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United States General Accounting Office

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

April 1992

OPERATION DESERT STORM

Apache Helicopter Was Considered Effective in Combat, but Reliability Problems Persist



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National Security and
International Affairs Division

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April 20, 1992

The Honorable J. 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 performance of the Apache during Operation Desert Storm.

Unless you announce the contents of this report earlier, we plan no further distribution of it for 30 days from 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 and the Senate Committee on Governmental Affairs, House Committee on Government Operations; the Director of the Office of Management and Budget; and the Secretaries of Defense and the Army. We will also provide copies to others upon request.

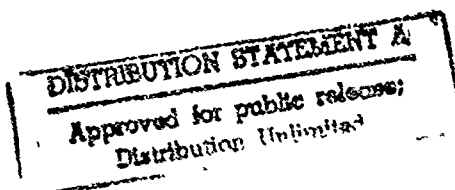
This report was prepared under the direction of Richard Davis, Director, Army Issues, who may be reached on (202) 275-4141 if you or your staff have any questions. Other major contributors are listed in appendix III.

Sincerely yours,



Frank C. Conahan
Assistant Comptroller General

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Executive Summary

Purpose

The Apache—the Army's \$14 million premier attack helicopter—received its first real test under combat conditions during Operation Desert Storm. In past reports, GAO has highlighted problems the Army has experienced with the Apache's reliability and logistical support that could have hindered the Apache's effectiveness during actual combat.

Concerned about the Apache's history of problems and their impact on the Apache's performance during Operation Desert Storm, the Chairman of the Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce, requested that GAO assess how well the Apache had performed during the war. Specifically, he asked GAO to determine (1) how well the Apache had performed its roles and missions during the air campaign and the ground war and (2) whether component reliability and logistical support problems that GAO previously reported had adversely affected the Apache's combat effectiveness.

Background

The Apache's primary mission is to find tanks and other targets and destroy them with its laser-guided Hellfire missiles, its 2.75-inch rockets, or its 30-millimeter gun. In August 1990 the U.S. Army began deploying the first of 274 Apaches to Saudi Arabia in support of U.S. and coalition forces.

To obtain an overview of unit operations and the performance of the Apache, GAO interviewed commanders and other officials at 11 of the 15 Apache units that had participated in the war. GAO also obtained responses to three sets of questions from 210 Apache personnel—101 pilots, 97 maintainers, and 12 supply personnel. GAO held group discussions with the same personnel regarding the Apache's performance. GAO relied heavily on this information because maintenance and other unit records were generally not available.

Results in Brief

The overall assessment of Apache pilots and commanders was that the Apache had proved its effectiveness by destroying 278 tanks and about 900 other targets and by providing the Army with timely intelligence data. During the air campaign, the Apache flew mostly armed reconnaissance missions, while during the 100-hour ground war, it flew mostly attack missions—which are its primary role.

The Apaches flew a limited number of missions during the war—a total of 83. It flew a limited number of missions primarily because of the perceived enemy threat to low-flying helicopters during the air campaign and

because ground commanders, who controlled the Apache's use and roles during the ground war, chose not to use it more.

The Apache's key weapons and other vital subsystems experienced reliability problems, which were sometimes amplified by the harsh desert environment. Also, logistical support problems such as parts shortages were experienced, which grounded some Apache aircraft. Nevertheless, Apache pilots and commanders told us the Apache had completed all assigned missions.

Principal Findings

The Apache Was Considered Effective in Carrying Out Roles and Missions

Apache personnel said that during the war, the Apache had provided timely intelligence data, which was used to plan future operations. The Apache's weapon systems also proved to be effective, according to Apache commanders and pilots. The Apache destroyed 278 tanks, over 500 light and armored vehicles, over 100 pieces of artillery, and a variety of other targets, according to data provided by Apache personnel. (GAO could not verify that these destroyed targets had not been double counted as kills for other weapon systems.) The 11 Apache units GAO visited had fired about 1,000 Hellfire missiles, and data provided by Apache personnel showed that the Hellfire's accuracy ranged from 40 to 100 percent—averaging about 76 percent.



Part of the Apache's overall effectiveness may be attributable to the relatively low enemy threat and resistance during the war. The Apache units most often faced a low threat environment and often encountered little enemy resistance, according to Apache personnel and a Department of Defense report on the war. Seven Apaches took enemy hits, and one additional Apache was shot down and later intentionally destroyed. There were no crew fatalities.

During the air campaign, Army division commanders used the Apache primarily for armed night reconnaissance missions in enemy territory because of its night vision and videotape capabilities, which provided timely intelligence information to division commanders. Twenty-nine, or 63 percent, of the 46 missions flown during the air campaign were armed night reconnaissance missions. The 17 remaining missions consisted of 10 attack, 5 security (an operation in which Apaches protect Army forces in a

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given area), 1 rescue, and 1 escort mission. According to Army and Air Force officials, the Apache's contact with the enemy was limited because its use might have alerted the enemy to the coalition forces' location. However, Apache units did engage enemy targets during 14 of the missions flown during the air campaign.

During the ground campaign, division commanders used the Apache to a greater extent in its primary role of destroying tanks, heavy armor, and other targets during close and deep attack missions. For example, on one mission against the Republican Guard, the 1st Battalion, 24th Aviation Brigade (1/24th), from Ft. Stewart, Georgia, destroyed 32 T-72 tanks, 50 armored vehicles, 38 air defense and artillery pieces, 54 wheeled vehicles, and other miscellaneous targets. The 11 Apache units GAO reviewed completed 37 missions during the ground war, of which 24, or 65 percent, were attack missions. The remaining 13 missions consisted of 6 armed reconnaissance and 7 security missions. Apache units engaged enemy targets during 28 of the 37 missions.

The Number of Apache Missions Was Limited

Coalition forces flew a total of 112,000 sorties during the air war, and approximately 67,200, or 60 percent, were combat-related missions, according to the July 1991 Department of Defense report on the war. (A "sortie" is defined as an operational flight by one aircraft.) Army officials told GAO that the Army does not track the number of sorties flown by its aircraft. However, to give some comparative order of magnitude, GAO used unit data to determine that Apaches made a total of 652 operational flights during 83 missions. According to Army and Air Force officials, the Apache's use was limited during the air campaign because (1) Iraqi air defenses were perceived to be a threat to low-flying aircraft such as the Apache and (2) the use of Apaches could have divulged the coalition's location prior to the ground war. During the ground campaign, use of the Apache was limited because (1) ground commanders, who controlled the use and roles of the Apache, chose not to use it more and (2) the Army was restricted in where it could use the Apache because of agreements with the Air Force.

Reliability and Logistical Problems Were Believed to Have Not Affected Apache's Overall Effectiveness

The Apache was able to perform its assigned missions during the war. However, component problems, sometimes intensified by harsh desert conditions, did adversely affect the performance of the Apache's essential weapons and other subsystems. For example, 56 of 95 pilots indicated that they had experienced failures with the 30-millimeter gun system, which

pilots and maintainers cited as the component that failed most frequently. One XVIII Corps Apache battalion commander reported a 50-percent failure rate, while a VII Corps Apache battalion commander noted that on one large mission, all 18 Apache aircraft had experienced gun failures. According to Apache pilots and maintainers, component malfunctions in the ammunition carrier drive system caused the majority of gun system failures.

Problems were also experienced with the Hellfire missile system. The majority of these problems related to environmental conditions such as blowing sand and smoke. Of 167 Apache pilots and maintainers responding to GAO's questions, 81 indicated that they had experienced some problems with reliability and accuracy.

Fifty-six of 98 pilots indicated that they had experienced problems with the targeting and night vision systems, which resulted in some difficulties in flying the aircraft and acquiring targets.

Maintainers cited the lack of spare parts as the most frequent reason some aircraft were not available to carry out missions; the next most frequent reasons were bad weather and scheduled maintenance. Little maintenance was performed on the Apaches during the 100-hour ground campaign because units advanced through enemy territory so rapidly that maintenance support could not keep up with the aircraft. These conditions were minimized by taking parts from other Apaches and by performing preventive maintenance on the aircraft prior to the start of the ground war.

Recommendations

GAO is making no recommendations in this report.

Agency Comments

As requested, GAO did not obtain fully coordinated Department of Defense comments on this report. However, GAO did obtain oral comments on a draft of this report from representatives of the Offices of the Secretary of Defense; the Under Secretary of Defense for Research and Engineering; the Assistant Secretary of the Army for Research, Development and Acquisition; the Army Deputy Chief of Staff for Logistics; and others. GAO has included their comments where appropriate.

