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Several versions of a new main battle tank and infantry combat vehicle have been under development since the early 1960's. Because of the need for compatibility in a combined arms team, the Army is developing a new main battle tank (XM-1) and an infantry fighting vehicle and intends to operate these vehicles as close to each other as battlefield conditions permit. Findings/Conclusions: Differences in mobility and survivability between the XM-1 and the infantry fighting vehicle could reduce their combat effectiveness as a team. A comparison of the two vehicles showed that: the infantry fighting vehicle has slower acceleration and less cross-country speed than the XM-1, subjecting it to greater exposure; the fighting vehicle is 2 feet higher than the XM-1, making it easier to see; the fighting vehicle's armor is inferior to that of the XM-1, making it easier to destroy; the fighting vehicle's main gunsight is easier to destroy, making it more susceptible to a firepower kill; and the fighting vehicle's diesel engine is noisier and more smokey, which could give away battlefield positions. While some differences may be unavoidable, a question remains whether the tactical doctrine covering use in combat can accomodate all the differences in the two vehicles and still maintain the combat effectiveness of both. Test results revealed that the operation of the fighting vehicle's main gun, its firing port weapons, and a swim barrier added to enable it to swim add considerably to the vehicle's complexity. Elements of the vehicle need redesigning in order for it to perform effectively. Recommendations: The Secretary of Defense should determine: whether, considering its advanced stage of development, the indicated design changes needed to make the infantry fighting vehicle effective can still be practicably made at an acceptable cost; and whether a tactical doctrine can be developed that can accommodate the incompatibilities between the fighting vehicle and the XM-1 and still provide the effectiveness anticipated from both. If the design changes and tactical doctrine are

unattainable, the Secretary should direct the Army to find alternatives to the infantry fighting vehicle. (Autnor/HTW)

REPORT TO THE CONGRESS

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

The Army's Proposed Close Combat Armored Vehicle Team

The Army is developing a new close combat armored vehicle team--a new main battle tank, the XM-1, and an infantry fighting vehicle for countering the future enemy ground attack.

Incompatibilities between the XM-1 and the infantry fighting vehicle may reduce their effectiveness as a team. The infantry fighting vehicle may be too complex for the soldiers to use.

PSAD-78-11

DECEMBER 12, 1977

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

B-163058

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

This report identifies the incompatibilities between the Army's proposed close combat vehicle team, the XM-1 main battle tank and the infantry fighting vehicle.

During our review of the Army's major research and development programs, it was apparent that too much time was spent in developing new combat vehicles, some of which may be too complex for the soldiers to use.

We made our review pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

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

Elmer B. Staats
Comptroller General
of the United States

D I G E S T

Several versions of a new main battle tank and infantry combat vehicle have been under development since the early 1960s. Events such as the 1973 war in the Middle East, proliferation of antitank weapons, the mushrooming Warsaw Pact, and the rising cost of weapons--all occurring during this development period--have confirmed the need for compatibility in a combined arms team. (See p. 1.)

To increase the effectiveness of such a team, the Department of the Army is developing a new main battle tank (XM-1) and an infantry fighting vehicle, previously identified as the mechanized infantry combat vehicle. The Army intends to operate these vehicles as close to each other as battlefield conditions permit.

The XM-1 and the infantry fighting vehicle are being designed to complement each other in firepower. Accomplishing this will depend on the successful development of the 25-mm cannon and firing port weapons for the infantry fighting vehicle. Significant differences in mobility and survivability could, however, reduce their combat effectiveness as a team.

GAO's comparison showed:

--The infantry fighting vehicle has slower acceleration and less cross-country speed than the XM-1, subjecting it to greater exposure.

--The infantry fighting vehicle is 2 feet higher than the XM-1, making it easier to see.

--The infantry fighting vehicle's armor is inferior to the XM-1's, making it easier to destroy.

--The infantry fighting vehicle's main gunsight is easier to destroy than the XM-1's gunsight, making the infantry fighting vehicle more susceptible to a firepower kill.

--The infantry fighting vehicle's diesel engine is noisy and smokey, compared to the XM-1's quiet and smokeless turbine engine, which could give away their battlefield positions and render both vehicles more vulnerable. (See p. 4.)

While some of these differences may be unavoidable, such as in their armor, gunsights, and engines, a question remains whether the tactical doctrine covering their use in combat can be developed to accommodate all the differences in the two vehicles and still maintain the combat effectiveness of both. Test results revealed that the operation of the infantry fighting vehicle's main gun, its firing port weapons, and a swim barrier added to enable it to swim add considerably to the vehicle's complexity.

GAO believes that elements of the vehicle need redesigning if it is to perform effectively. While the M113 may be inadequate, the infantry fighting vehicle, which is nearly four times as expensive, thus far has not shown to be much of an improvement.

RECOMMENDATIONS

The Secretary of Defense should determine:

--Whether, considering its advanced stage of development, the indicated design changes needed to make the infantry fighting vehicle effective can still be practicably made, at an acceptable cost.

--Whether a tactical doctrine can be developed that can accommodate the incompatibilities between the infantry fighting vehicle and the XM-1 and still provide the effectiveness anticipated from both.

GAO recommends that if the design changes and the tactical doctrine are unattainable, the

Secretary should direct the Army to find alternatives to the infantry fighting vehicle. (See p. 27.)

The Department of Defense did not respond to GAO's July 1977 request for comments on this report.

Contents

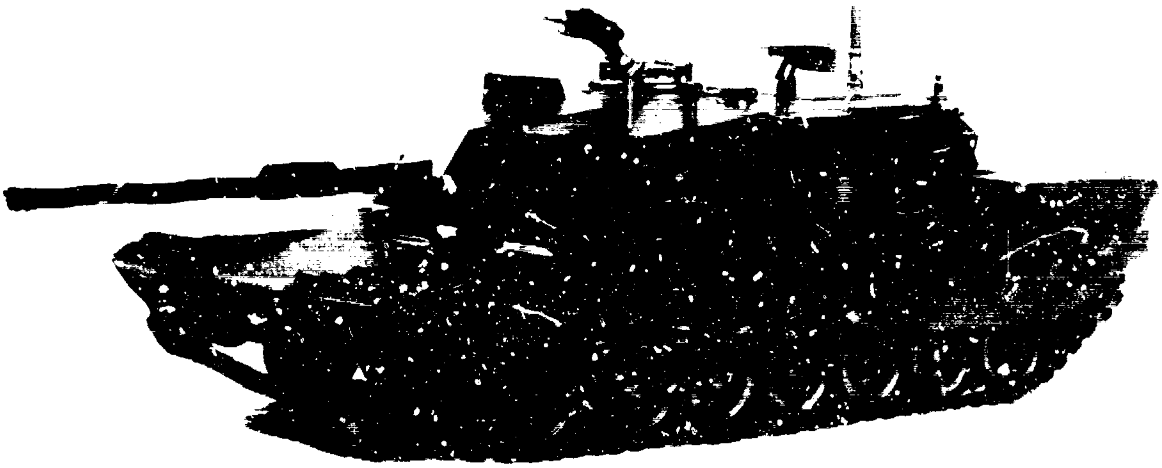
ABBREVIATIONS

DOD Department of Defense

GAO General Accounting Office

IFV infantry fighting vehicle

NATO North Atlantic Treaty Organization



XM-1 MAIN BATTLE TANK

INFANTRY FIGHTING VEHICLE

CHAPTER 1

INTRODUCTION

The 1973 Middle East War reinforced the belief that a combined arms team is required for success on the modern sophisticated battlefield. An important component of such a team is a combination of tanks and mechanized infantry. Using tanks without mechanized infantry during the early stages of the war, the Israelis suffered severe losses from antitank missiles fired in large numbers by Arab infantry. Overall, the tank was the dominant weapon on the battlefield, but its success depended in large measure on suppression of the numerous antitank weapons encountered.

