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Report to the Chairman, Subcommittee on Oversight and Investigations, Committee on Energy and Commerce, House of Representatives

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APACHE HELICOPTER

Reliability of Key Components Yet to Be Fully Demonstrated

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National Security and
International Affairs Division

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The Honorable John D. Dingell
Chairman, Subcommittee on Oversight
and Investigations
Committee on Energy and Commerce
House of Representatives

Dear Mr. Chairman:

In response to your request, we have reviewed the Army's efforts to address logistical support problems underlying the low availability rates associated with the Apache helicopter as discussed in our September 1990 report.[1] This report addresses the current status of the Army's efforts through August 1991 to improve the reliability of seven hardware components, as well as to improve maintenance capabilities for the Apache. In addition, we reviewed the performance of the Apache's FM antenna, whose poor reception has been a concern of field personnel for several years.

Background

In our 1990 report, we found that the fully-mission-capable rates for the Apache fell short of the Army's peacetime goal of 70 percent and decreased as Apache battalions accumulated flying hours.[2] We outlined serious logistical support problems, such as undersized maintenance organizations, weaknesses in repair capabilities, and frequent component failures, that contributed to the Apache's low availability rates.

Apache availability rates have improved during 1990 and 1991—most notably during Operation Desert Shield. This improvement has been due more to efforts such as increased supply and a greater concentration of maintenance resources than to improvements in reliability and maintenance capabilities. In February 1991, we testified that these efforts enabled the Army to work around component reliability problems that had continued in Saudi Arabia.

[1] Apache Helicopter: Serious Logistical Support Problems Must Be Solved to Realize Combat Potential (GAO/NSIAD-90-294, Sept. 28, 1990).

[2] The Army considers an Apache fully mission capable if it can perform all its assigned missions. It must be flyable and have all of its mission-essential equipment working.

Results in Brief

Army efforts to improve the reliability of selected hardware components have been ongoing for several years. Although the Army has made some progress in resolving key problems, as of August 1991, the improved components had not fully demonstrated their reliability. In addition, structural cracking in the tail boom has emerged as a potentially catastrophic problem as the aircraft accumulate flying hours, and the FM antenna reception problem has degraded the Apache's communication performance. The Army has also taken steps to increase the amount of maintenance manpower devoted to the Apache and to improve the performance of test equipment, but their effectiveness is not yet known.

Improved Reliability Has Yet to Be Fully Demonstrated on Several Key Components

The Army has been pursuing corrective actions on key hardware and structural components for several years. In our September 1990 report, we stated that the tail rotor swashplate, shaft-driven compressor, main rotor strap pack, main rotor blades, 30-millimeter gun, and target acquisition and designation sight were examples of key components that were experiencing frequent failures and adversely affecting availability. We also reported that several problems, such as structural cracks in the airframe's tail boom section, had begun to emerge as the aircraft aged. The Army has since made improvements on most of these components and is fielding the improved configurations. However, fielded components have not had time to fully demonstrate their reliability requirements.

Although not discussed in our September 1990 report, the performance of the Apache's FM antenna has been a source of concern to the Army for several years. Its poor reception is currently being addressed by the program office, and two new antenna designs have been selected.

Table 1 provides a brief summary of component problems, the type of fix, and the estimated date for completing the fix. The components are more fully discussed in appendixes I through VIII.

Table 1: Key Component Problems and Status of Proposed Fixes

Component	Problem	Type of fix	Estimated completion date
Tail rotor swashplate	Bearing failure	Redesign with larger bearing and improved seals	1st quarter, fiscal year 1993
Main rotor blades	Separation of materials	Cloth overlays	4th quarter, fiscal year 1992
Main rotor strap pack	Premature cracks in straps	Use of new material to increase durability	3rd quarter, fiscal year 1993
Shaft-driven compressor	Excessive vibration	Redesigned mount	2nd quarter, fiscal year 1995
30-millimeter gun	Frequent jamming	Improved ammunition carrier and use of more durable material	1st quarter, fiscal year 1995
Target acquisition and designation sight	Decline in reliability	Comprehensive program to improve component reliability	4th quarter, fiscal year 1996
Tail boom	Structural crack	Testing and field fix	To be determined
FM antenna	Poor reception	2 new antennas	4th quarter, fiscal year 1996

