BY THE COMPTROLLER GENERAL

Report To The Congress

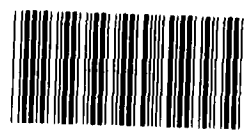
OF THE UNITED STATES

A Decision By The Secretary Of Defense Is Needed On The AV-8B Aircraft Program

The estimated cost of the AV-8B aircraft program has increased greatly although little progress has been made in completing its development. Intense competition for Navy aircraft procurement funds between the AV-8B and the F/A-18 aircraft program has created an element of controversy that has caused proponents and opponents to develop strong arguments for and against the capabilities of the AV-8B. The Congress wants it; the Secretary of Defense is undecided.

In the midst of this controversy, the Marine Corps remains convinced that the AV-8B will provide it with the most effective close air support through the end of this century.

A decision is needed by the Secretary of Defense.



PSAD-80-23
FEBRUARY 8, 1980

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-196884

To the President of the Senate and the
Speaker of the House of Representatives

This report discusses the status of the AV-8B aircraft program and the need for a decision by the Secretary of Defense on whether the program should continue. Agency officials associated with the program reviewed a draft of this report, and their comments have been incorporated as appropriate.

For the past several years, we have reported annually to the Congress on the status of selected major weapon systems. This report is one in a series that is being furnished to the Congress for its use in reviewing fiscal year 1981 requests for funds.

We are sending copies of this report to the Director, Office of Management and Budget, and the Secretary of Defense.

Comptroller General
of the United States

COMPTROLLER GENERAL'S REPORT TO THE CONGRESS

A DECISION BY THE SECRETARY OF DEFENSE IS NEEDED ON THE AV-8B AIRCRAFT PROGRAM

D I G E S T

The AV-8B aircraft, with its ability to take off and land vertically, is being designed for the Marine Corps, which contends that the plane will provide its forces with the most effective close air support through the end of this century. However, the program is experiencing severe cost growth, and its mission is a subject of controversy in the Department of Defense. Much of this growth is attributable to inflationary estimates because of delays in carrying out the program. (See p. 5.)

Although the Secretary of Defense decided not to request AV-8B development funds in the fiscal year 1980 budget and withheld much of the 1979 AV-8B development funds, strong congressional interest enabled the program to survive. In the fiscal year 1980 Defense budget, the Congress appropriated $180 million to permit its continued development. (See p. 4.)

Although it did this with the intent that it would achieve an initial operational capability in 1984, delays by Defense have forced this capability back 2 years to 1986. Should the AV-8B program proceed, these delays will add almost $1 billion to the total estimated cost. (See p. 6.)

If an initial operational capability were achieved in 1985, more than $350 million could be saved. This can be accomplished if procurement funds are granted in 1981 rather than in 1982 as now planned. (See p. 8.)

Further, at maximum production, Defense plans to acquire only four and one-half AV-8Bs each month. As in many other weapon

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procurements, low production rates are inefficient and stretching programs over many years allows inflation to drive costs upward. (See p. 8.)

Controversy over the AV-8B in the Department of Defense continues. Opponents argue that conventional aircraft provide greater speed and carry a greater payload; thus, they are more effective. Proponents argue that the AV-8B will provide more responsive close air support. In the midst of this controversy, the Marine Corps remains convinced that the AV-8B will provide it with the most effective close air support. (See pp. 12 and 13.)

The AV-8B program will incur other cost increases. For example, trainer aircraft will have to be purchased and a more effective gun system is needed. A 25-millimeter gun now being developed, which has a higher rate of fire and is more economical to maintain than the gun planned for the AV-8B, is one system being considered by the Navy. (See p. 9.)

RECOMMENDATIONS

The Secretary of Defense should decide to either proceed with or terminate the AV-8B program.

If he does decide to proceed with it, he should:

--Consider the cost savings attributable to the AV-8B program by requesting procurement funds in 1981 and changing the initial operational capability milestone to 1985.

--Evaluate alternatives to determine the most efficient AV-8B production rate.

--Include cost for necessary trainer aircraft and a more effective gun and ammunition in the AV-8B program.

If a decision is made to terminate this program, the Congress should be made aware of whether Defense has any plans for an alternative vertical and short takeoff and landing aircraft. (See pp. 10 and 11.)

A draft of this report was reviewed by officials associated with the management of the program, and their comments have been incorporated as appropriate.