The Department of the Army's current close combat arms team consists of M60 series tanks and M113 infantry carriers. However, this team has serious limitations in the critical areas of firepower, mobility, and survivability. The Army plans to replace this team with the XM-1 tank and the infantry fighting vehicle (IFV) previously identified as the mechanized infantry combat vehicle (MICV). These vehicles are to operate as close to each other as conditions permit.

The estimated unit costs for the XM-1 and the IFV (in fiscal year 1976 dollars) are $710,000 and $338,000, respectively. Comparable unit costs for the M60 and M113 are about $380,000 and $87,000, respectively.

The Army is developing the XM-1, expected to be available in the 1980s, to better counter the threat anticipated for that time and beyond. Compared to the M48 and M60 series tanks, the XM-1 will have less height; better agility; and, most significantly, a new type of armor which the Army claims tests have shown to be much less vulnerable than any employed in the past.

The IFV, expected to be available in May 1981, represents a change in military thinking. The IFV is to be the infantry's first combat vehicle designed to accompany tanks into battle. It is to provide the infantry more firepower than it has ever had and increased mobility for today's highly mechanized battlefield. Infantrymen now ride to the edge of the battlefield in the M113 armored personnel carrier and dismount. With the IFV, infantrymen will be able to fight both in and out of the vehicle.

To effectively act as a team, the XM-1 and IFV must complement each other. Although the XM-1 and the IFV are to work closely together, two different Army branches are responsible for developing them. The XM-1 tank is under the

Army armor branch, which is dedicated to maintaining and operating tanks. The IFV is under the Army infantry branch, which in the past has gone into battle on foot. It will now have a mounted fighting capability.

XM-1 DEVELOPMENT STATUS

The XM-1 tank development program is being coordinated by the Project Manager, XM-1 Tank System, Warren, Michigan. It is the latest in a series of main battle tank programs to replace M60 series tanks. In August 1963 the Army initiated an MBT70 program, which evolved into the XM803 program in January 1970. The MBT70/XM803 programs were canceled by the House and Senate Appropriations Committees in fiscal year 1972 on the basis that the tanks were too costly and too complex.

In August 1972 an Army task force--established to develop a simpler tank--recommended a new tank design resulting in the XM-1 concept. A competitive prototype development program between the General Motors Corporation and the Chrysler Corporation was approved in January 1973. Chrysler was selected over General Motors as the prime contractor for the XM-1 in November 1976. The Army is studying the feasibility of using a 120-mm rather than a 105-mm cannon.

IFV DEVELOPMENT STATUS

The IFV development program is being coordinated by the Project Manager, IFV, Warren, Michigan. Like the main battle tank program, the IFV program is not new and dates back to 1962. A related program to develop an IFV main gun--a 25-mm cannon--began in 1961. Initially the gun was to be used on many vehicles, but now it will be used only on the IFV. As a result, the IFV Project Manager has been given responsibility for the gun program. Over the years, the following significant events have altered the IFV program.

--To avoid a delay in fielding the IFV, the Army in 1975 decided to use an improved 20-mm cannon as an interim main gun, even though this cannon had a previous record of poor performance. This gun program was canceled in March 1977.

--In November 1976 a program reorientation resulted in a reconfigured IFV. Major changes included a two-man turret housing the commander and gunner and the addition of a TOW antitank missile launcher. The reconfigured IFV, called a TBAT-II, will have a 25-mm cannon. An earlier two-man turret vehicle design was dropped in 1969 as being, among other things, too expensive and heavy.

The prime contractor for the IFV is the FMC Corporation.

SCOPE OF REVIEW

To determine whether separate development affected the compatibility of the XM-1/IFV as a team and whether recent events affected the Army's and the Department of Defense's (DOD's) justifications for these systems, we interviewed officials at both the XM-1 and the IFV project offices and obtained pertinent data. We also visited Army agencies and contractors. (See app. I.)

CHAPTER 2

COMPATIBILITY OF XM-1/IFV

CLOSE COMBAT TEAM

Compatibility of the XM-1 and the IFV, when employed as a team, is essential to their survival and combat effectiveness. As a team, their overall combat effectiveness is a function of three major characteristics--firepower, mobility, and survivability. The XM-1 and IFV are to be compatible in firepower. The success of accomplishing this will depend on the development of the 25-mm cannon for the IFV and the firing port weapons. But significant differences in mobility and survivability could reduce their combat effectiveness as a team since:

--The IFV has slower acceleration and less cross-country speed than the XM-1, subjecting it to greater exposure.

--The IFV is 2 feet higher than the XM-1, making it easier to see.

--The IFV's armor is inferior to the XM-1's, making it easier to destroy.

--The IFV's main gunsight is easier to destroy than the XM-1's, making the IFV more susceptible to a firepower kill.

--The IFV diesel engine is noisy and smokey compared to the XM-1's quiet and smokeless turbine engine, which could give away their battlefield positicns and render both vehicles more vulnerable.

FIREPOWER

Within their related mission, the XM-1 and the IFV are to be complementary in firepower. The tank's primary purpose is to deliver ammunition against a variety of enemy targets--sometimes tanks and other armored vehicles, sometimes buildings and bunkers, and sometimes mounted and dismounted infantry. The IFV supports the tank and is primarily responsible for suppressing antitank weapons and infantry soldiers while on the move and from an overwatch position. A comparison of XM-1/IFV weapons follows.

Main weapon	Secondary weapons	Other weapons
XM-1 105-mm tank gun	Two 7.62-mm machineguns	-
	One 50-cal. machinegun	-
IFV 25-mm automatic gun (under development)	One 7.62-mm machinegun	TOW and DRAGON antitank missiles
		LAW antitank missiles
		Six 5.56-mm firing port weapons (under development)

Both the XM-1 and IFV have a stabilized fire control system which provides shoot-on-the-move capabilities.

MOBILITY

Mobility is generally discussed in terms of tactical environment. High mobility contributes tactically by permitting firepower to be moved quickly around the battlefield. It also permits rapid movement from one sheltered firing position to another. How quickly a vehicle moves depends on vehicle characteristics (e.g., weight, suspension system, gear ratios, and horsepower) and on the environment (e.g., terrain, vegetation, and weather).

A major concern of the Army is that the XM-1 and the IFV should be comparable in mobility. Increased mobility in certain tactical situations reduces the time a vehicle is exposed to hostile fire, and makes hostile tracking and aiming more difficult, reducing the probability of being hit.

To assess their compatibility, we analyzed the characteristics of both vehicles.

Characteristics	XM-1	IFV
Range (miles)	280-330	345
Maximum forward speed (mph)	45	44
Acceleration (0 to 20 mph)	6.1 sec.	7.7 sec.
Cross-country speed (mph)	25	a/16
Reverse speed (mph)	10-20	5-10
Maximum grade (%) ascend/descend	60	60
Turning radius	pivot	pivot
Ground clearance (inches)	19	18-22
Ground pressure (pound per square inch)	13.1	7.5
Trench crossing (inches)	109	100
Horsepower-ton ratio	25.5	21.3
Verticle obstacles (inches)	49	36

a/Due to mechanical failures, cross-country testing of the IFV was not completed. However, before testing was curtailed, IFV speeds averaged 16 mph when carrying the full complement of troops.