Efforts to Enhance Maintenance Capabilities Are Under Way

The Army has taken several steps to enhance maintenance support for the Apache, but their effectiveness has not been fully demonstrated. For example, in May 1990, the Vice Chief of Staff for the Army directed that Apache maintainers spend a minimum of 4.5 hours a day working on the aircraft, up from 2 to 3 hours a day. Implementation of this initiative was interrupted by the Persian Gulf conflict, and as of August 1991, the Army did not know the extent to which implementation had been resumed worldwide.

In addition, the Army initiated action to increase the size of Apache battalions by 35 personnel, including some maintainers. In the fall of 1989, the Vice Chief of Staff for the Army directed major commands to consider ways of funding these personnel increases. In response, the commander of Army forces in Europe disbanded an artillery battalion to free up personnel slots needed to increase the size of Apache battalions in Europe. As of August 1991, trained Apache personnel were beginning to fill those slots, and Army personnel did not expect trained personnel would be available to fill all the slots until fiscal year 1995.

The Army also began to focus on improving the capabilities of Apache maintenance personnel in troubleshooting and diagnosing problem parts. As of August 1991, the Army had purchased new troubleshooting manuals, developed and procured testing devices, retrofitted the Electronic Equipment Test Facility's central computer, and procured a diagnostic maintenance aid for the target acquisition designation sight and pilot night vision sensor.

Scope and Methodology

We conducted our work at (1) the U.S. Army Aviation Systems Command (AVSCOM), St. Louis, Missouri; (2) the U.S. Army Aviation Center, Ft. Rucker, Alabama, where Apache maintenance personnel are trained, contractor personnel work on flight school aircraft, and test aircraft are located; and (3) headquarters, Departments of Defense and the Army, Washington, D.C. In addition, we visited several Apache battalions located at Ft. Hood, Texas.

At AVSCOM, where we conducted the majority of our work, we interviewed personnel and obtained records from the various command directorates, the Advanced Attack Helicopter Program Manager's Office, the Target Acquisition and Designation Sight/Pilot Night Vision Sensor Project Manager's Office, and the Automatic Test Equipment Product Manager's Office. The major focus of our work was our analysis of the Army's efforts to improve component reliability and performance on the selected components discussed in our September 1990 report. We reviewed Army data on improvements made to those components and demonstrated through August 1991. We discussed these improvements with program and engineer representatives from AVSCOM.

We conducted our work from December 1990 through September 1991 in accordance with generally accepted government auditing standards. As requested, we did not obtain written agency comments. However, we discussed a draft of this report with program and Army officials and have incorporated their comments where appropriate.

We are sending copies of this report to the Chairmen, House and Senate Committees on Appropriations and on Armed Services, and the Secretaries of Defense and the Army. We will make copies available to other interested parties upon request.

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

Sincerely yours,

Richard Davis

Richard Davis
Director, Army Issues

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Abbreviations

AVSCOM	Army Aviation Systems Command
FM	frequency modulation

Tail Rotor Swashplate

The tail rotor swashplate, which actuates the tail rotor blades controlling the lateral movement of the aircraft, has a bearing that fails prematurely, causing the swashplate to seize and the aircraft to lose control. A failure in August 1987 caused a fatal crash and prompted the Army to replace the swashplate every 250 flight hours. The swashplate bearing is not reparable by the Army and is replaced by the manufacturer under contract. The Army's resolution for the problem included a redesigned swashplate with a larger bearing and improved seals. Although the redesigned swashplate had not experienced failures in the field as of August 1991, it had not been fielded long enough to demonstrate its 1,500-hour reliability requirement.