Contents

ABBREVIATIONS

VSTOL	vertical and short takeoff and landing
GAO	General Accounting Office

THE YAV-8B PROTOTYPE AIRCRAFT

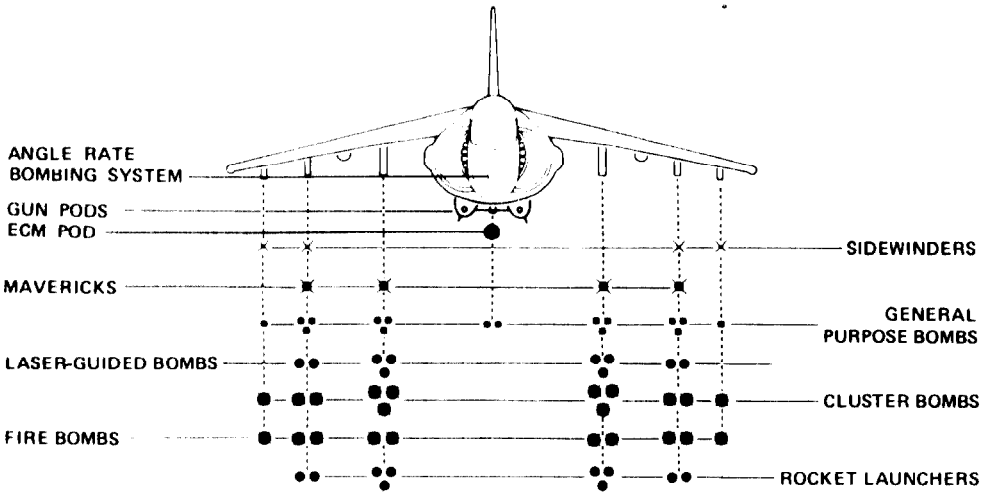
CHAPTER 1

INTRODUCTION

The AV-8B Advanced Harrier, a derivative of the AV-8A, is a fixed-wing aircraft that can take off and land vertically or with a short ground roll. This aircraft is being designed to fulfill a Marine Corps requirement for responsive close air support and flexible basing capabilities so that the aircraft can be located close to an expanding battlefield. Although this aircraft program is experiencing significant cost growth and its mission is a subject of controversy in the Department of Defense, the Marine Corps contends that the AV-8B will provide Marine Corps ground forces with the most effective close air support through the end of this century.

The AV-8A proved to the Marine Corps through 8 years of operational use that a vertical and short takeoff and landing (VSTOL) aircraft could satisfy the Marine Corps' requirement. However, this aircraft is limited in the weaponry it can carry and is vulnerable in typical combat scenarios. The AV-8B Advanced Harrier is being designed to combine the AV-8A's VSTOL capability with modern U.S. technology, such as a new, composite material wing; an advanced avionics system; and improved reliability and maintainability features. The YAV-8B prototype test recently proved that the AV-8B will be able to double the range or payload capabilities of the AV-8A. A new Angle Rate Bombing System is expected to give the AV-8B high accuracy in dropping iron bombs. In addition, the Advanced Harrier can carry missiles, precision-guided bombs, and other ordnance. Figure 1 shows the AV-8B armaments carriage.

AV-8B ARMAMENT SYSTEMS



The AV-8B's performance concepts were recently demonstrated by two YAV-8B prototype aircraft. These were constructed by modifying two AV-8As with a new wing, an enlarged engine inlet, reconfigured engine nozzles, and vertical-takeoff, lift-improvement devices. A comparison of the AV-8A, YAV-8B, and the AV-8B is presented in figure 2. The prototype aircraft also incorporated other modifications to test the improved reliability and maintainability modifications planned for the AV-8B.

Although the prototype test program identified some areas that require redesign, the Naval Air Test Center reported that the YAV-8B exhibited excellent potential to meet the requirements of a VSTOL tactical mission.

On November 15, 1979, during a routine maintenance checkout flight, one of the YAV-8B aircraft crashed. Preliminary analysis indicated the crash resulted from engine failure. The YAV-8B engine was a fully developed production engine. Program officials believed that the crash would not affect technical progress of the AV-8B program.

AV-8B CONTRACTORS

The AV-8B will be developed and produced by the McDonnell Douglas Corporation, which will subcontract a portion of the fuselage to British Aerospace, which originated the Harrier design. The AV-8B engine, very similar to the engine in the AV-8A, will be procured under a separate contract from another British company, Rolls Royce Limited.

FOREIGN MILITARY SALES POTENTIAL

In June 1979, the British Parliament discussed the need to improve and expand the United Kingdom's Harrier aircraft force in the 1980s and 1990s. Although their current Harrier aircraft, like the AV-8A, have deficiencies, the British are convinced that aircraft capable of VSTOL possess unique advantages that are required in their probable areas of conflict. Because of this, they have been studying the capabilities of the AV-8B as a possible replacement aircraft for the Royal Air Force.

