United States General Accounting Office

GAO

Report to the Chairman, Committee on Armed Services, House of Representatives

February 1991

ABRAMS TANK

Operating Costs More Than Expected

GAO/NSIAD-91-114

GAO

United States
General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division

B-242192

February 28, 1991

The Honorable Les Aspin
Chairman, Committee on
Armed Services
House of Representatives

Dear Mr. Chairman:

As requested, we evaluated the cost to operate and the readiness of the Army's M1 Abrams tank in the field. You asked us to (1) determine whether the Army expected the M1 tank to be cheaper to operate and support than its predecessor (the M60 tank), (2) evaluate the current cost to operate and support the M1 tank as compared to the M60 tank, and (3) determine whether the M1 tank was meeting its operational readiness goals in the field. All audit results were developed from data available prior to the initiation of Desert Storm operations.[1]

Results in Brief

The Abrams tank is faster, more survivable, and more lethal than the M60 tank. However, it is not cheaper to operate and support than the M60. The Abrams tank is currently three to four times as costly as the older M60 tank, although the Army had expected the Abrams to be cheaper to operate. The Army has begun several projects to reduce these operating and support (O&S) costs.

The Abrams tank's readiness rates indicate that in most months it meets the Army's 90-percent readiness requirement. However, the readiness reporting procedures contain reporting exceptions that may be helping the Abrams reach the readiness requirement.

Background

At the time of our field work, the active Army depended on three main battle tank models—the M60A3, the M1, and the M1A1. The M60A3 tank, first fielded in February 1979, is the oldest of the active models. This tank weighs 57 tons and has a 105-millimeter main gun, a .50-caliber machine gun, and a 7.62-millimeter machine gun. It is powered by a 750-horsepower diesel engine, which is capable of a top speed of 30 miles per hour. The majority of active Army M60A3 tanks, at the time of our field work, were assigned to the Eighth Army in South

[1]Prior to the commencement of hostilities on January 16, 1991, Operation Desert Storm was known as Operation Desert Shield.

Korea. However, in 1990, the last armor unit in South Korea exchanged its M60A3 tanks for M1 tanks. Currently, the active Army does not have significant numbers of M60A3 tanks.

The M1 Abrams tank was first fielded in February 1981 to units in the United States and in March 1982 to units in Europe. The M1 tank weighs 60.4 tons and has a 105-millimeter main gun, a .50-caliber machine gun, and two 7.62-millimeter machine guns. Its 1,500-horsepower turbine engine drives the tank at a top speed of 45 miles per hour which, along with its improved suspension system, allows the tank to move quickly across the battlefield, reducing its exposure time to threat weapons. The M1 tank is less vulnerable and more survivable than the M60A3 tank because, in addition to its faster speed, it has improved armor, compartmentalized main gun ammunition and fuel storage areas away from the crew compartment, and an automatic fire detection and suppression system. It also has an improved day-night fire control system. The majority of the active Army M1 tanks are assigned to units in the continental United States. However, recently many of these units have been sent to Saudi Arabia as part of Operation Desert Shield.

The M1A1 Abrams tank, an improved version of the M1 tank, was first fielded in September 1986 to units in the United States and in December 1986 to units in Europe. The M1A1 tank has improved armor, a 120-millimeter main gun, and a top speed of 41.5 miles per hour. It currently weighs 67 tons. The M1A1 crew's survivability has been improved by the addition of a nuclear, biological, and chemical protection system. The majority of the active Army M1A1 tanks are assigned to the U.S. Army, Europe, and to units of the Army's III Corps at Fort Bliss, Texas. However, recently many of these units have been sent to Saudi Arabia as part of Operation Desert Storm.

The Army Expected the Abrams Tank to Be Cheaper to Operate and Support Than Its Predecessor

The Army has produced an M1 tank that is faster, more survivable, and more lethal than its predecessor, the M60 tank. The Army had also planned that this tank would impose a maintenance and logistics burden no greater than the M60 tank. In fact, Army cost estimates done prior to its fielding indicated that the M1 would be cheaper to operate and support than the M60 tank. However, as the M1 tank's fielding date approached, the Army's estimate of the difference between the M1 and M60 tanks' O&S costs narrowed. Soon after the M1 tank's fielding date, the Army estimated these costs to be nearly the same.

In 1976, the Army issued cost estimates that compared the annual cost to operate and support an M60A3 tank with the annual cost to operate and support an XM1 tank (now the M1). These estimates showed that an XM1 tank would cost $1,200 per year less to operate and support than an M60A3 tank. Table 1 compares the individual O&S cost estimates for the M60A3 and XM1 tanks.