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Abbreviations

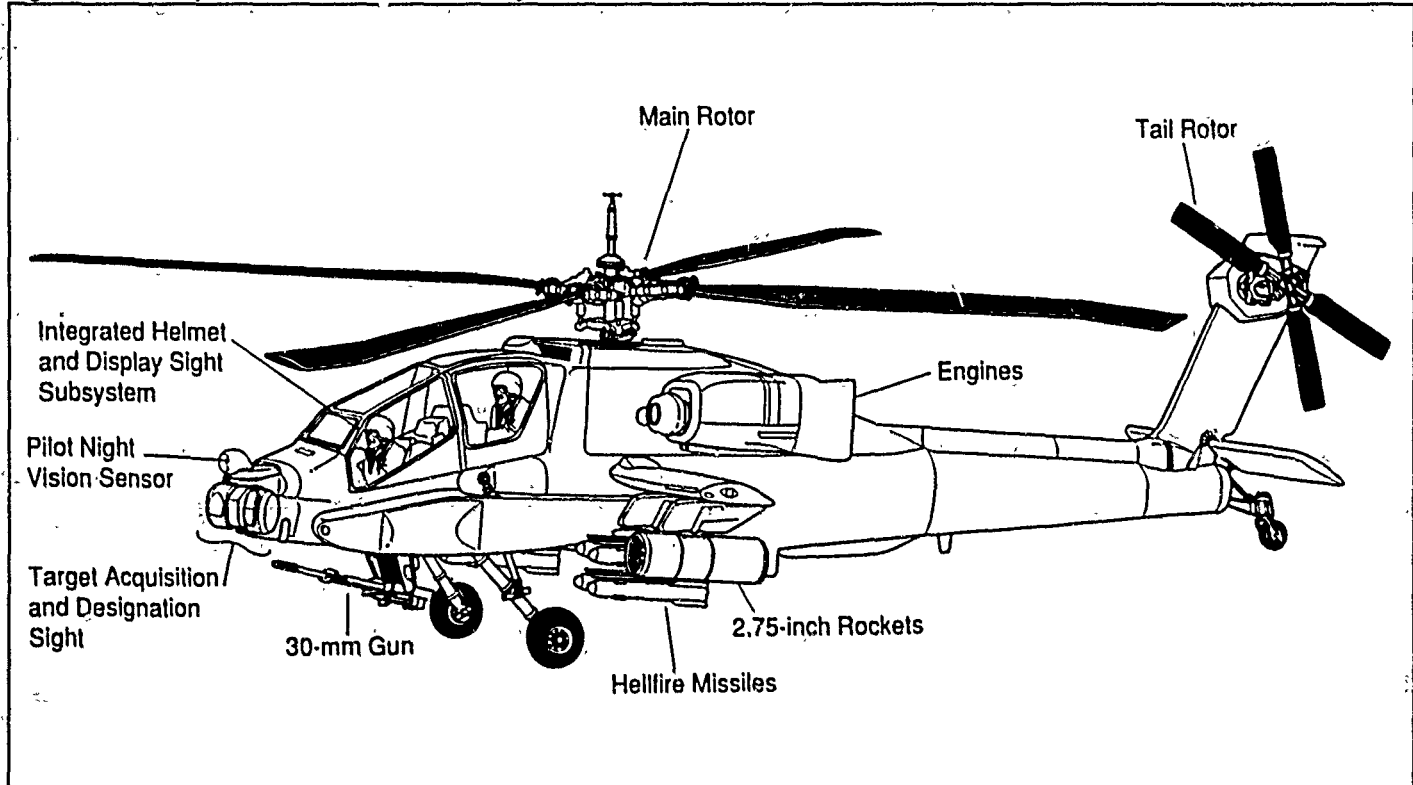
GAO General Accounting Office

Introduction

The Army's Apache is considered the most advanced attack helicopter in the world. It is a two-seat, twin-engine helicopter armed with the Hellfire antitank missile system, a 30-millimeter gun, and 2.75-inch rockets. The Apache's primary mission is to support ground forces by destroying enemy tanks and other ground targets from the air. As a secondary mission, the Apache assists air cavalry operations by providing firepower, security, and armed escort for unarmed helicopters. Considered part of the combat maneuver force, the Apache is not to operate from a fixed base in combat; rather, its operations and maintenance are to be conducted in forward areas and to move as the needs of battle dictate.

The Apache was designed for high-intensity conflicts against heavy forces. To be survivable and effective in this environment, the Apache was designed to (1) detect and engage targets from long ranges, (2) fly and fight at night and in adverse weather, and (3) evade enemy air defenses and withstand hits from munitions up to 23-millimeters in size. These requirements dictated the Apache's sophisticated subsystems and advanced features, some of which are depicted in figure 1.1.

Figure 1.1: The Apache and Its Essential Subsystems



The copilot/gunner, who sits in the front seat, uses the target acquisition and designation sight, referred to as the "targeting system," to find targets from long ranges with infrared, television, and direct-view optics. After finding a target, the copilot/gunner designates it with the sight's laser and guides the laser-seeking Hellfire missile to impact.¹ Just as the copilot/gunner uses the infrared sensor to find targets at night and during obscured weather conditions, the pilot uses an infrared night vision sensor to fly the Apache under the same conditions. These sensors are important because they give the Apache its stand-off range, its night vision, and its ability to guide the Hellfire missile—capabilities that set the Apache apart from other Army helicopters.

Program History and Current Status

The Apache's development began in 1973, and in 1976 Hughes Helicopters was selected as the prime contractor to complete development and production. Production began in 1982, and the first aircraft was delivered

¹A target can also be lased remotely by laser designators other than the copilot/gunner.

in 1984. McDonnell Douglas Helicopters bought Hughes in 1984 and is now the prime contractor. Other major contractors include Martin Marietta Orlando Aerospace, which produces the targeting and night vision sensors, and General Electric, which produces the engines.

The Army has bought 807 Apaches at a total acquisition cost of \$11.6 billion—about \$14.4 million per aircraft. As of January 31, 1992, a total of 705 had been delivered, and the Army had fielded 24 units, with 16 more units to be fielded by 1995. Apache units normally have a minimum of 18 Apache aircraft, along with scout and utility helicopters.

In addition to buying 807 Apaches, the Army also plans to upgrade the war-fighting capabilities of the Apache by converting about 227 Apaches to what is referred to as the “Longbow” Apache. The Army began this \$5.4 billion program in 1989. It involves placing a targeting radar above the rotor mast and replacing the Hellfire missile laser seeker with a radar seeker and giving the Apache a “fire and forget” capability with the radio-frequency Hellfire missile. Other changes are planned for the airframe to accommodate the Longbow modifications and associated avionics, including a vapor cooling system for the avionics bay, an expanded forward avionics bay to house necessary components, an upgraded processing system, and a fully integrated cockpit to reduce pilot work load.

The Apache Has a History of Component Reliability and Logistical Problems

The Apache has had a history of component reliability and logistical support problems—some of which the Army has been attempting to address for over 10 years. We first reported on these problems in 1983. In our September 1990 report,² we noted the fully-mission-capable rates for the Apache had fallen short of the Army’s peacetime goal of 70 percent and decreased as Apache units accumulated flying hours.³ We reported that the frequent failure of components—such as the 30-millimeter gun, the target and night vision systems, and other key components—and the consequent demand for maintenance and parts were major contributors to the Apache’s low fully-mission-capable rates. The Apache’s numerous complex components required many corrective and preventive maintenance actions. Maintenance units could not keep up with the Apache’s unexpectedly high work load because they were too small and

²Apache Helicopter: Serious Logistical Support Problems Must Be Solved to Realize Combat Potential (GAO/NSIAD-90-294, Sept. 28, 1990).

³The 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.

were not allowed to work on the Apache full time and because test equipment had not performed as expected. We concluded that the Apache demanded a level of logistical support that the Army had not been able to provide during peacetime and highlighted the importance of knowing the logistical support demands of the Apache in sustained combat.

The Army reported that Apache availability rates had improved during 1990 and 1991—most notably during Operation Desert Shield. In August 1990, the Army began to deploy Apaches with U.S. forces to Saudi Arabia in support of Operation Desert Shield. In February 1991, we advised the Chairman of the Subcommittee on Oversight and Investigation, House Committee on Energy and Commerce, that the Apache had achieved higher availability rates during Operation Desert Shield than it had in peacetime; however, we did not see evidence of overall improvements in Apache reliability and maintainability that would explain the higher fully-mission-capable rates. Instead, we attributed improvements in availability rates to the increased supply and greater concentration of maintenance resources. These factors had enabled the Army to better cope with component reliability problems.

In October 1991, we reported that, although the Army had made some progress in resolving reliability problems with key components such as the 30-millimeter gun and the targeting system, fielded components had not fully satisfied reliability requirements as of August 1991.⁴ We also reported on performance problems with the Apache's FM communications antenna. The Army has been aware of problems with the Apache's FM antenna since before February 1989.

Iraq Invades Kuwait, and the Apache Is Deployed With the U.S. Army

On August 2, 1990, Iraqi forces invaded Kuwait, and almost immediately after the invasion, the U.S. Army began deploying Apache units to support Operation Desert Shield. According to a Department of Defense report on the Persian Gulf war, the Army's 82d Airborne Division Ready Brigade, which included one Apache battalion, arrived in Saudi Arabia on August 8, 1990.⁵ The Army subsequently deployed additional Apache units, along with major divisions, from the XVIII Corps in the United States. In

⁴Apache Helicopter: Reliability of Key Components Yet to Be Fully Demonstrated (GAO/NSIAD-92-19, Oct. 3, 1991).

⁵Conduct of the Persian Gulf Conflict, July 1991. This report was provided to Congress pursuant to Title V, Persian Gulf Conflict Supplemental Authorization and Personnel Benefits Act of 1991 (Public Law 102-25).

November 1990, the Army began to deploy additional Apache units from the VII Corps in Europe to support coalition forces.