STATUS OF THE AV-8B PROGRAM

In our report dated January 30, 1979, we recommended that the Secretary of Defense not authorize full-scale development of the AV-8B until he was prepared to select it as the new Marine Corps light attack aircraft. We also recommended that existing assets be used to resolve any area of

COMPARISON OF THE AV-8A, YAV-8B, AND THE AV-8B

AV-8A

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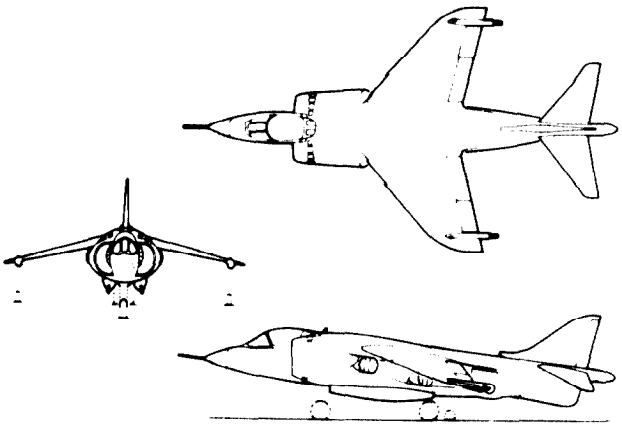
WIDTH 25.27 FT



AV-8B

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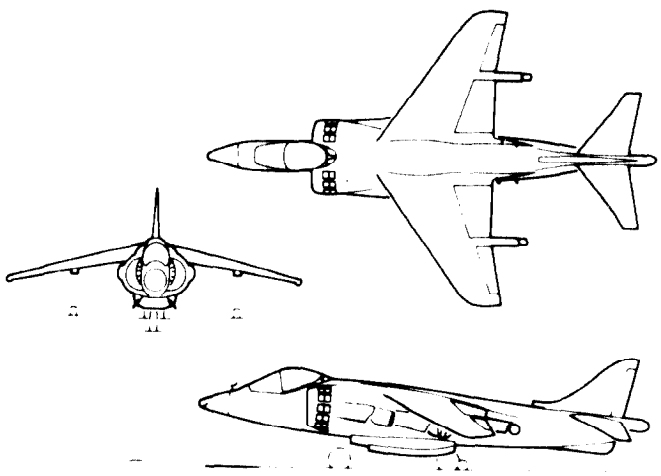

YAV-8B

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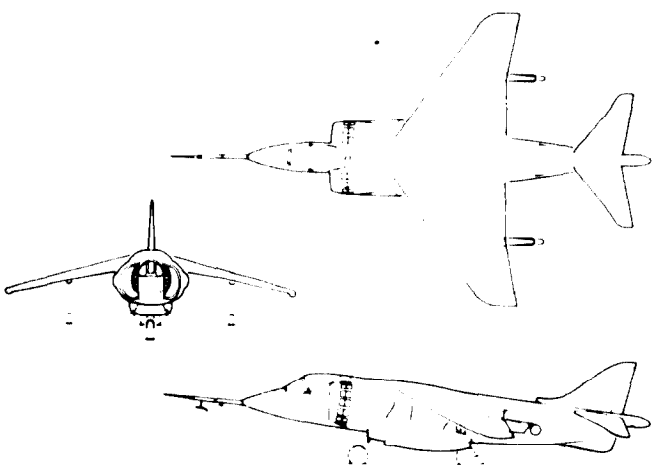

uncertainty regarding the effectiveness of the AV-8B. Should the AV-8B be authorized for full-scale development, we recommended that the risk of concurrency be thoroughly analyzed.

As our last report was being prepared for issuance, we were advised that the Secretary of Defense had decided not to request any fiscal year 1980 funds for the AV-8B program. We were also informed that $108 million of the $123 million originally programed for the AV-8B's development in fiscal year 1979 had been withheld from the program. These actions were initiated because Defense was concerned that in the long run the Navy could not afford to procure both the F/A-18 and the AV-8B at the same time. However, due to congressional insistence and keen interest in the development of a VSTOL aircraft, the fiscal year 1979 funds were reinstated in the program. And, more recently, although not included in Defense's budget request, the Congress, on its own initiative, appropriated $180 million in fiscal year 1980 to permit continued development of the AV-8B.

SCOPE OF REVIEW

We interviewed Government and contractor officials involved in the administration and management of the program. We also examined reports, correspondence, and other documentation having a bearing on what the status of the program is and whether it should move into full-scale development.

Chapter 2 of this report discusses what we perceive to be the principal issue relating to the AV-8B program--whether to proceed with or terminate it. Other issues discussed relate to the cost of the program.

Chapter 3 discusses the VSTOL aircraft versus conventional aircraft controversy as it relates to the Marine Corps' requirements for a close air support system.