Bearing and Seal Strengthened

Army documentation indicates that several factors might have contributed to the swashplate problem, including (1) inadequate bearing load capacity (actual loads exceeded design loads by 138 percent), (2) improper design (the use of dissimilar metals), and (3) inadequate testing. To resolve the problem, the redesign to the swashplate assembly called for a new bearing that was larger and stronger and for the interhousing assembly to be made of steel instead of aluminum, according to Army Aviation Systems Command (AVSCOM) engineers. In addition, the seal was strengthened so that it would no longer let water in and grease out, according to the engineers.

As of August 31, 1991, the Army had conducted bench testing and flight testing without a failure, but the redesigned swashplate had not yet demonstrated its reliability requirement of 1,500 hours through testing or actual usage. According to program personnel, the swashplate had demonstrated 982 hours on a lead-the-fleet test aircraft.[1]

Removal Interval Rate Raised

Swashplates were being evaluated in 250-hour increments on fielded aircraft from the flight school at Ft. Rucker, Alabama, whose aircraft fly more that those at any other location. According to AVSCOM engineers, after the first six redesigned swashplates to reach 250 flight hours were removed, Army and contractor personnel inspected them and concluded that the threshold for removal could safely be raised to 500 hours. The Army requested Ft. Rucker personnel to again remove the first six swashplates that reached the 500-hour threshold and to send them to the prime contractor for inspection. According to program personnel, if

[1]A lead-the-fleet test aircraft is an aircraft the Army flies at fairly high rates to determine the long-term reliability, maintainability, availability, and durability of the aircraft and its subsystems.

no problems are found, the threshold will be raised to 750 hours. As of August 1991, Ft. Rucker personnel had submitted the first redesigned swashplates to reach 500 hours for evaluation. Barring any problems, the Army plans to eventually raise the removal interval rate to the 1,500-hour reliability requirement.

Contractor to Bear Costs

The contractor agreed to pay for the design change; the installation of 552 redesigned bearings on existing swashplates, which are then retrofitted by the Army on fielded aircraft; and a supply of 90 spare components. The Army began testing the redesigned swashplate in October 1989 and installed it on fielded aircraft as older swashplates reached the 250-hour replacement interval. The redesign was incorporated into the production line in March 1991. As of September 1991, 295 spare and retrofit components had been made available to the field.

Main Rotor Blades

Separation of the materials in the Apache's four main rotor blades can cause them to vibrate excessively, forcing the pilot to land the aircraft. The blades are made with bonded composite materials and metal, and in several places along the surface the materials separate, or "debond." According to the Army, gluing voids in the production process caused the debonding. The Army implemented a total of eight fixes to the main rotor blades, although only one was designed to prevent the gluing voids. The other fixes were aimed at mitigating the debonding problem. Program personnel were encouraged by testing results of the improved blade on the lead-the-fleet aircraft; however, future blade problems could occur because the Army had not fully resolved the basic debonding problem. In addition, the Army had not tested the blades in hot and wet weather conditions, and until it does, the Army will not know whether additional debonding problems related to weather conditions could occur. Finally, the Army has experienced repair tooling problems since 1986 that could result in the scrapping of 96 blades valued at $8.6 million.

Adequacy of Fixes Questioned

Beginning in 1986, the Army initiated various types of fixes on the blade, including adding cloth overlays, a screw at the tip of the blade, and adhesive to the base of the blade. Program personnel stated that these fixes had improved the reliability of the blade, pointing to the test results on the lead-the-fleet aircraft and the reduced number of blades returned to depot for repairs. They believed the improved blade had demonstrated its reliability requirement of 1,500 hours because each of the three lead-the-fleet blades had been flown 1,857 hours as of the end of August 1991 without a failure. They also believed that depot repairs had decreased with the fielding of blades with all fixes.