The United Nations Security Council condemned Iraq's invasion of Kuwait and on November 29, 1990, passed Resolution Number 678, which authorized the use of force after January 15, 1991, to ensure Iraq's withdrawal from Kuwait. Iraqi forces refused to withdraw from Kuwait, and the air campaign portion of Operation Desert Storm began on January 16, 1991. The air campaign continued until February 24, 1991, when coalition forces attacked Iraqi forces and the ground campaign portion of Operation Desert Storm began. The ground war lasted 100 hours, and a cease-fire was declared on February 28, 1991.

A total of 15 Apache units, which included 274 Apache helicopters, were deployed to Southwest Asia. The following Apache units were deployed to Saudi Arabia and assigned to the XVIII Airborne Corps, Ft. Bragg, North Carolina:

- 24th Infantry Division (Mechanized)
1st Battalion, 24th Aviation Brigade, Ft. Stewart, Georgia
- 82d Airborne Division
1-82d Aviation (Attack) Battalion, 82d Aviation Brigade, Ft. Bragg, North Carolina
- 101st Airborne Division (Air Assault)
1st Battalion, 101st Aviation Regiment, Ft. Campbell, Kentucky
2nd Battalion, 229th Attack Helicopter Regiment, Ft. Rucker, Alabama
- 1st Cavalry Division⁶
1st Battalion, 227 Aviation Regiment, Ft. Hood, Texas
1st Battalion, 3rd Aviation Regiment, Ft. Hood, Texas
5th Battalion, 229th Aviation Regiment, Ft. Hood, Texas
- 12th Aviation Brigade
5th Squadron, 6th Cavalry, Wiesbaden, Germany
3rd Battalion, 227th Aviation Regiment, Hanau, Germany

The following Apache units were deployed to Saudi Arabia and assigned to the VII Corps, Stuttgart, Germany:

- 1st Infantry Division (Mechanized)
1st Battalion, 1st Aviation Regiment, Ft. Riley, Kansas

⁶The 1st Cavalry Division was initially attached to VII Corps and then, during the ground war, to Army Central Command reserve. The 5th Battalion, 229th Aviation Regiment, from Ft. Hood, Texas, was also deployed to Southwest Asia as theater war reserve.

- 1st Armored Division
2nd Battalion, 1st Aviation Regiment, Ansbach, Germany
3rd Battalion, 1st Aviation Regiment, Ansbach, Germany
- 3rd Armored Division
2nd Battalion, 227th Aviation Regiment, Hanau, Germany
- 11th Aviation Brigade
2nd Squadron, 6th Cavalry, Illesheim, Germany
4th Battalion, 229th Attack Helicopter Regiment, Illesheim, Germany

Objectives, Scope, and Methodology

The Chairman of the Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce, requested that we determine how well the Apache had performed in Operation Desert Storm. Specifically, we were asked to determine (1) how well the Apache had performed its roles and missions during the air campaign and ground war and (2) whether the component reliability and logistical support problems we previously reported had adversely affected the Apache's combat effectiveness.

We conducted the majority of our work at 11 of 15 Apache units that deployed. These 11 were located at Ft. Stewart, Georgia; Ft. Bragg, North Carolina; Ft. Campbell, Kentucky; Ft. Riley, Kansas; 2nd Wiesbaden, Hanau, Ansbach, and Illesheim, Germany. (See app. I for a listing of the 11 units we reviewed.) We visited these units primarily because they were more active than the remaining four units, which were essentially held in reserve. We also conducted work at the U.S. Army Aviation Systems Command, St. Louis, Missouri; and Headquarters, Departments of Defense and the Army, Washington, D.C. We visited the XVIII Corps Headquarters at Ft. Bragg, North Carolina, and the VII Corps Headquarters at Stuttgart, Germany.

At the 11 Apache units, we interviewed commanders and other officials to obtain an overview of unit operations and the performance of the Apache. We also obtained responses to three different sets of questions from 210 Apache personnel whom we considered most knowledgeable about the Apache's performance during the war. The 210 personnel included those who had (1) flown the Apache, (2) worked on the Apache, and (3) supplied Apache parts during the war. Specifically, we developed one set of questions requiring written responses for pilots, one set for maintainers, and a third set for supply personnel. We used these questions at each unit we visited, providing them to an average of 9 pilots and 10 maintainer/supply personnel at each location. A total of 101 pilots, 97

maintainers, and 12 supply personnel participated. The number of written responses to specific questions might have differed because individuals did not always answer every question. To select these personnel, we obtained unit rosters of pilots, maintainers, and supply personnel who had served with the units during the war. We asked unit command personnel to identify individuals from the roster who were on duty while we were at the unit, and we selected individuals from those identified as available. We administered the sets of questions to pilots and maintainer/supply personnel separately in a private setting without unit command personnel in attendance. We pledged confidentiality and explained that their written responses would not be shared with unit superiors and that they did not have to sign their names, although some did, on written responses. In addition, we held group discussions with the same personnel to provide them an opportunity to comment on any aspect, positive or negative, regarding the Apache's performance and to obtain additional insight on their responses.

We relied heavily on information we obtained through the responses to questions and group discussions because maintenance and other unit records were not generally available. When we visited units, their records were still in transit from Saudi Arabia. Also, official Army statistics on battle damage assessments were not available at the time of our review. At our request, unit commanders developed data on missions flown, assessed battle damage, and provided "lessons learned" reports, if these reports were available. We also viewed videotapes of the Apache's performance during the war at most units we visited. Finally, we relied on Department of Defense studies relating to the war effort.

We conducted our review from April 1991 to February 1992 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 did obtain oral comments on a draft of this report from representatives of the Offices of the Secretary of Defense; the Under Secretary of Defense for Research and Engineering; the Assistant Secretary of the Army for Research, Development and Acquisition; the Army Deputy Chief of Staff for Logistics; and others. We have included their comments where appropriate.

The Apache Was Considered Effective in Combat, Although It Played a Limited Role

The overall assessment of Apache pilots and commanders we interviewed and questioned was that the Apache had proved to be effective during the air and ground campaigns. Overall, the Apache destroyed 278 tanks and about 900 other targets, according to data provided by unit commanders. During the air campaign, the Apache provided the Army with timely intelligence data on enemy territory and destroyed enemy targets on some of those missions, according to Apache personnel. During the 100-hour ground war, the Apache's weapons systems—especially the Hellfire missile—proved to be effective in destroying tanks and other targets. Part of the Apache's effectiveness may be attributable to the lack of enemy threat and little enemy resistance, according to unit personnel.

Apache units completed 83 missions during Operation Desert Storm. Overall, attack missions accounted for 41 percent of the missions flown, while armed night reconnaissance missions accounted for 42 percent. During the air campaign, the Apache was used primarily for armed night reconnaissance rather than for performing its primary mission of attacking and destroying heavy armor. However, during the 100-hour ground war, the Apache was used to a greater extent in its traditional attack role.

Although Apache pilots and commanders believed the Apache was effective during the air and ground campaigns, the Apache flew relatively few missions during the war. Coalition forces flew a total of 112,000 "sorties"¹ during the air campaign, and approximately 67,200, or 60 percent, were combat-related missions, according to a July 1991 Department of Defense report on the Persian Gulf war. Using unit data, we determined that the Apaches had made 652 flights during the 83 missions. The Apache was limited during the air war primarily because of the need to keep the movement of coalition forces secret.

The Apache Believed to Be Effective During the Air and Ground Campaigns

Unit commanders and pilots told us that they were satisfied with the Apache's performance during the air campaign, providing the Army with timely intelligence data on enemy territory and destroying enemy targets.

Unit data indicated that the Apache inflicted damage on the enemy by destroying targets such as radar sites, tanks, armored vehicles, bunker complexes, and bridges. (We could not verify whether these destroyed targets had also been counted as kills by other weapon systems.) Unit data, for example, showed that on one mission against the Republican

¹A "sortie" is defined as an operational flight by one aircraft. A "mission" is defined as the dispatching of one or more aircraft to accomplish a particular task.

Chapter 2
The Apache Was Considered Effective in
Combat, Although It Played a Limited Role

Guard, the 1st Battalion, 24th Aviation Brigade (1/24th), from Ft. Stewart, Georgia, had destroyed 32 T-72 tanks, 50 armored vehicles, 38 air defense and artillery pieces, 54 wheeled vehicles, and other miscellaneous targets. Table 2.1 shows the numbers of targets reported as destroyed by each unit.

**Table 2.1: Overall Battle Damage
 Inflicted by the Apache**

Unit	Tanks	Armored vehicles	Artillery	Wheeled vehicles	Bunkers/ buildings	Other ^a	Total
1/24th	33	50	38	54	5	8	188
1/101st	0	6	3	18	5	22	54
1/82nd	3	7	3	5	5	0	23
5/6th	0	0	5	35	^b	2	42
3/227	0	0	7	3	24	6	40
2/227	25	^b	^b	^b	^b	92 ^c	117
2/6th	57	41	15	48	24	^b	185
2/1st	35	54	41	23	10	0	163
4/229	33	39	2	18	3	1	96
3/1st	77	31	6	71	30	0	215
1/1st	15	7	1	27	0	0	50
Total	278	235	121	302	106	131	1,173

^aIncluded are targets such as command centers, bridges, and miscellaneous targets. Excluded are enemy personnel.

^bFigures not available.