Table 1: Annual Operating and Support Costs Per Vehicle for the M60A3 Tank and the XM1 Tank

Constant 1976 dollars in thousands

	M60A3 tank[a]	XM1 tank[a]	Cost difference
Crew	$44.5	$44.5	0
Maintenance	29.4	26.0	$(3.4)
Vehicle overhaul	11.5	12.5	1.0
Ammunition	36.9	37.9	1.0
Fuel and lubricants	1.3	1.9	0.6
Personnel training	19.2	19.2	0
Integrated logistics support	1.2	1.2	0
Transportation	1.8	1.4	(0.4)
Indirect	16.6	16.6	0
Total[b]	**$162.4**	**$161.2**	**$(1.2)**

[a]Cost estimates are based on the production of 3,312 tanks, built at a rate of 60 per month, with each tank model having a 105-millimeter main gun.

[b]Total costs to operate each vehicle 1,200 miles a year in a 1,940-vehicle fleet.

Source: XM1 Tank System Baseline Cost Estimate, U.S. Army, 1976.

The Army issued a cost and operating effectiveness analysis in 1979 showing the annual cost to operate and support an XM1 tank in Europe to be $2,000 less than the annual cost to operate and support an M60A3 tank in Europe. The Army estimated that the annual cost to operate and support a tank in Europe would be $228,000 for the XM1 tank and $230,000 for the M60A3 tank in constant 1979 dollars.

In July 1981 hearings before the Subcommittee on International Trade, Finance, and Security Economics, Joint Economic Committee, the Army's Deputy Director for Weapons Systems stated that the Army expected the annual unit operating costs of the M60A3, the M1, and the M1E1 (now the M1A1) tanks to be "very nearly the same" in the field. The estimates, in constant fiscal year 1982 dollars, were $308,200 for the M60A3 tank, $310,600 for the M1 tank, and $338,200 for the M1A1 tank.

Current Abrams Tank O&S Costs Are Much Higher Than Those for the M60A3 Tank

The Material System Sustainment Factors for use in the fiscal year 1993 budget show that the M1 and M1A1 tanks cost 4.2 times and 3.2 times as much per mile, respectively, to operate and support than the M60A3 tank. The individual comparisons are shown in table 2.

The Army maintains several data systems that accumulate O&S cost information. None include all O&S costs.

Each year the Army issues Materiel System Sustainment Factors, which are the O&S cost factors the Army commands are to use in developing their operation and maintenance budgets. The factors are based on an average of actual unit-level costs over the most recent 3 years. The Army issues separate factors for repair and spare parts costs and the fuel used per mile by the individual weapons systems currently in the Army inventory. Fuel costs per mile can be developed by applying the cost per gallon to the fuel used per mile.

Table 2: Army's Estimated Annual O&S Costs Per Mile Per Tank for Repair Parts, Spare Parts, and Fuel

Constant fiscal year 1991 dollars

Type of cost	M60A3 tank	M1 tank	M1A1 tank
Repair parts	$17.00	$32.00	$38.00
Spare parts	32.00	176.00	117.00
Fuel	1.39	4.88	4.74
Total	**$50.39**	**$212.88**	**$159.74**

Source: Army Materiel System Sustainment Factors for the fiscal year 1993 budget, August 24, 1990.

These factors do not include unit-level O&S costs for crew, maintenance personnel, and ammunition. None of the Army data systems allocate these costs to the three tank models, and we did not attempt to develop this data.

Table 3 shows the costs of live 105-millimeter and 120-millimeter main gun rounds. However, the Army does not include the cost of live ammunition as an operating and support cost.

Table 3: Cost Per Round of 105-Millimeter and 120-Millimeter Tank Rounds

Constant fiscal year 1989 dollars

Type of round	105-millimeter (M60A3 and M1)	120-millimeter (M1A1)
High explosive antitank	$127	$1,033
Kinetic energy	148	711

Source: M1/M1A1 Tank System Baseline Cost Estimate, U.S. Army, June 1988.

Army Has Implemented Cost Reduction Efforts

The Army has undertaken a number of ongoing efforts to reduce Abrams O&S costs. These efforts include fielding a more durable tank track, reducing fuel usage, and improving fault diagnosis.

A More Durable Track

The poor durability of the Abrams tank track has been a key contributor to the high cost of its maintenance. The T-156 tank track, which has been in the fleet since the M1 tank was first fielded, has never met its original reliability, availability, maintainability, and durability requirement of 2,000 miles without replacement. This track's average durability is 850 miles on the M1 tank and 710 miles on the M1A1 tank. Army data from its 1988 Abrams cost estimate showed that tank track costs accounted for 47 percent of the M1 tank's and 52 percent of the M1A1 tank's annual per-mile repair parts cost.

