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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

Tests Results for 30-Millimeter Weapon System Inconclusive

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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, this report discusses the endurance, reliability, and accuracy of the Apache helicopter's 30-millimeter area weapon system during its recently completed tests.

Unless you announce the contents of this report earlier, we plan no further distribution of this report until 30 days after its issue date. At that time, we will send copies to the Chairmen of the Senate and House Committees on Armed Services and on Appropriations, the Senate Committee on Governmental Affairs, and the House Committee on Government Operations; the Director, Office of Management and Budget; and the Secretaries of Defense and the Army. We will also provide copies to others upon request.

This report was prepared under the direction of Henry L. Hinton, Jr., who may be reached at (202) 512-4126 if you or your staff have any questions concerning this report. Other major contributors are listed in appendix III.

Sincerely yours,

Frank C. Conahan

Frank C. Conahan
Assistant Comptroller General

Executive Summary

Purpose

The 30-millimeter area weapon system, one of the three mission-essential weapon systems on the Army's premiere attack helicopter, the AH-64 Apache, has experienced a history of reliability and accuracy problems. During Operation Desert Storm, for example, the 30-millimeter area weapon system on 18 Apaches malfunctioned and became inoperable while on an attack mission. Since the first Apache was delivered to the Army in 1984, the contractor had been unable to successfully demonstrate that the area weapon system could meet its endurance, reliability, and accuracy requirements. The Army, however, reported that the area weapon system successfully met these requirements in January 1992.

The Chairman of the Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce, requested that GAO review the Army's 1992 endurance, reliability, and accuracy tests for the area weapon system to determine whether the testing procedures and conditions resulted in sufficient information to fully assess these requirements.

Background

Each area weapon system, currently estimated to cost $225,000, consists of a 30-millimeter chain gun, a turret assembly, and an ammunition handling subsystem. It was designed to provide the crew with an accurate, quick response weapon for suppressive fire on soft and medium skinned targets, such as trucks.

McDonnell Douglas Helicopter Company, the contractor for the area weapon system, was unsuccessful in demonstrating the system's endurance and reliability requirements in its 1984 test. The contractor completed a second test in January 1992, and in May 1992 reported that the area weapon system had passed its endurance and reliability requirements.

The area weapon system did not pass previous accuracy tests in 1985, 1988, and 1989. In January 1992, the Army concluded that the area weapon system had been able to adequately demonstrate its accuracy requirements.

Results in Brief

While the Army maintains that the Apache's area weapon system has passed most endurance requirements, exceeded reliability requirements, and passed accuracy requirements, testing procedures and conditions did

not produce sufficient information to fully assess whether these requirements were met.

The 1992 endurance and reliability test plan (1) set the test at 100,000 rounds, resulting in statistically insignificant confidence levels for endurance and insufficient assessments of several reliability requirements for individual components; (2) included favorable test conditions, such as having the test performed in a controlled environment instead of in an operational environment that may have allowed the area weapon system to achieve a higher reliability measure; and (3) did not evaluate a key 30-millimeter gun reliability requirement.

Regarding the 1992 accuracy test, the Army (1) reduced its performance criteria from 19 required target points to only 1 "must-meet" target point and allowed the contractor to pay a $1 million penalty for each missed target point, and (2) tested only one of three different Apache fuselage configurations, thus the results may not be applicable to the entire Apache fleet.

Principal Findings

Endurance and Reliability Test Plan Yielded Inconclusive Results

The January 1992, 100,000-round test results were statistically insignificant because of the low endurance confidence levels achieved. For example, in this size test, there is only a 19-percent confidence level that a 50,000-round component will meet its minimum life expectancy. According to a representative from the U.S. Army Armament Research, Development and Engineering Center—the Army's scientific advisor—a 19-percent confidence level may not be generalized to the rest of the area weapon systems in the Apache fleet. A Research Center technician told GAO that to have meaningful test results, the confidence levels should be a minimum of 80 percent. In 1988, the Research Center proposed a 1.1-million round endurance test, which would have demonstrated at least a 90-percent confidence level for all components. Apache program office representatives indicated that the test was set at 100,000 rounds because of limited funding and the extended time that would have been required to perform a more extensive test.

The limited number of test rounds did not allow for a sufficient assessment of several key reliability requirements, according to Research

Center representatives. For example, there were nine area weapon system components that did not meet their reliability requirement.

Test Conditions May Have Helped System to Pass

The Army's test plan included favorable test conditions that may have allowed the area weapon system to achieve a higher reliability measure. For instance, the plan allowed field maintenance standards to be used, which let maintenance personnel inspect and replace parts that appear faulty to avoid gun stoppages. Representatives from the U.S. Army Materiel Systems Analysis Activity, the Army's independent test evaluator, believe that this practice created a higher mean-round-between-stoppage measurement because replacing parts was not counted against this measurement. Mean-round-between-stoppage is the expected number of rounds fired before the area weapon system jams or becomes inoperable.

Another favorable test condition allowed for varying the amounts of ammunition rounds to be loaded into the area weapon system. The area weapon system, designed to carry a maximum load of 1,200 rounds, performed part of the test carrying loads as small as 300 rounds. Representatives from the Research Center stated that carrying lighter loads puts less stress on the area weapon system resulting in fewer stoppages. In addition, GAO reported in April 1992 that the area weapon system experienced a greater number of stoppages when carrying near maximum loads.[1]

A third favorable condition was that the reliability test was conducted primarily indoors, in a relatively clean, controlled environment. The Army fired only 5,000 of the 100,000 rounds, or 5 percent, during an airborne portion of the test. The configuration of the indoor test bay did not permit the gun to move to its maximum firing angles or take into consideration the operational environment factors. Therefore, the Army does not have a full understanding of how the area weapon system will perform in an operational environment.

Key Reliability Requirement Not Assessed

The test plan also did not require that a key gun reliability measurement be evaluated. According to contractual requirements, the gun has a system reliability requirement of 12,400 mean-round-between-failure, which is the expected number of rounds that can be fired before a component fails regardless of whether it caused a stoppage or not. This specification

[1]Operation Desert Storm: Apache Helicopter Was Considered Effective in Combat, but Reliability Problems Persist (GAO/NSIAD-92-146, Apr. 20, 1992).

measures the gun's overall reliability. GAO's and the Research Center's analyses of the test data showed that the gun achieved a mean-round-between-failure of 4,008. An Apache program official stated that the contractual requirement of 12,400 mean-round-between-failure has always been referred to as a mean-round-between-stoppage requirement and, therefore, the Army plans no further test.

Accuracy Requirements Were Reduced and Results May Not Apply to All Aircraft

The contract specifications for area weapon system accuracy were significantly reduced. The Army reduced its accuracy performance criteria from 19 required target points to only 1 must-meet target point and allowed the contractor to pay a $1 million penalty per each missed point. According to the accuracy test results, the area weapon system hit 16 of the 19 previously required target points resulting in a $3 million penalty for the contractor. In addition, the Army capped the contractor's total liability for both missed points and retrofitting costs at $8 million.

The test also did not sufficiently assess accuracy because the test limited its assessment to only one of the three different Apache fuselage configurations that make up the Apache fleet. Of the 761 Apaches delivered as of December 1992, 152 had different configurations from the test aircraft. Research Center and U.S. Army Materiel Systems Analysis Activity representatives told GAO that they do not know whether the test results could be applied to aircraft with different configurations. The Army plans to conduct a follow-up accuracy test in October 1993 to validate the incorporation of the January 1992 accuracy improvements into production aircraft.