CHAPTER 2

DELAYS CONTINUE TO INCREASE AV-8B PROGRAM COSTS

A major issue in the AV-8B program is cost growth of almost $1 billion. Most of this growth is attributable to inflation resulting from delays in the AV-8B program. Actions could be taken, however, to reduce this cost growth.

AV-8B PROGRAM COSTS

AV-8B estimated program costs have increased significantly. Last year the AV-8B program was estimated at almost $6.2 billion, and it has now increased by $923 million to over $7.1 billion. Through fiscal year 1979, the AV-8B program has received less than 4 percent of its current total projected funding requirement. Since the program began in 1976 and through 1979, $267 million has been spent developing this aircraft.

AV-8B Funding through Fiscal Year 1979

	Millions
YAV-8B prototype program	$144
Transition to full-scale development	60
Long-lead items and preproduction tooling	63
Total	$267

The current AV-8B project office procurement plan, for which procurement funds would be authorized in fiscal year 1982, shows that $691 million more will be required for research and development and nearly $6.15 billion will be required to procure 336 AV-8B aircraft. (See the following table.)

DEFENSE FUNDING DEFERRALS ADDED MILLIONS TO AV-8B COST

Two Department of Defense funding actions resulted in delaying the AV-8B procurement program. The combined effect of these actions postponed the AV-8B's initial operational

capability by 2 years 1/ and was the principal cause of the program's cost growth. The AV-8B's initial operational capability is now planned to occur in 1986. Each year that the initial operational capability milestone was delayed, total acquisition costs increased an average of $461 million. (See the following table.)

The Congress consistently favored an early initial operational capability for the AV-8B. In May 1978, the Senate Armed Services Committee stated that it expected the Department of Defense to support the AV-8B program and recommended authorizing funds to accomplish the Navy's originally planned initial operational capability. However, events prevented this from happening.

The Department of Defense's withholding of funds programed for the AV-8B program caused the initial delay and cost growth. In January 1979, Defense officials decided not to request any fiscal year 1980 funds for the AV-8B program and also withheld about $108 million of the $123 million appropriated by the Congress to permit the AV-8B's development in fiscal year 1979. We reported that these funds were impounded and that Defense failed to notify the Congress of this action as required by the Impoundment Control Act of 1974, 31 U.S.C. 1403 (1976). According to an AV-8B project official, this impoundment caused a 4-month delay in the program's progress and was the critical event precluding AV-8B's initial operational capability in 1984. The Navy was forced to recast the AV-8B's initial operational capability to 1985.

The second Defense action that delayed the AV-8B program was also associated with an attempt to terminate the program. When Defense officials decided not to request AV-8B funds in the fiscal year 1980 budget, they also withdrew all AV-8B program funds from the 5-year defense plan. Later, because of congressional insistence, the AV-8B program was reinstated in this funding plan. The new 5-year funding profile for the AV-8B, however, does not include aircraft procurement funds until 1982. This action postpones the program's initial operational capability again--to 1986.

Defense delayed deciding whether AV-8B program should proceed

Although the Congress clearly indicated that the AV-8B program should proceed, the Department of Defense has delayed

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1/AV-8B initial operational capability occurs when the 30th aircraft is delivered to the Marine Corps.

AV-8B FUNDING PROFILES

AT VARIOUS INITIAL OPERATIONAL CAPABILITY MILESTONES

INITIAL OPERATIONAL CAPABILITY BY FISCAL YEAR

FISCAL YEAR FUNDING REQUIREMENTS IN MILLIONS

		1976-79	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	TOTAL
1984:	DEVELOPMENT FUNDS	$267.0	$236.8	$210.5	$115.8	$23.3								$ 853.4
	PRODUCTION FUNDS		33.6	407.3	454.1	806.5	$861.4	$761.4	$804.3	$801.0	$399.7			5,329.3
														$6,182.7
1985:	DEVELOPMENT FUNDS	267.0	212.6	223.2	123.2	39.5	11.6							$ 877.1
	PRODUCTION FUNDS			35.5	463.6	536.5	930.0	858.1	935.2	847.8	844.3	$421.3		5,872.3
														$6,749.4
1986:	DEVELOPMENT FUNDS	267.0	180.0	243.8	164.8	64.2	37.8							$ 957.6
	PRODUCTION FUNDS				37.3	587.0	610.4	970.0	887.8	862.8	890.0	862.5	$440.6	6,148.4
														$7,106.0

(Note: These funding profiles reflect the acquisition of 4.5 AV-8B s per month or a total of 336 aircraft according to the current production plan.)