The Army's past assessment of the mobility of the XM-1 compared to the IFV's has been primarily a comparison of vehicle requirements as stated in the material need documents. There has been little attempt to assess the impact of the differences on battlefield tactics. For example, in a November 1975 report, an IFV special study group, formed to, among other things, review material need requirements, compared the mobility requirements of the IFV and the XM-1 and concluded:

> "* * * the comparison reveals that the attributes of the two vehicles are very similar, with the exception of three areas. The XM-1 shows a significant advantage over the IFV in terms of reverse speed and horsepower-to-ton ratio. The IFV is substantially better than the XM-1 in regard to ground pressure. However, taking all the characteristics collectively, it appears that the two vehicles have compatible mobility. * * *"

However, the report did not assess the impact of the differences in mobility on battlefield tactics.

The study group did not comment on the differences in acceleration and cross-country speed. As a result of these differences, the IFV will be exposed longer to enemy fire than the XM-1. Longer exposure time, according to the Army, increases the probability of being hit and killed.

The study group may have assumed its discussion of horsepower-to-ton ratios adequately covered acceleration because the two are directly related. Although the XM-1 has a cross-country speed requirement, the IFV does not. This probably accounts for the omission of this factor. We believe the cross-country capability of the vehicles is important to consider, because rapid movement from one position to another could require both vehicles going cross country together.

In tests over the same rough cross-country terrain, the XM-1 averaged 25 mph compared to IFV's average 16 mph during a partially completed test. Testing was stopped after 2.6 miles because of a broken idler arm; however, a testing official said that above 16 mph, the ride became unbearable to the passengers. Over more mild terrain, the XM-1 averaged 33 mph compared to the IFV's 27 mph using professional civilian drivers and 20 mph using military drivers. Our experience of riding in both vehicles shows that the IFV rides much more roughly than the XM-1 and will probably have to go much more slowly because of the amount of shock transmitted to the mounted squad when traveling cross country.

The Army hopes to improve the IFV's cross-country speeds by improving the suspension system. This matter was under study when we concluded our fieldwork.

SURVIVABILITY

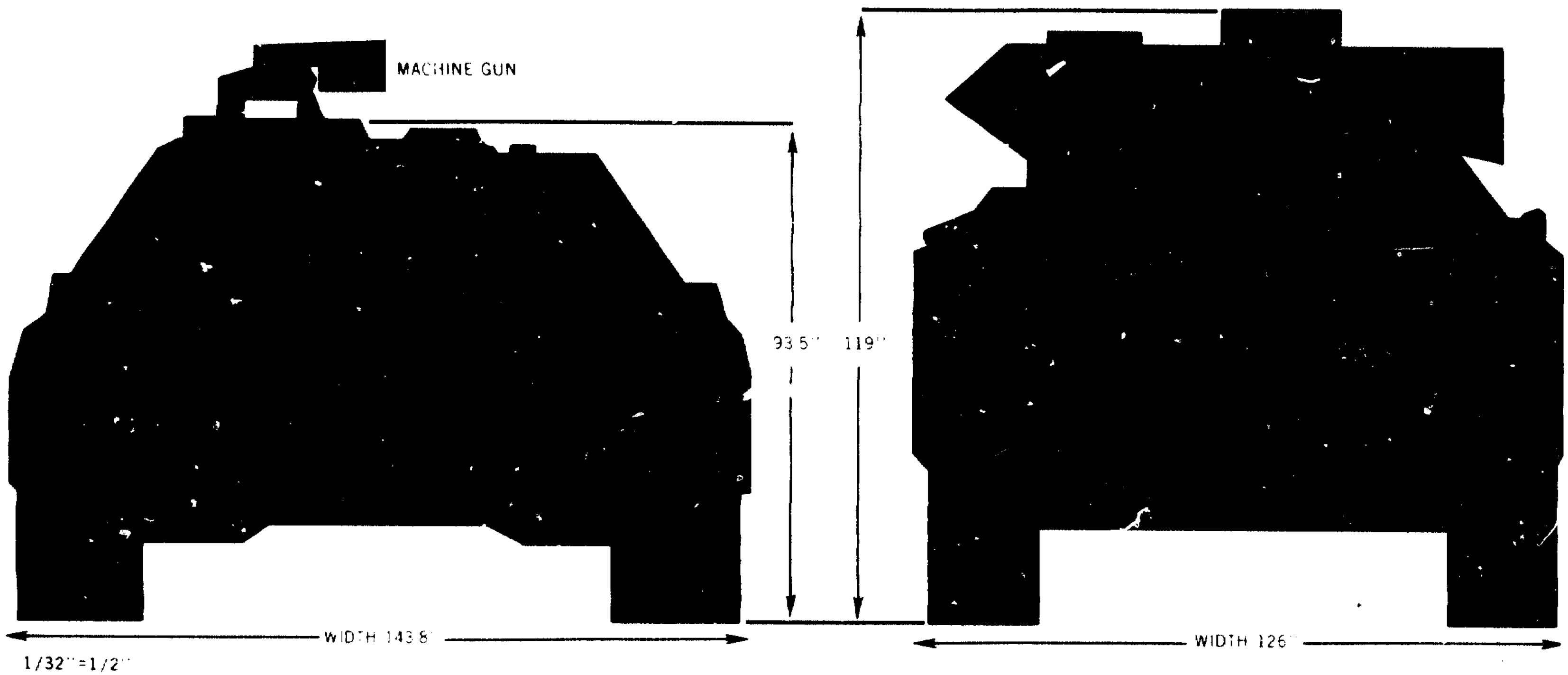
Combat survivability is the measure of a crew/weapons system's capability to complete its battlefield mission without major damage. Survivability encompasses armor protection, in addition to the firepower and mobility already discussed. It also includes size and silhouette of the vehicle, internal design of vital components, protected storage of the ammunition and fuel, as well as the reduction of all signs (noise, light, smoke, etc.) that permit detection by enemy gunners.

The IFV differs significantly from the XM-1 in silhouette, armor protection, and in noise and smoke emission from its diesel engine. Also the IFV's gunsight is more vulnerable to enemy fire because it is more lightly armored than the rest of the IFV and is exposed. These differences between the XM-1 and the IFV may impair their combat survivability as a team.

Silhouette

The IFV's silhouette will be 25.5 inches higher than the XM-1's silhouette, illustrated on the following page.

SILHOUETTE COMPARISON OF THE XM-I AND INFANTRY FIGHTING VEHICLE



XM-I TANK

INFANTRY FIGHTING VEHICLE (IFV)

In its XM-1 program, the Army placed great emphasis on obtaining a lower tank by reducing the XM-1 height requirement to 90 to 95 inches. The Army characterized the M60, which is 117.6 inches high, as the largest tank in the world and unacceptable because it presented too large a target to the enemy. The Army also estimated that by reducing the height of the XM-1 to 90 to 95 inches, it could also reduce its probability of being hit when fully exposed by more than 33 percent compared to the M60. The XM-1 prototype has been reduced to 93.5 inches. In comparison, the current version of IFV is 119 inches tall, slightly taller than the M60 and 25.5 inches taller than the XM-1 (excluding its 50-caliber machinegun, which extends above the turret but which if destroyed will not affect other tank systems).

Apparently there are differing opinions within the Army on the impact of silhouette on survivability, and there has been no real attempt to assess the differences in size between the XM-1 and the IFV. Such an assessment seems warranted in light of their relationship as members of the close combat team.