Recommendations

GAO recommends that the Secretary of the Army (1) require the contractor to retest the area weapon system to ensure that it meets contract reliability specifications, (2) operationally test the area weapon system to determine what the field users can realistically expect to achieve in terms of reliability performance and distribute the results to the user community, and (3) validate the accuracy improvements on each of the fuselage different configurations during the October 1993 accuracy test.

Agency Comments

As requested, GAO did not obtain fully coordinated Department of Defense comments on this report. However, GAO discussed the results of its review with officials from the Offices of the Under Secretary of Defense for Acquisition; the Assistant Secretary of the Army for Research,

Development, and Acquisition; and the Apache Program Manager. They generally agreed with the results of the review and provided some clarifications that were incorporated in the text where appropriate.

Contents

Executive Summary		2
Chapter 1 Introduction		10
	Characteristics of the AWS	10
	AWS Endurance, Reliability, and Accuracy Requirements	12
	AWS Has Had a History of Reliability Problems	13
	AWS Experienced Accuracy Difficulties in the Past	15
	AWS Endurance, Reliability, and Accuracy Tests Concluded in 1992	15
	Objective, Scope, and Methodology	16
Chapter 2 Endurance and Reliability Test Plan Yielded Inconclusive Results		18
	Endurance and Reliability Test Results for 1992	18
	Test Did Not Sufficiently Assess Endurance Requirements	21
	Test Conditions Did Not Allow for an Adequate Reliability Assessment	23
	Test Plan Did Not Require a Key Gun Specification to Be Assessed	25
	The Army Plans Additional Corrective Action	25
	Conclusions	26
	Recommendations	26
Chapter 3 Accuracy Requirements Were Reduced and Results May Not Apply to All Aircraft		27
	Army Passes AWS on First Article Accuracy Test	27
	Contract Requirement Was Reduced	29
	Test Did Not Assess AWS Accuracy on Various Apache Fuselages	30
	Conclusions	32
	Recommendation	32
Appendixes		
	Appendix I: 19-Point First Article Accuracy Test Matrix	34
	Appendix II: Memorandum of Agreement Reducing AWS Accuracy Performance Requirements	35
	Appendix III: Major Contributors to This Report	37
Tables		
	Table 2.1: 30-Millimeter Gun Components Not Meeting Minimum Life Endurance Requirements	19
	Table 2.2: Assessment of AWS Reliability Requirements	20
	Table 2.3: The 12 Scored Stoppages for the Reliability Test	21

Table 2.4: Confidence Levels Associated With Different Size Endurance Tests 22
Table 3.1: Aircraft Tail Number by Fuselage Configuration 30

Figure

Figure 1.1: The Apache's Area Weapon System 11

Abbreviations

AWS	Area Weapon System
GAO	General Accounting Office
MRBF	mean-round-between-failure
MRBS	mean-round-between-stoppage
MTBF	mean-time-between-failure

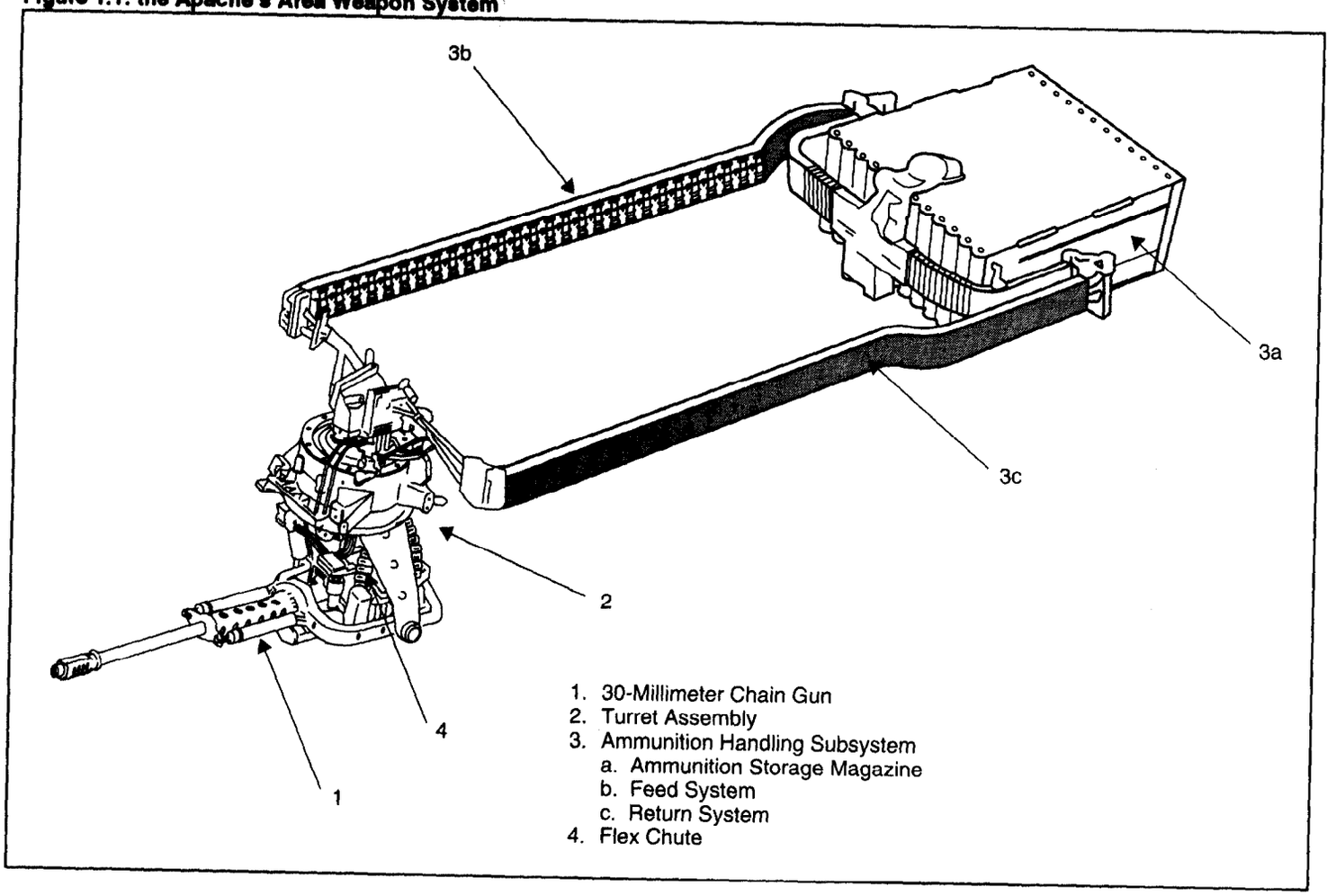
Introduction

The AH-64 Apache is the Army's premiere attack helicopter. McDonnell Douglas Helicopter Company, the contractor for the Apache, including the area weapon system, began delivering the helicopter to the Army in 1984. The Apache's primary mission is to support ground forces by destroying enemy tanks and other ground targets by air. As a secondary mission, the Apache assists air cavalry operations by providing firepower, security, and armed escort for unarmed helicopters. The Apache incorporates integrated armament, fire control, avionics, and visionics subsystems along with substantial performance and survivability characteristics. The Apache has four wing-mounted pylons for mounting Hellfire antitank missiles, 2.75-inch folding fin aerial rocket pods, or external fuel tanks. Additional armament includes the 30-millimeter area weapon system (AWS).