Note: Officials in the Office of the Secretary of Defense estimate that the AV-8B's procurement cost may be 20% greater than the costs presented above. They attribute their potential increase, in part, to the additional administrative charges inherent in multi-national weapon system contracts.

deciding whether the AV-8B should go into engineering development. In July 1979, the Navy and Marine Corps briefed the Secretary's Defense Systems Acquisition Review Council on the results of the YAV-8B prototype test program. They reported that technology development goals had been met and that all other program elements were on schedule. Because of the success of this prototype effort, the Navy recommended beginning AV-8B engineering development.

Although the Review Council (charged with making recommendations on weapon system acquisitions) reviewed the Navy's presentation and recommendation in July 1979, it made no recommendation--either to continue or to discontinue the program. No decision has yet been made on this matter.

ACTIONS CAN BE TAKEN TO REDUCE AV-8B COSTS

The AV-8B program's estimated cost has grown almost $1 billion. Revising the Navy's current plan, which is still possible, could result in substantial cost savings. The proposed revision would advance the initial operational capability to 1985 and increase the AV-8B's production rate.

A 1985 initial operational capability is attainable

Advancing the AV-8B initial operational capability to 1985 could save over $350 million. The only problem in accomplishing this is the timing and availability of production funds.

Although the AV-8B project office has developed a schedule with an initial operational capability in mid-1986, no programmatic, development, or production constraint would prevent meeting this milestone in 1985. According to the AV-8B program manager, this could be achieved by providing production funds in fiscal year 1981 with an initial commitment of $35 million as shown in table 1. Funding requirements for each year in the 1985 capability plan are less than requirements for comparable years in the 1986 plan, resulting in potential savings of $356 million.

AV-8B's low production rate and inflation

Production rates have a major impact on program costs. At maximum production, Defense plans to acquire only four and one-half AV-8Bs each month. Although this production level is

driven by estimates of funds available for the AV-8B, it nonetheless results in production inefficiencies for the prime contractor, higher costs through purchasing parts and supplies in small quantities, and application of annual fixed costs to fewer production units. In addition, the low production rate extends the procurement over more years with accompanying higher costs attributable to inflation.

According to the Marine Corps project manager, alternative production rates were not presented to the Defense Systems Acquisition Review Council because he developed the highest production rate possible given the projected expenditures for the AV-8B.

Although costs for alternate production rates were not calculated by the Navy, McDonnell Douglas, the prime contractor, predicted substantial savings through higher production rates. As an example, a McDonnell Douglas official estimated that program costs might be decreased by 15 percent, or more than $900 million, based on current program estimates, if production were increased to nine aircraft a month.

A slow production rate is inefficient, and inflation increases costs on long-term programs. The AV-8B project manager related that the AV-8B's production rate has been constrained to reduce its effect on the Navy's annual aircraft procurement budget. This action resulted because of the fierce competition for Navy aircraft funds among the AV-8B, the F/A-18, and other aircraft programs.

SOME ADDITIONS TO AV-8B PROGRAM COSTS

While AV-8B program costs can be reduced, other costs associated with a requirement for additional trainer aircraft and a more effective gun system are not presently included in total program cost estimates, but should be.

When AV-8A aircraft were first purchased from the United Kingdom, eight TAV-8A trainer aircraft were also acquired. Additional VSTOL trainer aircraft will be required to train AV-8B Marine Corps pilots. However, the cost of developing and producing a TAV-8B trainer aircraft may not be necessary. According to an AV-8B project official, it is possible to train AV-8B pilots in TAV-8A aircraft. The Navy has estimated the cost of purchasing 18 new TAV-8As and updating 6 currently owned TAV-8As at $351 million.

Additionally, although the cost of acquiring a more effective gun system has not been included in the AV-8B funding profiles, it should be. The Marine Corps recognizes that the gun system planned for the AV-8B will have to be changed. The 30-millimeter gun now employed on the AV-8A and planned for the AV-8B is very expensive to maintain and uses low-velocity ammunition. A Navy AV-8B Gun System study concluded that the AV-8A's 30-millimeter gun should be eliminated because of its poor reliability and high ammunition cost.

A candidate system to replace the AV-8A 30-millimeter gun is the 25-millimeter gun system. A 25-millimeter prototype gun has recently been tested and shown to be highly effective against armored targets. Equipping 336 AV-8Bs with the new gun would increase procurement cost by about $34 million. The cost to develop 25-millimeter armor-piercing ammunition has been estimated at $2.7 million.

According to the AV-8B program manager, the new gun has not been included in the current cost estimate because it was deemed more prudent to defer this item until after the Department of Defense committed itself to the AV-8B aircraft program.

CONCLUSIONS

A major issue in the AV-8B program is cost growth. Much of this growth, however, has been caused by Defense's delay in developing the AV-8B aircraft.