Armor protection

Vast differences in XM-1 and IFV armor protection may cause a problem in the two vehicles effectively fighting together. This problem was pointed out by an Army tank special study group in June 1975. The group suggested that the differences required a thorough evaluation and tradeoff analysis with respect to the capability of the IFV to fight close to the XM-1. The study group based its concern on the fact that of eight enemy guns and missiles likely to be directed toward the XM-1 and the IFV, five could defeat the IFV while none could defeat the XM-1. The Army has done nothing to alter this situation.

Ordinarily, having less armor protection can be compensated for to an undetermined extent by superior mobility and/or agility. But here the IFV also comes up short. It has slower acceleration, less cross-country speed, and less reverse speed than the XM-1.

Weight and cost are the reasons the IFV's armor protection cannot be strengthened.

IFV gunsight not adequately protected

The IFV main gunsight for aiming the 25-mm and 7.62-mm guns and the TOW missiles is 14 inches high and is mounted on the turret. IFV officials said it has less ballistic protection than the rest of the IFV because the added weight of protective armor would adversely affect the swim capability of the IFV. The IFV is already lightly armored; however, its main gunsight will have even less protection. This limited protection, combined with the fact that the IFV has no effective secondary gunner's sight, leaves it susceptible to a firepower kill that would eliminate the use of its main weapons.

The XM-1's main gunsight is similar in quality to IFV's sight. Even though its main sight is heavily armored, the XM-1 also has a telescopic secondary gunner sight, which enables the tank to continue firing if its main sight is destroyed. XM-1 project officials told us that without such a backup a damaged main sight would amount to a firepower kill. They compared the damaged sight without a backup to trying to fire a rifle after being poked in the eye.

XM-1 turbine engine versus IFV diesel engine

If combat survivability is increased as the exhaust plume and engine noise are reduced, as the Army indicates, then the XM-1 will survive better as a result of its smokeless, quiet turbine engine. This survivability, however, may be reduced when the XM-1 is operating next to the smokey, noisy diesel-powered IFV.

We observed both the XM-1 and the IFV in field testing. The XM-1 produced no smoke and ran noticeably more quietly than the IFV, whose exhaust plume was easily sighted from about 3,000 meters away.

The decision to develop the turbine engine for the tank was not made until November 1976--long after the IFV was under development, and although reliability of the turbine engine is still uncertain, the XM-1 project office is optimistic about successfully fielding the XM-1 with that engine.

We believe the Army needs to make an early assessment of the potential effect that the smokey, noisy IFV may have on the survival of the close combat team, so that it can seek alternatives to deal with this, if necessary.

LACK OF A WRITTEN PLAN (TACTICS)

Some of the differences in the design and performance of the IFV and the XM-1 evidence the absence of a tactical doctrine specifiying how the XM-1 and the IFV will be expected to operate together. For example, the IFV may be used alongside the XM-1 or at some undetermined distance to the rear of the tanks.

In the case of the IFV, the Army is following a concept of developing a new weapon system and then determining how it will be used. Army officials said the tactics for the IFV will be refined as soldiers train with the vehicle. In fact, this was one reason the Army wanted to field an interim version of the IFV--a plan it has now abandoned because testing did not substantiate its practicality. We believe that the Army should develop its written plan now, so that it may make vehicle modifications, if warranted, in a timely and less expensive manner.

CHAPTER 3

DESIGN AND OPERATIONAL COMPLEXITY OF IFV

IFV test results indicate that the system may be more complex than the Army originally anticipated. Intensive training will be needed to improve the ability of the IFV crew to carry out its mission; however, problems with complexity may continue to plague the program. In our opinion, unless the role of the gunner is simplified and problems are overcome in the weapons system, the average soldier probably will not be able to achieve a high degree of proficiency in operating the vehicle's main guns and firing port weapons. In addition, continuing track/suspension system and transmission problems may indicate that the state of the art in these areas has not kept pace with the high performance expected of the IFV. As no XM-1 production prototypes have been tested, we could not make a similar evaluation of this vehicle.

IFV TEST RESULTS CAUSE CONCERN

The IFV is much more complex than the M113 it is replacing. The M113's only armament is a 0.50-caliber machinegun mounted on top of the vehicle and fired from an open hatch. Army officials refer to it as a battle taxi--not a combat vehicle. In contrast, the IFV will have a 25-mm automatic dual feed cannon; a 7.62-mm machinegun; and a sophisticated antitank missile system, the TOW. The operation of these weapons will be the primary responsibility of one man--the gunner. Additional firepower is to be provided by six firing port weapons on the sides and rear of the vehicle and fired from within by mounted infantrymen.

The IFV will be heavier than the M113 but is expected to achieve superior mobility because of a higher horsepower engine, a more responsive transmission, and an improved suspension system. The IFV will be required to make pivotal turns on hillsides with slopes of up to 40 percent. The IFV will be a complex vehicle that places an increased maintenance and operating burden on the soldier-mechanic and the soldier-combatant. Army commanders in Europe said deployment of sophisticated new equipment has increased the difficulty of training soldiers to properly repair and maintain the equipment.

Test results to date indicate that the complexity of the IFV could cause the Army problems in fully achieving the expected improvements in firepower and mobility.

Firepower

Main weapons breakdowns and extensive cleaning time, the main gunner's complex role, and the questionable design of the firing port weapon system caused problems in testing the IFV.

Testing was conducted at Fort Benning, Georgia, from October through December 1976 to determine how effective the IFV is and how well soldiers can operate it on a battlefield. The IFV with a one-man turret and a 20-mm main gun without TOW missile capability was tested.

Weapon station performance, i.e., how the main guns and gunner perform, was designated as a critical area to be evaluated. On January 4, 1977, the Army stopped live fire testing because of an unusually high number of problems.

Main weapons breakdowns

About 90 weapon station malfunctions caused about 825 hours of vehicle downtime. Many of the failures were caused by the complex automatic feeding system used to load the main guns. (See app. II.)

Army officials had differing opinions as to the cause of the malfunctions. IFV project officials said the soldiers selected were not adequately trained to operate the complex weapon station. Testing officials disagreed, stating that improvement in equipment design was necessary to eliminate possibilities for human error. Firing tests were rescheduled for April 1977 with the understanding the equipment design deficiencies would be corrected and the soldier test group would receive intensive training. However, the tests were canceled pending development of the reconfigured IFV with a two-man turret, 25-mm gun and antitank missile capability. Because of these changes, IFV project officials do not expect the reconfigured IFV to encounter problems similar to those experienced to date in testing.

The 20-mm cannon will be replaced by one of two 25-mm cannons under competitive development. IFV project officials are confident that both 25-mm gun contractors are designing their guns so the problems experienced with the 20-mm gun can be avoided. They believe the 25-mm gun will be more successful because:

--The 20-mm gun was originally designed as an aircraft weapon to operate in a clean environment. Consequently, it was very sensitive to dirt and fouling. The 25-mm gun contractors are designing the guns to operate in a dirty ground environment.

--For the 20-mm gun, the feed chutes were twisted out of alinement between the ammunition box and the gun. The 25-mm gun feed chutes are directly alined from the ammunition box to the gun.

--In the 20-mm gun ammunition box, rounds were merely stacked in the box from the bottom up and the gun was not always able to exert enough pull to force the rounds up through the gun. The 25-mm gun is designed to exert more pull force. In addition, the rounds will be placed in the ammunition box so the gun will not have to pull them as far.