^cEstimated number of targets destroyed on two missions, which included targets such as armored vehicles, artillery, wheeled vehicles, and command posts.

Source: GAO's analysis of Apache unit data.

According to Apache commanders and pilots, the Apache's weapons systems—the Hellfire missile, the 2.75-inch rocket, and the 30-millimeter gun—proved to be effective, destroying a variety of targets at close and distant ranges. Although Apache pilots were generally pleased with the performance of the Apache's weapon systems, they experienced some problems.

Unit commanders and pilots told us that the Hellfire missile was effective against tanks and other heavy armored targets in the war. At the units that tracked accuracy, we found that Hellfire accuracy ranged from 40 to 100 percent, averaging about 76 percent. The 11 Apache units fired a total of about 1,000 Hellfire missiles during Operation Desert Storm, according to data furnished by unit personnel. Although Apache personnel believed the

Hellfire missile system was effective, it did experience some problems that affected its accuracy. (See ch. 3 for a discussion of these problems.)

Apache unit commanders and pilots believed the 30-millimeter gun system was effective in suppressing enemy forces and destroying soft-skinned targets such as lightweight vehicles. A 30-millimeter round penetrated even the rear portion of a T-72 tank turret, according to a study conducted by the U.S. Army Materiel Systems Analysis Activity.² Ten of the 11 Apache units we visited expended approximately 98,000 rounds of 30-millimeter ammunition. Although pleased with the effectiveness of the gun in destroying enemy targets, Apache personnel told us that they had continued to experience performance problems with the gun system. (See ch. 3 for a discussion of these problems.)

The 2.75-inch rocket, also known as the "Hydra 70-millimeter aerial rocket," is to be used tactically against ground targets such as aircraft on the ground, troops, personnel carriers, ammunition storage areas, fuel tanks, and radar equipment. Apache personnel generally were pleased with the performance of the 2.75-inch rockets. Ten of the 11 Apache units we visited had used approximately 3,700 rockets during Operation Desert Storm, according to the units' data. Although unit personnel did not keep statistics on the accuracy of the 2.75-inch rocket, Apache personnel told us that some models of the rockets had proved more effective than others. One version of the rocket, the MK66 multipurpose submunition rocket, enjoyed high success rates, according to the study conducted by the U.S. Army Materiel Systems Analysis Activity. The study also reported that other versions of the rocket had not been as effective as that version. One unit commander suggested the Army buy only the MK66 multipurpose submunition rocket.

Unit commanders told us that the Apache was effective in providing division commanders videotaped reconnaissance information that could be viewed promptly after Apaches returned from missions. This was useful because intelligence information provided by coalition forces usually took about 4 days to obtain, according to unit commanders.

Part of the Apache's overall effectiveness may be attributable to the relatively low enemy threat and resistance during Operation Desert Storm. The Apache units most often faced a low threat environment and often encountered little enemy resistance, according to Apache personnel and a Department of Defense report. The perceived threat did not materialize,

²This study was conducted for the U.S. Army Materiel Command.

primarily because of the effectiveness of the coalition forces' air campaign. As a result, the Apache encountered little battle damage, and only one Apache was lost to enemy fire.

While the Iraqis had considerable air defense capabilities, these capabilities were not used much during the war. According to the July 1991 Department of Defense report on the Persian Gulf war and an Air Force official, the Iraqis had discovered that when they turned on radar, they drew instantaneous fire from coalition forces. Pilots told us that on occasion they had been "pinged" with Iraqi radar, but the Iraqis had not locked on with their radar. Consequently, the Iraqis did not shoot missiles very often, according to Apache personnel. Army officers from several Apache units also told us that they believed Iraqi forces had been unable to locate attacking Apache aircraft, especially at night.

Apache pilots at units we visited told us that at times, the Apache had encountered sporadic small arms fire and on some occasions, antiaircraft artillery fire. However, Iraqis had not fired at them to a great extent, and few Apaches had sustained battle damage.

On the basis of data furnished by the 11 units, we calculated that a total of eight Apaches had been hit by enemy fire during the war and only one had been destroyed. The most extensive damage to any Apache was inflicted on the first day of the war, when an Apache from the 1st Battalion, 227 Aviation Regiment (1/227), Fort Hood, Texas, was shot down by what was believed to be 79-millimeter antiaircraft artillery, according to the battalion commander. The Apache pilot and copilot escaped serious injury and were rescued by another Apache crew, according to Apache personnel. Subsequently, the downed Apache was intentionally destroyed to prevent the enemy from studying the aircraft. Seven other Apaches received minor battle damage, but they were able to complete their missions, according to unit reports. Five of the seven Apaches were damaged by small arms fire; another was hit by a missile fragment; and the seventh was hit by small arms fire or antiaircraft artillery. According to Apache personnel, no Apache crew members lost their lives during the war.

Overview of the Apache's Roles and Missions During the War

During the war the Apache primarily performed two roles—armed reconnaissance and attack. The Apache flew 35 armed reconnaissance missions, 34 attack missions, and 14 other missions. Sixty-two percent of the armed reconnaissance and attack missions were flown at night. The types of missions flown are shown in figure 2.1.

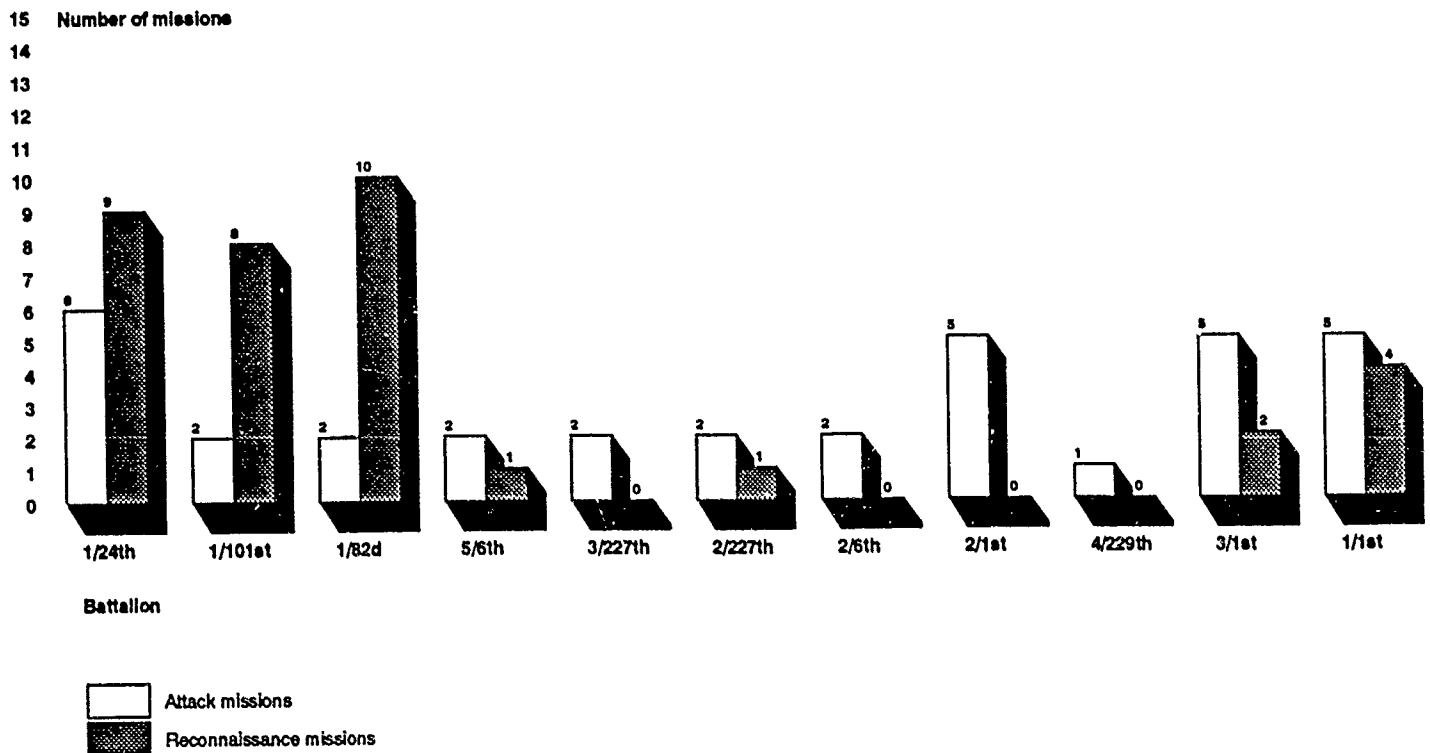
Figure 2.1: Apache Missions Flown in
Operation Desert Storm



Source: GAO's analysis of Apache unit data.

The frequency of attack and reconnaissance missions varied by unit. For example, the 1/24th had the greatest number of these missions of the units we reviewed with 15 (6 attack and 9 reconnaissance). The 4th Battalion, 229th Attack Helicopter Regiment (4/229th), from Illesheim, Germany, flew the fewest missions during the war—one attack mission. The attack and reconnaissance missions flown by the 11 Apache units are shown in figure 2.2.