By delaying the initial operational capability from 1984 to 1986, the total procurement budget would increase by almost $1 billion. The AV-8B's planned production rate further exacerbates the cost growth problem.

The AV-8B program's cost growth can be reduced. Time still permits advancing the AV-8B's production schedule and revising the production rate.

Additional trainer aircraft and a more effective gun system are important to the operational use of the AV-8B; and their costs should be, but are not included in the program.

RECOMMENDATIONS

We recommend that the Secretary of Defense decide to either proceed with or terminate the AV-8B program. If he does decide to proceed with it, he should:

--Consider the cost savings attributable to the AV-8B program by requesting procurement funds in 1981 and changing the initial operational capability milestone to 1985.

--Evaluate alternatives to determine the most efficient AV-8B production rate.

--Include cost for necessary trainer aircraft and a more effective gun and ammunition in the AV-8B program.

If a decision is made to terminate this program, the Congress should be made aware of whether Defense has any plans for an alternative VSTOL aircraft.

CHAPTER 3

AV-8B's EFFECTIVENESS FOR THE MARINE CORPS CLOSE AIR SUPPORT MISSION IS CONTROVERSIAL

The use of a VSTOL aircraft in a hostile environment, as opposed to a conventional takeoff and landing aircraft, has been the subject of extensive controversy in the Department of Defense. The resolution of this controversy, which now surrounds the AV-8B program, is not absolute since the AV-8B's effectiveness depends upon the environment in which it will operate. If the battle area has no useable airfields and is distant from aircraft carriers, the AV-8B's effectiveness must be rated highly. However, if airfields or carriers are available close to the battle area, conventional takeoff and landing aircraft may be superior.

The Marine Corps sees its close air support mission as somewhat unique in that it involves beach landings in areas where airfields may not be readily accessible. The Marine Corps is tasked with securing the beach area and pushing the enemy farther inland. As this mission evolves and the battle expands, effective close air support may become the difference between success and failure.

Close air support aircraft will be directed by Marine Corps ground forces to attack targets that impede their forward assault. The ability of aircraft to respond quickly to the needs of the assault force and attack targets while they have high tactical importance is a critical element. It is this element that drives the Marine Corps requirement for responsive close air support aircraft.

Marine Corps officials want the AV-8B aircraft to fulfill its close air support requirements. They maintain their experience over the past 8 years with the AV-8A proved to them that VSTOL aircraft could meet their close air support requirements and that the VSTOL concept of operations is viable. The AV-8B is being designed to enhance the capabilities of the AV-8A and provide the Marine Corps with a more capable aircraft.

VULNERABILITY OF VSTOL AIRCRAFT TO ENEMY FIGHTERS

Can the Navy's proposed new VSTOL operate in the presence of enemy fighter aircraft? The AV-8B has a limited air combat capability; however, it is not expected to provide area air superiority.

The AV-8B was designed for close air support and, like other dedicated close air support or attack aircraft, will need fighter aircraft to provide air superiority over the battle area. The Army's attack helicopters and the Navy's and Marine Corps' A-7 and A-4 aircraft all require support from fighter aircraft to ensure completing their missions without interference from enemy aircraft. Although the AV-8B will possess a limited air-to-air fighter capability, it would not normally be employed against advanced enemy aircraft specifically designed for air-to-air combat.

Air superiority is not needed solely for the AV-8B but is a prerequisite before the amphibious assault mission can be executed. Air superiority is required to provide Marine Corps forces with safe transit from transport ships to the battle area. This transit is usually made in helicopters or amphibious landing vehicles.

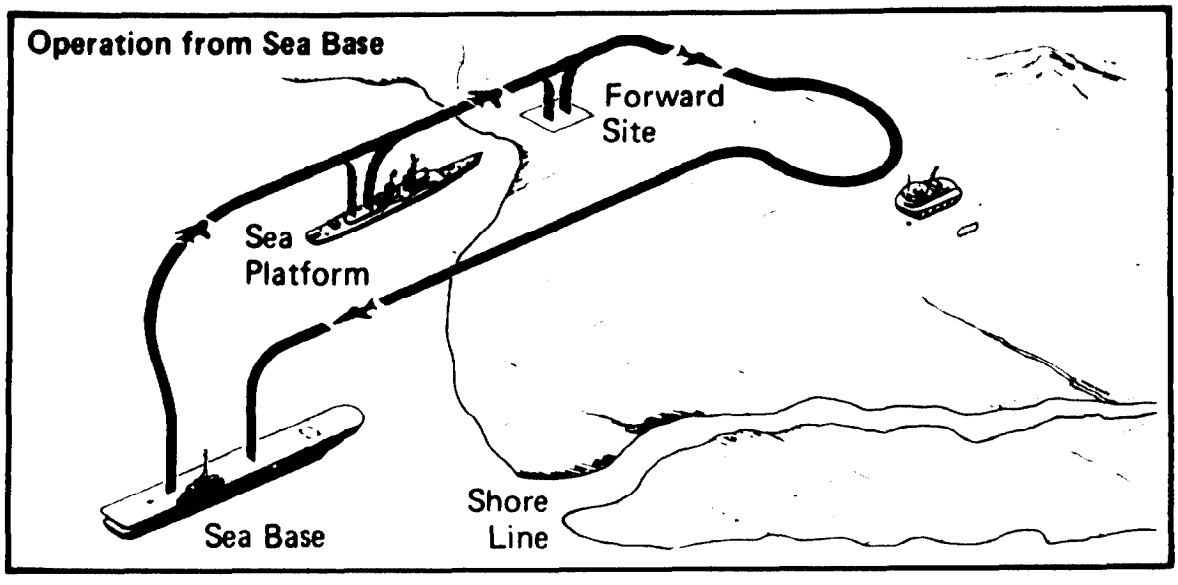
WHY VSTOL AIRCRAFT IF CONVENTIONAL AIRCRAFT NEEDED FOR AIR SUPERIORITY?