AVSCOM engineers, however, expressed concerns regarding the adequacy of the fixes. They believed that the majority did not address the gluing voids and only contained the debonding problem, lessening the potential need for depot maintenance. Only one of the eight fixes—in which the amount of adhesive was doubled at the tip of the blade—structurally improved the blade and helped prevent debonding. According to AVSCOM engineers, the cloth overlays did not prevent debonding. Instead, they cover the areas that tend to debond and prevent the wind from catching the debonded areas and ripping them off. AVSCOM engineers also indicated that the cloth overlays could cover up the debonded areas, preventing maintenance personnel from visually inspecting the blades.

Climatic Testing Will Not Be Conducted

For several years, the Army and contractor discussed conducting testing to determine how well the main rotor blade would meet its expected life of 4,250 hours under hot and wet weather conditions. According to program and AVSCOM engineers, this testing would provide useful information as to whether the blade would meet its 4,250-hour life requirement under more realistic climatic conditions. This type of testing has never been conducted on the blade. Program personnel said this testing was not required as a part of the original qualification testing, and they had decided at the time of our review not to conduct it.

Army and Contractor Shared Costs of Fixes

The Army and the contractor have shared the cost of the fixes. For example, the contractor has paid for the fixes incorporated into the production line, while the Army has paid for retrofitting fielded aircraft. The Army started adding initial fixes on the production line blades as early as December 1986. The latest fixes were added into the production line in December 1989. As of August 1991, a total of 548 improved blades had been issued to the field as spare parts.

Repair Problems Could Result in Main Rotor Blades Being Scrapped

According to program engineers, 96 rotor blades worth an estimated $8.6 million were awaiting repair at the manufacturer's plant as of August 1991. These blades may be scrapped because of problems in developing a special "hot bond" tool and repair process for fixes at the base of the blades. AVSCOM engineers and program personnel believed that the repairs might never be made because of problems in achieving an acceptable bond between the adhesive and composite material. Some of these blades have been awaiting repair since 1986, and as of August 1991, program personnel had not made a decision on scrapping them. If they are scrapped, the question of compensation is subject to negotiation, according to program personnel.

Main Rotor Strap Pack

Steel straps that help secure and control the main rotor blades crack prematurely and must be replaced because they cannot be repaired. A series of 22 of these steel straps comprise the four strap packs contained in the main rotor hub system. Failure of a strap pack could result in loss of control of the main rotor system and catastrophic loss of the aircraft, according to Army personnel.

The strap pack never passed qualification testing and has been a problem since 1984. According to an AVSCOM engineer representative, sources of the problem have been difficult to pinpoint because of the variations of the component in the field. Design changes, including use of a stronger construction material, have been incorporated that the prime contractor estimated would improve the reliability of the component fivefold. However, AVSCOM engineers indicated that the redesign fixed only part of the strap pack and that the component would continue to fail prematurely in other sections. The strap pack has a 4,500-hour life requirement and is not repairable. The contractor agreed to bear the costs of the redesign.

Effectiveness of Redesign Not Yet Demonstrated

The redesign, intended to reduce the stress on the strap pack laminates, called for improving the shoe area of the strap pack, polishing the edges on the individual laminates, and changing the material used to make the straps. According to the program engineers, the prime contractor tested the redesigned component and anticipated an increase in service life by a factor of five. However, the engineers acknowledged it was too early to determine the adequacy of the fix in the field. AVSCOM engineers pointed out that the redesigned component had not demonstrated its 4,500-hour requirement, and they believed the contractor was overestimating its improved reliability. They estimated that the redesign would improve the overall durability by a factor of only two. Program personnel stated that as of August 1991 there were not any redesigned strap packs with more than about 500 hours on fielded aircraft and the strap packs were inspected every 10 flight hours or 14 calendar days, whichever came first, by field personnel.