--The 25-mm ammunition will have a groove on the shell of the round, which will be used to guide the round through the feed chute. The 20-mm round had no such groove and as a result rounds became misalined in the feed chute.

The changes being incorporated into the 25-mm gun and feed system should make it more reliable. However, both guns are in the development stage and must undergo additional testing. During our visits to the gun manufacturers, both guns looked impressive being fired remotely from a gun mount. In a demonstration of a mockup of the weapon station given us at the IFV contractor, a jam did occur in the feed mechanism. In 1979 the 25-mm gun will be mounted in the vehicle and fired by soldiers in a simulated battlefield environment. Only then will information be available to determine if previous problems have been corrected and if any new problems exist.

The 7.62-mm gun will also be replaced. The new gun, a 7.62-mm Belgian gun, will be used on both the XM-1 and the IFV. At the time of our review, the new gun had not been tested in either vehicle. XM-1 operational testing using regular soldiers is to begin in April 1978; similar IFV testing is not scheduled until 1979.

<u>Main weapons extensive cleaning time</u>

For effective operation, the 20-mm gun required cleaning after firing 600 rounds. As the gun can fire over 300 rounds a minute, in battle the gun may have required cleaning after only a few minutes. During testing, it took between 1 hour and 20 minutes to 2 hours to clean the main guns. Failure to clean the guns could make them inoperable.

The 25-mm gun contractors expect their guns to fire more rounds before cleaning than the 20-mm gun. One gun is expected to fire 1,000 rounds, while the other is expected to fire 4,000 rounds before cleaning. No data was available on the time needed to clean either of the new guns. Although expectations are high for both, their performance will not be known until tested by the people who will be using them--the infantrymen.

Main gunner's complex role

Test results indicate the IFV gunner's role to be more difficult than anticipated. This is particularly alarming when one considers that the gunner's ability to acquire and identify targets was not fully tested. The gunner was told where the target would appear and was able to select the gun and ammunition type before encountering a target. These advantages will not exist on the battlefield.

Why is the gunner's role so difficult? To begin with, the infantry has never had a vehicle with a cannon as a main gun. As its first gun, it chose a complex automatic dual-feed gun firing different types of ammunition needed for various types of targets. After identifying and acquiring the target, the gunner must select the right ammunition to defeat it. In addition, the gunner must operate an automatic machinegun and, in the proposed new IFV, will fire the TOW missile.

When it comes to firing mounted cannons, Army tank personnel possess the most knowledge. After years of experience, tank personnel know what they can reasonably expect from their crews. However, the infantry, with its limited experience, expected the IFV gunner to do those things normally done in a tank by the commander, the gunner, and the loader, as shown below.

Crew Task Comparison

XM-1 tank			IFV	
Commander	Gunner	Loader	Commander	Gunner
Commands vehicle and crew Acquires, identifies, and designates targets Selects weapon and ammunition Services 50-cal. machinegun	Engages target	Loads and services cannon and 7.62-mm machineguns	Commands vehicle and squad Controls squad fires (mounted and dismounted)	Acquires and identifies targets Selects weapon and ammunition Engages target Loads and services cannon and 7.62-mm machinegun

An indication of how the complex role could affect the gunner's performance in battle can be obtained from analyzing test results. Test data from mock battles shows that IFV gunners were erroneously firing at enemy tanks--which they cannot kill--instead of the lightly armored vehicles they are expected to kill. IFV officials believe the reconfigured IFV with a two-man turret will enable the commander to assume more of the duties of the gunner. We believe problems could continue especially when the commander is dismounted or is otherwise occupied with the squad.

In response to the test results, IFV officials have decided that IFV gunners selected must meet more stringent requirements than the average infantry soldier. Whether enough soldiers meeting such requirements will be available, is not known. Once selected, the gunner must receive very specialized training in operating the weapons and in target acquisitions. The high degree of proficiency required must be maintained not only for one test but every day to maintain combat readiness. IFV officials seem correct in saying that training and the retention of proficiency will be the Army's most significant problem once the IFV is fielded.

The Army recognized that training a gunner to operate the one-man turret 20-mm gun was a major problem. However, the gunner's duties will increase on the current IFV because of the addition of the TOW antitank missile system. The TOW is a complex wire-guided missile which the gunner must steer into the target. The vehicle must be stopped from the time the missile is fired until it hits its target--usually about 15 seconds at maximum ranges. Instead of simplifying the gunner's role, the Army has made it more difficult.

Tank personnel know how difficult it is to maintain a high level of proficiency. To help maintain proficiency, they are developing a training device to simulate actual tank operations. This simulator will cost less to operate than actual tanks and could be used in areas where land use is limited, for example, in Europe. Such a simulator may also be adaptable to the IFV program for training gunners to operate the complex weapon station or in determining whether the gunner's role can be simplified.

Questionable design of firing port weapon system

The IFV has six firing ports--two on each side and two in the rear of the vehicle--through which automatic rifles can be fired by the infantry squad in the vehicle. During testing, significant problems were encountered in the firing port weapon system.

The sight is about 2 feet above the gun, requiring the soldier to "shoot from the hip" instead of aiming directly at the target. As a result, the infantryman must learn to shoot low and "walk" the gun up to the target. In addition, tracers must be used to determine where the ammunition is hitting.

During testing, problems surfaced concerning the effective use of firing port weapons. For example, the guns can fire 1,000 rounds a minute but are loaded with only 30-round ammunition clips. Soldiers, in attempting to "walk" the gun up to target, could expend their 30-round clip of ammunition before reaching the target. In testing, some interruption of fire was noted when the gunners were required to change clips.

The design of the firing port weapon-sighting device created another testing problem. Soldiers looking through the sight see their rounds as being on target, but actually they are above target. This is referred to as a visual parallax.

Further, when soldiers fire tracer rounds side by side, they may have difficulty determining which rounds are theirs and consequently may not be able to correct misdirected fire.

Adding to the complexity, the infantryman has to use and maintain two rifles--one mounted as a firing port weapon and the other for dismounted operations. The same gun cannot be used in both roles as the Soviets do in their vehicles. The Army advised us that the firing port weapon is still under development.

Mobility

Test results to date show that many problems were experienced with the track/suspension system and transmission, which have led us to question whether the IFV will be able to meet its demanding mobility requirements. The IFV must be able to fight on hillside slopes, make pivotal turns, and move cross country to occupy and withdraw from positions quickly. These rigid requirements have put much stress on the track/suspension system and transmission as evidenced by test results. Army officials state that with training and experience drivers can adjust to the vehicle. However, a driver may limit the high performance expectations of the vehicle in fear of throwing a track or breaking the suspension system or transmission.

IFV track/suspension problems

During operational testing at Fort Benning (October through December 1976), with typical infantrymen as drivers, problems were encountered with the track/suspension system primarily in the area of track throws. Of 15 recorded incidents considered significant enough to disable the IFV in combat, 3 were track throws and 1 involved the suspension system. Six other track/suspension problems recorded were not considered as significant by the Army, and eight other partial track throws were experienced but not recorded because repairs were made on the test course. Fort Benning officials attributed track throws to the following:

--Improper track tension adjustment. Improper tightening resulted in a too loose or too rigid track for conditions. Testing officials will recommend an engineering modification to the track tension system, hopefully to solve this problem.

--A buildup of sand between the track sprocket and roadwheel forcing the track off the wheel. The condition usually occurs during pivotal turns on sandy hills. Testing officials said that because of its weight, the IFV may be more susceptible to this problem than lighter track vehicles. No modifications are planned.

