost of about $4.4 billion.

TABLE B-7. NUMBER OF F-14s OR F/A-18s REQUIRED FOR TEN SQUADRONS

Aircraft	Number per Squadron	15-Year Buy Factor a/	Total
F-14	12	2.15	258
F/A-18	12	2.06	248

a/ From Table B-1.

The F-14s are assumed to be procured according to the schedule shown in Table B-8. At an average unit cost of $43.32 million, they would cost $11.2 billion.

TABLE B-8. PROCUREMENT SCHEDULE FOR TEN SQUADRONS OF F-14s

Fiscal Year	Number Procured	Cumulative Total for Ten Squadrons	Cost (millions of 1983 dollars)
1983	24 a/	12	579
1984	30	42	1,300
1985	30	72	1,300
1986	30	102	1,300
1987	30	132	1,300
1988	30	162	1,300
1989	30	192	1,300
1990	30	222	1,300
1991	36	258	1,560

a/ 12 aircraft procured in 1983 complete the inventory for the 18 existing squadrons.

Savings from buying the F/A-18 rather than the F-14 would be as shown in Table B-9.

TABLE B-9. SAVINGS ARISING FROM BUYING TEN SQUADRONS OF F/A-18s RATHER THAN TEN SQUADRONS OF F-14s (In millions of 1983 dollars)

	F/A-18 Is Navy's Light-Attack Aircraft			F/A-18 Is Not Navy's Light-Attack Aircraft		
Fiscal Year	Cost Avoided By Not Buying the F-14 a/	Cost of F/A-18	Net Savings	Cost Avoided By Not Buying the F-14 a/	Cost of F/A-18	Net Savings
1983	579	--	579	579	--	579
1984	1,300	--	1,300	1,300	--	1,300
1985	1,300	--	1,300	1,300	--	1,300
1986	1,300	--	1,300	1,300	(684)	616
1987	1,300	--	1,300	1,300	(3,784)	(2,484)
1988	1,300	--	1,300	1,300	--	1,300
1989	1,300	--	1,300	1,300	--	1,300
1990	1,300	(3,819)	(2,519)	1,300	--	1,300
1991	1,560	(448)	1,112	1,560	--	1,560

a/ Table B-8 last column.

Attack Alternatives

Cost of the F/A-18. Using the 15-year buy factor, 693 F/A-18s would be needed for 28 squadrons. If these were taken off the end of the program given in the December 1981 Selected Acquisition Report, they would be the last 657 (the total for the last three years of the program, 1988-1990) at $17.2 million per unit plus 36 from the preceding year at $23.5 per unit, for a total cost of $12.1 billion. A disproportionate amount of the costs of support equipment appear early in the F/A-18 program. If the procurement of support was redistributed more evenly throughout the program, the cost of the last 693 would rise to about $13.3 billion.

Cost of the A-6E. Twenty-eight squadrons of ten aircraft each would require 583 A-6Es. These would be procured according to the profile shown in Table B-10.

Several methodologies were employed to estimate the cost of procuring A-6Es at these high yearly rates. The calculated total costs for 583 aircraft spanned the range of $8.8 billion to $12.5 billion in 1983 dollars.

The procurement profile shown in Table B-10 requires a change in the rate of A-6E production from the 12 per year that has prevailed in recent years (the Administration has asked for 8 per year in fiscal years 1983 and 1984) to 96 per year. Estimating unit costs at such an enormous change in procurement rate involves considerable speculation, since few data are available upon which to base such projections.

TABLE B-10. A-6E PROCUREMENT SCHEDULE

Fiscal Year	Total Number Procured a/	Number Procured for New Squadrons
1986	24	12
1987	56	44
1988	84	72
1989	96	84
1990	96	84
1991	96	84
1992	96	84
1993	96	84
1994	47	35
Total	691	583

a/ Includes 12 per year procured regardless of which light attack option is chosen.

Two models of the behavior of unit cost with yearly rate changes are used in the Defense Department. One is of the form: 2/

$$F = 0.162 \left[\frac{\text{New Rate}}{\text{Old Rate}}\right]^{-1.669} + 0.838$$

F is the factor used to multiply the old unit cost to get the new unit cost.