Contractor Redesigned Strap Pack at No Cost to Army

The prime contractor agreed to bear the costs of the redesign and incorporated it into the production line in March 1991. The Army's agreement with the prime contractor also calls for the contractor to provide 390 spare components at no cost. Army personnel will install the redesigned strap pack on fielded aircraft when two or more of the 22 steel laminates break. As of August 1991, 955 redesigned strap packs had been issued to the field as spare parts.

Shaft-Driven Compressor

The shaft-driven compressor, part of the environmental control system cooling many aircraft components, has failed at least eight different ways during its early fielding. Some of the failures resulted in the compressor exploding, each potentially causing a fire. The Army has been aware of these failures since 1983. Army engineers suggested two basic design flaws as the possible causes of failure: (1) the compressor was too light and lacked the durability to operate at high speeds and (2) the unit's oil was supplied by the transmission, whereas most compressors of this type have self-contained oil supplies. In trying to address these problems, the Army had fielded nine configurations of the compressor as of August 1991. Because the latest compressor did not correct all problems, the most serious of which is the rupture of the impeller, the Army recently approved another configuration. It was being tested during our review and was scheduled to be installed on fielded aircraft starting in 1992. Army personnel believed the latest change would address the underlying cause of the impeller rupture problem.

Most Problems Believed to Be Resolved

According to program engineers, the improvements incorporated up to and including the latest fielded configuration, referred to as the -17, corrected all the different types of failure except for the impeller rupture. The improvements to the -17 compressor were adopted in February 1989 and involved improving the surge valve and the oil screen filters. These changes prevented debris from entering the pump, thereby providing for oil to be returned to the transmission in case of internal compressor failure. The -17 improvements were incorporated into the production line in November 1989. Although the Army was not bearing the cost of the engineering change, it was absorbing the costs associated with incorporating the -17 compressor on fielded aircraft. As of August 1991, 264 improved compressors had been issued to the field as spares. It had demonstrated 1,226 mean hours between failure, compared with 1,075 hours for its predecessor. Neither configuration achieved the 1,500-hour reliability requirement for this component.

Latest Configuration Addresses Impeller Rupture

According to AVSCOM engineers, the prime contractor completed another no-cost design change, the -19, in hopes of addressing the impeller rupture. This design change was the first to address the underlying cause of compressor failures, which the engineers believed were related to excessive internal vibration. The problem occurs when the air seal and the impeller rub together, causing the impeller to burst. The impeller rupture occurs during a maneuver that calls for pilots to simulate an engine failure. During this exercise the compressor overspeeds to 110 percent, and the resulting vibrations cause the impeller to burst. The -19 configuration changes involved placing a thin washer between the impeller and the air seal to act as a buffer and installing a redesigned resilient mount to reduce the vibration load to the impeller area. As of August 1991, the contractor had built 10 prototype -19 compressors and was flight-testing them at Ft. Rucker. One of the prototypes was to be tested on the lead-the-fleet aircraft. The Army planned to incorporate this improvement on fielded aircraft starting in 1992.

30-Millimeter Gun

The 30-millimeter gun, mounted on the bottom of the helicopter, has had a history of problems dating back more than 10 years. Two subcomponents, the carrier drive links and the flex chute, frequently break, rendering the gun incapable of firing. The carrier drive links, which make up a conveyor belt carrying the ammunition from the ammunition box to the gun, break or bend, causing the conveyor belt to jam, according to program personnel. The flex chute, which guides and supports the loaded round carriers as they move downward toward the gun, also breaks, causing the carrier belt to jam. The gun has undergone numerous design changes to resolve these problems, but as of August 1991, these changes had been unable to bring it up to reliability and accuracy requirements.