Figure 2.2: Attack and Reconnaissance Missions Performed by Units

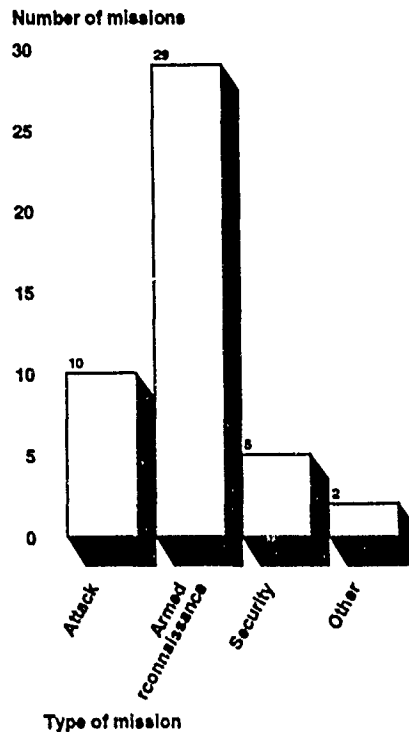


Source: GAO's analysis of Apache unit data.

The Air Campaign

During the air campaign, the 11 Apache units completed a total of 46 missions, of which 29 were armed reconnaissance missions, mainly at night. Although reconnaissance is not the Apache's primary role, the Army frequently used the Apache in this role because of its ability to fly at night and to videotape enemy territory. The 17 remaining missions consisted of 10 attack, 5 security, 1 rescue, and 1 escort mission. Data provided by the 11 Apache units we visited also showed that enemy targets had been engaged on 14 of the 46 missions flown. See figure 2.3 for a display of the types of missions flown during the air campaign.

Figure 2.3: Types of Missions Flown in
the Air Campaign



Source: GAO's analysis of Apache unit data.

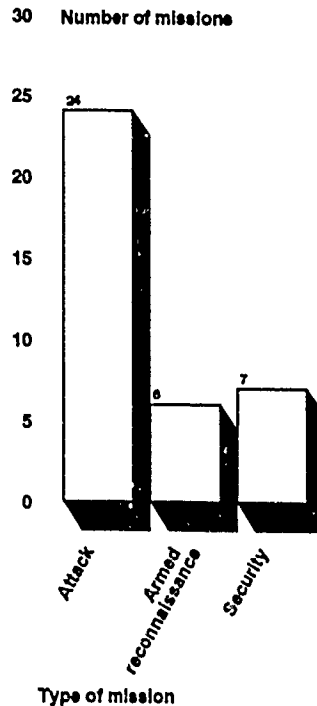
The Apache participated in one of the first strikes of the air campaign. On January 17, 1991—January 16 in the United States—eight Apaches from the 1st Battalion, 101st Aviation Regiment (1/101st), Ft. Campbell, Kentucky, assisted by a U.S. Air Force special operations squadron, raided two Iraqi radar sites. The Apaches destroyed Iraqi radar sites with Hellfire missiles, 2.75-inch rockets, and the 30-millimeter gun, according to the Apache unit commander and videotapes.

The Ground Campaign

During the ground campaign, division commanders used the Apache to a greater extent in its primary role of destroying tanks, heavy armor, and other targets during close and deep attack missions. The 11 Apache units we reviewed completed 37 missions during the ground war, broken down as follows: 24 attack, 7 security, and 6 armed reconnaissance missions. Apache units we reviewed—primarily VII Corps units—engaged enemy targets during 28 of the 37 missions. Figure 2.4 shows the types of missions flown during the ground campaign.

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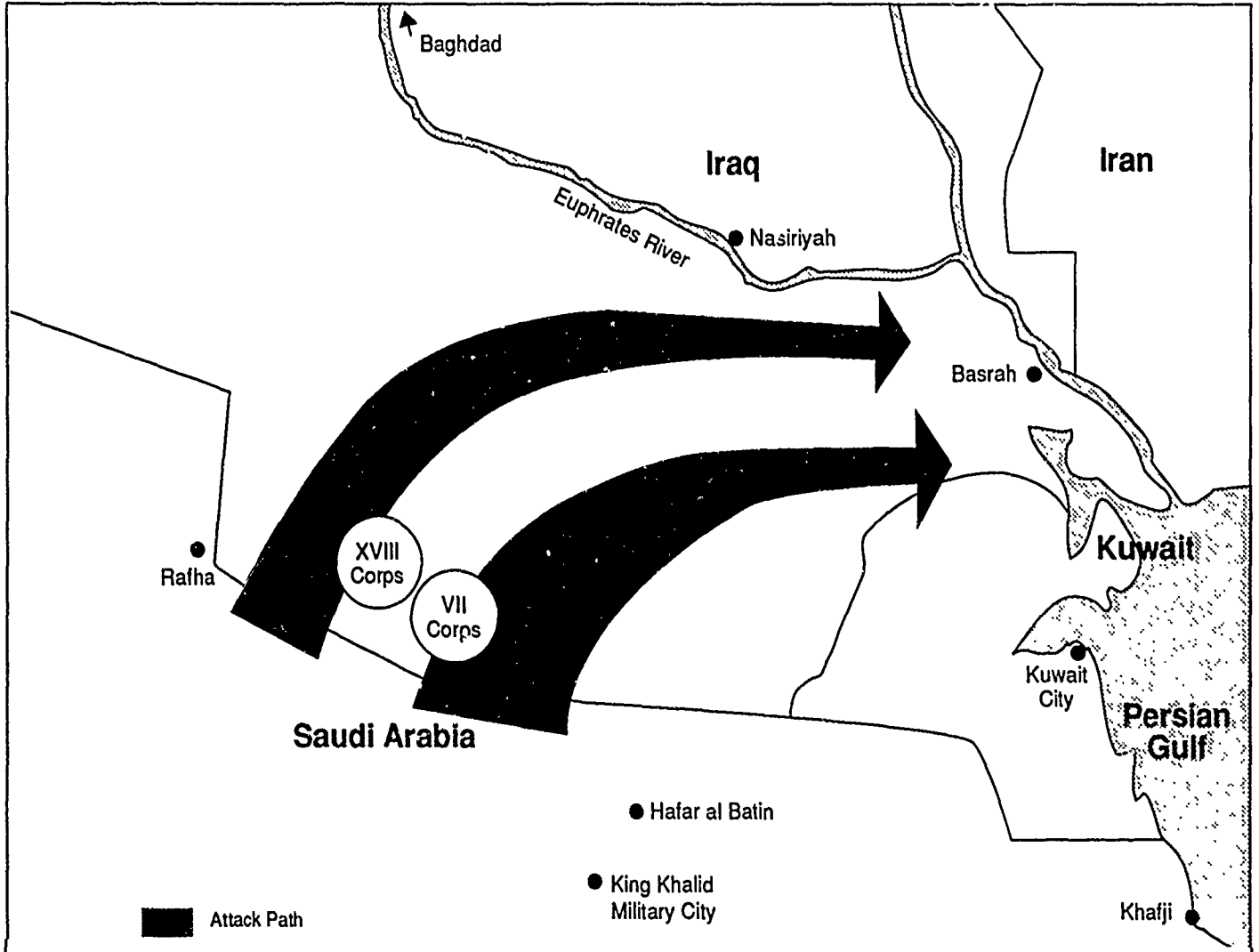
Figure 2.4: Types of Missions Flown in
the Ground Campaign



Source: GAO's analysis of Apache unit data.

According to data provided by Apache unit commanders, the Apache was used in a variety of ways during the ground war. It was used to destroy fixed fortifications, bridges, and Iraqi Republican Guard units and to lead the way for several Army divisions. For example, Apache units were ordered to destroy Republican Guard forces attempting to reinforce Iraqi units. On at least one occasion, the Apache's assignment was to attack enemy targets 15 to 20 kilometers in front of U.S. ground forces to clear the battlefield so the Army's 24th Mechanized Division could move forward. The coalition's "left hook" strategy was designed to sweep west and flank most of Iraq's fixed fortified defenses. Figure 2.5 shows the Apache's attack paths into Iraq and Kuwait.

Figure 2.5: Coalition and Apache Attack Paths Into Kuwait and Iraq



Source: U.S. Army.

The Apache Played a Limited Role During the War

While Apache pilots and commanders believed the Apache was effective in destroying targets and completing its missions, the number of Apache flights during the war was limited. The services track activities of various aircraft, but the Army does not track the number of sorties its aircraft fly. To give some order of magnitude as to the Apache's usage during the war we offer the following information.

Coalition forces flew a total of 112,000 sorties during the air war, and approximately 67,200, or 60 percent, were combat-related, according to the July 1991 Department of Defense report on the Persian Gulf war. For comparison purposes, we determined from unit data that the Apaches made 652 individual flights during the 83 Apache missions. (See appendix II for a description of each mission and the number of Apaches flown on each one.)

Pilots from several units told us that they had been somewhat frustrated that they had not been assigned more attack missions during the air campaign. Fifty-nine of 98 pilots indicated that the Army had not maximized the combat potential of the Apache during Operation Desert Storm.

According to Army and Air Force officials, the Apache played a limited role during the air campaign because (1) Iraqi air defenses were perceived to be a threat to low-flying helicopters like the Apache and the coalition wished to keep casualties to a minimum and (2) the coalition's strategy in conducting the secret "left hook" maneuver prevented the extensive use of Apaches because it might have revealed the forces' location. During the ground campaign the Apache's role was limited because (1) ground commanders, who determined the usage and roles of the Apache, did not choose to use it more and (2) the Army did not have the freedom to use the Apache anywhere on the battlefield because of agreements with the Air Force.

