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Army's Apache Helicopter Has Proven Difficult to Support

Statement of
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National Security and International
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Committee on Energy and Commerce
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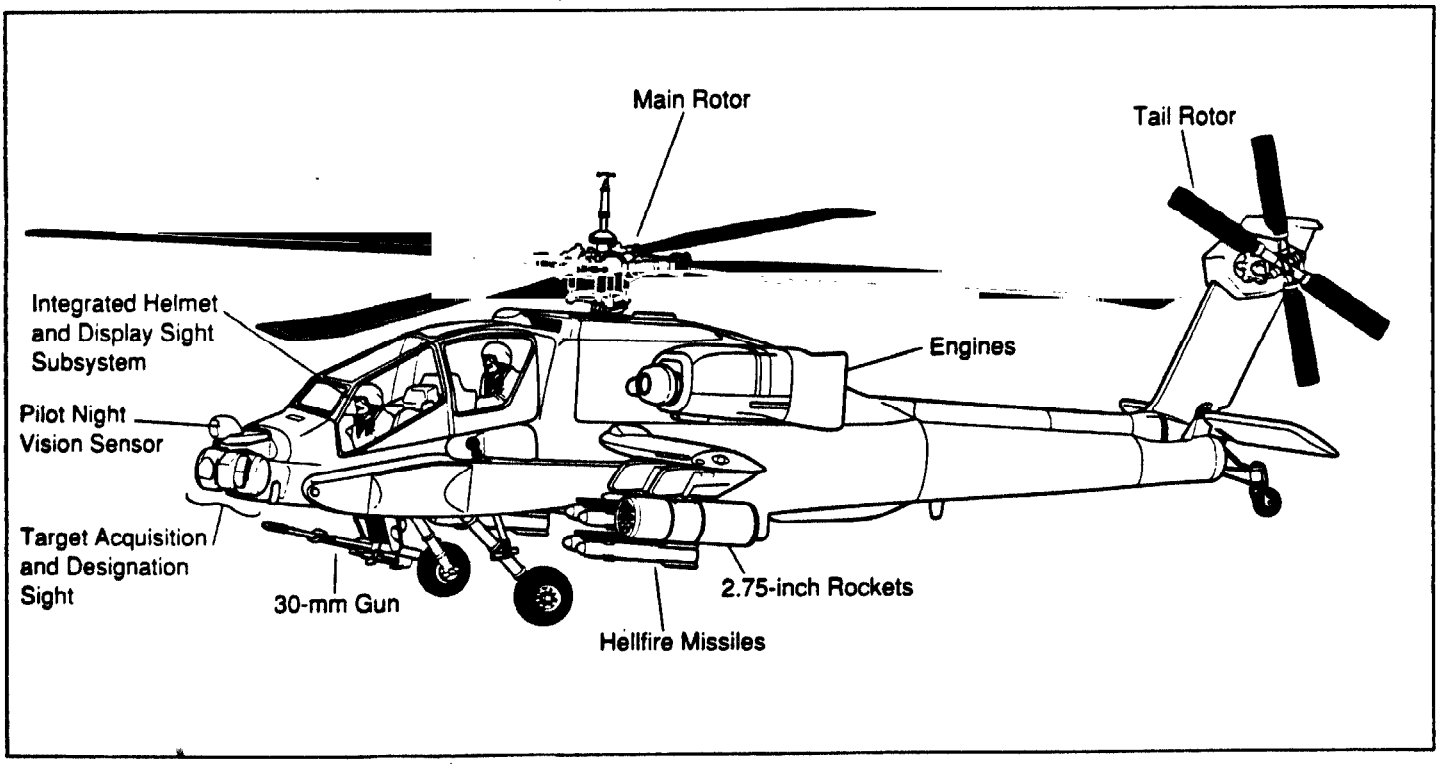
rotor mast to work with a new seeker in the Hellfire missile. The Army estimates the costs to equip the Apache with the radar and associated avionics at $3.4 billion.

APACHE AVAILABILITY RATES ARE LOW AND HAVE DECLINED AS AIRCRAFT ACCUMULATE HOURS

The Army tracks availability daily against its goal that 70 percent of Apaches are to be fully mission capable. An Apache is fully mission capable if it can perform all of its assigned missions. To be fully mission capable, the Apache's basic airframe (including its engines and rotors) and other essential systems must be operational. Figure 1 depicts these systems. Other systems essential to being fully mission capable, but not shown in the figure, are aircraft survivability equipment, radios, and the radar altimeter.