The Army has developed a new tank track, the T-158 track, to replace the T-156 track. The T-158 track has replaceable pads, and the contractor has guaranteed the track for 2,100 miles and the pads for 878 miles. The Army is currently fielding the new T-158 track on M1A1 tanks in Europe. This new track has not been in use long enough to obtain actual cost savings data. The Army estimates that the T-158 track will save $297.9 million in O&S costs over the tank fleet's 20-year life.

These estimated cost savings may be overstated because the Army, in its savings estimate, did not consider the potential effects of the increased weight of the new track. The new T-158 track weighs 11,736 pounds per set, while the older T-156 track weighs 8,940 pounds per set. This increase of 2,796 pounds could cause an increase in fuel usage and road wheel and suspension wear. Both could cause increases in O&S costs and, therefore, would reduce the estimated savings resulting from the change to the T-158 track.

Reducing Fuel Usage

Fuel consumption has been a continuing concern since the M1 tank was fielded. The Army expected the Abrams tank to use more fuel than the M60A3 tank. The M1 tank used more fuel than originally anticipated. According to Army officials the Army originally estimated that the M1 turbine engine would use about 100 percent more fuel than the M60 diesel engine. However, current Army data shows that the M1 tank uses 251 percent more fuel and the M1A1 tank uses 241 percent more fuel

per mile than the M60A3 tank. The Army has two programs to reduce the Abrams tank's fuel usage—an auxiliary power unit and a new engine recuperator.

Auxiliary Power Unit

The Army may install a small auxiliary power unit (APU) onto the rear of the Abrams tank. The APU will save fuel by allowing the tank's electrical systems to work without operating the tank's main turbine engine. Currently, the turbine engine must be on to power the turret, lights, crew compartment heater, and other electrical equipment.

The APU is a 5-kilowatt gasoline engine generator with an 8-gallon fuel tank. The Army estimates that installing APUs on the entire Abrams tank fleet will save $494 million over the 20-year life of the fleet.

Engine Recuperator

The Army has experienced poor reliability of the Abrams engine recuperator. The engine recuperator uses hot exhaust air and thus increases the turbine engine's operating efficiency and reduces fuel usage. The recuperators have been susceptible to cracking and catastrophic failures called "blowouts." As the tank weight has increased from the M1 to the M1A1 models and the M1A1's nuclear, biological, and chemical system has made more demands on the engine, recuperator blowouts have become more frequent—failing at about 150 hours of operation.

The recuperator contractor's initial reaction to the blowout problem was to institute a new quality control process and new laser welding techniques for the recuperators. These changes have extended the recuperator's life to about 350 hours, but the blowout problem has not been completely solved.

Three contractors are now competing for the right to develop an alternate recuperator. Production of the new recuperator is not scheduled to begin until 1992. The Army has not estimated the O&S cost savings associated with this improvement effort.

Improving Fault Diagnosis

The Army has developed a new diagnostic test set for use on Army weapons systems. The test set is used to determine which component has failed and the reason for the failure. The Army has not developed the software to allow the test set to be used on the Abrams tanks; however, once it does, it estimates it will save $107 million in hardware and maintenance costs over the life of the tank fleet.

The Army's estimate of these savings may be overstated. The diagnostic test set is currently in use on other weapons systems and has had many problems, including faulty and time-consuming diagnoses, and the Army has had difficulty in transporting the sets because they are housed in five to seven containers, depending on the tank model.

Abrams Tank Readiness Rates Are High but With Many Reporting Exceptions

The Abrams operational readiness data indicates that the Abrams tanks have exceeded the Army's mission-capable goal of 90 percent in all but 2 of the 12 quarters prior to January 1990. This 3-year readiness data shows that the M1 tank's mission-capable rate ranged from a high of 93 percent in the third quarter of fiscal year 1988 to a low of 88 percent in the first quarter of fiscal year 1990. The M1 tank's readiness rate was below the Army's mission-capable goal in the first quarters of fiscal years 1989 and 1990 (89 percent and 88 percent, respectively). During the same 3-year period, the M1A1 tank's mission-capable rate ranged from a high of 96 percent in the fourth quarter of fiscal year 1987 to a low of slightly less than 92 percent in the fourth quarter of fiscal year 1989.

The Army's readiness reporting procedures for tracked and wheeled vehicles contain reporting exceptions that may allow some non-mission-capable tanks to be reported as mission capable. However, data was not available to determine the percentage of tanks reported mission capable as a result of these exceptions. Discussions of these reporting exceptions follow.

First, tank readiness is determined once a day. As long as a tank is mission capable at the time operational readiness is determined, it is considered mission capable the whole day.