The specific numbers in the equation were obtained from aggregated data collected on several airplanes, with a stated range of validity from a 17 percent reduction in buy rate to an 85 percent increase. Clearly, an eightfold increase in buy rate is far beyond the stated region of validity of the model. Some analysts maintain that the model ought not to be applied to the rate of production of the A-6E only, but to combined rates of production of all the aircraft produced by the manufacturer (Grumman Corporation), and furthermore should be applied to all the main systems of the airplane individually, to allow for the different business bases of the different manufacturers of the airframe, engine, and so on. While this would bring the calculation close to the region of validity of the model (Grumman now produces 50 to 60 aircraft per year), it would introduce even more speculation into the modeling process: What will Grumman's business base be in 1990?

The model raises several other problems:

- o It predicts that unit cost can never be reduced by more than 16.2 percent.
- o It appears to be incapable of explaining the change in unit cost in the A-6E between fiscal years 1982 and 1983.
- o It is not self-consistent in the sense that if it is used to calculate the cost at rate 2 from the cost at rate 1, it will not yield the proper cost for rate 1 when applied once again.

2/ Commander Steve J. Balut, "Three Views of the Impact of Production Rates Changes: I. Redistributing Fixed Overhead Costs," Concepts: The Journal of Defense Systems Acquisition Management, vol. 4 (Spring 1981), pp. 63-76.

Despite these shortcomings, the model has proved useful within the Defense Department. Applying it to the case under consideration using different sets of assumptions yields costs for the additional A-6Es of $11.2 billion to $12.5 billion.

A second model developed within the Defense Department is of the form: 3/

$$\text{Cost} = (\text{Constant})(\text{Rate})^{x}$$

or, put in terms consistent with the other model:

$$F = \left[\frac{\text{New Rate}}{\text{Old Rate}}\right]^{x}$$

In this model, the driving factor x must somehow be determined. Large aggregations of data from many different types of systems resulted in a value of x = -0.1844. Applying this directly to the program shown in Table B-10, beginning with a unit cost of $26.7 million--the 1982 cost (in 1983 dollars) at 12 per year--yields a total cost of $10.0 billion, after subtracting a steady buy of 12 per year as was done using the other model. Another, more sophisticated application of this model using different sets of assumptions--including some supplied by the manufacturer--yields total costs of $8.8 billion to $9.6 billion. 4/

Cost of the A-7E. Using a training squadron fraction of 25 percent, a pipeline fraction of 14 percent, and 3.5 percent yearly attrition, 700 A-7Es would be needed for 28 squadrons. Applying different methodologies to calculate the unit cost, the total cost for 700 A-7Es would fall in the range of $5.5 billion to $7.6 billion in 1983 dollars. They would be procured in fiscal years 1986-1992.

3/ See John C. Bemis, "Three Views of the Impact of Production Rate Changes: III. A Model for Examining the Cost Implications of Production Rate," Concepts: The Journal of Defense Systems Acquisition Management, vol. 4 (Spring 1981), pp. 84-94.

4/ These other sets of assumptions include a learning curve, and different applications of the rate model to different components.

Cost of the A-7X. It was assumed that 700 A-7Xs would also be needed. These aircraft would cost \$8.2 billion to \$10.3 billion in 1983 dollars. They are procured in fiscal years 1986-1993.

Life-Cycle Costs. These calculations of procurement costs ignored differences in costs of operation among the different aircraft, and differences in their service lives. These differences are captured by using a 15-year buy factor that includes only the portion of the service life used in 15 years, plus the cost of 15 years' operation. The equation is:

$$\text{Buy factor} = \left(1 + \frac{\text{FRS}}{100}\right) \times$$

$$\left(1 + \frac{\text{pipeline}}{100} + \text{life} \times \frac{\text{attrition}}{100}\right) \times \left(15/\text{life}\right)$$

The fifteen-year total costs are tabulated in Table B-11.

Summary. Table B-12 compares the alternatives in procurement and 15-year life-cycle costs.

TABLE B-11. FIFTEEN-YEAR TOTAL COST COMPARISON OF ATTACK AIRCRAFT ALTERNATIVES

Option	Aircraft	Service Life (years)	Buy Factor	Average Unit Cost (in millions of 1983 dollars)	Procurement (in billions of 1983 dollars)	Yearly Operation (in millions of 1983 dollars per aircraft) a/	Total 15-Year Costs (in billion of 1983 dollars) b/
Navy Preferred	F/A-18	15	2.06	17.5-19.3	12.1-13.3	2.22	26.1-27.3
Current Force	A-7E	17	1.91	7.9-10.9	5.1-7.0	1.74	16.1-18.0
Re-engined A-7	A-7X	13 c/	2.30	12.0-14.7	8.5-11.4	1.91 d/	20.5-23.4
All A-6E	A-6E	23	1.51	15.1-21.4	6.4-9.0	2.86	21.4-24.1

a/ Supplied by the Navy, except A-7X; includes personnel.

b/ Fifteen years' operation of active aircraft and training aircraft, plus procurement.

c/ Based on manufacturer's comparison of A-7E and A-7X service hours.

d/ Ten percent greater than for the A-7E.