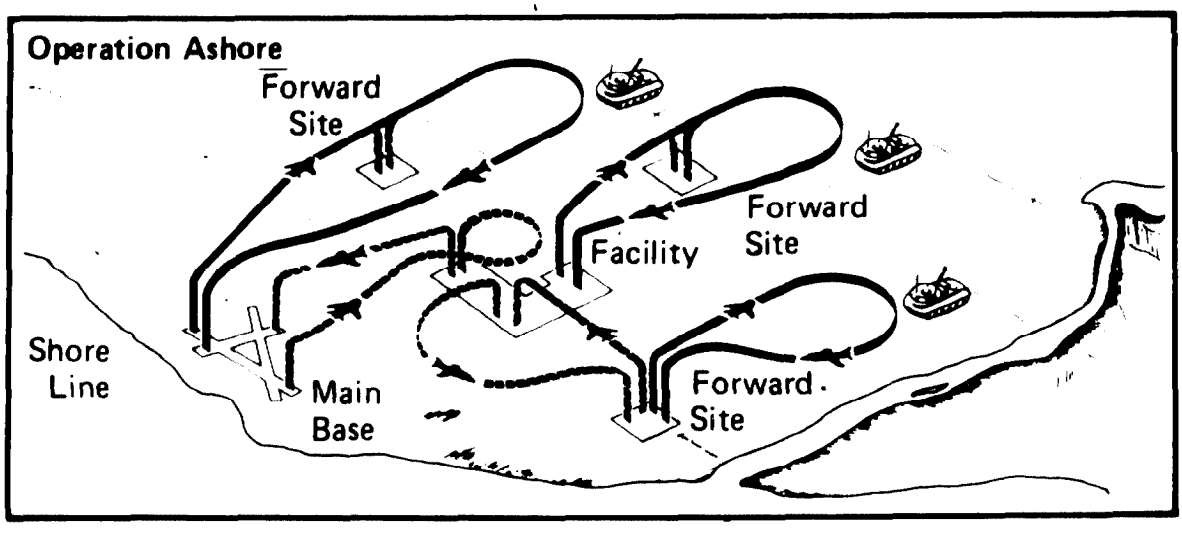
AV-8B opponents have stated that, if carrier-based fighter aircraft are necessary for air superiority, attack aircraft could also be launched from these platforms to provide close air support to the assault force. AV-8B proponents disagree, responding that the carrier-based, conventional attack aircraft cannot quickly respond to the needs of the Marine Corps.

Conventional takeoff and landing aircraft, the Marine Corps insists, are limited by the accessibility of aircraft carriers or adequate air fields. Conventional attack aircraft launched from an aircraft carrier may have to loiter in the air some distance from the battle area until directed to attack a ground target. This air-loiter activity consumes large amounts of fuel and can limit the amount of time conventional aircraft can remain on station. Because they may be land based, sea based, or required to loiter in the air at a significant distance from the battle area to avoid the enemy threat, the Marine Corps maintains that conventional attack aircraft may not be as responsive as VSTOL aircraft to a request for close air support.

The Marine Corps contends VSTOL aircraft can meet the response need. Because the VSTOL aircraft can operate from dispersed, austere sites, they can be based close to the battle area, where the Marine Corps is. Figure 3 shows how the Marine Corps plans to use the AV-8B.