Second, if the tank is non-mission capable at the time readiness is determined, the unit is not required to classify it non-mission capable if the problem can be repaired within 24 hours. The Abrams tank is designed for easy maintenance, with many maintenance problems able to be corrected by removing and replacing modular components. As a result, only four Abrams maintenance actions require more than 24 hours to complete.

Third, a unit can classify the tank as mission capable even though the problem is not corrected within 24 hours. For example, Abrams tanks require a semiannual scheduled maintenance that includes removing and disassembling the engine and transmission to replace the seals. This

maintenance takes about 5 days; however, tanks undergoing this maintenance are considered mission capable while their engines and transmissions are disassembled because the tank can be put back into operating order within 24 hours.

Fourth, a unit that has two tanks considered non-mission capable for different reasons may report only one tank as non-mission capable. If necessary, the parts from the one tank could be installed on the other to make it mission capable. The Army calls this action a "controlled exchange."

Finally, a tank requiring extensive repairs can be traded for another tank in good condition. Each tank division has from two to six tanks called "division float tanks," which are not included in the readiness rates. If a unit has a tank requiring extensive repairs outside the unit's motor pool, the unit can trade the defective tank for one of the division's float tanks. The tank undergoing repair then becomes one of the division's float tanks and is not counted in readiness rates.

Our scope and methodology are described in appendix I. We obtained informal comments from Office of the Secretary of Defense and Army officials on a draft of this report and incorporated them as appropriate.

Unless you publicly announce its contents earlier, we plan no further distribution of this report until 20 days from its issue date. At that time, we will send copies to the Secretaries of Defense and the Army, other congressional committees, and other interested parties. Copies will also be made available to others on request.

Please contact me on (202) 275-4141 if you or your staff have any questions concerning this report. The major contributors to this report are listed in appendix II.

Sincerely yours,

Richard Davis

Richard Davis
Director, Army Issues

Scope and Methodology

We interviewed officials from Headquarters, Department of Defense, Washington, D.C.; Headquarters, U.S. Army, Washington, D.C.; Headquarters, U.S. Army, Europe, Heidelburg, West Germany; Headquarters, V Corps, Frankfurt, West Germany; the U.S. Army Materiel Command, Alexandria, Virginia; the U.S. Army Materiel Support Analysis Activity, Aberdeen Proving Ground, Maryland; the U.S. Army Tank Automotive Command, Warren, Michigan; the U.S. Army Armor Center and School, Fort Knox, Kentucky; the U.S. Army Materiel Readiness Support Activity, Lexington, Kentucky; the U.S. Army Cost Analysis Center, Washington, D.C.; the Two Hundredth Theater Army Materiel Management Command, Zweibrucken, West Germany; the First Cavalry Division, Fort Hood, Texas; and the Third Armored Cavalry Regiment, Fort Bliss, Texas.

At these locations, we reviewed Army cost data sources in order to develop costs (actual and estimated) of operating and supporting the Abrams and M60A3 tanks. The cost data we reviewed was developed by the Army from 1982 through 1989. We discussed with Army officials their efforts to improve tank performance and to reduce operational and support costs.

Also, we reviewed documents related to the readiness of the M1 and M1A1 tanks reported from January 1987 through December 1989 to determine whether the tanks were meeting the Army's readiness requirements. We did not verify the accuracy of the readiness data because the units do not keep the basic documents upon which they identify the problems requiring maintenance. The documents are thrown away once the problem is corrected.

We performed our review from October 1989 through August 1990 in accordance with generally accepted government auditing standards.

Major Contributors to This Report

National Security and International Affairs Division, Washington, D.C.	Henry L. Hinton, Associate Director F. James Shafer, Assistant Director Lawrence D. Gaston, Jr., Evaluator-in-Charge Jana M. McDonough, Evaluator
Detroit Regional Office	Lawrence L. Charron, Site Senior Rickey J. Belanger, Evaluator
Dallas Regional Office	Alberto Ayala, Site Senior Merrie C. Nichols, Evaluator
European Office	Donald R. Hunts, Site Senior Robert E. Martin, Evaluator

Requests for copies of GAO reports should be sent to:

U.S. General Accounting Office
Post Office Box 6015
Gaithersburg, Maryland 20877

Telephone 202-275-6241

The first five copies of each report are free. Additional copies are $2.00 each.

There is a 25% discount on orders for 100 or more copies mailed to a single address.

Orders must be prepaid by cash or by check or money order made out to the Superintendent of Documents.

United States
General Accounting Office
Washington, D.C. 20548

Official Business
Penalty for Private Use $300

First-Class Mail
Postage & Fees Paid
GAO
Permit No. G100