Figure 1: The Apache's Essential Systems

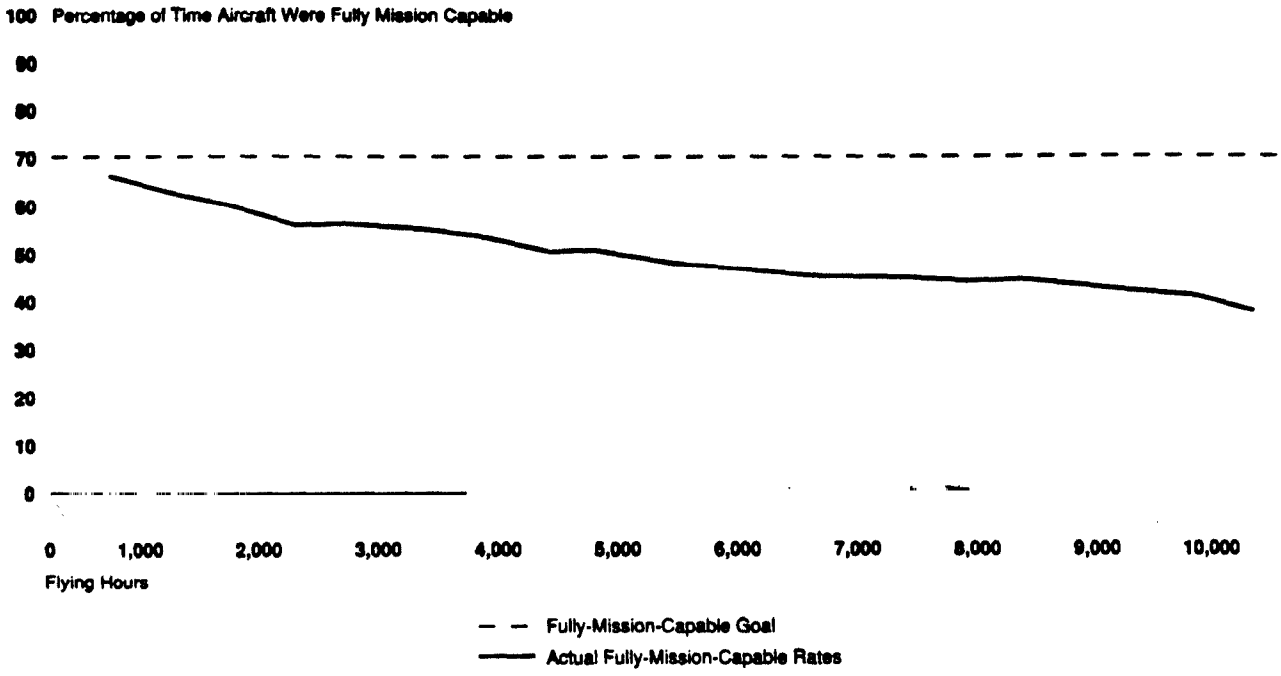


The Apache is at its peak combat effectiveness and survivability when it is fully mission capable. If one or more of the Apache's essential systems are inoperative but the helicopter is at least flyable for training purposes, it is classified as "partially mission capable." If it is not capable of flying or performing any assigned missions, it is classified as "non-mission capable." According to the Army's goals, the Apache is to be partially mission capable no more than 5 percent of the time and non-mission capable no more than 25 percent of the time.

On the basis of the 11 active combat battalions fielded when our work began, we found that the Apache's fully-mission-capable rates are low--averaging 49 percent during 1989. For the same period, the 11 battalions had partially-mission-capable rates of 14 percent and non-mission-capable rates of 37 percent. The Apache fleet did not meet the fully-mission-capable requirement in the 3 preceding years.

Perhaps more significantly, we found that fully-mission-capable rates have decreased as units have aged and accumulated flight hours. Figure 2 depicts the average rates for the 11 battalions as they have accumulated flying hours since fielding began in 1986 through December 15, 1989.

Figure 2: Apache Fully-Mission-Capable Rates and Accumulated Flying Hours



Source: GAO analysis of Army data.

Figure 2 shows that when each of the 11 combat battalions accumulated about 500 hours, they had averaged a 67 percent fully-mission-capable rate since initial fielding. By December 15, 1989, only 2 of the 11 battalions had accumulated over 10,000 hours, and they had averaged a 38 percent fully-mission-capable rate since they began operations in 1986. One of the contributing factors to this degradation is that, over time, the Apache's maintenance demands increase while battalions lose experienced maintainers. In 1989, fully-mission-capable rates dropped faster and were lower than would normally be expected due to a severe storm in May 1989 that damaged over 100 Apaches at Fort Hood, Texas. Average fully-mission-capable rates for the 11 battalions dropped from 58 percent during the first 5 months of 1989 to 42 percent in the last 7 months. However, the pattern of declining rates and accumulated

flying hours changed little after the storm. In my opinion, the storm only worsened an already poor situation.