Army personnel told us that the Commander of U.S. Central Command had given high priority to keeping coalition casualties to an absolute minimum, while also achieving military objectives. In addition, because of the perceived threat to low-flying aircraft posed by Iraqi air defenses, coalition military planners allowed only aircraft considered to be a low risk against Iraqi air defense systems—those that conducted their missions above 10,000 feet—to participate in the air campaign, according to an Air Force official. On combat missions the Apache generally flew as low to the ground as possible to avoid being detected visually or by radar. The flight altitude varied from 35 to 100 feet on attack missions during the war, according to an Army headquarters official. According to Apache pilots, if they encountered enemy forces while en route to mission targets, they either engaged or avoided these forces, depending on the importance of the primary mission objective.

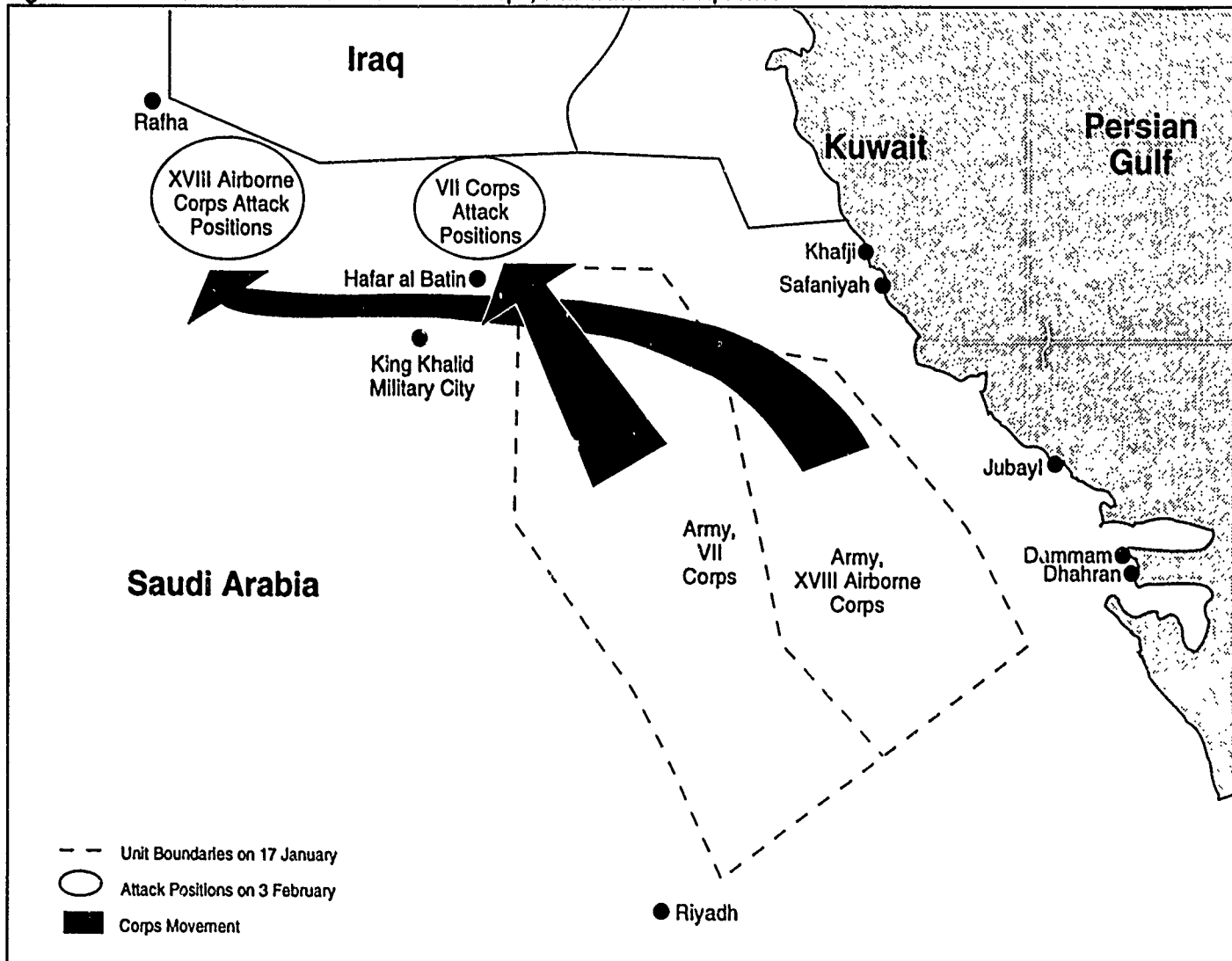
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Central Command officials responsible for planning the air campaign decided that the risk involved in employing the Apache against fixed targets was unnecessary because of the prewar density of Iraq's air defense systems and the absence of terrain features that would enhance the Apache's ability to elude air defense radars, according to Air Force and Army officials. The risk analysis approach for deciding what assets to use in the air campaign also extended to U.S. Air Force and U.S. Marine Corps helicopters and close air support aircraft, according to an Air Force official who helped plan the air campaign.

A division commander also told us that the Army was trying to hide its whereabouts from the Iraqis as part of the coalition's overall secret "left hook" strategy, which was designed to sweep west and flank most of Iraq's defenses. Thus, the coalition's ground forces, which included Apache units, were not allowed to attack the enemy prior to the start of the ground war. In addition, the Army was basically restricted to operating within Saudi Arabia until the ground war started. (See fig. 2.6.)

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Figure 2.6: Secret Movement of the XVIII and VII Corps, Which Included Apaches



Source: U.S. Army.

Army personnel told us that the Apache is considered a divisional asset by Army doctrine and, as such, was under the control of the division commanders during the air and ground campaigns. It was used in direct support of their ground forces, and therefore, it was up to the ground commanders to determine how much they used the Apache and in what roles.

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In addition, Army personnel told us that the Apache's role in the war had been limited because the U.S. Army and the Air Force had agreed on a fire support coordination line. The agreement gave the Air Force tactical control of all air activity beyond the line—for deep operations—while the Army had operational control of the area up to the line—for close operations. Until about February 24, the line was the Kuwait and Iraq border.

Component Reliability and Logistical Support Problems Were Believed to Have Not Affected the Apache's Overall Effectiveness

Although the Apache's key weapons and other vital subsystems experienced problems that were sometimes exacerbated by the harsh desert environment, Apache pilots and unit commanders told us the Apache's overall combat effectiveness had not been compromised. Logistical support problems, such as parts shortages, had grounded some Apache aircraft, according to maintainers and supply personnel. In addition, maintainers told us that during the 100-hour ground war most maintainers had not been available to perform maintenance on the Apache, if needed, because of the rapid advancement of Apaches. These conditions, however, did not keep Apaches from performing assigned missions, according to pilots and maintainers, because (1) Apache personnel had taken action to minimize problems, (2) pilots had multiple weapon systems to choose from in the event one became inoperable, (3) other Apache aircraft were available to fly missions when one became inoperable, and (4) pilots flew aircraft with degraded capabilities.

Component Reliability and Environmental Conditions Affected Some Key Apache Systems

The 30-millimeter gun system, the targeting system, and the night vision system all experienced significant problems during Operation Desert Storm, according to unit personnel. Environmental conditions such as blowing sand and smoke also affected the picture quality of the targeting and night vision optical devices aboard the Apache and, to a lesser extent, impeded the performance of the laser-guided Hellfire missile system. Apache personnel told us that they had also experienced problems with the Apache's communications system.

To minimize reliability and environmental problems, Apache personnel had taken actions such as loading less 30-millimeter ammunition and using different firing techniques to minimize gun stoppages, relying on other aircraft to designate targets and to relay messages, and performing preventive maintenance prior to the start of the ground war.

30-Millimeter Gun System Malfunctioned Frequently

Although Apache pilots told us that the 30-millimeter gun had been effective in suppressing enemy forces and destroying "soft-skinned" targets such as trucks, they had experienced extensive problems with the gun system. Apache pilots cited the 30-millimeter gun system as the component that had failed most frequently during missions. Overall, 56 of 95 pilots and 72 of 82 maintainers who answered our questions indicated that they had experienced 30-millimeter gun system malfunctions during the war. They believed that the majority of gun system failures had been caused by component malfunctions within the ammunition carrier drive

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system, which caused the gun to jam. They indicated that sand had created additional problems with the carrier drive system. Ammunition case swelling was the second most frequently mentioned cause of 30-millimeter gun jams.

Unit commanders also acknowledged problems with the 30-millimeter gun in unit after-action reports. For example, one XVIII Corps battalion commander reported a 50-percent failure rate with the 30-millimeter gun system, while another XVIII Corps battalion commander told us that on two deep attack missions, 7 out of 11 guns had malfunctioned. A VII Corps squadron commander noted that on one mission, all 18 Apache aircraft had experienced gun failures. These failures were caused by ammunition case swelling and problems with the carrier drive.

Not all Apache units experienced extensive problems with the 30-millimeter gun. For example, pilots from the 1st Battalion, 1st Aviation Regiment (1/1st), from Ft. Riley, Kansas, told us that the newer Apache aircraft with some of the gun improvements installed had fewer problems than older models. Pilots from two other units used different firing techniques to help reduce the number of gun jams. One technique involved selecting the number of rounds to be fired at one time and keeping the trigger pulled until all these rounds had left the gun. Apache pilots from the 1/101st Battalion indicated that they had used this technique and experienced only one 30-millimeter gun jam during Operation Desert Storm, and this one had been caused by a carrier drive system problem.