Reliability Has Not Been Demonstrated

Carrier drive links and the flex chute are the two primary contributors to gun stoppages and breakage, according to a program representative. According to program documentation, the gun has demonstrated excellent reliability in terms of stoppages during ongoing testing. However, the gun's reliability requirement of 3,838 rounds between stoppages has not been demonstrated. In addition, the gun has not passed first article test accuracy requirements.[1]

The contractor has initiated a series of design changes to improve round control, according to program personnel. The third and latest design change to the carrier drive links, providing more surface area to grab the ammunition, was incorporated into the production line in the spring of 1991. The contractor strengthened the flex chute by changing its construction material from aluminum to a more durable thermal plastic and incorporated the design change into the production line in the fall of 1990. The contractor was bearing the cost of incorporating these changes into the production line. However, according to a program representative, the Army expects to incur about $17 million in parts and other costs to retrofit fielded aircraft, which is scheduled to begin about January 1993.

Army Testing Gun's Performance

The Army was evaluating the gun's reliability and component life at the time of our review by performing a 100,000-round reliability test. It also planned to begin a first article test of its accuracy in November 1991. Both tests are designed to measure the gun's performance with the

[1]The purpose of first article testing is to validate production techniques and demonstrate that the production units can meet the same performance requirements as the prototype units.

latest improved components. The Army and the prime contractor began the 100,000-round reliability test in mid-December 1990 and completed the first half of that testing in August 1991. According to program documentation, the gun experienced few stoppages during this part of the test. However, eight flex chutes experiencing the same failures as before were removed during inspections. Army documentation states that the performance of the flex chute is unsatisfactory and continues to be a frequent maintenance problem and that the contractor is proposing another fix. Other component problems were experienced during this testing, including one component that might not meet its 20,000-round minimum life requirement. The second half of this test started in September 1991.

The prime contractor was also conducting a program to improve gun accuracy that focused on software changes to the fire control computer. This program should be completed sometime in September or October 1991. The Army was then scheduled to perform a first article test in November 1991 to measure the gun's performance against accuracy specifications, according to program personnel.

The contractor agreed to bear the cost of the accuracy improvement program. In addition, the Army negotiated an agreement in May 1991 in which the contractor would be liable for up to $8 million for failing to meet accuracy specifications and incorporating accuracy changes on aircraft. The agreement also stated that gun accuracy specifications, if not met, would be changed to reflect first article test results once the improvement program and other requirements are met.

Target Acquisition and Designation Sight

The target acquisition and designation sight has historically required frequent maintenance and has been a significant contributor to the aircraft's downtime. The sight enables the Apache to find targets and guide its weapons from long ranges using television, infrared, laser, and direct-view optics. It is the Apache's most sophisticated system, involving 26 major electrical, optical, and mechanical components. Recent reliability data furnished by the contractor shows that the sight was not meeting its reliability requirement and that reliability was decreasing, which could result in an increase in the maintenance burden. Program and AVSCOM engineer personnel believed that reliability improvements were possible but that cost trade-offs would be involved. In addition, unexpected problems that were emerging, such as a recent failure of the laser power monitor, could contribute to a further decline in reliability.

System Requires Frequent Maintenance

As we stated in our September 1990 report, the targeting acquisition sight required frequent maintenance because of its complexity. According to program personnel, the targeting acquisition sight's electrical unit and night sensor assembly required more maintenance than any other targeting sight component. The wiring harness on the targeting acquisition sight also required frequent maintenance, according to AVSCOM engineers. The harness passed its original qualification test, but Army personnel decided that the harness was not repairable after 800 flight hours of use and must be replaced if it breaks. Another related problem was that the electromagnetic interference coating made the wires stiff, less flexible, and more susceptible to breaking.

Maintenance Burden Could Increase With Decline in Reliability

Recent evaluations by the contractor showed that the sight did not meet its reliability requirement of 125 hours and that its reliability could be declining. Such a decline could result in an increasing maintenance burden for the component.