The Apache's fully-mission-capable rates have been maintained under fairly favorable operating conditions. Each Apache in the 11 battalions has flown an average of only 12.8 hours per month. By comparison, the Marine Corps typically flies its AH-1 Cobra attack helicopter and its AV-8B Harrier jet twice as many hours per month. If the Apache were flown as much, the demand for maintenance and parts would increase. Similarly, firing weapons such as the missile and gun takes place only during a small portion of the Apache's flying hours and may generate more maintenance downtime with more usage. The Army's reliance on contractor support also benefits Apache availability. I will discuss contractor support later in more detail.

One must be careful not to interpret the availability rates too literally--they are more useful as indicators than as precise measurements. For example, the availability of the entire Apache fleet can drop suddenly when the aircraft must be grounded to make a safety-related inspection or repair. Likewise, battalions can achieve high availability rates in short-duration exercises when they are well prepared. Battalions located in Europe tend to have higher availability rates than those in the United States because their personnel and aircraft are assigned a higher priority, and they have more contractor assistance available. Another reason that the Apache's availability rates cannot be taken too literally is that an Apache does not always have to be fully mission capable to perform the particular mission at hand. For example, an Apache with an inoperative night vision sensor is still capable of performing a day mission, but may not be able to perform the same mission at night.

COMPONENT FAILURES CREATE HIGH DEMAND FOR MAINTENANCE AND PARTS

The frequent failures of key components and the resulting high demand for maintenance and parts are major contributors to the Apache's low availability. The major problems with component reliability involve (1) basic flight components, such as the main rotor and the tail rotor (whose failure impairs the Apache's ability to fly) and (2) sophisticated electronic components and armament (whose failure impairs the Apache's mission effectiveness). Problems can also vary, depending on weather conditions. In humid conditions, cooled electronic components can suffer from moisture buildup; in the desert, sand ingestion and avionics cooling can pose problems; and in rain, water can leak into the cockpit and the avionics compartments.

Some key components fail or require maintenance much more often than expected. Examples of these components are listed in table 1, along with their expected and demonstrated intervals between failures or replacements.

Table 1: Expected and Demonstrated Replacement/Failure Intervals for Apache Components

	Replacement/failure interval	
Component	Expected	Demonstrated
Main rotor blades	1,500 hours	164 hours
Main rotor strap pack	1,500 hours	520 hours
Shaft driven compressor	2,000 hours	400 hours
Tail rotor swashplate	1,500 hours	250 hours
30-mm gun	3,838 rounds	1,048 rounds

Further, electronic components such as the target acquisition and designation sight are major sources of downtime on the Apache.

These problems are not new, and the Army has been working to resolve them. However, over time, new problems emerge that also require solutions. For instance, inspections attendant to the

extensive 500-hour scheduled maintenance have disclosed more extensive damage than expected, including deteriorating fuel cells, airframe cracks, and rust in some major components such as transmissions. Also, manufacturing defects have been found on a production lot of several main rotor components. While there are indications that the defects could reduce component lives and could pose a safety problem, the Army has not yet determined the severity of the defects. We plan to continue work on these manufacturing defects.

High failure rates among components place a heavy burden on maintenance units. For example, removing and replacing a main rotor blade takes about 20 maintenance man-hours and results in 8 hours of non-mission capable time--excluding the time it takes to repair the blade itself. Failures in electronic components are demanding a significant amount of time to accurately troubleshoot; the Commander of U.S. Army, Europe, has reported that up to 50 percent of the time on the hangar floor is spent on troubleshooting and diagnostics. The burden of preventive maintenance has also increased, as many special inspections have been added to monitor problem components. For example, the preventive maintenance service performed every 10 flight hours or 14 days takes 5 hours rather than the 1.5 hours it is supposed to take.

In peacetime, the maintenance burden is somewhat eased by the availability of aircraft hangars. Some maintenance tasks that are currently performed inside the hangars would be more difficult, if not inadvisable, to perform outdoors or on unprepared surfaces. For example, the hangar provides the clean environment required for performing maintenance on the Apache's night vision and targeting sensors, and the hangar's overhead hoist facilitates the removal of the aircraft's major components such as the main rotor head.

The supply of key replacement parts cannot keep up with demand. Spares for many key components are not available from unit supply stocks, and units must order replacements for those components not reparable by intermediate maintenance. As might be expected, many components in short supply--such as main rotor blades, main rotor strap packs, and targeting sight components--also experience high failure rates. To minimize aircraft downtime awaiting replacement parts, maintenance units routinely take parts from Apaches already down. In some cases, supply is limited because suppliers have not been able to meet the competing demands of producing components for new Apaches and producing spares and repairing components for fielded Apaches.

MAINTENANCE MANPOWER AND EQUIPMENT ARE INSUFFICIENT TO MEET DEMANDS

Aircraft availability also suffers because Apache maintenance personnel and equipment are insufficient to keep up with the Apache's maintenance burden. The Apache battalion organization, which is responsible for 18 Apaches, 13 OH-58 observation helicopters, and 3 UH-60 utility helicopters, was not structured to satisfy the Apache's requirements, but rather those of the less complex Cobra.

The Apache battalion is currently authorized 264 people, about 100 of whom are involved with helicopter maintenance. In comparison, the Marine Corps provides twice as many maintenance personnel to a squadron of 12 Cobras and 12 UH-1 Hueys. According to the Army's manpower analysis for the Apache, the battalion should have 366 people, including about 160 for helicopter maintenance. Even this analysis appears conservative, considering that current estimates of maintenance man-hour requirements and combat flying hours are much higher than assumed by the manpower analysis.

The maintenance capacity of the austere Apache battalion is further limited in that (1) Apache maintainers spend only about 30 percent of their time on maintenance due to other demands and (2) several battalions are staffed at fewer than the 264 people authorized. As a result of the overtime needed to keep up with demands and the limited career path within direct maintenance, the Army is starting to have morale and reenlistment problems among Apache maintainers.

The Army's ability to meet maintenance demands has also been hampered by automatic test and diagnostic equipment that has not proven capable of the quick and accurate troubleshooting of faults in electronic components essential to high rates of availability. This equipment is central to the Apache's three-level maintenance concept, whereby (1) fault detection equipment aboard the Apache is to detect failed components for unit-level maintainers to remove, (2) a mobile electronic test facility at the intermediate level is to diagnose the failed components so they can be repaired, and (3) repairs not possible or practical at the intermediate level are to be sent to depot facilities.

The built-in fault detection/location system has experienced difficulty in locating the source of faults, and 40 percent of the time it detects faults that do not exist. As a result, additional manual troubleshooting is required, and a greater work load is passed on to the intermediate-level electronic test facility. The test facility is slow in testing electronic components, and the spare circuit cards needed to repair the components are in short supply. Originally, the test facility was intended to be capable of testing and repairing circuit cards, but the Army later deleted this capability. Consequently, many of the components the test facility should test are instead passed on to contractor facilities. Those it does test can take over 30 days to repair at the intermediate level.

These repair problems, coupled with the shortage of spare parts, can have a crippling effect on the Apache battalion: when a critical component fails, maintainers cannot easily replace or quickly repair it. Instead, the aircraft must do without the component and remain partially capable or non-mission capable for extended periods, unless the same component is taken from another Apache.

THE ARMY RECEIVES CONSIDERABLE SUPPORT FROM CONTRACTORS

The Army relies heavily on contractors to alleviate the Apache's maintenance burden. Apache units have contractor technical representatives available full-time to assist in troubleshooting and in advising Army personnel. Some units have hired contractors to help perform actual unit and intermediate-level maintenance: contractors perform a significant portion of the unit-level maintenance at two battalions in Europe.

The Army had originally planned to take over depot-level maintenance at this stage in the program. However, most depot maintenance is still performed by contractors. The delay in transitioning to Army depot support has occurred for several reasons, including the unavailability of funds. Because of the sophistication and technical problems associated with avionics components, and on the basis of cost benefit analyses, the Army decided that some components such as the targeting and night vision sensors, will indefinitely remain with contractor depot maintenance.

Contractor Special Repair Activities, originally fielded to alleviate production problems with the targeting and night vision sensors, have become integral to the repair of these sensors. Although they are considered depots, the repair activities carry much of the work load originally intended for the Army's

intermediate-level electronic test facility and repair shops. The Army plans to establish additional Special Repair Activities for the repair of some mechanical and other electronic components. Army officials told us that they would like to staff the repair activities with Army personnel, but they must overcome the obstacles of first getting the additional people and then providing them with a career path so the Army can retain their expertise.

SEVERAL ASPECTS OF THE APACHE'S ACQUISITION HAVE CONTRIBUTED TO THE CURRENT PROBLEMS

While the problems of availability, reliability, maintenance, and supply are manifest today, to a large extent their origins can be traced back to problems identified at the time of the production decision and to weaknesses in how the Army measures the Apache's performance against its requirements.

In preparing for the 1982 production decision, Army logisticians warned of the undemonstrated ability of the Apache's on-board and off-board diagnostic equipment to perform as required. Also, the targeting sensor and the 30-mm gun fell short of reliability requirements during 1981 operational and subsequent testing. We reported these concerns in 1981 and 1983, and it is disconcerting to find the same problems today.[1] Since the initial production decision, the Army Materiel Systems Analysis Activity has formally disapproved subsequent releases of more Apaches to the field due to logistic support, reliability, and other concerns. The Activity was overruled in each case, and fielding continued.

I believe that problems with the Apache's logistic support have

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[1]See The Army's Advanced Attack Helicopter Is Not Ready for Production (MASAD-82-8, Dec. 1, 1981) and The Army's AH-64 Helicopter and Hellfire Missile Retain Risks as They Enter Production (GAO/C-MASAD-83-9, Jan. 26, 1983).

persisted because of the following competing priorities experienced during production:

-- Apache production began when numerous design changes were still required.

-- Resources were concentrated on achieving high rates of production.

-- A low-rate production phase and follow-on operational testing were omitted (these steps would have been prudent, given the aircraft's design instability and the immaturity of diagnostic equipment).

-- Staffing constraints prevented increasing the number of Apache maintainers.

In addition, while the Apache is experiencing low fully-mission-capable rates in the field, in testing the Army determined that the Apache had met, or nearly met, its design requirements for reliability, maintainability, and availability. This seeming contradiction exists because many of the factors affecting the Apache's performance in the field were excluded from performance measurements during testing.

For example, during testing, the Apache met its mission reliability requirement of 19.5 hours between failures, but this measurement included only a small portion of failures. It included only inherent hardware failures that caused mission aborts in flight, and it excluded the performance of the 30-mm gun. Measurements that shed more light on operations and maintenance in the field are available--such as the rate of failures in mission-essential equipment, which, according to Army data, occur every 1.5 to 2.4 hours. However, there are no standards by which to judge such measurements because Apache requirements are not defined in these terms.

Similarly, the Army's estimate that the Apache needs 7 or fewer maintenance man-hours per flight hour--which is well within the requirement of 8 to 13 man-hours--understates the helicopter's

actual maintenance burden in the field. The Army's estimate is not based on complete information. At selected battalions, the Army collects some man-hour data on unscheduled (or corrective) maintenance, but it excludes scheduled (or preventive) maintenance. In tests, calculations of maintenance man-hours have also excluded a significant amount of scheduled maintenance and have been further reduced by the participation of contractor personnel.

The estimate of 7 maintenance man-hours per flight hour seems unreasonably low because it (1) is inconsistent with estimates that expert contractor maintainers at the Army's aviation school expend at least twice as many maintenance man-hours per Apache flight hour, and (2) is inconsistent with the more complete estimates of maintenance man-hours calculated by other services on their aircraft. For example, according to the Marine Corps, the simpler UH-1 helicopter requires 16 direct maintenance man-hours per flight hour, while the AV-8B requires about 28 per flight hour. Furthermore, if the 7 maintenance man-hours were accurate, it would lead to the erroneous conclusion that the Apache battalion has too many maintainers.

The Army has assessed the Apache as meeting its 75-percent availability design requirement during testing. However, availability as measured during testing combines fully-mission-capable time with partially-mission-capable time. Thus, it includes Apaches that have failures in mission-essential systems--such as the sensors and weapons. Availability during testing further benefited from contractor maintenance assistance and from the exclusion of key scheduled maintenance.

Had the Army established more operationally realistic requirements for Apache reliability, maintainability, and availability and assessed performance against these requirements, the shortcomings of the helicopter and the Army's support capabilities would have been more evident. Such an assessment could have led to better

decisions and corrective actions before this late stage in the program. The Army has acknowledged the limitations of the Apache's reliability, availability, and maintainability requirements. In 1982, it issued a regulation mandating the use of operational requirements for new systems. However, the Apache's requirements have not been redefined in these operational terms, and performance is still measured against the limited requirements.

APACHE SUPPORT PROBLEMS MAY BE MAGNIFIED DURING COMBAT

The Apache's problems with logistic support are likely to be magnified under sustained combat conditions, when demands will be much more strenuous. It is difficult to envision how the Army will be able to adequately support the Apache under anticipated combat conditions that include (1) battalion-sized operations, in which Army tactics call for 15 of the 18 Apaches per battalion to fly missions at one time; (2) flying hours at least five times greater than current levels; (3) frequent weapons firing; (4) battle damage; and (5) the possible loss or degradation of peacetime conditions, such as aircraft hangars. To some extent, increased work load would be offset by the expected increase in the productivity of maintainers in combat and the latitude to fly aircraft in combat that would not be considered flyable in peacetime.

The Apache's performance in Panama provided several insights into the logistics challenge of combat operations. According to the Army, the first six Apaches sent to Panama were able to perform assigned missions successfully. This performance was made possible by the following extraordinary logistical support conditions: (1) spare parts were taken from contractor production lines and from other Apaches; (2) the Apaches were based in an Air Force hangar, and Air Force maintenance personnel and equipment were instrumental in repairing battle damage; and (3) maintenance was

performed 24 hours a day. Although this was a small operation relative to that of an Apache battalion, it does indicate the high concentration of resources that would be needed to support the aircraft in combat--a concentration of resources currently not available to Apache battalions.

The Apache did demonstrate several of its performance strengths in Panama, including its ability to deliver firepower accurately from long ranges, to conduct missions at night, and to withstand hits from ground fire. On the other hand, the Apaches had problems early in the operation because rainy and humid conditions caused moisture buildup in electronic components. Had these conditions not eased, the Apache might not have been able to operate as needed. The first mission of the operation illustrated the impact of reliability problems: one of the two Apaches assigned to the mission aborted before takeoff because of a hydraulics problem, while the second Apache, after completing its assigned mission, had an opportunity to provide additional mission support but was unable to because of an electronics failure.

THE ARMY HAS NUMEROUS CORRECTIVE ACTIONS UNDERWAY

The Army has recognized many of the Apache's problems with low availability and with logistic support. It has formed an Apache Action Team and has drawn together cognizant Army organizations and contractors to identify problems and implement solutions. The Army and its contractors are currently developing and testing improvements to the rotor blades, the tail rotor swashplate, the 30-mm gun, the targeting system, and many other components. The Army has also initiated actions to augment and improve diagnostic equipment and to increase the size and productivity of maintenance organizations. As I mentioned previously, the Army also plans to increase contractor support.

Component improvements, which are just beginning to reach the field, should provide some relief in the form of more reliability, less maintenance, and reduced demand for parts. However, it will take 1 to 2 years for most of the improvements to be fielded, and it will take longer to demonstrate their effectiveness. Such demonstration is important because several problems with components have proven difficult to correct despite previous improvements.

It is difficult to predict the effectiveness of these corrective actions because of the absence of the information needed to accurately define the overall problem in terms of sustained combat operations. While I have discussed the more tangible problems of component reliability and maintenance manpower, there are several other factors critical to sustaining high sortie rates in combat. These include (1) the number of personnel available to perform other combat-support functions, (2) the responsiveness of the supply system, and (3) the responsiveness of maintenance organizations beyond the unit level. The demands of sustained combat operations cannot be defined by routine peacetime operations or by operations for which special support arrangements have been made, such as exercises and the Panama operation.

According to Army officials, the Army has not operationally tested the basic Apache combat unit--the battalion--under conditions that approximate sustained combat. Testing under such conditions, which will entail a high number of flying hours, frequent weapons firing, and realistic maintenance and supply resources, is essential to determining the Apache's aggregate logistics demands in terms of parts, repairs, people, and organizational structure. Such testing is also essential to determining the Army's ability to meet these demands.

Unless the Army records complete maintenance man-hours actually expended on the Apache, it will be unable to determine the proper size of maintenance organizations. The 6th Cavalry Brigade,

located at Ft. Hood, Texas, has proposed a concentrated effort to collect maintenance man-hours expended on the Apache, but Army officials stated that funds were not available to support the effort. Further, the Army's flying hour requirements are vaguely defined: for peacetime, the Army has not specified the minimum number of hours necessary to maintain proficiency or to train as a unit; for wartime, the Army originally specified combat flying hour rates of 4 hours per aircraft per day, but its current manpower requirements analysis is based on only 2.1 hours per day.

CONCLUDING REMARKS

Despite the Apache's few flying hours, its reliance on contractor support, and its overworked maintenance units, its fully-mission-capable rates have fallen far short of goals and have declined as flight hours have been accumulated. It is the combination of these factors that indicates that the Apache's problems are serious and go beyond normal growing pains.

I believe that the Apache's low fully-mission-capable rates are symptomatic of a complex problem that can be simply stated: the helicopter demands a high level of logistical support that the Army has not been able to provide. It is clear that the helicopter and its support equipment are part of the problem. Likewise, it is clear that the Apache has brought to the forefront systemic weaknesses in the Army's structure and approach to aviation support. These weaknesses, which can be partly attributed to the fact that the Apache is the Army's first experience with a sophisticated attack aircraft, are likely to grow in significance as the Army's weapons become more complex.

Taken together, these logistical support problems, which prevent the Army from taking full advantage of the Apache's advanced war-fighting capabilities, are likely to be magnified under more stressful combat conditions. This is unfortunate because the

Apache has demonstrated that when it works, its technical performance is excellent. Army aviators find it to be far superior to the Cobra attack helicopter in all performance dimensions, including flight performance, night vision, target attack, and survivability.

Procuring and fielding additional Apaches will create a greater demand for logistic support resources when such resources will be needed for already fielded Apaches. Considering this prospect, as well as recent decisions to reduce combat forces in Europe, we believe that the Apache procurement should be limited to the 675 already under contract. This quantity would still leave the Army with more Apaches than its original procurement objective of 536. Moreover, forgoing procurement of the remaining 132 Apaches, for which almost $1.5 billion is included in the fiscal year 1990 appropriation for the Department of Defense, would allow the Department to provide the increases in personnel, maintenance and test equipment, replacement parts, and component reliability it needs to fully realize the currently fielded helicopters' combat potential. At a minimum, fielding fewer Apaches will help curb demands for logistic support.

Logistic supportability has not enjoyed a high enough priority to resolve long-standing problems, but this must change. Accordingly, we recommend that the Congress direct the Secretary of Defense to limit the Apache procurement to the 675 currently under contract and to transfer fiscal year 1990 funds appropriated for the procurement of additional Apaches from the Army's Aircraft Procurement appropriation to such other appropriation accounts in such amounts as the Secretary determines is necessary to provide the increased logistical support the Apache requires.

The Department of Defense must allow these difficult logistic support lessons, so painfully learned, to guide its decisions regarding the Apache Longbow modification. Cost aside, the Longbow

offers the promise of significant gains in combat potential, but it also involves additional sophisticated electronics that will require logistic support. To ensure that the desire for increased capability does not again outweigh the logistical wherewithal to employ it, we recommend that the Secretary of Defense defer incorporation of the Longbow modification until the Army demonstrates that (1) it has overcome the logistic support problems the Apache has experienced and (2) the Longbow's availability and flying hours will not be similarly compromised.

We believe that the Army must step up its efforts to develop information critical to identifying and resolving support problems as they are likely to occur during combat. Therefore, we recommend that the Secretary of Defense direct the Army to operationally test the Apache in battalion-sized units or greater with a focus on illuminating (1) the as yet unknown demands of supporting the Apache in sustained combat operations and (2) the changes in logistic support resources and structure needed to meet the demands. Repeating such a test in the future could measure progress in preparing for the support of combat operations. We also recommend that the Secretary of Defense direct the Army to apply the lessons learned by the other services in logistically supporting their complex aircraft, particularly in defining their personnel and organizational requirements, collecting key support information, and using contractor support.

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While our audit work on the Apache is essentially complete, we have not yet drafted a detailed report. Because this testimony precedes our report, neither the Secretary of Defense nor the Secretary of the Army has had the opportunity to formally comment on the results of our work. However, we have briefed key officials from the Offices of the Secretaries of Defense and of the Army on the major facts, conclusions, and recommendations I have presented today. I am encouraged by our subsequent discussions with Army officials,

during which we have learned that they are planning several corrective actions along the lines of what we recommended.

Mr. Chairman, this concludes my prepared statement. I would be pleased to respond to any questions.

OBJECTIVES, SCOPE, AND METHODOLOGY

We conducted our review of the Apache program at the joint request of the Chairmen of the Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce, and of the House Committee on Armed Services. The request was prompted by concerns that the Apache was experiencing low availability rates in the field. Accordingly, the objectives of our review were to determine the Apache's availability in the field as measured by fully-mission-capable rates and if we found the rates to be low, to (1) determine the causes of low rates, (2) identify the potential implications for combat operations, and (3) identify the Army's corrective actions. We conducted our audit work from May 1989 through April 1990 in accordance with generally accepted government auditing standards.

We conducted the majority of our work at (1) the U.S. Army Aviation Systems Command, St. Louis, Missouri; (2) eight Apache battalions located at Ft. Hood, Texas; Illesheim, West Germany; Wiesbaden, West Germany; and Ft. Bragg, North Carolina; and (3) Headquarters, Departments of Defense and the Army, Washington, D.C. We visited the Army Aviation Center, Ft. Rucker, Alabama; Ft. Eustis, Virginia; the U.S. Army Materiel Systems Analysis Activity, Aberdeen, Maryland; the U.S. Army Operational Test and Evaluation Agency, Alexandria, Virginia; the Special Repair Activity at Kileen, Texas; and the McDonnell Douglas Helicopter Company, Mesa, Arizona. We also observed an Apache field training exercise at the National Training Center, Ft. Irwin, California, and a gunnery exercise in West Germany.

At the U.S. Army Aviation Systems Command, we interviewed personnel and reviewed and obtained records from the various command directorates, the Advanced Attack Helicopter Program Manager's Office, the Target Acquisition Designation Sight/Pilot Night Vision Sensor Project Manager's Office, and the Automatic Test Equipment Product Manager's Office. Topics covered were Apache fleet readiness, Army studies and analyses of Apache availability problems, supply of spare and repair parts, individual component reliability, corrective actions, maintenance man-hours expended, and warranty information.

A major focus of our work at the Aviation Systems Command was our analysis of the Apache readiness database. Using the Army's data, we performed detailed analyses on the availability rates of the 11 Apache combat battalions in the field at the time we began our review. We excluded such data for other Apache units, such as training units, because their operations did not necessarily reflect those of combat units. We performed a limited reliability assessment of the Army's database by testing the accuracy of input data for 1 of the 11 fielded combat units. We found an input

error rate of less than 1 percent for input data and concluded that the accuracy of the database was acceptable for review purposes. However, we found a system error that resulted in the omission of one month's data from the database for that unit. We included the omitted data in our analysis, and the data had no material effect on our work. It does, however, have a potential impact on reporting the Apache's readiness rates. We discussed this situation with Command officials, and they are taking appropriate action to correct the situation. They also stated that, while omission of such data does distort readiness reporting, such omissions occur infrequently.

At the eight combat battalions where we conducted detailed audit work, we analyzed individual Apache readiness reports to ensure that they were accurately prepared according to Army regulations and to further ensure that the readiness database was reliable. Overall, we found a low incidence of errors in recording readiness data at the combat units. One battalion in West Germany had erroneously overstated fully-mission-capable rates by 11 percent in the data we examined. Also, the Ft. Bragg battalion excluded consideration of aircraft survivability equipment in its calculation of fully-mission-capable rates. However, we did not find these occurrences to a significant degree in the other battalions, and we do not think that they had a significant effect on the overall availability rates.

We spent a considerable amount of time at these battalions with maintainers, pilots, and command personnel to fully understand the factors affecting the Apache's availability. In particular, we discussed individual component reliability, preventive and corrective maintenance, supply of spare and repair parts, diagnostic equipment, training, contractor support, expended maintenance man-hours, adequacy of the battalion's size, and the amount of time productively spent on maintaining the aircraft. Although we covered many topics in our visits to Ft. Eustis and Ft. Rucker, perhaps most significant were those concerning the basis for the Apache battalion's current design and the results of the Army's manpower requirements analysis regarding the Apache battalion organization.

Throughout the course of our review, we were concerned with the effects of a severe storm at Ft. Hood, Texas, which damaged over 100 Apaches in May 1989. We took several steps to ensure that our analysis of the Apache's availability was not skewed by the storm damage. For example, we took snapshots of the readiness database before and after the storm to ensure that our analysis of fully-mission-capable rates and accumulated flying hours was not unduly influenced by the storm damage. We also concentrated our work with the eight battalions on operations and records before the storm. Even with these allowances, the storm's influence could not be

completely eliminated because of the longer term effect it had on the overall demand for critical parts. In the final analysis, we believe that the storm did lower fully-mission-capable rates significantly during the latter half of 1989. However, while the storm worsened the Apache's availability problems, it did not cause them. Before the storm, fully-mission-capable rates were already significantly below the Army's goal and had shown decline with accumulated flight hours.

We discussed the Apache's availability and logistic support problems with Headquarters officials from the Departments of Defense and the Army. We talked to several people who had been involved with the Apache program in years past to gain perspective on past decisions and events that could shed light on some of the Apache's current problems, such as the interpretation of requirements and test results, the status of the Apache program at the time of the production decision, and lessons learned. We obtained and analyzed reports from key tests and evaluations of the Apache conducted since 1981. We also held discussions with Air Force and Marine Corps personnel to gain their insights on aircraft maintenance, support, expended man-hours, flying hour rates, training, and contractor support.

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