Maintainers from the 4/229th Battalion also told us they had used a commercial lubricant at the forward arming and refueling point to help lubricate and clean the 30-millimeter gun. They believed that the commercial lubricant worked better than the lubricant the Army routinely provided. In addition, some unit personnel had tried to minimize gun stoppages by loading the gun to less than its maximum capacity of 1,200 rounds. The average number of rounds loaded in the gun ranged from about 600 to 800 rounds, according to pilots we questioned. However, one unit commander told us that his personnel had loaded the gun to almost full capacity.

The Apache's Targeting and Night Vision Systems Experienced Malfunctions and Degraded Performance

The Apache successfully acquired targets and flew night missions during the war, as discussed in chapter 2. However, 56 of 98 pilots and 68 of 76 maintainers indicated that they had experienced problems with the targeting and night vision systems. Pilots and maintainers cited problems with targeting and night vision system components as the second most frequently occurring malfunction. Problems with performance and component reliability on these systems resulted in some difficulties in flying and acquiring targets during daytime and at night, according to Apache pilots. These problems were generally attributed to limitations of the forward-looking infrared components¹ for the targeting and night vision systems and environmental conditions such as blowing sand, oil well fire smoke, and the lack of distinctive desert terrain features. More specifically, problems included complete component failure, poor picture resolution and a shuttering or jumping picture (both related to the forward-looking infrared components), intermittent daylight television capability, and uncommanded movements of these components.

The forward-looking infrared component's picture deterioration is a function of age, according to pilots. As one of the system's components ages, the picture becomes less clear. The component's picture quality is further degraded when pilots try to acquire targets at night and in poor environmental conditions such as heavy wind, rain, and blowing sand, according to unit personnel. The degraded night vision equipment had a direct impact on the pilots' ability to fly night missions. Forty-five of 95 pilots answering our questions indicated that they had had some difficulty flying the Apache during Operation Desert Storm. The main reasons cited were the poor quality of the night vision equipment's picture and poor environmental conditions.

The Apache's Hellfire Missile System Experienced Some Problems

Apache pilots and commanders told us that the Hellfire missile had been effective in destroying targets. However, 81 of 167 Apache pilots and maintainers indicated they had experienced some reliability and accuracy problems with the missile system.² Unit personnel could not always pinpoint reasons that some Hellfire missiles had missed targets. However, they cited as possible reasons (1) environmental conditions such as blowing sand, smoke, and haze, which at times prevented the Apache's

¹These components convert thermal energy into video images of objects such as buildings, tanks, personnel, or terrain features.

²For a more detailed discussion of the Hellfire's performance during Operation Desert Storm, see Operation Desert Shield/Desert Storm: Observations on the Performance of the Army's Hellfire Missile (GAO/NSIAD-92-156, Mar. 30, 1992).

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targeting laser from locking on to intended targets; (2) mechanical problems with the missile launcher; and (3) a weak targeting system laser power unit, which guides the missile.

Environmental conditions were frequently cited as explanations for the Hellfire missile's misses. Several conditions interfered with the targeting laser beam, which guides the missile, causing it to break its lock on the target and therefore miss shots. Some pilots experienced "backscatter," a condition that occurs when the targeting laser's energy is reflected off obscurants such as blowing sand. That condition interrupted the laser beam on the way to the target, and in these cases, the missile's laser seeker locked on to the backscatter, causing the missile to miss the target. Another condition that interfered with the targeting laser is known as "smoke contrails," according to pilots. Smoke sometimes came off the rear of a launched missile when the temperature reached dew point, interfering with the laser tracking beam and causing the missile to miss the target. Pilots from a unit located at Illeshiem, Germany, told us that they would fire a Hellfire and then lase the target once the missile had left the rails in order to overcome the backscatter problem. This practice is known as "lock-on-after-launch." Apache pilots from the 1/1st told us they had overcome the problem by waiting for the smoke to clear before locking on with the laser. Apache pilots from the 1/24th had used other aircraft to remotely lase targets because of smoke contrail conditions.

Apache pilots told us that insects covering the laser seeker might also have adversely affected the accuracy of the Hellfire missile. For example, pilots from the 3rd Battalion, 227th Aviation Regiment (3/227th), located in Hanau, Germany, told us that while on a mission in the Euphrates River Valley in Iraq, bugs had attached themselves to the seeker head of the Hellfire missile, thereby affecting the Hellfire seeker's ability to lock on to the laser beam, which was focused on the target. Approximately 20 Hellfire missiles were fired during the mission, and 6 missed intended targets due to this problem, according to Apache personnel. They believe that if they had covered the seeker heads, the heads would have remained clean. However, someone had taken the covers off the aircraft before they deployed to Saudi Arabia, according to pilots.

Pilots and maintainers also cited mechanical problems that had adversely affected the Hellfire's performance. These problems included complete system failures, the improper positioning of missiles on the launch rails, and the failure of the missile to leave the launch rails when commanded.

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Pilots we questioned also indicated the performance of the laser power unit, which is part of the targeting system, had possibly contributed to the Hellfire's accuracy problems. One pilot from the 2nd Battalion, 1st Aviation Regiment, located at Ansbach, Germany, indicated that he had been able to acquire targets using the targeting system, but had had to move in closer to engage the enemy because the targeting laser seemed to be too weak or was not able to penetrate smoke, dust, or sand. Pilots also reported that during one mission the targeting laser had not locked on to targets at distances over 1,500 meters.

Pilots and battalion commanders commented that, in light of the problems they had experienced, they wanted more live firing of the weapon systems in training. Sixty-six of 99 pilots we questioned indicated that they had fired a Hellfire missile in training prior to participating in combat missions, while 33 had not. However, most of those who had previous Hellfire experience indicated they had fired only one or two missiles.

The Apache's
Communication System
Experienced Some
Problems

The Apache experienced communication problems during Operation Desert Storm. Apache personnel from several units indicated that they had experienced problems communicating with each other on missions at close and distant ranges. Over 40 of 100 pilots who answered our questions indicated that they had experienced problems communicating with other aircraft. They indicated that the problems related to the limited range of the UHF and FM (secure) radios. According to unit personnel, the poor quality of the equipment and the position of the antenna had contributed to the problems.

One XVIII Corps battalion commander believes that the Apache's greatest weakness during the war was its poor communication ability. The commander told us that the Apache's effective communication range had been less than 20 kilometers. The Apache's communications were therefore not reliable over the distances that the Apache was required to operate in. Unit personnel from Ansbach, Germany, indicated that they had experienced radio communication problems when their aircraft were 5 to 7 kilometers in front of the forward troops. Pilots from the 1/24th told us that while on deep attack missions ranging from 60 to 120 kilometers, they could not communicate back to their division; they were able to communicate only among themselves.

Pilots minimized communication problems by using other aircraft to relay messages. For example, pilots from Ft. Campbell, Kentucky, prepositioned

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an OH-58 scout helicopter during the night and a Blackhawk helicopter during the day to act as relays to convey the Apache messages during missions.

A pilot from the 1st Aviation (Attack) Battalion, 82d Aviation Brigade (1-82d), Ft. Bragg, North Carolina, related a specific incident that had taken place during a deep attack combat mission. The pilot said that while on the mission, he had had to leave the engagement area because his Apache had a component malfunction. Before he left the area he had tried to call his wing man 13 times but could not reach him, so he left the mission without making contact. According to this pilot, the other Apache pilots on the mission had thought for a time that he had been shot down.

Logistical Support
Problems Surfaced
During the War

Apache personnel experienced some logistical support problems during the war. At times, shortages of critical components, such as main rotor blades and tail rotor swashplates, grounded some aircraft during the conflict. Maintainers complained about the quality and quantity of tools used to repair Apaches. They also told us that the rapid movement of Apache units had limited maintenance support provided by unit personnel during the 100-hour ground war. Maintainers said that they had performed little maintenance on the aircraft during this period. Apache personnel told us that they had minimized the impact of these problems by borrowing parts, using personal tools, and doing extensive preventive maintenance on aircraft prior to the start of the ground war.

Spare Part Shortages
Occurred

The Apaches experienced parts shortages during the war that caused some aircraft to be grounded, according to supply and maintenance personnel who responded to our questions. Seventy-one of the 94 maintainers and supply personnel indicated that they had experienced Apache spare parts shortages. Maintainers cited the lack of spare parts as the most frequent reason some aircraft were not available to carry out their missions. Next cited were bad weather and scheduled maintenance. The following spare parts were most frequently cited as difficult to obtain. The lack of these parts sometimes caused aircraft to be grounded:

1. Environmental control units (the unit itself, shut-off valves, and the cooling turbine)
2. Auxiliary power units
3. Rotor blades
4. Targeting and night vision components

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5. Common hardware
6. Black boxes (electronic components)
7. Navigation equipment
8. Main rotor heads
9. Tail rotor swashplates
10. Engine fuel filters

The impact of these shortages was minimized for the most part by taking parts from other Apache aircraft and by borrowing parts from other Apache units, according to Apache maintainers. Borrowing parts from other Apache aircraft—a practice known as “controlled substitution”—is frequently done to obtain spare parts in peacetime as well as in wartime. Fifty-one of 65 maintainers we questioned indicated that controlled substitution had been used in theater, and 39 indicated that it had been used to an equal or greater extent than it had been in peacetime.

