United States General Accounting Office

GAO

Report to the Chairman, Committee on Armed Services, House of Representatives

September 1991

OPERATION DESERT STORM

The Services' Efforts to Provide Logistics Support for Selected Weapon Systems

GAO/NSIAD-91-321

GAO

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

National Security and
International Affairs Division

B-243797

September 26, 1991

The Honorable Les Aspin
Chairman, Committee on Armed Services
House of Representatives

Dear Mr. Chairman:

This report responds to your January 9, 1991, request that we provide the Committee a "snap shot" of the logistics efforts undertaken by the services for selected Army, Navy, Air Force, and Marine Corps air and ground weapon systems deployed to the Persian Gulf in support of Operation Desert Shield.

As agreed with your office, we excluded Navy surface and subsurface systems from our review because these systems are routinely forward deployed, and according to Navy officials, the naval deployment to the Persian Gulf, while intensive and demanding, was not much different from normal operations.

We are sending copies of this report to the Secretaries of Defense, the Army, the Navy, and the Air Force; the Chairmen of the House and Senate Committees on Appropriations, the House Committee on Government Operations, the Senate Committee on Governmental Affairs, and the Senate Committee on Armed Services; and the Director of the Office of Management and Budget. Copies may also be made available to others upon request.

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

Sincerely yours,

Frank C. Conahan
Assistant Comptroller General

Executive Summary

Purpose

After Iraq's invasion of Kuwait in August 1990, the Department of Defense began a massive mobilization and deployment of troops, equipment, and materiel to the Persian Gulf to counter the invasion and protect U.S. vital interests in the area.

Concerned about the stress that this deployment placed on the services' logistics system, the Chairman of the House Armed Services Committee asked GAO to provide the Committee a "snap shot" of the mission capability rates of selected Army, Navy, Air Force, and Marine Corps air and ground weapon systems[1] deployed to the Persian Gulf in support of Operation Desert Shield. He also asked that GAO determine

- whether these rates had been achieved at the expense of the non-deployed forces,
- what logistics actions the services had taken to ensure high mission capability rates for the deployed systems,
- whether the services had anticipated sustainability problems, and
- whether the services had planned for or anticipated the types of problems that arise in a desert environment.

Background

The huge and complex deployment of troops and equipment to the Persian Gulf occurred over a period of 5 months, and the logistics support base was developed when U.S. forces were not involved in hostilities. At its peak, the deployment included over a half a million troops; thousands of aircraft, tanks, armored vehicles, and other weapon systems; and millions of tons of food, water, and other supplies.

Results in Brief

The services were generally able to attain and maintain high equipment operational capability rates for the systems deployed in support of Operation Desert Shield/Desert Storm. The services initially had to give priority to the deployed forces and, to varying degrees, reduce the mission capability rates of the non-deployed forces.

To ensure that the high mission capability rates continued, the services employed a wide range of logistics support initiatives, including expedited deliveries, expedited contract awards, and increased maintenance and repair capability. While some of these added logistics measures

[1]The Army weapons GAO reviewed were the AH-64, UH-60, OH-58D, and CH-47D helicopters; the M1A1 Abrams tank; and the M-2 and M-3 Bradley Fighting Vehicles. The Navy and Marine Corps systems GAO reviewed were the A-6 aircraft, the AH-1 helicopter, and the M-60 tank. Air Force systems were the A-10, F-15, F-16, and C-141 aircraft.

would only be used in a wartime environment because of the costs involved, others have peacetime application and could be incorporated into the day-to-day logistics structure.

If the conflict had continued for a protracted period, sustainability could have become a major problem for the Army's air and ground systems. On the other hand, the Navy, the Marine Corps, and the Air Force did not anticipate any systemic sustainability problems because they had sufficient numbers of parts in their inventories or on order. They did, however, monitor certain key parts to ensure that sustainability problems did not develop and that there was an uninterrupted supply of these items.

The Army, the Marine Corps, and the Air Force experienced problems with certain of their rotary-wing aircraft systems operating in a desert environment. The Army knew about some of these problems for as long as 8 years but had not corrected them because of higher priority funding requirements. As a result, modification work orders had to be expedited when the problems recurred during Operation Desert Shield.

Principal Findings

High Mission Capability Rates Were Generally Achieved

For the selected systems in GAO's review, the Army, Navy, Air Force, and Marine Corps were generally able to meet or exceed their mission capability goals for their deployed forces. To varying extents, these rates were attained and maintained at the expense of the non-deployed systems. To illustrate, flying hours for the non-deployed Army units were reduced because the spare and repair parts were not available to support the Persian Gulf requirements and the flying hour requirements of the non-deployed forces. Because of the short duration of Operation Desert Storm, the reduced flying hours had little effect on the operational capability of the non-deployed forces. However, in a protracted conflict, this reduction could have had a significant effect on the training and capability of those forces when deployed to the theater of operation at a later time.

For all the services, the mission capability rates of the non-deployed forces were initially degraded. However, in a relatively short period, the rates rebounded to meet or exceed the mission capability standards established by the services.

Logistics Measures Used to Ensure High Mission Capability Rates

All the services employed a host of logistics initiatives to ensure that their deployed forces continued to maintain high mission capability rates. For the most part, these initiatives were not unique to the specific weapon systems GAO selected for review. Instead, the initiatives applied to the full range of logistics functions and included (1) expediting the delivery of critical parts to the theater, (2) expediting deliveries under existing contracts and expediting contract awards, (3) reducing production lead time, (4) increasing and expanding intermediate and depot repair programs, (5) increasing the visibility of wholesale and retail inventories, (6) transferring end items of equipment and parts from other theaters, and (7) establishing in-theater stocks of spare and repair parts. While many of these logistics initiatives would be employed only in a crisis because of the added expense involved, others could be applied during peacetime. Initiatives such as expediting the delivery of critically needed items, expediting deliveries under existing contracts, and reducing production lead time all have the effect of reducing investment in inventories without adversely affecting operational capability. While some of these initiatives were already being undertaken by the services, Operation Desert Shield/Desert Storm intensified the services' efforts in these areas.

Sustainability of the Deployed Systems in a Protracted Conflict Could Be a Problem

In a protracted conflict, sustainability of the deployed systems could be the weakest link in the logistics chain, particularly for Army systems. Because of the increased operating tempo and the desert environment of Operation Desert Shield/Desert Storm, the Army increased its estimated operating requirements for spare and repair parts by as much as five times the normal usage rate. On the basis of the estimated usage rates of many of the Army's critical items, GAO estimates that the inventory could have been exhausted within the first 30 days of combat. