United States General Accounting Office

GAO

Report to the Chairman, Committee on Governmental Affairs
United States Senate

April 1986

WEAPON SYSTEMS

Problems With Army's High Mobility Multipurpose Wheeled Vehicle Continue

GAO/NSIAD-86-79

GAO

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

National Security and International
Affairs Division

B-214579

April 4, 1986

The Honorable William V. Roth, Jr., Chairman
Committee on Governmental Affairs
United States Senate

Dear Mr. Chairman:

This letter is in response to your request of June 27, 1984, and subsequent agreements with your office that we monitor the initial production and operational tests of the Army's High Mobility Multipurpose Wheeled Vehicle (HMMWV). You asked that we

- prepare a report on these tests and assess the realism of the operational test,
- give particular attention to modifications incorporated to correct previously disclosed deficiencies, and
- compare results of the 1982 tests of the prototype vehicles with results of the 1984 tests of initial production vehicles completed on the weapons carrier and utility versions of the HMMWV.

In addition, you asked for results to date of the ongoing testing of the shelter carrier, a version not tested before.

Testing of the weapons carrier and utility versions was completed in December 1984. The shelter carrier tests, begun in August 1985, are still being evaluated. Testing of the remaining version of the HMMWV, the ambulance, has not started.

The results of the tests completed in 1984 on the weapons carrier and utility vehicles revealed that their reliability improved significantly over that shown in the 1982 tests of their prototypes. We found no reason to question the realism of the 1984 operational tests. However, some important performance and reliability problems persist.

The vehicles are too heavy to be airlifted by helicopter in certain environmental conditions. While the HMMWV has met the requirement to run on flat tires, many tires have been wearing improperly because of interaction with a metal device installed on the wheels to enable the vehicle to run when the tires go flat. The effect is to shorten the tires' useful life. In 120,000 miles of initial production testing, the weapons carrier and utility vehicles experienced over 30 flats, indicating a need to repair

or replace a tire an average of about every 3,600 miles. The Army is still trying to procure a more efficient run-flat tire system.

The weapons carriers also experienced reliability problems in the 1984 tests with their turrets, which did not fully rotate consistently, and with their hatch doors, which frequently jammed. Further tests showed the hatch door problem had been corrected. However, the turret still exhibited rotating difficulties when it was retested in May 1985 after a contractor modification. The Army has decided to field the vehicle despite the problem. Other modifications to correct deficiencies disclosed in the 1984 tests are still being tested.

Repetitive HMMWV problems which occurred both in the 1982 and 1984 tests are identified in appendix II.

The ongoing tests of the shelter carrier have revealed durability problems with the vehicle's rear axle differential. According to the Army's tester, these are due to the shelter carrier's heavy weight. The contractor, on the other hand, has attributed the problems to improper maintenance procedures stemming from errors in the maintenance manual. The Army is still evaluating this matter.

Our specific findings are summarized below and are discussed in more detail in appendix I.

Background

The HMMWV is a 1-1/4-ton vehicle which is replacing a portion of the family of tactical vehicles used by the Army, the Air Force, and the Marine Corps. The vehicles being replaced range in size from 1/4 to 1-1/4 tons and include the M151 and M247 utility trucks, the M880 and M561 cargo trucks, and the M792 ambulance.

Because of the urgent need for the HMMWV, the Army accelerated its acquisition from a planned 7-year period to 5 years and compressed the testing schedule from 14 months to 5. Development and operational tests of the weapons carrier and utility versions were held in 1982. The HMMWV's performance exceeded that of the vehicles it is replacing, but in the operational tests, its reliability and maintainability were well below the Army requirements. Nevertheless, the Army, in March 1983, awarded a $1.2 billion 5-year production contract for about 55,000 vehicles to the AM General Corporation of Detroit, Michigan. AM General Corporation was subsequently acquired by the LTV Corporation of Dallas, Texas.

In a June 1984 report to the Secretary of Defense, we concluded that the production decision was premature in light of reliability problems disclosed in the 1982 operational tests. We felt that a multiyear production contract was not warranted in view of the numerous design changes necessitated by the disappointing operational test results. The Department of Defense (DOD) disagreed.

Reduced HMMWV Operating Capability

The operational effectiveness of the HMMWV, particularly the weapons carrier, will likely be diminished because, in certain conditions, it is too heavy to be transported by the Black Hawk helicopter in tactical operations and because its ability to run on flat tires was achieved only at the expense of a shortened tire life. Both were major Army requirements. The run-flat tire requirement is one which calls for the vehicle to operate for 30 miles with two flat tires on a hard surface road. A metal device inserted on the wheel to keep the tire from fully deflating can, at the same time, severely damage the tire. We believe the Army should have ensured that both issues were satisfactorily resolved during the development phase of this program before the production contract was awarded. The Army, however, went into production without resolving either.

Tactical Deployability

The HMMWV weapons carrier, even if it were devoid of crew or armament, would be too heavy to be airlifted and transported by the Army's utility helicopter—the UH 60A Black Hawk—at a 4,000-foot altitude and 95-degree temperature, such as would be encountered in desert conditions, notably in the Middle East. In more favorable altitude and temperature conditions, such as those in Europe, it could not be lifted if fully loaded. In those circumstances, a second helicopter would be needed to carry crew, gear, and armament. Transportability by the Black Hawk from one location to another on the battlefield has been a primary requirement for the HMMWV since the program began in November 1979.

Run-Flat Requirement

Another requirement for the HMMWV was that it be capable of continuing to operate with two flat tires for 30 miles to provide it with improved survivability. Production test results demonstrated that the vehicle could run on the current run-flat system for up to the required number of miles but that the tire was often severely damaged due to its interaction with the run-flat device over a period of time. The tire's life is, therefore, considerably shortened. This problem is a carryover from the

1982 development and operational tests, where numerous tire failures were also experienced. Because of the many tires that would require replacement, the Army has decided to implement a product improvement program to develop an effective run-flat tire system.

HMMWV Reliability

The 1984 tests of the HMMWV's reliability produced mixed results. The vehicle's mission reliability, measured by the mean miles traveled between hardware failures severe enough to stop the vehicle from completing its mission, significantly improved over the reliability shown in the 1982 tests. Both the weapons carrier and the utility vehicles exceeded the required 1,600 mean miles between failures by substantial margins. The vehicles, however, still required frequent unscheduled maintenance—corrective actions that did not affect completing the mission but that could not await regularly scheduled maintenance—reflecting a potentially high logistics burden.

In the 1984 initial production test, the vehicles met the maintenance ratio requirements which call for vehicle maintenance hours not to exceed 15.8 percent of the operating hours. However, as in the 1982 operational test, the vehicles again failed in the 1984 operational test to achieve the maintenance ratio requirements. The vehicles also did not meet the goal of 200 mean miles between unscheduled maintenance actions. Many hardware deficiencies experienced during the 1984 tests had also presented problems during the 1982 development and operational tests. Some of the frequently affected parts included the run-flat tires, service brakes, geared hubs, radiators, and accessory drive pulleys. (See app. II.)

The Army conditionally accepted the weapons carriers and utility vehicles, pending AM General's correction of several open production test deficiencies, such as cooling, heating, and noise problems. One problem involving the weapons carrier's turret was removed from the list of open deficiencies, although a recent test showed that the turret was still binding periodically.

The turret deficiency is a major concern since it affects the capability to fire the TOW missiles. During the 1984 tests of the production vehicles, the Army had problems with the turret. The turret was hard to turn, sometimes binding. This deficiency was scored as a mission failure during the tests. AM General modified the turret to correct the deficiencies. The modified turret was retested at Aberdeen Proving Ground,

Maryland, in May 1985, where it again malfunctioned, experiencing heavy binding. The Army plans no further testing.

Besides the modifications to correct the open deficiencies, AM General, on its own volition, began making modifications to correct other vehicle deficiencies. These changes included modifications to the engine, the fuel system, the electrical system, and the steering.

1984 Operational Testing Was Realistic

When procedures for the 1984 operational tests were formulated, there was some concern that the tests would not be realistic if the Army carried out plans to control test course speeds. In the recent tests, the Army exercised tighter controls over driver abuse, which Army program officials said occurred in the 1982 tests, by using monitoring devices in the vehicles to indicate if they were driven beyond performance parameters established for speed and the time it took to run the test course. By accompanying drivers over the test course at speeds within the established parameters, we determined that this additional monitoring had not adversely affected the realism of the testing.

Ongoing Tests of the Shelter Carrier

Initial production testing of the shelter carrier showed, according to Army testers, that the vehicle experienced rear axle differential and other component failures due to the vehicle's heavy weight. The rear axle failures occurred on the two vehicles tested at Aberdeen. A weak rear axle differential would adversely affect the vehicle's mobility. Army evaluators tentatively scored these as durability failures. If their evaluation is confirmed in the Army's final assessment of vehicle failures, scheduled for March 1986, it would appear to warrant a corrective modification before the shelter carrier is produced.

Conclusions

The production weapons carrier and utility vehicles, while displaying improved reliability over the prototype versions tested in 1982, continue to experience some important reliability and performance problems that could affect both combat effectiveness and operational maintenance and support. The problems with (1) the HMMWV weapons carrier's weight, which restricts the opportunities for the Black Hawk helicopter to airlift the vehicle, (2) the run-flat tires that have needed frequent replacement or repair, and (3) some of the other hardware deficiencies, should have been resolved in the development phase where they were first identified and before the 5-year production contract was awarded.

The vehicles most seriously affected by the critical problems that remain are the weapons carriers. Their usefulness in combat could be impaired unless the turret problem is solved. An affordable solution to the tire problem is still to be demonstrated, and a solution to the weight problem, which could further restrict the weapons carriers' combat use, does not seem within reach.

Although the Army is still evaluating the shelter carrier's test results, particularly those involving problems with the vehicle's rear axle differential, it seems apparent that weight problems plague this version of the HMMWV also. The other heavy HMMWV version, the ambulance, is still to be tested.

Agency Comments and Our Evaluation

DOD concurred with our findings except for the matter of the weapons carrier's turret ring. According to DOD, the effectiveness of the contractor's modifications to the turret and of prescribed preventive maintenance checks was confirmed in an assessment which the Army made in April 1985. DOD stated that while the turret experienced some rotation resistance in the May 1985 test, the test conditions were considerably more stringent than those to be expected in a combat environment. DOD indicated that the Army plans to continue evaluating deployed vehicles to confirm that the turret operates properly.

The April 1985 assessment to which DOD referred was held for the purpose of evaluating the procedures for live firing of the TOW launcher mounted on the weapons carrier, as well as procedures to be followed in case of misfires, but not to confirm that the turret worked properly. According to the Army's Operational Test and Evaluation Agency official who directed the assessment, testing of the modified turret was the responsibility of the Army's Test and Evaluation Command (TECOM). In response to our inquiries, TECOM officials told us in November 1985 that in their view the turret fixes had not been proven in testing.

DOD also stated that the HMMWV's performance capabilities far outweighed the Black Hawk's restricted ability to lift the vehicle. Although not satisfied with the life demonstrated by the run-flat tires, the Army accepted the tires because a better run-flat system has not been found. DOD's comments are included in their entirety in appendix III.

As arranged with your office, we plan no further distribution of this report until the day after the date of the report. At that time, we will

send copies to the Chairmen of the House and Senate Armed Services and Appropriations Committees and of the House Committee on Government Operations. We will also send copies to the Secretary of Defense and to the Secretaries of the Army, the Navy, and the Air Force. Copies will also be available to other interested parties who request them.

Sincerely yours,

Frank C. Conahan
Director

Contents

Abbreviations

DOD	Department of Defense
GAO	General Accounting Office
HMMWV	High Mobility Multipurpose Wheeled Vehicle
NSIAD	National Security and International Affairs Division
TECOM	U.S. Army Test and Evaluation Command

Some Major Problems With the Army's High Mobility Multipurpose Wheeled Vehicle Are Continuing

Background

The High Mobility Multipurpose Wheeled Vehicle (HMMWV) is a joint service program under which the Army, the Air Force, and the Marine Corps are replacing a portion of their existing 1/4- to 1-1/4-ton tactical vehicles with several versions of a single 1-1/4-ton vehicle. The vehicles being replaced include the M151 and M247 utility trucks, the M880 and M561 cargo trucks, and the M792 ambulance. Because of an urgent need for the HMMWV, the Army accelerated its acquisition from a planned 7-year period to 5 years and compressed the testing schedule from 14 months to 5.

Having prime responsibility for developing, testing and procuring HMMWVs, the Army awarded prototype development contracts to three firms in 1981. The firms' prototype vehicles underwent development and operational tests in 1982. The AM General Corporation of Detroit, Michigan, the winner, submitted a prototype whose performance exceeded that of the vehicles it was to replace. However, in the operational tests, its reliability and maintainability were well below the Army's requirements. Nevertheless, in March 1983, the Army awarded a $1.2 billion 5-year production contract to AM General for about 55,000 vehicles. They include about 20,000 weapons carriers, of which 4,600 carry the TOW missile; 30,000 utility vehicles, which transport cargo and troops; 4,000 ambulances; and 1,000 shelter carriers. Prices range from about $19,000 to $37,000 per vehicle. In September 1983, AM General was acquired by the LTV Corporation of Dallas, Texas.

In June 1984, we issued a report to the Secretary of Defense[1] questioning the Army's decision to award a multiyear full-scale production contract for the HMMWV. In our opinion, reliability problems disclosed during the 1982 testing of the prototype vehicles indicated that additional operational tests should have been conducted before large sums were committed for production. Further, we concluded that the vehicles' design instability did not warrant the use of a multiyear contract. The Department of Defense (DOD) disagreed. The vehicle has since undergone numerous design changes to correct hardware problems experienced during development and operational testing.

The modified production vehicles of two versions of the HMMWV—the weapons carrier and utility vehicle—were evaluated during initial production tests, which ran from July through December 1984, to determine if the earlier problems had been corrected. Testing of the shelter

[1] Army's Decision to Begin Production of the High Mobility Multipurpose Wheeled Vehicle Was Premature (GAO/NSIAD-84-136, June 12, 1984).

carrier, begun in August 1985, is almost complete, but testing of the remaining version, the ambulance, has not started. The testing of the ambulance has not yet been scheduled.

Initial production tests are similar to development tests. They are planned and conducted by the Army Test and Evaluation Command (TECOM). Tests were run at the Aberdeen, Maryland, and Yuma, Arizona, Proving Grounds.

Because of the HMMWV's unsatisfactory performance in the 1982 operational tests, Army headquarters ordered that a follow-on operational test be conducted, in addition to the initial production test. The purpose of the operational testing was to determine the vehicle's operational effectiveness and reliability by (1) verifying corrections to shortcomings identified in prior operational tests and (2) identifying any new shortcomings introduced as a result of the latest design changes. Testing was performed in 1984 at several test sites, including Fort Hunter-Liggett, California, the site of the 1982 HMMWV operational tests. The tests were managed by the Army's Operational Test and Evaluation Agency.

Objective, Scope, and Methodology

We were requested by the Chairman, Senate Committee on Governmental Affairs, to monitor the initial production and operational tests conducted in 1984 on the weapons carrier and utility vehicles and to compare the results with the 1982 test results. We were asked to give particular attention to modifications to the vehicle which had been incorporated to correct deficiencies disclosed in the earlier testing. We were also requested to evaluate the realism of the 1984 follow-on operational tests and to provide the current results of the ongoing testing of the shelter carrier.

We interviewed officials at Army Headquarters; the U.S. Army Tank-Automotive Command, Warren, Michigan; TECOM and the Army Materiel Systems Analysis Activity, Aberdeen Proving Ground, Maryland; the Army Operational Test and Evaluation Agency, Falls Church, Virginia; and the Office of the Director, Defense Test and Evaluation, in the Office of the Under Secretary of Defense, Research and Engineering. We also examined test data at Aberdeen and Yuma Proving Grounds and Fort Hunter-Liggett. In addition, we attended HMMWV scoring conferences, as well as briefings by test evaluators.

Our review of the weapons carrier and utility vehicle testing began in July 1984 and was completed in May 1985. However, we extended our

review to December 1985 in order to monitor the tests on the HMMWV shelter carrier which began in August 1985 and which the Army is still evaluating.

Our review was made in accordance with generally accepted government auditing standards.

Reduced Operational Capability

The operational effectiveness of the HMMWV, particularly the weapons carrier, will likely be diminished because, in certain conditions, it is too heavy to be transported by the Black Hawk helicopter in tactical operations and because its ability to run on flat tires was achieved only at the expense of a shortened tire life. The ability to be lifted by the Black Hawk and to run on flat tires were major Army requirements. Because of its weight, the HMMWV cannot be airlifted at altitudes of 4,000 feet when the temperature reaches 95 degrees, a condition often prevalent in the Middle East. The run-flat tire capability the Army has sought is one which permits the vehicle to continue to operate with two flat tires on hard surface roads for up to 30 miles. The HMMWV was able to achieve this in testing by having a run-flat device installed on the wheels to keep the tires from fully deflating, but not without frequent damage to the tire. Although both shortcomings were identified in early development and operational testing, the Army proceeded into production without ensuring that they were resolved. The Army would like to obtain a more effective run-flat tire system, but a practical solution to the transportability problem may not be achieved without an expensive helicopter product improvement program.

Tactical Deployability

The HMMWV weapons carrier with its payload—crew, armament, and personal gear—was required to be airlifted by the Army's Black Hawk helicopter during combat. This requirement was driven by the HMMWV's mission scenario, which calls for it to be deployed with the highly mobile light infantry division. Test results showed, however, that the loaded weapons carrier is too heavy to be lifted by the Black Hawk in certain temperature and altitude conditions. The weapons carrier, fully loaded, weighs about 8,150 pounds, whereas the Black Hawk can lift no more than 8,000 pounds. At favorable temperatures and altitudes, such as those in Europe, the unloaded weapons carrier could be airlifted but a second helicopter would be required to carry the crew, armament, and personal gear. However, in desert environments, even the empty vehicle is too heavy to be lifted, thus eliminating its deployability by the Black

Hawk under conditions likely to be found often in a Middle East scenario, e.g., a 4,000-foot altitude at a 95-degree temperature.

The weapons carrier's excessive weight and the Black Hawk's limited ability to transport it were evident in early HMMWV development tests. The original weight goals established in December 1979 for the weapons carrier were 4,700 pounds when empty and 7,200 pounds when fully loaded. These were increased in March 1981 to 5,000 and 7,500 pounds, respectively, in the HMMWV prototype specifications. The prototype vehicles tested in 1982 exceeded these specifications, weighing 5,780 pounds when empty and about 7,770 when fully loaded.

Despite the increased weight and the apparent effect on the HMMWV's availability for certain missions, the Army authorized a multiyear production contract for the vehicle. Since then, modifications to the weapons carrier have increased its weight to 6,020 pounds when empty and 8,150 pounds when fully loaded. The Army ultimately waived the weight specifications.

In 1984, the Army Aviation Center at Fort Rucker, Alabama, proposed a $7 billion improvement to the Black Hawk which, among other things, would enable it to lift the heavier HMMWV weapons carrier. The proposal was not approved at Army Headquarters because it was inadequately supported.

The Army has rewritten the system specification regarding the HMMWV's transportability by the Black Hawk. The change reveals that the HMMWV is to be lifted by the Black Hawk whenever the vehicle's weight is within the helicopter's lift capability. Thus, restricting the HMMWV's transportability by the Black Hawk to those occasions when the environmental conditions are favorable will no longer be inconsistent with this particular requirement.

Run-Flat Tires

The HMMWV run-flat tire specification was initiated to enable the vehicle to move up to 30 miles with two deflated tires. This was achieved by attaching a metal device to the wheel which prevents the tire from deflating completely. The production tests indicated the run-flat devices enabled the vehicles to meet the 30-mile requirement. However, with the device installed, the tires were prone to an unusual amount of wear. After continuous interaction with the run-flat device, many tires began to deteriorate. The tires, which have undergone a series of modifications, are costly to replace.

Production test results of the weapons carrier and utility vehicles indicated the run-flat tires could continue to have a short life span. During 120,000 miles of initial production testing, over 30 flat tires were experienced with the test vehicles, indicating the Army can expect, on the average, to repair or replace a tire about every 3,600 miles. The contract did not specify any tire life requirement. Because of the excessive number of tire repairs and replacements, the Army plans to initiate a product improvement program to develop a different tire and a suitable run-flat system to go with it.

HMMWV's Reliability

During the 1984 testing of the weapons carrier and utility vehicles, the HMMWV demonstrated improved reliability over what it showed in the 1982 tests of the prototype vehicles. Mission reliability, as measured by mean miles between hardware failures severe enough to abort the vehicle's mission, was significantly better. System reliability as measured by mean miles between unscheduled maintenance actions—corrective actions that cannot await the scheduled periodic maintenance—also increased. However, the vehicle still fell short of the specification for this measure of reliability. The vehicles met the required maintenance ratio—the relationship of vehicle maintenance hours to operating hours—in the initial production tests, but they fell short in the 1984 operational tests.

The contract specification for mission reliability, 1,600 mean miles between mission failures, was exceeded in the initial production test. While there was no similar contractual requirement for the vehicles to meet in the follow-on operational tests, the HMMWV also exceeded the contract specification in those tests.

Mission reliability results are presented in table I.1 for both phases of testing.

Table I.1 Comparison of Mean Miles Between Mission Failures

	Utility vehicles	Weapons carriers
1982 development test	2,702	1,108
1984 initial production test	4,292	2,937
1982 operational test	521	300
1984 operational test	1,737	4,586

The vehicles' reliability is also reflected by the mean miles achieved before an unscheduled maintenance action becomes necessary and by

the ratio of maintenance hours expended on the vehicles to their operating hours. These two measurements are prime indicators of the degree of maintenance the vehicles could require.

A requirement for 320 mean miles between unscheduled maintenance actions was originally established in the HMMWV specifications. This requirement was included in the specifications at the request of the Army Logistics Evaluation Agency. In the 1982 tests, the prototype HMMWVs failed to meet this requirement by a wide margin, achieving only 107 mean miles between unscheduled maintenance actions in development tests and 82 mean miles in operational tests. The "requirement" was subsequently changed to a "goal" and reduced to 200 mean miles in the production contract specifications. During the 1984 initial production testing, the vehicles showed an improvement over the prototypes tested in 1982, achieving 177 mean miles between unscheduled maintenance actions. In the operational phase of the 1984 testing, the vehicles achieved only 134 mean miles between unscheduled maintenance actions, well short of the reduced goal of 200 mean miles.

With regard to the maintenance ratio, the 1984 test results were mixed. The requirement is that maintenance hours not exceed 15.8 percent of operating hours. In initial production testing, the weapons carrier and utility vehicles met the required maintenance ratio. In the operational tests, however, the maintenance ratios reached 27 percent for the utility vehicles and 28 percent for the weapons carriers. These levels were even higher, i.e., worse, than the levels measured in the 1982 operational tests.

Open Production Test Deficiencies

AM General was required to correct performance-related deficiencies for which corrections are still being tested. These open deficiencies were identified during initial production testing in 1984 of the weapons carrier and utility versions. Army acceptance of the production vehicles is conditional, pending correction of these deficiencies.

The deficiencies are as follows:

- A cooling problem occurs when the vehicle is carrying a full load.
- The vehicle's interior and exterior noise levels exceed established criteria.
- The heater and defroster fail to operate properly.
- Some vehicle seats are easily broken.

Another deficiency, no longer included among those identified earlier, involved the turret, which periodically could not be rotated. The deficiency was scored as a failure during the 1984 tests. AM General modified the turret, and it was retested at Aberdeen Proving Ground in May 1985 but still malfunctioned, experiencing heavy binding, which impeded its rotation. Nevertheless, the Army decided to begin fielding the weapons carrier and has not required the contractor to expend any further effort on the turret. The turret deficiency, in our view, is a major concern since it affects the capability to fire the TOW missile.

Other Vehicle Modifications

AM General, on its own volition, has made modifications which relate to other identified vehicle deficiencies, in addition to the open deficiencies the contractor was required to correct. These other modifications included some which involved the engine, the parking brake, the fuel system, the electrical system, and the steering.

These changes, while extensive, do not address a potential problem involving mud contamination of other major vehicle subsystems.

- Mud, water, and dirt enter the engine during muddy operations.
- The radiator has cooling problems during vehicle operations in muddy conditions.
- The vehicle's open brake system exposes the brake pads to mud and water contamination.

Premature engine wear is a continuing problem first identified in the 1982 development tests, where one engine failure was attributed to dirt contamination. Engine contamination, in our opinion, is a concern because it persisted after modifications which were supposed to have solved this problem were made to the air intake system. AM General agreed to further modify the air induction system and other possible sources of contamination at the oil dipstick and oil filler tubes.

Similarly, excessive brake pad wear was reported during muddy conditions in the 1982 development and 1984 initial production tests. While the problem was attributed to the open brake system, the Army concluded that it may be only partially correctable unless a sealed brake system is provided. According to Army officials, they were studying the cost trade-off of a sealed system.

Operational Testing in 1984 Was Realistic

The Army exercised tighter controls over the 1984 operational tests than it did over the 1982 operational tests. Because of criticism by Army program officials that drivers abused vehicles during the 1982 tests, the Army installed monitoring devices in the vehicles to measure such things as speed and the time it took to run the test course. The drivers' performances, as measured by these devices, were then compared with preestablished performance criteria. The criteria were derived from suggestions by a panel of selected personnel from various government agencies, including Army and Marine Corps Operational Test and Evaluation Agencies. When monitoring indicated that vehicles were being driven in excess of established performance parameters, the drivers were to be counseled. We were told of five instances where drivers had to be cautioned about speeding—for exceeding 60 miles an hour on hard surface roads.

In our view, this monitoring did not affect the realism of the tests. In accompanying drivers on test courses, we observed that the speeds driven were not constrained below what would be appropriate for reasonable safety precautions.

Ongoing Testing of the Shelter Carrier

After accumulating about 10,000 miles of endurance testing on each of two shelter carriers during initial production testing, several component failures were identified by TECOM as being related to the shelter carrier's heavy weight—8,600 pounds. Those noted were

- high engine water temperatures (five occurrences);
- excessive wear of parking brake, brake pad, and rotor assemblies (eight occurrences);
- upper and lower control arm ball stud failures (four occurrences);
- upper and lower arm failures (three occurrences);
- rear axle differential gears binding and loss of antislip capability (four occurrences);
- front drive shaft universal joint failures (two occurrences);
- rear suspension crossmember cracking (two occurrences); and
- shock absorber and attaching bracket failures (four occurrences).

The Army scored the rear axle differential breakdowns—one on one shelter carrier and three on another—as mission failures. The contractor stated that the failures were caused by a lubrication problem which was due to following improper instructions in the maintenance manual. The Army scorers disagreed.

If the differential failures are judged to be durability failures in the Army's final assessment of the shelter carrier failures, scheduled for March 1986, a corrective modification to the rear axle differential would be required.

Repetitive HMMWV Problem Areas and Implemented or Proposed Corrections

1982 test	Correction	1984 test	Correction
Engine Air Induction System			
Water and mud contaminated air filter and engine.	Installed baffles in air cleaner box. Redesigned air plenum- to-air intake manifold seal.	Two engines failed; failure attributed to mud and water contamination entering engine crankcase: Mud and water entered through air intake. Dirt entered around oil filler cap gasket, oil dipstick, and rear main crankshaft seal. Engine oil analysis showed an increasing rate of engine wear on all production test vehicles.	Modified vehicle air induction system, added sealer to oil dipstick tube, and plugged engine valley hole.
Tires			
Run-flat tires experienced numerous failures.	Modified tire and reduced width of run- flat device.	Tires experienced cracks and excessive wear.	Tire composition and tread design improved. The Army plans to implement a product improvement program.
Accessory Drive Pulleys and Belts			
Aluminum pulleys and belts became excessively worn.	Revised pulley coating to preserve use of aluminum and to attain lightweight configuration.	High wear of pulley and belt assemblies attributed to operation in muddy conditions. Two mission failures and 67 unscheduled maintenance actions resulted.	Aluminum pulleys changed to cast iron pulleys. Decreased diameter of alternator pulley hole
Deep Water Fording			
Major components were contaminated with water in both 30- and 60- inch ford.	Incorporated pressurized vent system. Restricted vehicle entry speed for fording.	In 30-inch ford, the vehicle stalled due to thermal shock to fuel injector pump and geared hub contamination. In 60-inch ford, the transfer case and geared hub became contaminated.	Added insulating boot to fuel injector pump, modified geared hub seal, and changed operations manual to restrict speed of entry.
Geared Hubs, Upper and Lower Ball Joints			
Fractured geared hub housing. Lower ball joints became loose.	Material changed from cast to modular iron. Increased strength of lower ball joint fasteners.	Geared hub was contaminated with water and mud. Ball joint fasteners were too brittle and broke.	Modified geared hub lip seal and half shaft. Changed bolt used for fastener.
Lights			
Side marker lamps were inoperative.	Relocated side marker lamp assembly.	Lamps, including side marker lamps, failed numerous times.	No new action is planned.
Service Brake			
Brake pads were excessively worn.	Modified brake components and established post- operation cleaning procedures for extreme mud conditions.	Brake pad eroded prematurely during muddy conditions. Expected brake pad life (Aberdeen Proving Ground data): Front 4,400 miles. Rear, 10,000 miles.	Army plans to study cost effectiveness of implementing a product improvement program.
Parking Brake			
Parking brakes failed.	Redesigned parking brake from a foot- to a hand-operated system.	Parking brake failed to hold on 40-percent slope and required excessive force to operate.	TECOM considers problem closed.

1982 test	Correction	1984 test	Correction
Noise			
Interior noise was excessive.	Improved sound-deadening material in proposed production vehicle.	Interior and exterior noise was excessive.	Open test of deficiency under terms of Army conditional acceptance agreement.
Driver's Seat			
Seat frame welds cracked.	Different seat used for production.	Driver seat frame cracked.	No action is planned.
		Driver seat springs broke.	Spring supplier to improve quality control procedures.
Front Prop Shaft			
Center support bearing worn on two-piece drive shaft.	Bearing eliminated by redesign to a one-piece drive shaft.	Front single-piece drive shaft failed at high speeds.	Revised two-piece drive shaft incorporated.
Full-Load Cooling			
Cooling in original prototype configuration was unsatisfactory. After modification and retest, several components were recognized as having marginal cooling ability.	Relocated radiator and redesigned radiator fan .	Production vehicle failed full-load cooling requirement.	Open test deficiency under terms of Army conditional acceptance agreement, with at least eight cooling system modifications being applied to production vehicles. In addition, the cooling specification was reduced.
Helicopter Transportability			
Loaded helicopter weight exceeded specification. Although lifted by the UH 60A Black Hawk helicopter, it was noted frequent no-lift situations would be encountered.	No effective action taken as HMMWV weight requirement was increased to accommodate practical design limitations.	Production vehicles were too heavy to be externally transported by UH 60A Black Hawk as required.	Specification changed to required HMMWV lift by UH 60A Black Hawk within current vehicle weight limitations.
Prototype height and width clearances judged unsafe for internal loading in CH-47 and CH-53 helicopters.	Not available.	Production vehicles were too wide to be internally transported in CH-47 and CH-53 helicopters as required.	Contract specification was changed; internal CH-47 and CH-53 lift requirement was deleted.
Weapon Station			
Weapon station design was unsatisfactory.	Redesigned weapon station:	Turret failed to rotate due to binding of turret ring.	Contractor increased spacing of ball bearings and made a users manual change to require daily exercising of turret. Program management officials believed that a 500-mile TOW operational assessment validated fix. TECOM, however, did not agree fix had been properly validated. Hinge and latch improved and validated by TECOM.
	Cupola was eliminated.	Missile loading hatch was difficult to open and sometimes could not be opened.	
	Hatch door configuration was changed.		

Advance Comments From the Department of Defense

THE UNDER SECRETARY OF DEFENSE

WASHINGTON D C 20301

RESEARCH AND ENGINEERING

(TWP)

18 FEB 1986

Mr. Frank C. Conahan
Director, National Security and
International Affairs Division
U.S. General Accounting Office
441 G Street, N.W.
Washington, DC 20548

Dear Mr. Conahan:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report entitled, "Some Problems with the Army's High Mobility Multipurpose Wheeled Vehicle Continue," dated 3 January 1986 (GAO Code 393074/OSD Case 6911).

The detailed DoD comments on each finding are provided in the attachment. DoD concurs with the findings that address HMMWV operating capability, maintenance reliability, 1984 operational testing, and ongoing testing of the shelter carrier. DoD partially concurs with the finding which addresses turret reliability. The DoD response provides reasons for the partial concurrence and puts the cited problem in proper perspective. Thank you for the opportunity of commenting on the draft report.

Sincerely,

Donald A. Hicks

Attachment

**GAO DRAFT REPORT - DATED JANUARY 3, 1986 (GAO CODE 393074)
OSD CASE 6911**

"WEAPON SYSTEMS--SOME PROBLEMS WITH THE ARMY'S HIGH MOBILITY MULTIPURPOSE WHEELED VEHICLE (HMMWV) CONTINUE"

DEPARTMENT OF DEFENSE COMMENTS

* * * * *

FINDINGS

- **FINDING A: Reduced HMMWV Operating Capability.** The GAO reported that one major Army requirement for the HMMWV since the program began in November 1979, is the ability of the Army Black Hawk helicopter to transport the HMMWV weapons carrier. The GAO found, however, that the HMMWV will be too heavy, even without crew or armament, to be transported by the Black Hawk at a 4,000-foot altitude and 95-degree temperature, such as would be encountered in desert conditions in the Middle East. In more favorable altitude and temperature conditions, such as in Europe, the GAO reported that the HMMWV could not be lifted if fully loaded with crew and armament. Another major Army requirement for the HMMWV, the GAO reported, was that the HMMWV be capable of continuing to operate with two flat tires for 30 miles to improve survivability. The GAO found, however, that production test results demonstrated the tires were often severely damaged, considerably shortening their life. The GAO also reported that this tire problem was a carryover from the 1982 development and operational tests, where numerous tire failures were also experienced. The GAO concluded that the operational effectiveness of the HMMWV, particularly the weapons carrier, will likely be diminished because it is too heavy to be transported and because of the shortened tire life. The GAO also concluded that a solution to the weight problem does not seem within reach, and an affordable solution to the tire problem is still to be demonstrated. The GAO further concluded that the Army should have ensured both these issues were satisfactorily resolved during the development phase of the HMMWV program before awarding the March 1983, $1.2 billion 5-year production contract. The GAO noted conclusions in its June 1984 report (OSD Case 6498) that the Army production decision was premature and a multiyear contract was not warranted. (pp. 4-5, and 9, GAO Draft Report)

Now on pp 3-6

DoD Response: Concur. The Army decided that the restricted lift profile with the Blackhawk helicopter was far outweighed by other capabilities of the vehicle. Final

Enclosure

revision of the system specification and continued production were approved at the Joint Services Quarterly Interim Program Review (IPR) held March 27-29, 1985. Although not satisfield with demonstrated life of the run-flat tires, the Army approved continued production at the same IPR because the run-flat tires in fact achieved the required capability and because a superior run-flat system had not been identified.

- **FINDING B: HMMWV Reliability (Maintenance And Hardware Deficiencies).** The GAO reported that the 1984 tests of HMMWV's reliability produced mixed results. The GAO found that, in the 1984 initial production test, the weapons carrier and the utility vehicles met the maintenance ratio requirements (maintenance hours compared to operating hours); however, as in the 1982 operational test, the vehicles again failed in the 1984 operational test to achieve the maintenance ratio requirements. The GAO also found that the vehicles did not meet the goal of 200 mean miles between unscheduled maintenance actions. The GAO further found that many hardware deficiencies experienced during the 1984 tests were problems during the 1982 development and operational tests--frequently affected parts included the tires, brakes, geared hubs, radiators, and accessory drive pulleys. (The GAO identified repetitive HMMWV problems that occurred both in the 1982 and 1984 tests in Appendix II of the Draft Report). The GAO concluded that these hardware deficiencies should have been resolved in the development phase where they were first identified and before the 5-year production contract was awarded. (pp. 2, 6 Letter, pp. 15-18 Appendix II, GAO Draft Report)

Now on pp. 1-2, 4, and 19-20

DoD Response: Concur. After a thorough analysis of Initial Production Test (IPT) and Follow On Evaluation results, the Army decided that the strong performance demonstrated by the HMMWV in terms of Mean Miles Between Mission Failure, Mean Time to Repair, and Maintenance Ratio outweighed the relatively weaker performance assessed against the measure of Mean Miles Between Unscheduled Maintenance Actions. As a result, the Army approved continued production of the HMMWV and amended the Reliability Availability and Maintainability criteria to reflect the capability of production vehicles, as recorded in the March 27-29, 1985, Minutes of the Joint Services Quarterly IPR.

- **FINDING C: HMMWV Reliability (Turret Deficiency).** The GAO reported that the Army conditionally accepted the delivery of weapons carrier and utility vehicles, pending AM General's correction of several open production test

deficiencies, such as cooling, fording, noise and parking brake problems. The GAO found, however, that a turret deficiency was removed from the list of open deficiencies, but is still a major concern because the deficiency affects the capability of HMMWV to fire TOW missles. The GAO also found that during 1984 tests of the production vehicles, the turret was hard to turn, sometimes binding, and this deficiency was scored as a mission failure. Although AM General modified the turret to correct the deficiency, the GAO found that the modified turret was retested in May, 1985, where it again malfunctioned, experiencing heavy binding. The GAO reported that the Army planned no further testing and decided to field the vehicle despite the turret problem. The GAO concluded that the combat usefulness of approximately 20,000 weapons carriers the Army is procuring could be impaired unless the turret problem is solved. (pp. 2,6,7, and 9, GAO Draft Report)

Now on pp. 1-2 and 4-6

DoD Response: Partially concur. The HMMWV weapon station was redesigned based on problems experienced in the operational tests. The turret ring bearing spacing was increased and preventative maintenance checks and services (PMCS) to exercise the turret ring on a daily basis were added to the manual. The effectiveness of the design change and PMCS adjustments was confirmed during an operational assessment at Aberdeen Proving Ground, Maryland, in April 1985. Although some rotation resistance was experienced during a May 1985 dust chamber test, it occured only after subjecting the turret ring to an extreme amount of contamination, considerably in excess of that which can be reasonably expected in a field/combat environment. A continuing post-fielding evaluation of HMMWV will confirm proper turret ring operation.

- **FINDING D: 1984 Operational Testing Was Realistic.** The GAO reported that for the 1984 operational tests, the Army exercised tighter controls over driver abuse of the vehicles, which Army program officials said occurred in the 1982 tests. The GAO pointed out that monitoring devices were in the 1984 vehicles to indicate whether they were driven beyond performance parameters established for speed and the time it took to run the test course. The GAO noted that, when these procedures were first formulated, it was concerned the tests would not be realistic if the Army controlled test course speeds. The GAO found, however, that the additional monitoring had not adversely affected the realism of the testing when it accompanied drivers over the test course at speeds within the established parameters. The GAO, therefore, concluded that the operational testing was realistic. (p. 8, GAO Draft Report)

Now on p. 5

DoD Response: Concur.

Now on pp. 2 and 5-6

- **FINDING E: Ongoing Tests Of The Shelter Carrier.** The GAO reported that, during initial production testing of the shelter carrier, rear axle and other component failures occurred. The GAO also reported that, according to the Army's tester, these failures were due to the shelter carrier's heavy weight. The GAO further reported, however, that the contractor attributed the problems to improper maintenance procedures stemming from errors in the maintenance manual. The GAO found that Army evaluators tentatively scored these failures as durability failures. The GAO concluded that if the evaluators' scoring is confirmed in the Army's final assessment of vehicle failures, scheduled for April 1986, a corrective modification is warranted before the shelter carrier is produced. The GAO also concluded that, although the Army is still evaluating the shelter carrier's test results, weight problems plague this version of HMMWV also. Finally, the GAO noted that the other heavy HMMWV version, the ambulance, is still to be tested. (pp. 3 and 8-10, GAO Draft Report)

  DoD Response: Concur. The initial production testing of the shelter carrier is not expected to be completed until February 1986. A final assessment conference is scheduled for late, February 1986. All failures will be reviewed at this time as well as the need for corrective modifications for production prior to fielding of the shelter carrier.

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.

34215

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