TABLE B-12. COST COMPARISON OF ATTACK AIRCRAFT ALTERNATIVES
(In billions of 1983 dollars)

Option	Aircraft	Procurement		15-Year Life Cycle	
		Cost	Savings Over F/A-18	Total Cost	Savings Over F/A-18
Navy Preferred	F/A-18	12.1-13.3	--	26.1-27.3	--
Current Force	A-7E	5.5-7.6	4.5-7.8	16.1-18.0	8.1-11.2
Re-engined A-7s	A-7X	8.2-10.3	1.8-5.1	20.5-23.4	2.7-6.8
All A-6Es	A-6E	8.8-12.5	(0.4)-4.5 a/	21.4-24.1	2.0-5.9

a/ Parentheses indicate more costly than F/A-18.

APPENDIX C. EXPANSION OF THE CARRIER FORCE AT CURRENT AIRCRAFT PRODUCTION RATES

Under the current shipbuilding schedule, one new air wing will be required in 1983 and a second in 1986 or 1987. These schedules can be met with the annual production rates that have prevailed in recent years: 30 F-14s, 12 A-6Es, 6 EA-6Bs, and 6 E-2Cs. The anticipated F/A-18 production can also support the expansion.

This was demonstrated by analyzing inventory levels, beginning with actual 1981 inventory levels, adding and subtracting new production, anticipated attrition, and aircraft conversions year by year. (Current inventory levels are classified information; this report presents a summary of the numerical analysis and not the actual analysis.)

F-14

A constant production rate of 30 per year can support 20 squadrons by 1983, 22 squadrons by 1985, 24 squadrons by 1988, 26 squadrons by 1991, and 28 squadrons by 1993. The planned reduction of production to 24 for fiscal year 1983 will not affect this schedule. This schedule can probably be accelerated by keeping inactive inventories (i.e. advance attrition) below authorized levels until all squadrons are equipped.

A-6E

Continued production of 12 per year will support the introduction of one squadron in 1983 and one squadron in 1986-1987. This includes an allowance for the conversion of four aircraft per year to the KA-6D. The planned reduction to 8 per year in fiscal years 1983 and 1984 will not affect the Navy's ability to meet this schedule.

KA-6D

The Navy is currently short some KA-6Ds in the pipeline. An average of four conversions per year will support the planned expansion and correct the shortfall.

EA-6B

The Navy is currently short several EA-6B squadrons, and is short in overall Navy and Marine Corps inventory. The shortage in active squadrons is made up by assigning Marine Corps EA-6B detachments to carriers. The current building rate of six per year is sufficient to support the expansion (assuming the continued assignment of Marine Corps detachments and carriers), and eradicate the shortfall by the early 1990s.

E-2C

The Navy still operates E-2B aircraft on some carriers. A buildup rate of 6 E-2Cs per year will support the establishment of one E-2C squadron in 1983, one in 1986-1987, and the elimination of all E-2B aircraft from the inventory by the early 1990s.

S-3A, SH-3, SH-60

The inventories of both the S-3A and the SH-3 contain attrition aircraft that were bought in anticipation of closing the production lines. The expansion can be accommodated either by reducing the number of aircraft per squadron, or by activating some attrition (and pipeline) aircraft, or by some combination of both. 1/ Activating attrition aircraft would result in eventual reduction in numbers per squadron as aircraft are lost and cannot be replaced. In the case of the S-3A, reductions in the number per squadron would occur at the latest at the time of the second expansion wing. SH-3 reductions would begin at about the time of introduction of the second expansion wing. However, the planned production of the carrier variant of the SH-60 beginning in 1986 should make such reductions unnecessary.

F/A-18

In 1980, 25 production aircraft were funded. These, together with 9 that were funded in previous years, should be completed during 1982 and would then be available to form two squadrons for a new wing. Sixty aircraft funded in 1981 would be available soon after. All 1,366 would be funded by the early 1990s.

1/ For example, one S-3A squadron can be created by reducing the number of embarked aircraft from ten to nine.