--The use of inexperienced drivers.

During development testing at Aberdeen Proving Ground, Maryland, from October 1976 to March 1977, with professional drivers, four additional track throws were recorded. Further, at Aberdeen the vehicle was tested over rougher terrain than at Fort Benning. This testing disclosed serious problems with the suspension system. The vehicle, in going over rough cross-country terrain, hit the ground at its front or rear causing parts of the suspension to break. An IFV official said this had occurred on at least five occasions. As a result, the contractor is reevaluating the entire track/suspension system to be used on the reconfigured IFV.

As early as 1974 the IFV experienced track throw problems. The cause was traced to components of the suspension system affecting roadwheel durability causing the track to be misguided and/or thrown off. The Army installed a new roadwheel and considered the problem solved. However, problems continue today indicating superior performance expected of the IFV may be limited by its track/suspension system.

The IFV is a heavy vehicle--about 47,000 pounds, compared to the 25,000-pound M113 it is to replace. A testing official said the IFV is more susceptible to track throws than lighter tracked vehicles because its greater weight exerts more stress on the track.

The reconfigured IFV is to have an improved track/suspension system designed to eliminate existing mobility problems.

Transmission breakdowns

Transmission problems have long plagued the IFV program. Army officials believe the more serious problems have been overcome; however, problems continue to occur.

In 1975 the IFV program was delayed 5 months to fix transmission difficulties identified in testing. In February 1976 testing was stopped because of the questionable reliability of the transmission. Its reliability was so questionable and critical that the Army contracted for a backup transmission with another contractor. In June 1977 the original contractor's transmission was selected for the reconfigured IFV based on competitive evaluation.

During tests of the modified and competing transmission at Fort Benning from October through December 1976, 5 of the 15 recorded combat disabling incidents involved the transmission.

During tests at Aberdeen begun in October 1976 and continuing as of May 1977, at least 14 transmission failures were recorded. All were classified as combat mission failures--significant enough to have rendered the vehicle immobile in combat. A testing official said that seven failures had been incurred by each of the competing transmissions.

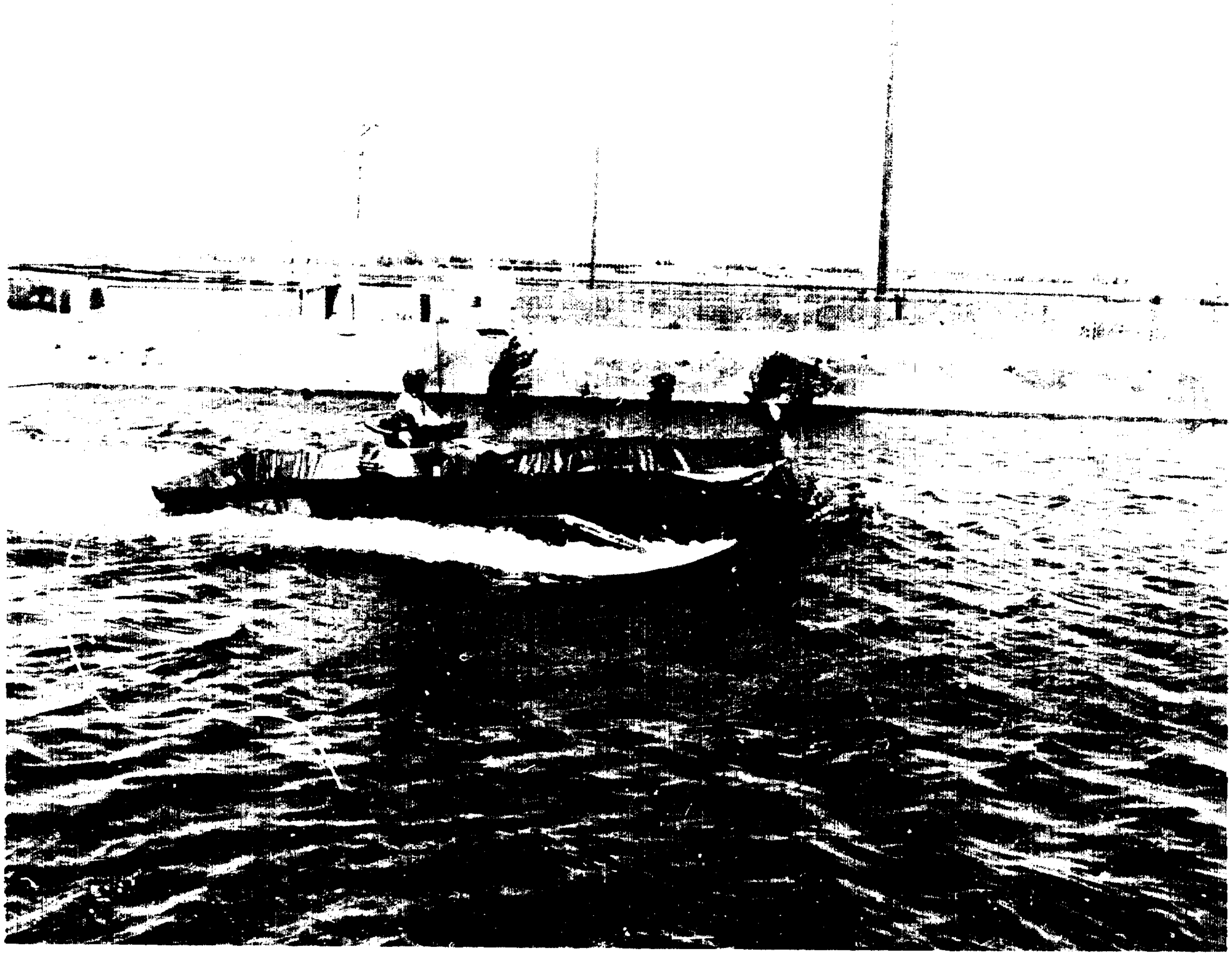
The transmissions were being tested in the now obsolete one-man turret IFV. However, the current IFV will be heavier--by at least 2,000 pounds--than the test vehicle. Vehicle weight increases have already exceeded suspension system capabilities and could place an additional burden on the transmission.