Characteristics of the AWS

The AWS consists of the 30-millimeter chain gun, a turret assembly, and an ammunition handling subsystem. Each AWS, currently estimated to cost $225,000, is designed to provide the crew with an accurate, quick response weapon for suppressive fire on soft and medium skinned targets, such as trucks. The AWS is shown in figure 1.1.

Figure 1.1: the Apache's Area Weapon System



The 30-millimeter chain gun is a single barrel, externally powered chain weapon. Its electrically driven chain and sprocket rotating bolt mechanism are designed to eliminate the vibration caused by firing the gun and low reliability inherent in self-powered guns. The gun is designed to fire linkless ammunition at about 600 rounds per minute from a 1,200-round magazine and be capable of destroying targets 3,000 meters away, thus making the gun a lethal threat to light vehicles and deployed infantry.

The gun is mounted in a remotely controlled turret and is directed through the fire control system. The turret is designed to swing 110 degrees on each side of the fuselage center line, pivot down 60 degrees, and up

11 degrees to provide a very flexible, accurate field of fire over a broad area.

The ammunition handling system receives and stores 30-millimeter linkless ammunition and delivers the ammunition through fixed and flexible feed chutes to the gun on demand. The handling system is comprised of an ammunition storage magazine, the ammunition feed system, and the ammunition return system.

AWS Endurance, Reliability, and Accuracy Requirements

AWS contract requirements reflect the Army's needs, which were developed by the user and contained in the materiel need document. AWS contract requirements are expressed as endurance, mission reliability, and accuracy. Some contract requirements also address system reliability for the gun and some specific AWS components.

Minimum Life Endurance Requirements

The system contract specification provides minimum life endurance requirements for the 30-millimeter gun and its components. Component minimum life requirements are described by an Apache program office representative as the minimum time that components are expected to last before replacement is required. For instance, the minimum life requirement for the barrel assembly is 10,000 rounds.

Mission and System Reliability Requirements

Mission reliability is defined by Department of Defense guidance 3235.1-H Test and Evaluation of System Reliability, Availability, and Maintainability as the probability that a system will perform mission essential functions for a certain period of time under the conditions stated in the mission profile. A system or subsystem with high mission reliability has a high probability of successfully completing the defined mission.

The AWS' mission reliability requirement was originally set in the Apache's 1972 materiel need document. At that time, the Army established a minimum requirement of a 92-percent probability of firing 1,000 rounds without jamming or becoming inoperable, which calculates to a mean-round-between-stoppage (MRBS) of 11,993. MRBS is the expected number of rounds fired before the AWS jams or becomes inoperable.[1] The current Apache contract specifications require the AWS to have a mission reliability of a 92-percent probability of firing 320 rounds without jamming or becoming inoperable, which calculates to a MRBS of 3,838. Justification

[1]During this test, the MRBS for the AWS is calculated by dividing the number of scored component stoppages into the total number of rounds fired.

for this reduced reliability requirement was that Army personnel believed the technology was not available to develop a 30-millimeter gun that would achieve the original MRBS requirement. They believed the requirement was not realistic and was beyond the state of the art.

Contract specifications also provide system reliability requirements for the 30-millimeter gun and certain AWS components. These requirements are stated in terms of mean-time-between-failure (MTBF) or mean-round-between-failure (MRBF), depending on whether the component's life is measured in hours or rounds achieved. Simply stated, MTBF can be interpreted as the expected length of time a system will operate between failures. The turret control box, for instance, has a MTBF of 1,500 hours. The MRBF is the expected number of rounds a system will be operational between failures. The gun specification is 12,400 MRBF.

AWS Accuracy Requirements

As part of the initial 1982 production contract, the Defense Systems Acquisition Review Committee III listed a variety of performance characteristics, including accuracy, which had to be demonstrated in a first article test.[2]

Generally, the accuracy specification requirement is categorized into two firing range classes, a 1-kilometer range and 2- and 3-kilometer ranges. For the first class, the measure of accuracy is the probability of at least one hit on a 3-meter by 3-meter vertical target for a 50-round burst. For the second class, the measure of accuracy is the expected number of hits in a 50-meter by 50-meter horizontal area when 50 rounds are fired. The specific requirements are presented in the materiel needs statement and system specification, both of which are contained in classified documents.

AWS Has Had a History of Reliability Problems

The Apache's AWS has had a history of reliability problems dating back more than 10 years. In 1984, the contractor conducted a test in which the AWS failed to meet its endurance and reliability requirements. According to an Apache program office representative and contractor documentation, of the 133 AWS gun components tested, 111, or 83 percent, did not demonstrate their minimum life requirements either because of the number of failures exhibited or because insufficient rounds were fired. In addition, the AWS' overall reliability requirement of 3,838 MRBS and some individual component system reliability requirements were not

[2]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.

demonstrated. The gun reliability requirement of 12,400 MRBF was not addressed during this test. Contract specifications required this test as part of the production airworthiness qualification program testing before entering production. However, Army officials decided to enter into production prior to the contractor meeting these and other requirements because they believed they had a critical need to meet. At the conclusion of this test, the contractor embarked on a reliability improvement program that ran through 1990.

We have reported on AWS' performance in prior reports. In September 1990,[3] we reported that the frequent failure of the 30-millimeter gun was one of the major contributing factors prohibiting the Apache from achieving its required fully mission capable rate.[4] We also reported that the AWS demonstrated a MRBS of 1,048 versus the contract requirement of 3,838. We pointed out that the Army had numerous corrective actions underway to improve component reliability, and Apache program office representatives acknowledged that it would be several years before all fixes would be incorporated on fielded aircraft. However, as of February 1993, all the component reliability improvements had not been fielded. We also reported in 1990 that the gun was considered a problem in Panama during "Operation Just Cause." At that time, the Apache company commander chose to limit the number of rounds loaded on the gun to 300 rounds out of a possible 1,200 rounds because of its history of jamming.

In October 1991, we reported that the Army had initiated a series of design changes to the AWS to improve its performance.[5] Failures of the carrier drive links and the flex chute, both of which are part of the ammunition handling system, were identified as the two primary contributors to gun stoppages and breakage. The Army incorporated a more durable flex chute into the production line in the fall of 1990 and an improved carrier drive link in the spring of 1991. However, as of August 1991, these changes had not been able to bring the AWS up to its reliability requirements.

In our April 1992 report, we highlighted that Apache pilots cited the 30-millimeter gun as the component that failed most frequently during

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

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

[5]Apache Helicopter: Reliability of Key Components Yet to Be Fully Demonstrated (GAO/NSIAD-92-19, Oct. 3, 1991).

Operation Desert Storm missions.[6] Overall, 56 of the 95 pilots and 72 of the 82 maintenance personnel we interviewed indicated that they had experienced or witnessed failures with the gun. They specified that ammunition carrier drive system component malfunctions caused the majority of the gun failures.

AWS Experienced Accuracy Difficulties in the Past

AWS' accuracy has also been an issue the Army has been trying to resolve since the AWS failed its first article test in 1985. In 1986, the contractor initiated a detailed development program to improve AWS' accuracy, which lasted through 1988. In February 1988, the contractor tested new design changes on an aircraft and the AWS nearly met all of its accuracy requirements. However, in May 1989, when the Army conducted a second first article test to validate the modifications on a production aircraft, the AWS failed.