Tools Were Lacking in Both
Quality and Quantity

Another complaint voiced by maintainers and supply personnel related to the poor quality and insufficient quantity of tools on hand to maintain Apaches. Maintainers at the 1/82d told us that when ordering tools through the Army supply system, it often took several months to receive replacements. The supply person for the 5th Squadron, 6th Cavalry (5/6th), from Wiesbaden, Germany, said that the supply system had never replaced broken tools. Maintainers told us that to minimize this problem, they had brought personal tools from home or had purchased new tools with their own money from commercial sources to take to Saudi Arabia. Some maintainers suggested that the Army should have given them a tool allowance so they could have purchased tools of the proper quality and quantity to maintain the Apache.

Apache Aircraft Outpaced
Logistical Support During
the Ground War

During the 100-hour ground war, Apache units were positioned in front of the Army's main body. With the exception of a small contingency of maintainers, Apache maintainers generally stayed with division logistical support and never linked up with the aircraft during the 100-hour ground war. As a result, aircraft went 3 to 4 days without crew chiefs' seeing them, according to Apache maintainers.

Maintainers indicated that extensive preventive maintenance prior to the start of the ground war had enabled the aircraft to continue missions during the fast-paced, 100-hour ground campaign without encountering major problems. Maintainers, however, also indicated that the Apache

could not have continued to perform very long at that pace without maintenance.

Of the 70 pilots responding to questions, 43 estimated that their units could have continued the pace for a few days to 2 weeks. A few pilots believed that they had outrun their logistical support and could not have gone further.

A brigade commander also told us that fuel had been running very short by the fourth day of the ground war and that if the war had not ended when it had, the Army would have had to stop moving forward in order to allow the logistical support from Saudi Arabia to catch up with all the units. A division commander also told us that it is normal to pause, regroup, rearm, and refuel after 4 days of continuous battle. He also said that any weapon system, not just the Apache, would need to regroup after 4 days of continuous combat. He said that by the fourth day, soldiers at the forward arming refueling points were near the end of their physical ability to maintain continuous operations.

Pilots suggested several ways to alleviate this problem in the future. Suggestions included having maintenance elements travel closely with aircraft to where they stay overnight to better ensure success and placing the crew chiefs in the forward arming refueling points and in the forward assembly areas.

Additional Factors That Helped Ensure Apaches Completed Assigned Missions

Other factors also helped the Apaches perform assigned missions. Assigned missions were completed in part because (1) pilots had multiple weapon systems to choose from in the event one became inoperable, (2) other Apache aircraft were available to perform missions when one became inoperable, and (3) pilots flew degraded aircraft.

Multiple Weapon Systems Compensated for Some Reliability Problems

As previously discussed, Apache pilots experienced problems with the Apache's weapons systems—especially the 30-millimeter gun system. When questioned about the consequences of armament malfunctions, pilots most often responded that the lack of the 30-millimeter gun had made the aircraft vulnerable at close ranges. An XVIII Corps unit commander told us that some of his pilots had had to resort to using the rockets when their 30-millimeter guns malfunctioned, as they had on many occasions. In addition, several VII Corps pilots indicated that the lack of a

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30-millimeter gun had forced them to use one of the other two weapon systems aboard the Apache when destroying targets.

The Army Had More Than
Enough Apaches to
Perform Missions

The Army had 274 Apache aircraft on hand during the war. One hundred forty-eight of 189 pilots and maintainers we questioned indicated that on any given day they had had at least 15 of approximately 18 aircraft available to go on combat or combat-support missions. This number was enough to carry out assigned missions, because, on average, only about eight aircraft were needed on a mission. Of the 83 missions flown by the Apache units we reviewed, only 14 required the use of 15 or more aircraft at one time. According to the maintainers we questioned, the most frequent explanation for Apaches' not being available for combat was the shortage of spare parts.

Pilots Flew Apaches With
Malfunctioning Equipment

While Apache units had sufficient numbers of aircraft available for each mission, many aircraft flown on missions were less than fully mission capable. According to 64 of 93 pilots we questioned, they had flown missions during which they had not been able to fully use the capabilities of the Apache because systems were inoperable. The failure of components such as weapon systems or the optics normally degrades the aircraft's status to partially mission capable in peacetime. However, Apache personnel told us that when such components failed in Saudi Arabia, they were at times judged to be non-mission essential, and consequently these aircraft were flown. Pilots could use their own judgment in determining whether to fly the degraded aircraft; a majority chose to fly, according to pilots.

Eleven Apache Units GAO Reviewed

24th Infantry Division (Mechanized)

1st Battalion, 24th Aviation Brigade, Ft. Stewart, Georgia

82d Airborne Division

1-82d Aviation (Attack) Battalion, 82d Aviation Brigade, Ft. Bragg, North Carolina

101st Airborne Division (Air Assault)

1st Battalion, 101st Aviation Regiment, Ft. Campbell, Kentucky

12th Combat Aviation Brigade

5th Squadron, 6th Cavalry, Wiesbaden, Germany

3rd Battalion, 227th Aviation Regiment, Hanau, Germany

1st Infantry Division (Mechanized)

1st Battalion, 1st Aviation Regiment, Ft. Riley, Kansas

1st Armored Division

2nd Battalion, 1st Aviation Regiment, Ansbach, Germany

3rd Battalion, 1st Aviation Regiment, Ansbach, Germany

3rd Armored Division

2nd Battalion, 227th Aviation Regiment, Hanau, Germany

11th Combat Aviation Brigade

2nd Squadron, 6th Cavalry, Illesheim, Germany

4th Battalion, 229th Attack Helicopter Regiment, Illesheim, Germany

Number of Apache Aircraft Per Mission

Unit	Campaign	Date	Type of mission	Number of aircraft
1/101st	Air war	1/17	Attack	9
		2/14	Armed reconnaissance	12
		2/15	Armed reconnaissance	2
		2/16	Armed reconnaissance	7
		2/20	Armed reconnaissance	5
		2/21	Armed reconnaissance	6
		2/22	Armed reconnaissance	2
		2/23	Security	2
	Ground war	2/24	Armed reconnaissance	18
		2/25	Armed reconnaissance	4
		2/25	Security	6
		2/26	Security	6
		2/27	Security	5
		2/27	Attack	12
		2/28	Security	3
		3/1	Security	6
		3/2	Security	5
		3/3	Security	4
1/82d	Air war	2/8	Armed reconnaissance	1
		2/9	Armed reconnaissance	2
		2/10	Armed reconnaissance	2
		2/11	Armed reconnaissance	2
		2/12	Armed reconnaissance	2
		2/13	Armed reconnaissance	1
		2/15	Armed reconnaissance	5
		2/16	Armed reconnaissance	1
		2/17	Armed reconnaissance	1
		2/18	Attack	15
		2/20	Attack	10
		2/23	Armed reconnaissance	4

(continued)

Appendix II
Number of Apache Aircraft Per Mission

Unit	Campaign	Date	Type of mission	Number of aircraft
1/24th	Air war	1/23	Armed reconnaissance	1
		1/31	Security	2
		2/1	Armed reconnaissance	3
		2/10	Armed reconnaissance	3
		2/12	Security	4
		2/13	Security	6
		2/14	Armed reconnaissance	6
		2/16	Armed reconnaissance	1
		2/17	Attack	7
		2/18	Armed reconnaissance	3
		2/19	Armed reconnaissance	5
		2/19	Security	2
		2/20	Attack	8
		2/20	Armed reconnaissance	6
		2/21	Rescue operation	2
		2/21	Attack	5
		2/21	Armed reconnaissance	6
	Ground war	2/26	Attack	5
		2/27	Attack	19
		3/2	Attack	18
3/227	Air war	2/20	Attack	9
		2/23	Escort (insertion/extraction)	3
	Ground war	2/27	Attack	14
5/6th	Air war	2/18	Attack	11
		2/20	Attack	11
		2/23	Armed reconnaissance	6
2/227	Ground war	2/25	Armed reconnaissance	22
		2/26	Attack	24
		2/27	Attack	24
2/6th	Air war	2/16	Attack	18
	Ground war	2/27	Attack	18
2/1st	Ground war	2/25	Attack	12
		2/26	Attack	18
		2/26	Attack	6
		2/27	Attack	12
		2/28	Attack	17
4/229	Ground war	2/26	Attack	18

(continued)

Appendix II
Number of Apache Aircraft Per Mission

Unit	Campaign	Date	Type of mission	Number of aircraft
3/1st	Air war	2/23	Armed reconnaissance	8
	Ground war	2/25	Attack	4
		2/25	Attack	9
		2/26	Attack	19
		2/27	Attack	5
		2/27	Armed reconnaissance	6
		2/27	Attack	18
1/1st	Air war	2/22	Armed reconnaissance	10
		2/23	Armed reconnaissance	9
	Ground war	2/24	Armed reconnaissance	6
		2/24	Attack	10
		2/25	Attack	4
		2/26	Armed reconnaissance	9
		2/27	Attack	5
		2/27	Attack	5
		2/28	Attack	10
Total			83 missions	652

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