Usefulness of swim barrier questionable

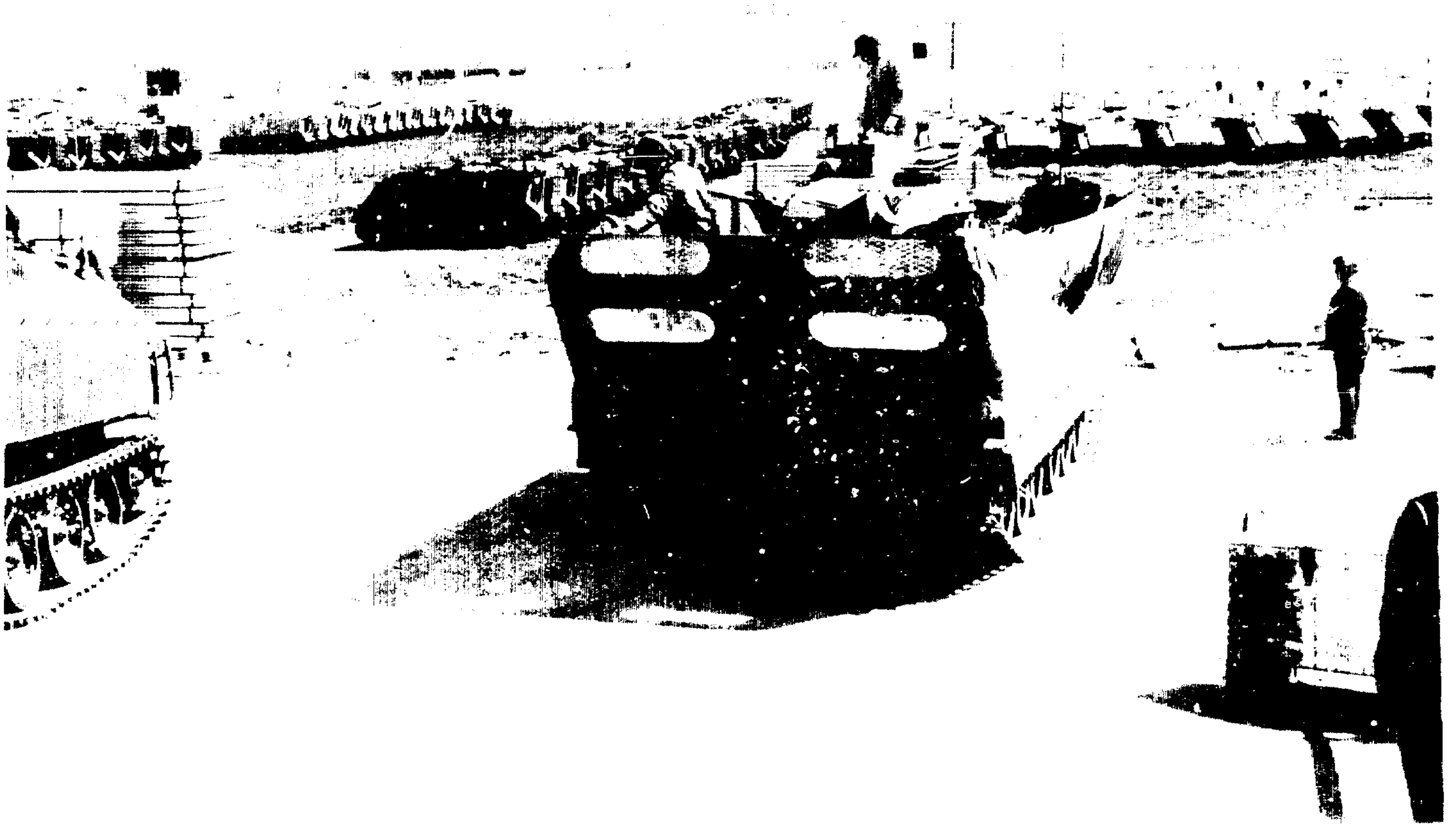
A factor limiting the amount of armor the IFV has is the requirement that the vehicle be able to swim. The value of this tradeoff appears doubtful. IFV officials say that the IFV must be able to swim to maintain the momentum of the battle and because the Soviet armored personnel carrier (BMP) can swim. On the other hand, the XM-1 does not swim and neither does the West German version of the IFV.

The Army estimates that only 3 percent of the waterways in Europe require a swim capability to achieve a crossing. It is unlikely, therefore, that the IFV will have much opportunity or need to swim.

In any case, the IFV has already become so heavy (an estimated weight of about 47,000 pounds) that it cannot swim without a swim barrier. We watched the IFV swim with its barrier. The barrier, as shown on pages 21 and 22, is constructed of a canvaslike material, which is vulnerable even to small arms fire. The barrier must be erected manually by the IFV crew. Under hostile fire this would leave the crew dangerously exposed. When the barrier is erected, the IFV, in firing its own weapons, risks blowing a hole through the barrier and possibly sinking itself. Project officials estimate the swim requirement adds $1,500 to the cost of each vehicle.



IFV IN TEST TANK WITH SWIM BARRIER



IFV SWIM BARRIER

CHAPTER 4

OTHER FACTORS THAT

COULD INFLUENCE MISSION EFFECTIVENESS

The strategic importance of Western Europe to the security of the United States remains second only to that of the territorial United States itself. It is the major area in which weapon systems and Forces of the United States and the Soviet Union immediately face each other. It is because of this strategic factor that a substantial portion of U.S. Forces (contributing to North Atlantic Treaty Organization (NATO) Forces) are located in Europe.

The U.S. strategy to achieve success in a European conflict includes standardizing equipment with its NATO allies and fielding better equipment than the Soviet Union and its Warsaw Pact allies.

Considering U.S. military philosophy, the XM-1 and the IFV may be superior in some categories to the Soviet T72 tank, which is being introduced into the Soviet force, and the Soviet BMP currently used by the Warsaw Pact. The BMP is of 1960s vintage, and the Soviets may be developing a much improved version.

U.S. vehicles lag far behind those of the Soviets in two areas--the limited standardization between the United States and its NATO allies and the lack of chemical, biological, and radiological protection systems.

STANDARDIZATION WITH NATO FORCES

Warsaw Pact doctrine, weapons, and equipment are generally standardized, unlike those of NATO countries. However, standardization has encountered serious political, economic, and military obstacles in almost every NATO nation, including the United States. Standardization of doctrine and equipment would enhance NATO's military operating effectiveness. However, at best, standardization will be a gradual process, which takes time to show concrete results.

Plans to standardize some portions of the XM-1 tank

The decision to enter full-scale engineering development, which was originally scheduled for July 1976, was postponed in order that the potential benefits of standardization between the XM-1 and the German Leopard 2 tanks could be studied. On August 4, 1976, the Secretary of Defense announced that a major step had been taken enhancing the level of standardization in tank programs of Germany and the United States through an addendum to a December 1974 memorandum of understanding on tank development.

The addendum establishes the objectives of achieving maximum commonality of major components between the two tanks. The components specified were the turbine powerpack, the track and associated suspension system, fuel, the night vision device, metric fasteners at crew-serviced interfaces, and the gunner's auxiliary telescope. In addition, the United States agreed to develop an XM-1 turret capable of accepting a 105-mm or a 120-mm gun. Currently the Army prefers a 105-mm gun and the German developers prefer a 120-mm gun. There is some agreement on the 7.62-mm machinegun which is used by the United States, the Dutch, the Germans, and the French.

An option which might be attractive to both the United States and its NATO allies would be for the United States to adopt the German or English 120-mm gun in exchange for an agreement by NATO countries to adopt the turbine engine. However, as discussed previously, the turbine engine has to undergo much testing before it can be considered an effective replacement for the diesel engines used by NATO countries. Further, the Army, at present, does not show much interest in the 120-mm gun. In our opinion, the chances for a major breakthrough in standardization appear limited for the near future.

Plans to standardize subcomponents and ammunition of IFV

Unlike the XM-1/German Leopard 2 tank competition and standardization agreements, the IFV has been developed somewhat independently of similar NATO armored personnel carriers. In the absence of documented standardization attempts, we asked project officials whether standardization with NATO countries was a consideration in the IFV program. The officials said foreign vehicles had been considered but had been eliminated as viable candidates. The officials said that despite the rejection, the IFV had some items in common with weapon systems of NATO countries, mostly at the subcomponent and ammunition level. They listed a slave cable (used to start a vehicle), a towing pintle, 25-mm ammunition, 7.62-mm ammunition, TOW missiles, and fuel. In addition, they said one of their 25-mm guns under consideration is a modified version of a 25-mm gun produced by Oerlikon in Switzerland and used within NATO.

Consequently, the major standardization appears to be in the ammunition area. Even here standardization is limited. Only the Dutch using the Oerlikon gun use 25-mm ammunition on their armored personnel carriers. The Germans and the French use 20-mm ammunition being replaced on the IFV. As mentioned above, the Dutch, the Germans, and the French all use 7.62-mm machineguns. The Germans and the Dutch have ground-mounted TOWs.