As a result of the May 1989 failure, the contractor initiated numerous additional attempts to remedy the accuracy problem. Those attempts included: gun and turret testing, gun firing rate and weight modifications, procedural variations, system error analyses, AWS harmonization, ammunition testing, and specification changes.[7] After the contractor completed its evaluations, it recommended to the Army a series of fire control computer software changes, which included "body bending" corrector values. Body bending is the twisting of the airframe, which results from the recoil of the gun when fired. The contractor implemented its recommendations to include new body bending corrector values into the fire control computer software during its latest accuracy improvement program.

AWS Endurance, Reliability, and Accuracy Tests Concluded in 1992

In recognition of the previous unsuccessful attempts at meeting endurance, reliability, and accuracy requirements and the conclusion of the improvement programs in place to resolve the identified problems, the Army and the contractor conducted another set of tests to demonstrate these requirements.

In 1988, the Army initiated action to conduct an endurance and reliability test to demonstrate AWS specification requirements. After Army and

[6]Operation Desert Storm: Apache Helicopter Was Considered Effective in Combat, but Reliability Problems Persist (GAO/NSIAD-92-146, Apr. 20, 1992).

[7]Harmonization is a procedure in which the co-pilot/gunner fires rounds downrange to determine where the rounds are landing relative to the target and enters a correction factor into the computer to adjust for any misalignment.

contractor representatives considered various alternatives pertaining to the scope of the test, a 100,000-round test plan was approved by the Apache program manager in 1989. The testing was scheduled to begin mid-1990, but was delayed by the start of Operation Desert Shield until December 1990. The test was conducted from December 1990 through January 1992. The Army, agreeing with the contractor's May 1992 report, concluded that the AWS met most component minimum life requirements and surpassed its mission reliability requirement of 3,838 MRBS.

In 1991, the contractor concluded its evaluations and tests on accuracy improvement changes to the AWS. The Army conducted the AWS accuracy test at its test facility located in Yuma, Arizona, using a similar test plan to what they had used in previous attempts to pass accuracy requirements. The test took place from December 1991 through January 1992. Upon the completion of this test, the Army concluded that the AWS had been able to adequately demonstrate its accuracy requirements.

Objective, Scope, and Methodology

The Chairman of the Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce, requested that we review the Army's 1992 endurance, reliability, and accuracy tests for the AWS to determine whether the testing procedures and conditions resulted in sufficient information to fully assess the testing requirements.

We conducted our work at the U.S. Army Aviation and Troop Command, St. Louis, Missouri; the U.S. Army Materiel Systems Analysis Activity, Aberdeen, Maryland; the U.S. Army Aviation Center, Fort Rucker, Alabama, where the Training and Doctrine Command System Manager for Airborne Target Acquisition and Weapon Systems resides; the U.S. Army Armament Research, Development and Engineering Center, Picatinny Arsenal, New Jersey; the U.S. Army Armament Munitions and Chemical Command, Rock Island, Illinois; the Defense Contract Management Command's Defense Plant Representative Office, Mesa, Arizona; and the McDonnell Douglas Helicopter Company, Mesa, Arizona.

To determine the adequacy of the tests, we compared the current test plans to the contract specifications that were to be measured. In addition, we obtained expert opinion on the test plans from Army armament testing personnel and the independent evaluators of each test. At the various locations we visited, we interviewed personnel and obtained and analyzed documentation to gain an understanding of how the tests were developed and conducted, the actual test results, and the interpretation of those

results. We also obtained the raw data from the endurance and reliability test and a copy of the contractor's test report to verify the results obtained.

We conducted our review from June 1992 through February 1993 in accordance with generally accepted government auditing standards. As requested, we did not obtain fully coordinated Department of Defense comments on this report. However, we discussed the results of our review with officials from the Offices of the Under Secretary of Defense for Acquisition; the Assistant Secretary of the Army for Research, Development, and Acquisition; and the Apache Program Manager. They generally agreed with the results of our review and provided some clarifications that were incorporated in the text where appropriate.

Endurance and Reliability Test Plan Yielded Inconclusive Results

According to contractor test results and Apache program office representatives, while some did not, most AWS components met minimum life endurance requirements and surpassed reliability requirements. Concerning the AWS components that failed to meet minimum life endurance requirements, the contractor has proposed changes that it believes will address problem areas. The Army plans on reassessing these components in a 150,000-round test in 1993 designed to establish maximum life endurance parameters.

However, our analysis of the Army's January 1992 AWS test shows that the test produced inconclusive results because the testing procedures and conditions provided insufficient information to fully assess all endurance and reliability requirements. Specifically, the test results were of limited value because the test plan (1) limited the test to 100,000 rounds resulting in endurance confidence levels for individual components that are not statistically meaningful and insufficient assessments of several reliability requirements for individual components, (2) contained conditions that may have allowed the AWS to achieve a higher reliability measure, and (3) did not evaluate a key 30-millimeter gun reliability requirement.

Endurance and Reliability Test Results for 1992

The contractor's test report, which the Army accepted, concluded that the AWS passed most endurance testing requirements and surpassed its MRBS reliability requirement. The contractor conducted the test at its facility in Mesa, Arizona, and at the Army's Yuma Proving Ground, in Yuma, Arizona.

The test was comprised of two approximately 50,000-round test segments. The actual firing was done from two AWSs attached to fixed test stands in an enclosed room with a narrow tunnel approximately 70 feet long, except for 5,000 rounds that were fired from an airborne Apache helicopter at Yuma Proving Grounds. The Apache program manager included the airborne test in order to determine whether any significant reliability or minimum life problems would occur on the aircraft that had not been experienced on the test stand. The gun fired 3,810 of the 5,000 rounds from the airborne Apache at various firing angles. This was a change from the 1984 test plan when all rounds were fired from the test stand.

The AWSs used for testing were not production line models. They were comprised of components removed from Army aircraft, approved product improvement components, and certain experimental components approved by the Army for engineering evaluation.

The Defense Plant Representative Office personnel on-site at Mesa, Arizona, accepted oversight responsibilities for the test rather than the Apache program office manager. As part of their oversight responsibilities, they were asked to verify failures that occurred during the test. According to an Apache program office representative, the total cost of the entire test was approximately $2.8 million.

Some Gun Components Failed to Meet Endurance Requirements

The test report data showed that 12 of the 133 30-millimeter gun components did not meet minimum life endurance requirements. Table 2.1 lists these 12 components.

Table 2.1: 30-Millimeter Gun Components Not Meeting Minimum Life Endurance Requirements

Components	Minimum life requirement (rounds)	Minimum demonstrated value (rounds)[a]
Gun receiver	50,000	[b]
Timing pin spring	50,000	38,080
Chain guide screw	50,000	9,981
Aft track huck bolt	50,000	21,300
Bearing support	50,000	6,020
Aft track	25,000	15,212
Drive gear bushing	20,000	10,707
Recoil adapter	20,000	6,020
Loadhead bolt	20,000	10,020
Chain assembly	10,000	8,676
Firing pin assembly	10,000	7,351
Clevis pin	10,000	7,351

[a]Figures contained in the contractor's 1992 Endurance and Reliability test report.

[b]Cracks on the receivers were not discovered until after the test was completed. However, the contractor agreed with the Army that any cracks in the receiver constituted a failure.

Some AWS Components Did Not Meet Reliability Requirements

An assessment of the test results by the U.S. Army Armament, Research, Development, and Engineering Center, hereafter referred to as the Research Center, showed that some key AWS components failed to demonstrate their system reliability requirements. The Research Center sent this assessment to the Apache program manager on October 1, 1992. Subsequently, the Apache program manager provided this assessment to the U.S. Army Armament, Munitions, and Chemical Command, the Research Center's parent organization. The U.S. Army Armament,

Munitions, and Chemical Command concluded that the Research Center's analysis was not an official Army position and that the agreed upon 100,000-round test plan and scoring criteria was to be an assessment of gun stoppages. Table 2.2 contains the Research Center's calculations of the test results of AWS component reliability.

Table 2.2: Assessment of AWS Reliability Requirements

Component	Requirement	Demonstrated[a]
30-millimeter gun	12,400 MRBF	4,008 MRBF
Turret subsystem		
Turret assembly	50,000 MRBF	49,573 MRBF
Hydraulic motor assembly	4,000 MTBF	[b]
Hydraulic actuator assembly	3,000 MTBF	[b]
Ammunition handling subsystem		
Ammunition storage magazine	50,000 MRBF	99,147 MRBF
Carrier drive assembly	50,000 MRBF	99,147 MRBF
Conveyor assembly	10,000 MRBF	[c]16,525 MRBF
Forward flex chute and gun transfer housing	10,000 MRBF	[c]5,508 MRBF
Electronic controls		
Gun control box	1,000 MTBF	[b]
Turret control box	1,500 MTBF	[b]
Train rate sensor	3,000 MTBF	[d]
Magazine controller/rounds counter	6,000 MTBF	[b]

[a]Figures provided by the U.S. Army Armament Research, Development, and Engineering Center.

[b]Research Center representatives maintain these components have not fully demonstrated reliability requirements because of limited testing.

[c]Value calculated by GAO based on Research Center data.

[d]According to a program representative, this component failed reliability testing because of design related problems, which caused five stoppages.

One of the key AWS components that did not meet its system reliability requirement was the flex chute. A total of 20 flex chute failures occurred during testing, of which 18 were scored against its MRBF requirement of 10,000. The test report cited problems relating to fatigue failures of parts associated with the track segment of the flex chute and poor spot welds, which caused the gun to jam. In our October 1991 and April 1992 reports, we noted that the flex chute had had problems for over 10 years; those problems continued during this test.

The 100,000-round test also generated data to assess the AWS overall MRBS requirement. The contractor's test report indicated that there were a total of 14 gun stoppages that took place during the test. The Army's scoring panel disregarded 2 of the 14 stoppages because 1 resulted from another part's failure and the other was scored as an ammunition problem. The 12 remaining scored stoppages equates to a 8,350 MRBS, which exceeds the requirement of a 92-percent probability of firing 320 rounds of ammunition without jamming or becoming inoperable, which calculates to 3,838 MRBS. The 12 scored stoppages involved 6 different components. Table 2.3 lists the scored stoppages.

Table 2.3: The 12 Scored Stoppages for the Reliability Test

Component	Number of stoppages
30-millimeter gun	
Clevis pin	2
Chain assembly	2
Drive gear bushing	1
Turret assembly	
Train rate sensor	5
Ammunition handling system	
Flex chute	1
Ammunition carrier	1

Source: Contractor's test report.

The component that caused the most gun stoppages during the test was the train rate sensor. This sensor is a small electronic box mounted on the turret, which monitors the rate the turret rotates and makes sure the gun points in the correct direction. According to an Apache program office representative, the train rate sensor feeds information to the turret control box, which relays the data to the fire control computer so the fire control computer can adjust as needed. The failures that happened during testing were all related to electrical subcomponent malfunctions.

Test Did Not Sufficiently Assess Endurance Requirements

Our analysis of the endurance testing shows that the tests are inconclusive primarily because the 100,000-round test results were statistically insignificant because of the low confidence levels achieved. Also, the test plan was not sufficient to determine meaningful component life data because the plan contained two different objectives, endurance and reliability, which did not allow the components to be tested to failure.

Research Center representatives stated that the test results associated with low confidence levels may not be generalized to the rest of the Apache fleet. According to the Army's training materials, the Army considers a reasonable confidence level value to be between 50 to 100 percent. A Research Center technician told us that the confidence levels associated with any test should be at least 80 percent. Some of the AWS components tested are expected to have a minimum life of 50,000 rounds. With a 100,000-round test using 2 guns, there is a 19-percent confidence level that a 50,000-round component will meet its life expectancy. Table 2.4 shows confidence levels that can be expected from firing varying numbers of rounds.

Table 2.4: Confidence Levels Associated With Different Size Endurance Tests

Component minimum life requirement	100,000 rounds, 2 guns (percent)	250,000 rounds, 5 guns (percent)	1,100,000 rounds, 22 guns (percent)
10,000	65	93	99.9
20,000	41	73	99.7
25,000	34	65	99
50,000	19	41	90

Source: U.S. Army Armament Research, Development, and Engineering Center.

In October 1988, the Research Center proposed a 1.1-million round endurance test, which would have demonstrated at least a 90-percent confidence level for all components. According to Research Center representatives, this proposal was designed without consideration to cost or the time it would have taken to conduct it.

The Research Center recognized that its proposal raised affordability concerns. Consequently, it recommended the endurance test be scaled down to a 5-gun, 250,000-round test, followed by other tests, which would take approximately 4 years to complete. They felt this proposal was reasonable, if the Army was willing to accept a lower degree of confidence. The 250,000-round test would still demonstrate a 93-percent confidence level for 10,000-round components, such as the chain assembly. Research Center data showed that the estimated cost of this 4-year test was $25 million, or about 8 percent of the estimated total cost to field all the 975 AWSS, including spares. Research Center representatives believed that the estimated $25 million expenditure would be offset by future savings in maintenance, spare parts, and improved readiness of the

AWS. However, the Apache program manager decided on a $2.8 million, 100,000-round test because of funding and time constraints.

The test plan required the contractor to conduct component minimum life endurance and reliability testing concurrently. Endurance and reliability tests are designed to achieve different objectives. Research Center representatives told us that, ideally, minimum life endurance testing is conducted first, followed by maximum life testing. Once that has taken place, and new minimum component life standards are established, then component reliability testing can be done. This sequence of testing provides the best insight to endurance and reliability results. According to U.S. Army Materiel Systems Analysis Activity representatives, the normal process to establish component life is to test to failure. However, if the test had allowed the components to be tested to failure, reliability data could not have been gathered at the same time.

Test Conditions Did Not Allow for an Adequate Reliability Assessment

Our analysis also shows that the Army's test plan included several favorable test conditions that may have made it easier for the AWS to obtain a higher MRBS measure. As a result, sufficient information was not developed to determine if the AWS met its system reliability requirement. According to Apache program office and U.S. Army Armament, Munitions, and Chemical Command representatives, the Army introduced field maintenance standards that allowed for operational maintenance, as it would be done in the field, into a controlled design test environment. In accordance with the Army Aviation Unit and Intermediate Maintenance Manual for Armament Subsystems, personnel in the field are allowed to replace components that appear faulty to avoid gun stoppages. Consequently, during the test, the contractor personnel were allowed to remove components that failed before they caused a gun stoppage. The changing of a failed component that did not cause a stoppage counted against the minimum life requirement of the component but not against the overall mission reliability requirement of 3,838 MRBS. U.S. Army Armament, Munitions and Chemical Command representatives told us that in retrospect these types of maintenance actions should have been counted against the MRBS reliability requirement. Not doing so favorably affected the MRBS results. This was a change from the 1984 test in which inspections and component changes were performed on a schedule.

Another favorable condition was that the test plan also called for the AWS to be tested carrying varying loads of ammunition. The AWS, designed to carry a maximum of 1,200 rounds, has experienced several problems in the

past when fully loaded. For instance, as we noted in our April 1992 report, field personnel reported having more problems with the flex chute when carrying near maximum loads during Operation Desert Storm. As a result, some units carried less than maximum loads to help avoid gun stoppage problems.

According to an Apache program office representative, the Apache program manager decided to vary ammunition loads during the test to assess how well the gun system worked at different loads. Approximately 31 percent of the ammunition loaded represented 1,200-round loads, while 40 percent of the ammunition loaded represented 800- to 1,100-round loads, and 29 percent of the ammunition loaded represented 300- to 700-round loads. Of the 12 scored stoppages experienced during the test, 11 occurred at loads of 800 rounds or more. Research Center representatives believe that varying loads reduced weight and stress on the system. The practice of varying loads is also a change from the 1984 test in which the AWS was tested at its capacity of 1,200 rounds.

A third favorable condition was that most of the test was conducted in an indoor test facility, which restricted the movement of the gun. The configuration of the test room did not permit the gun to fire at various angles during the test. However, an Apache program office representative told us that the AWS was able to achieve all of its firing angles during the airborne portion of the test. According to the test report, 3,810 of the 5,000 rounds fired during the airborne portion of the test were fired at a range of angles and no stoppages occurred during that time. Conducting most of the test in an indoor environment was also a change from the 1984 test in which the test was conducted outdoors.

The 100,000-round test was a design test, according to an Apache program office representative, and as such was conducted for the most part in an indoor, relatively clean, controlled environment. The gun was mounted on an open test stand and was maintained by experienced contractor personnel. The use of the open test stand exposed the AWS components to closer scrutiny by contractor maintenance personnel, allowing them to easily identify potential failures. In assessing testing results, U.S. Army Materiel Systems Analysis Activity personnel noted that the test should be viewed as what the AWS can do under ideal conditions and not necessarily the reliability that would be expected in the field. In the field, the AWS would be subject to a wide range of heat, moisture, and dust conditions. It would normally be maintained by Army personnel whose level of expertise would greatly vary depending on the person's experience level.

Test Plan Did Not Require a Key Gun Specification to Be Assessed

Our review indicated that the test plan did not require a critical 30-millimeter gun specification to be assessed. The specification requires the gun to meet a 12,400 MRBF system reliability requirement. Meeting this specification is a measure of the gun's overall reliability, but this was not addressed in the contractor's report on testing results. The Research Center, in an October 1992 letter to the U.S. Army Armament, Munitions, and Chemical Command headquarters, stated that the MRBF had not been met. Based on the Research Center's review of the contractor's test results, and our assessment, the gun demonstrated a MRBF of 4,008 in the 100,000-round test.

An Apache program office representative was aware of the Research Center's concerns about the 30-millimeter gun not meeting its MRBF requirement of 12,400. However, according to that representative, the MRBF requirement of 12,400 has always been referred to as an MRBS requirement. The Apache program representative believed that the requirement should be construed as an MRBS requirement and, as of January 31, 1993, planned on taking no action on this item. In addition, this representative believed other components, identified by the Research Center as not having fully demonstrated their requirements, such as the gun control box, have satisfied component reliability requirements based on reliability, availability, and maintainability data collected since the 1984 test and scored by the Army. Therefore, the Apache program office representative believes that no further testing is necessary on those items.

The Army Plans Additional Corrective Action

The Army is preparing to conduct a 150,000-round maximum life endurance and reliability test in March 1993. The purpose of this test is to establish AWS component maximum life endurance parameters. One of the objectives of this test is to reevaluate the AWS components that did not meet minimum life endurance and reliability requirements during the 100,000-round test. The contractor has proposed design changes to several components that failed to previously demonstrate their minimum life or reliability requirements. Some of the design changes that will be tested involve the flex chute and the receiver. One of the changes to the flex chute involves strengthening materials on some of the subcomponents. The contractor design change proposal for the receiver involves different machining techniques to address cracks that surfaced during testing. A contractor representative said that if the design changes meet requirements, they will be incorporated into the production line at no cost to the Army.

Changes resulting from the 100,000-round test, as well as other improvements proposed for the AWS components, are to be retrofitted to the Apache fleet at the Army's expense. The Army currently estimates this cost to be approximately $18 million.

Conclusions

While the Army maintains the AWS has passed most endurance requirements and surpassed reliability requirements, our analysis shows the results are inconclusive because testing procedures and favorable conditions did not produce sufficient information to fully assess whether requirements were met. In particular, the 100,000-round test did not generate statistically meaningful endurance data or sufficiently assess several reliability requirements for individual components, the test conditions may have made it easier for the AWS to demonstrate a higher reliability, and the test plan did not require a key gun specification to be assessed. While the testing decisions were strongly influenced by cost and time constraints, much of the results are of little value to assessing whether endurance and reliability requirements have been met. Currently, the Apache program manager has no plans to require the contractor to demonstrate the MRBF requirement for the gun. Because of the inconclusive nature of the test, we believe the capability of the AWS to satisfy all of its endurance and reliability requirements has not been fully demonstrated. In addition, the results achieved during this 100,000-round design test have limited application to fielded aircraft because this test did not replicate an operational environment in which the gun would have been subjected to more stringent conditions.

Recommendations

We recommend that the Secretary of the Army (1) require the contractor to retest the AWS to ensure that it meets contract reliability specifications and (2) operationally test the AWS to determine what the field users can realistically expect to achieve in terms of reliability performance and distribute the results to the user community.

Accuracy Requirements Were Reduced and Results May Not Apply to All Aircraft

The 1992 accuracy test contained reduced requirements from the original contract specifications and had a limited design test. In January 1992, the Army concluded that the AWS had successfully met its accuracy requirement by achieving 16 out of the 19 required target points. The Army had reduced the AWS accuracy performance criteria from 19 required target points to only 1 "must-meet target" and allowed the contractor to pay a $1 million penalty for each missed point. Moreover, the test results provide only limited value because its assessment applies to only one of three Apache fuselage configurations. The performance results of the one fuselage type tested may not be applicable to the entire Apache helicopter fleet. The Army plans to conduct a follow-up accuracy test in October 1993 to validate the incorporation of the January 1992 accuracy modifications in production aircraft.

Army Passes AWS on First Article Accuracy Test

The Army passed the AWS on its first article accuracy test, which was completed in January 1992. This test consisted of one Apache helicopter (Production Vehicle 685), with a contractor pilot and an Army co-pilot/gunner. AWS accuracy performance was judged upon the results of the co-pilot/gunner firing at a 19-point first article test matrix. The test called for 10 repetitions of each target point using a 21-round burst for the first 17 target points and a 51-round burst for target points 18 and 19. The test also allowed for the AWS and aircraft systems to be maintained by the contractor's personnel. This test matrix was similar to the ones used during the 1985 and 1989 first article accuracy tests. See appendix I for a copy of the 19-point test matrix.

The targets were of three types. The first two types were stationary horizontal targets, 50 meter by 50 meter and 3 meter by 3 meter in size, with steel targets located in the centers for use as aiming points. The second type of target was a moving target, 3 meter by 3 meter in size, fastened on a rail system that moved the target from either the right or left at a speed of 25 miles an hour.

The Army allowed the contractor to conduct preflight firings to ensure operation of all the aircraft's applicable subsystems. This included firing at target points similar to the 19 first article accuracy target points but on adjacent ranges. The co-pilot/gunner did not participate in this pretest firing, and he told us that these pretest firings did not introduce any biases into the formal test. During the scored test, the pilot was required to fly to a specific location, and then the co-pilot/gunner would engage the respective target while at an altitude ranging between 90 and 150 feet. The

co-pilot/gunner told us that he would "laser range" the given target, lock on to the target, pull the trigger, and then the AWS would take over. The co-pilot/gunner stated that he was specifically instructed not to apply his own correction factor to help compensate for any errors in the system.

U.S. Army Test and Evaluation Command personnel were present during or gave prior approval to any changes made during the test. The Yuma Proving Ground was responsible for collecting the raw data and presenting the data to U.S. Army Materiel Systems Analysis Activity representatives, who acted as the independent evaluators of the test. It was the U.S. Army Materiel Systems Analysis Activity's responsibility to decide whether the 30-millimeter gun had passed or failed the accuracy test.

The contractor's and U.S. Army Materiel Systems Analysis Activity's reports indicated the AWS successfully met 16 out of the 19 required target points without the use of harmonization. U.S. Army Materiel Systems Analysis Activity representatives stated that they felt this level of performance was acceptable to conclude the AWS passed its first article test accuracy requirements. The representatives pointed out that they not only looked at the design specification when making their conclusion, but also at the system's mission. They said that the three missed points, points 7, 12, and 13 (as described in appendix I), were all at the 3-kilometer range, and the user community was willing to accept degraded performance at this distance. In addition, they said they had to look at the criticality of a point and determine if it was cost-effective to retest the missed shot. In the past, the contractor tested a proposed adjustment for the 3-kilometer shot, but during testing it distorted the closer shots. The U.S. Army Materiel Systems Analysis Activity concluded it was not worth trying to fix the three missed points at the expense of jeopardizing the 1- and 2-kilometer range shots.

The contractor's report stated that the failed points were affected by variations in (1) the uncalculated wind velocity and direction at the target location and (2) the ammunition muzzle velocity of individual rounds. However, according to Army documentation, the ammunition and environmental variables were not the sole factors causing the aircraft to fail the three target points. Since two of the five 3-kilometer points were met under similar conditions and the two points that met specification were significantly better than the three that did not, the Army believed it was other factors that influenced the performance.

Contract Requirement Was Reduced

The Army's criteria to judge success during the 1992 accuracy test was reduced from the accuracy criteria contained in the contract specification. In May 1991, the Apache program manager and the contractor entered into an agreement that allowed the contractor to pass its first article test accuracy requirements by only successfully demonstrating 1 of the 19 required target points and paying a $1 million penalty for each point not achieved. The one must-meet target point was at the 1-kilometer range. In addition, the agreement required the contractor to retrofit the fleet with the accuracy improvements. The agreement capped the contractor's total liability, for both missed points and retrofitting costs, at $8 million. (See app. II for a copy of the agreement.)

Research Center, U.S. Army Materiel System Analysis Activity, and user community representatives did not agree with the reduced performance requirements contained in the agreement. Research Center representatives stated that although they did not mind the intent of the agreement because the primary purpose of the 30-millimeter gun is to provide area suppression, they were against only requiring the one must-meet target point and the use of harmonization during the test. U.S. Army Materiel Systems Analysis Activity representatives had similar concerns. They stated that it was their mission to determine whether the AWS met its requirements. They said that if the AWS had only passed the 1 must-meet point and missed the other 18, they would not have stated the system's accuracy specifications had been met.

The user community representative at Fort Rucker, Alabama, stated that they were not involved in developing the Apache program manager's agreement that required the AWS to pass only the one must-meet target point and disagreed with it. They were asked to give input to the Apache program office on their prioritization of the different target points. This document stated that the 3-kilometer shots were the least important. After the test, the user community indicated that they were willing to accept reduced performance at the 3-kilometer range, but did not accept reduced performance at the 1- and 2-kilometer range. The representative explained that the primary mission of the AWS is as a self-defense weapon system. He believed that for this role the 1-kilometer shot is the most important and is willing to accept reduced accuracy at longer ranges. He felt the 3-kilometer shot was not essential for the Apache to complete its mission because the co-pilot/gunner would choose a different weapon at that range.

Research Center and U.S. Army Materiel System Analysis Activity representatives stated that they were willing to accept the AWS demonstrated performance as long as the user community was willing to accept reduced performance at the 3-kilometer range. Regarding the missed shots, these representatives stated that they would have liked to have seen all the points made, but they support the user community's position. As a result, U.S. Army Materiel Systems Analysis Activity concluded that the AWS had passed its first article accuracy test requirements.

The Apache program office concluded that in accordance with the agreement, the one must-meet target point was passed without harmonization; therefore, the contractor was not responsible for further design changes. However, the contractor owes the Army $3 million for the three missed target points. In addition, as of April 1992, the Apache program office instructed the contractor to proceed immediately with a full fleet retrofit program of the accuracy hardware and software changes. The Army capped the contractor's total liability at $3 million for missed points and up to $5 million in retrofitting costs.

Test Did Not Assess AWS Accuracy on Various Apache Fuselages

The test did not sufficiently assess accuracy for the Apache fleet because the test was performed on only one of the three different fuselage configurations that make up the fleet. According to McDonnell Douglas Helicopter Company records, there were 155 aircraft that did not have the same fuselage as the aircraft tested. Table 3.1 contains the breakout of the different fuselage configurations. The 155 of the 761 Apaches not represented by the test aircraft are listed in the first two structure categories. We recently were advised that three of these aircraft have been dropped from the Army's inventory.

Table 3.1: Aircraft Tail Number by Fuselage Configuration

Aircraft tail numbers	Description of structure	Total
PV01-PV117 and PV123	First year production—This configuration reflected no changes to the gun support structure.	118
PV118-PV122 and PV124-PV155	Retrofit kit—This configuration implemented the stiffening kit originally designated for use by the Army in the field to update the first year production aircraft.	37
PV156 and subsequent (PV761)	Modified production—This configuration implements the modified 91.7 frame and gun intercostals/supports.	606

The contractor identified body bending as a significant problem in correcting accuracy performance. Body bending is the twisting of the airframe, which results from the recoil of the gun when fired. New accuracy improvements include incorporating body bending characteristic data into the fire control computer software. To do so, the contractor collected data from five production "600 series tail number" aircraft and combined it with prior test data from Production Vehicles 145 and 450 to derive a 25-point body bending matrix for the fire control computer software. To calculate the body bending corrector values, the contractor derived a mean average performance using data from the seven aircraft. According to this contractor representative, because of the large number of 600 series aircraft in the calculations, the resulting matrix was weighted in their favor.