According to a program representative, the contractor's most recent assessment of reliability showed the system was achieving 121 hours between failures. This figure was based on a 6-month moving average for the entire fleet covering the months October 1990 through March 1991. The contractor's assessment also showed that the 6-month moving average was below the system's requirement of 125 hours since August 1990. Program personnel provided data that showed the 6-month moving average was approximately 150 hours during 1988 and

1989. The contractor was evaluating the decline in reliability and possible solutions at the time of our review.

Program and AVSCOM engineer personnel believed that reliability could be improved but that cost trade-offs would be involved. AVSCOM and program engineers continued to evaluate all proposed design changes to determine if they were logical, added value, and solved a problem. However, the targeting acquisition sight uses some outdated technology developed in the 1960s, and some things could not be changed without a complete redesign. Many engineering changes initially approved by AVSCOM engineers were rejected by the project manager because of the expense involved, according to AVSCOM engineer personnel.

Unexpected Problems Emerging

In addition to long-standing component problems, other unexpected problems have emerged that could adversely affect maintenance of this component. For example, in May 1990, the contractor discovered that the monitor for the sight laser's energy output was malfunctioning. As the laser's energy output decreased, the monitor failed to set off the warning lights in the cockpit. Contractor personnel tested all the laser transceiver units from June to November 1990 and found that power on one-quarter of the lasers had degraded to below the 40-percent specification value. According to program personnel, the laser's power was expected to degrade with age and use, but the monitor was supposed to give a low-power warning when the power degraded to below 80 percent of the specification value and a failure warning when it degraded to below 40 percent. During July and August 1990, contractor personnel found that the laser monitor malfunction had been caused by a loose mounting of the monitor. Defective laser transceiver units were replaced by March 30, 1991.

Tail Boom

Structural cracks have been detected in the Apache's tail boom—the horizontal portion of the Apache attaching the tail rotor system to the main body of the aircraft—which could prove to be catastrophic because of the loads it carries in helping to support the tail rotor system. Loss of the tail boom would likely result in loss of the aircraft. The Army has been aware of major problems with the tail boom since 1987, but they have remained unresolved for more than 4 years because the Army and the contractor could not reach agreement on the conditions of continued testing. Consequently, the tail boom has yet to demonstrate its 4,500-hour life requirement. As of August 1991, testing of the tail boom was scheduled to be restarted in October 1991, and an engineering change was in the process of being approved to address the problem. In addition, a testing device was being provided to field personnel that for the first time would give them the capability to detect minor structural cracks.

Cracks Could Be Catastrophic

When the prime contractor tested the tail boom for fatigue in 1985, the test specimen incurred a failure at 2,400 hours. The prime contractor, however, maintained that the failure was unrepresentative because the test did not simulate real load conditions, according to AVSCOM engineers. The Army agreed that the landing loads used during the test were not representative of actual usage and agreed to restart the test with a second specimen. The second test started in September 1986 using the entire tail boom, vertical fin, landing gear strut, and stabilator attachments. The loads placed on the tail boom were tested to simulate all fatigue loads experienced by the aircraft in flight and landing. The test was stopped in June 1987, after 1,900 hours, because of a crack of the bulkhead. During inspection of the test specimen, a crack was also found in the "2L stringer" portion of the tail boom. According to AVSCOM engineers, failure in the 2L stringer would be catastrophic because it is designed to carry the heaviest loads in that section of the tail.

Tests Held Up for More Than 4 Years

The prime contractor originally agreed to restart testing of the tail boom for 4,500 hours to demonstrate its life requirement, but the testing has been held up for more than 4 years. The Army and the contractor have disagreed on (1) who would pay for continuance of the test and (2) whether to fix the 2L stringer before the test continued or test it to determine whether the crack would grow and result in catastrophic failure. Consequently, the testing had not been restarted as of August 1991, and the tail boom had not demonstrated its 4,500-hour life requirement.