BASING FLEXIBILITY IS A UNIQUE ADVANTAGE OF VSTOL





AV-8B--DESIGNED TO SATISFY THE MARINE CORPS' CLOSE AIR SUPPORT REQUIREMENT

The AV-8B, a derivative of the AV-8A, is expected to fulfill the Marine Corps' requirement for a close air support aircraft with an enhanced VSTOL flexibility through the end of this century. The AV-8B is being designed to provide longer range, heavier payload, and improved effectiveness and survivability through an advanced avionics system.

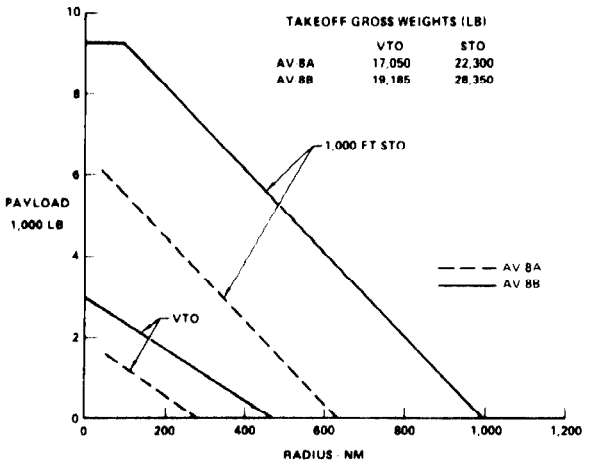
And, although the AV-8B cannot compete against advanced enemy fighter aircraft or attain supersonic speed, the Marine Corps believes the AV-8B's VSTOL capability combined with its payload carrying abilities make it a highly effective weapon system. The AV-8B, like the AV-8A, will be able to operate from a variety of ships, ranging from amphibious aviation ships to nuclear aircraft carriers, as well as modified merchant ships.

Improvements in range and payload

The AV-8B combines the vectored-thrust concept with modern technology to provide an aircraft that doubles the payload or radius capability of its predecessor aircraft, the AV-8A. Modifications to the AV-8 wing, use of lightweight composite materials, and improvements in controlling engine thrust should enhance AV-8B effectiveness without an engine change.

A comparison of AV-8A and AV-8B payload-range performances for vertical and short takeoffs is shown in figure 4.

AV-8A AND AV-8B PAYLOAD - RADIUS COMPARISON



Note: VTO is vertical takeoff and STO is short takeoff.

AV-8B will use a new bombing system

The Marine Corps plans to use the new Angle Rate Bombing System to give the AV-8B greater offensive effectiveness. This system is intended primarily for dropping unguided bombs. It uses television or laser detection devices to track a target and automatically release the bombs when the aircraft arrives at the optimal drop point. The bombing system provides the pilot with steering cues based on the aircraft's angle and distance from the target. This information allows the pilot to make any bombing approach desired, use terrain features to mask the approach, or conduct evasive maneuvers should antiaircraft weapons be encountered.

The Angle Rate Bombing System's television tracking mode allows early target identification well before it would be possible by the naked eye. In a close air support mission, early target identification is critical. The television system emits no energy, allowing the AV-8B to track targets without alerting the enemy, as happens with the laser detection system.

The alternative laser spot tracker mode is designed for acquiring targets not visible to the AV-8B pilot due to darkness or distance. This system, used in conjunction with a forward air controller, detects a target or an area near a target illuminated by the forward controller's laser beam. Although this laser beam is invisible, the Angle Rate Bombing System can detect it and track the illuminated subject automatically. Should the forward air controller's laser beam be interrupted, the Angle Rate Bombing System automatically directs the AV-8B pilot to a weapon release position.

As part of the Navy's operational evaluation process, the Angle Rate Bombing System was tested in an A-4M aircraft during February 1979. The test agency concluded that the Angle Rate Bombing System was highly accurate and desirable for the close air support mission.

Improvements to make AV-8B more survivable

The Marine Corps believes that the AV-8B has many features that enhance its survivability in a hostile environment. The AV-8B's VSTOL capability, small size, smokeless engine, and advanced avionics system are elements the Marine Corps cites that aid its survivability.

The AV-8B aircraft is also highly maneuverable. AV-8A aircraft have proven that a flight technique known as vectoring (changing the direction of engine exhaust) in forward flight enables it to outmaneuver other aircraft in air-to-air engagements.

Unlike the AV-8A, the AV-8B will have an advanced avionics system that can detect radar-guided antiaircraft weapons. It will also possess a secured communications capability. Further, the AV-8B can also carry an airborne self-protection jammer. This unit, which is carried in a pod, can jam the signals of weapons directed at the AV-8B.

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The Marine Corps, building on its AV-8A experience, anticipates a much more effective AV-8B VSTOL system. Payload range improvements were demonstrated in the YAV-8B prototype program. In addition, the Angle Rate Bombing System has been evaluated and found acceptable.

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