CHEMICAL WARFARE CAPABILITIES

The Soviet Union continues to maintain a significant chemical warfare capability. The evidence is that the Soviets regard chemical capabilities as an integral part of their offensive war-fighting capability. For example, they conduct extensive training and stress operating proficiency in a chemical warfare protective posture. Also officials cite reports from Soviet defectors that the political decision to use chemlical warfare already has been made, and Soviet commanders can issue the orders on their own.

During the last decade, the Soviet/Warsaw Pact nations have equipped many of their combat vehicles with some form of collective protection and have placed greater emphasis on keeping leakage to a minimum when designing their vehicles than has the United States. Consequently, the Soviets have fielded vehicles that can provide an agent-free interior. Also it is believed that many Soviet vehicles have removal systems (that will prevent dust/residual radiation from entering through the filter system during operations in radioactive fallout areas), detection devices, mounted decontamination systems, and automatic and manual controls for providing a better seal when exposed to nuclear attacks.

Unlike the Soviets, the XM-1's crew must rely primarily on individual protective masks and clothing against chemical warfare.

A January 1977 Defense Department report also stresses the U.S. concern in this area. The report states the United States is moving to achieve:

--Protective capabilities (detection, warning, medical defense, and protective and decontamination equipment).

--An adequate, available, and survivable chemical munitions stockpile.

--Well-trained forces to use the protective equipment and to retaliate following a chemical warfare attack.

In view of the increasing Soviet and DOD interest in chemical warfare, it seems questionable in the development stage not to introduce a better system in a tank planned to be used on the battlefield of the future.

As with the XM-1, the IFV lacks a chemical warfare protection system. The BMP's collective protection device gave the Soviets their first true capability for crossing chemically, biologically, and radiologically contaminated areas either completely or partially sealed. Also the system enables the vehicle to fire its SAGGER missile from a completely buttoned-up position and some limited coaxial fire in a chemical and biological environment.

Like the XM-1 tank crew, IFV occupants will rely primarily on individual protective masks and clothing for operation in a toxic environment.

ECONOMIC ANALYSIS SUPPORTING IFV ACQUISITION

Before beginning the development of a new weapon system, the Army generally compares the cost and operational effectiveness of the proposed system with those of other potential systems and/or existing systems. Without a complete and current economic analysis, the Army has little assurance it is proceeding with the best alternative(s).

The latest economic analysis of the IFV dates from April 1970. Since then there have been several events which could affect the analysis--enemy threat assumptions have changed, the XM-1 program has replaced the MBT70/XM803 program, the 25-mm gun has replaced the 20-mm gun, the TOW missile launcher has been added, the current design calls for a two-man turret, and IFV costs have increased from an estimated $99,300 to an estimated $338,000. Thus an updated analysis of the IFV is long overdue. The Army target date for an updated analysis giving consideration to such changes is January 1978.

The new analysis will compare the reconfigured version of the IFV to (1) an IFV with a one-man turret 20-mm gun, (2) an IFV with a two-man turret 25-mm gun but no TOW, (3) the M113A1, and (4) the Dutch armored infantry fighting vehicle. The new IFV analysis will not consider the possibility of an improved BMP being fielded by the Soviets. U.S. intelligence sources believe that if the Soviets consider the 25-mm gun a serious threat, they will field an improved BMP in the early 1980s.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

According to a comparison of their characteristics and performance during testing, the IFV has some differences with the XM-1 that may cause them to be incompatible and may reduce their effectiveness as a close combat team. The IFV is slower, taller, less protected, and more conspicuous by its smoke and noise than the XM-1.

While some of the differences, such as in their armor, gunsights, and engines, may be unavoidable, a question remains whether a tactical doctrine covering their use in combat can be developed to accommodate two vehicles which, though they are to be mutually supportive, are so different in mobility, height, and in other respects.

Test results revealed that the operation of the IFV's main gun, its firing port weapons, and a swim barrier added to enable it to swim add considerably to the vehicle's complexity. Neither the IFV nor the XM-1 has protection for chemical warfare. Some redesigning of the IFV appears necessary to permit the vehicle's performing effectively.

While the M113 may be inadequate to meet the Army's requirements, the IFV, which is nearly four times as expensive, thus far has not shown to be much of an improvement.

RECOMMENDATIONS

We recommend that the Secretary of Defense determine:

--Whether, considering its advanced stage of development, the indicated design changes needed to make the IFV effective can still be practically made at an acceptable cost.

--Whether a tactical doctrine can be developed that can accommodate the incompatibilities between the IFV and the XM-1 and still provide the effectiveness anticipated from both.

We recommend that, if the design changes and tactical doctrine are unattainable, the Secretary direct the Army to find alternatives to the IFV.

We also recommend that the Secretary require the Army to rejustify using individual protective masks and clothing against chemical warfare rather than equipping its new vehicles with protective systems.

ARMY AGENCIES AND CONTRACTORS VISITED

Combined Arms Combat Development Agency, Fort Leavenworth, Kansas

Army Training and Doctrine Command, Fort Monroe, Virginia--responsible for XM-1 and IFV requirements

Army Infantry School, Fort Benning, Georgia--user of the IFV; also a test site

Army Armor School, Fort Knox, Kentucky--user of XM-1 tank

Aberdeen Proving Ground, Maryland--IFV test site

Army Weapons Command, Rock Island, Illinois--former IFV 25-mm gun project office

FMC Corporation, San Jose, California--IFV vehicle contractor

Hughes Helicopter, Culver City, California--IFV 25-mm gun contractor

Ford Aerospace and Communications Corporation, Aeronutronic Division, Newport Beach, California--IFV 25-mm gun contractor

WEAPON STATION MALFUNCTIONS DURING IFV TESTING

FORT BENNING, GEORGIA

OCTOBER THROUGH DECEMBER 1976

20-mm main gun:		
Feed failure (misalined rounds)	14	
Dual feeder jammed	5	
Electrical failures	8	
Parts failures	5	
Other	11	43
7.62-mm coaxial machinegun--secondary armament:		
Feed failure (misalined rounds)	12	
Missing or broken parts	9	
Charging handle broken	4	
Other	8	33
Miscellaneous weapon station:		
Sighting problems	7	
Uncontrollable drift in station	2	
Other	5	14
Total		90

PRINCIPAL OFFICIALS OF THE DEPARTMENTS OF DEFENSE AND THE ARMY RESPONSIBLE FOR ADMINISTERING ACTIVITIES DISCUSSED IN THIS REPORT

	Tenure of office From	To
DEPARTMENT OF DEFENSE		
SECRETARY OF DEFENSE:		
Harold Brown	Jan. 1977	Present
Donald H. Rumsfeld	Nov. 1975	Jan. 1977
UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING:		
William J. Perry	Apr. 1977	Present
Malcolm R. Currie	June 1973	Jan. 1977
DEPARTMENT OF THE ARMY		
SECRETARY OF THE ARMY:		
Clifford L. Alexander	Jan. 1977	Present
Martin R. Hoffman	Aug. 1975	Jan. 1977
PROJECT MANAGER, XM-I:		
Brig. Gen. Donald M. Babers	July 1977	Present
Major Gen. Robert J. Baer	Sept. 1972	June 1977
PROJECT MANAGER, IFV:		
Brig. Gen. Stan R. Sheridan	July 1975	Present

(951317)

GPC 925-281