According to program personnel, the prime contractor and the Army were in the midst of negotiations for restarting the tail boom test. The program office's position as of August 1991 was that the Army would pay for the test to resume and that the test would continue without fixing the 2L stringer for 500 hours, at which time a strap patch would be placed over this portion of the tail boom for the remaining 2,000 hours. They estimated that testing would resume in October 1991 and would take a year of nonstop flying to accumulate 2,500 hours. They also believed that the compromise of letting the tail boom go unpatched for 500 hours would provide some data on whether the 2L stringer crack would grow and cause a catastrophic failure and, when patched, would provide information on the adequacy of the proposed fix. However, AVSCOM engineers believed the strap patch should be installed on the entire fleet regardless of the test results because of the potential for catastrophic failure. The financial responsibility of installing the strap patch on the fleet had not yet been negotiated, according to program personnel.

Testing Devices Scheduled for Fielding by End of 1991

Army field maintenance personnel did not have an adequate method of inspecting the Apache's tail boom for possible cracks until August 1991. They visually inspected the tail boom, but, according to AVSCOM engineers, even trained personnel have trouble locating cracks with visual inspection alone. The Army was having the prime contractor modify existing CH-47 "eddy current" testers with probes for use in inspecting the Apache tail boom for possible cracks. AVSCOM engineers believed that if tail boom inspections using this tester were conducted after every 250 hours of flight, minor cracks could be detected. They estimated that this device would be in the field by the end of 1991. As of August 1991, two test probes had been sent to Ft. Rucker, Alabama, to start testing its aircraft, some which had flown more than 2,000 hours.

FM Communications Antenna

The Apache's FM radio, which is used for pilot communications, has experienced poor reception when flying nap-of-the-earth—that is, flying close to the ground. Pilots also experienced problems with it during Operation Desert Storm. At the Army's direction, the Avionics Research and Development Activity tested and evaluated different FM communications antennas for the Apache's pilot and copilot gunner to determine ways to improve nap-of-the-earth communications. The Army selected two designs in August 1991.

Communications Problems Considered Severe

The Army has been aware of the Apache's communications problems for a number of years, and the program office has addressed them as a top priority in its readiness improvement program since February 1989. Although the problems are not unique to the Apache, program engineers considered the performance of the FM antenna to be more of a problem on the Apache than on other Army aircraft. In addition, personnel from several Apache battalions told us they experienced complications trying to communicate with one another during missions in Operation Desert Storm.

According to program personnel, the source of these problems was the heavy electronic activity on board the Apache, coupled with the aircraft's flying nap-of-the-earth, where objects can interfere with radio transmissions. The FM antenna had passed its original specification requirements, but the testing requirements had not called for the Apache to fly nap-of-the-earth. According to program engineers, when the Avionics Research and Development Activity started testing new antennas in November 1989, the Army had no criteria for nap-of-the-earth communications. Subsequently, Army officials established a target of being able to communicate nap-of-the-earth at a distance of 25 kilometers at altitudes between 50 and 150 feet over terrain similar to that of Ft. Rucker, Alabama. According to program engineers, both of the selected designs were able to meet the nap-of-the-earth target.

New Antennas Selected

In August 1991, the Army selected the dipole antenna for the pilot and the vertical stabilizer trailing edge antenna for the copilot gunner. According to program engineers, (1) the dipole antenna was twice as effective as the existing antenna, and (2) the vertical stabilizer trailing edge antenna was 50 percent more effective than the existing antenna but had demonstrated only one-half the performance of the dipole antenna. As a result, the prime contractor recommended that it investigate an alternate antenna design in lieu of the new vertical stabilizer trailing edge antenna. The Apache program office gave the prime contractor until the first quarter of fiscal year 1994 to develop a better design. If testing for a new design is not completed by that date, program personnel plan to install the vertical stabilizer trailing edge antennas in 254 upgraded Apache B models.

In September 1991, the contractor submitted an initial proposal to the program office for engineering changes needed to facilitate installation of the dipole antenna. According to program engineers, the Army planned to begin retrofitting 790 aircraft with the dipole antenna in April 1992. Since the original FM communications antenna met specification requirements, the Army will bear the expense of buying and installing the new antennas.

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Orders may also be placed by calling (202) 275-6241.