Research Center and U.S. Army Materiel Systems Analysis Activity representatives also expressed concerns about the applicability of the body bending data fix to all the Apache fleet aircraft. They acknowledge that the test aircraft was similar to the aircraft used by the contractor to collect body bending characteristic data. They believe that it is not known whether the developed body bending software fix that represents the "newer" series aircraft can be applied to the "older" aircraft in the fleet. Both the Research Center and U.S. Army Materiel Systems Analysis Activity representatives believe that the accuracy improvements should be applied to the other two older series of aircraft and then tested to determine what impact the improvements have on the aircraft's accuracy.

In addition to testing only one aircraft, the test was performed under ideal conditions. Research Center and U.S. Army Materiel System Analysis Activity representatives cautioned that the results achieved in this test may not be replicated in the field because of these ideal testing conditions. The January 1992 test was considered a design test to determine whether the AWS met accuracy design specifications. It was conducted under ideal conditions, which meant the test assumed 100-percent reliability of all the aircraft component parts. If components malfunctioned, the Army repeated the target. The test was also conducted under very strict environmental conditions, such as daytime firing, wind velocity of 5 knots and below for 2- and 3-kilometer shots and 10 knots and below for 1-kilometer shots, and aircraft altitude between 90 and 150 feet. Research Center and U.S. Army Materiel System Analysis Activity representatives believe the Army can only say that an identical series aircraft firing under the same design conditions will perform in a similar manner. A design test varies from an operational test in that an operational test would have

taken all conditions and results into consideration when scoring the results.

Army representatives stated that a test will be conducted in October 1993 to validate the incorporation of the January 1992 accuracy improvements into production aircraft. Currently, the Army plans to test only one aircraft from the production line, which will be a similar airframe as the last test aircraft. In addition, Apache program office representatives told us that they plan to retrofit the 152 aircraft, which have different fuselage configurations, with hardware supports to upgrade them to the same configuration as the production aircraft. The time frame of this retrofit has not been established.

Conclusions

The Army concluded that AWS had successfully met its accuracy requirement, however, the Army accepted reduced AWS performance from the original contract specification. Moreover, the results achieved from the one aircraft assessed may not represent the other two types of fuselages within the Apache fleet. The body bending characteristics of the remaining 152 aircraft with different fuselage configurations may be significantly different from the body bending data entered into the fire control computer software. The Army plans to validate the accuracy improvements in October 1993.

Recommendation

We recommend the Secretary of the Army direct the Apache program manager to validate the accuracy improvements on multiple aircraft, one from each of the three Apache fuselage types, during the October 1993 accuracy test.

19-Point First Article Accuracy Test Matrix

Test point	Target azimuth[a]	Target range[b]	Apache speed[c]	Type of maneuver	Target type	Target size[d]	Rounds per burst
1	0	1	0	Hover	Vertical	3X3	21
2	–45	1	0	Hover	Vertical	3X3	21
3	–90	1	0	Hover	Vertical	3X3	21
4	+45	1	0	Hover	Vertical	3X3	21
5	+90	1	0	Hover	Vertical	3X3	21
6	0	2	0	Hover	Horizontal	50X50	21
7	0	3	0	Hover	Horizontal	50X50	21
8	0	1	80	Forward	Vertical	3X3	21
9	[e]	1	80	Left veer	Vertical	3X3	21
10	[e]	1	80	Right veer	Vertical	3X3	21
11	0	2	80	Forward	Horizontal	50X50	21
12	0	3	35	Forward	Horizontal	50X50	21
13	0	3	80	Forward	Horizontal	50X50	21
14	[e]	2	80	Left veer	Horizontal	50X50	21
15	[e]	2	80	Right veer	Horizontal	50X50	21
16	[e]	3	80	Left veer	Horizontal	50X50	21
17	[e]	3	80	Right veer	Horizontal	50X50	21
18	0	1	0	Hover	Moving	3X3	51
19	0	1	80	Forward	Moving	3X3	51

[a]Azimuth is the offset angle between the 30-millimeter gun and the nose of the helicopter and is measured in degrees.

[b]Target range measured in kilometers.

[c]Apache speed measured in knots.

[d]Target size measured in meters.

[e]Not Applicable for this maneuver.

Memorandum of Agreement Reducing AWS Accuracy Performance Requirements

MCDONNELL DOUGLAS

McDonnell Douglas Helicopter Company

AMSAV-A-PD 15 May 1991

MEMORANDUM OF AGREEMENT

SUBJECT: Area Weapons System (AWS) Gun Accuracy Settlement

1. On this date the undersigned representatives of the US Army AVSCOM and McDonnell Douglas Helicopter Company (MDHC) reached agreement on final settlement of all issues related to AH-64 30MM gun accuracy. Terms of this agreement are as follows.

a. MDHC agreed to complete the gun improvement program identified in their letter 9011-1144/4000 dated 16 November 1990, Subject: Contract DAAJ09-89-C-A003, Area Weapons System (AWS) Accuracy except as noted on the attached sheet. The Government will provide normal Government Furnished Property to support the AWS Improvement Program and AWS test (firing range, ammo, test aircraft, systems, etc.).

b. MDHC agrees to accept point #1 (1 Kilometer, 0 Azimuth, at a hover) as a must meet point. The contractor will be authorized to use harmonization to test this point if it cannot be achieved without harmonization. In the event this point is not passed MDHC accepts responsibility to make whatever additional changes necessary to successfully pass this point.

c. The additional 18 points are valued at one million dollars per point (or a total value of $18 million). As each point is passed during conduct of the Gun Improvement Program the 18 million will be reduced by one million dollars if passed without harmonization and 750 thousand dollars if passed with harmonization. The contractor agrees to pay to the Government the balance left after completion of all testing except as addressed in paragraph e. below.

d. The contractor agrees to retrofit the fleet with only those improvements identified as a result of the gun improvement program identified in paragraph 1a. above unless such retrofit is specifically waived by the Government.

e. The Government agrees to cap the contractor's total liability under paragraphs c. and d. above at eight million dollars. In the event that MDHC fails to pass one or more points the contractor agrees to pay a minimum of one million dollars under paragraph c. and in addition retrofit cost is capped at seven million dollars. If the contractor passes all test points such that no consideration is due under paragraph c. the contractor agrees to perform the retrofit program and such retrofit cost is capped at eight million dollars.

f. The Government will immediately release the approximately 5.5 million dollars of associated Pre-lot V withhold. The Government will also immediately release $120,000 of the existing $200,000 withhold for each aircraft delivered since November 1990. The Government will reduce the current withhold to $80,000 per aircraft until the AWS Improvement Program identified in 1.a. above is completed. Upon completion of the AWS Improvement Program, the withhold will be reduced to $25,000 per aircraft until scheduled completion of the retrofit as identified in the resulting ECP. At the time of completion of the Improvement Program, the difference between $80,000 and $25,000 will be released.

g. This agreement constitutes full and final settlement of any and all issues in regards to AWS accuracy and all open first article issues.

2. The parties further agree that upon completion of the Area Weapon Improvement Program, successfully completing the must meet point, and completion of retrofit the first article test required by contract will be considered to have been successfully passed and the specification will be changed to reflect the test results.

R. W. Goodman
MDHC

Charles C. Trendley
Contracting Officer
15 May 91

Note: This agreement supercedes in full the agreement between MDHC and AVSCOM dated 10 May 91.

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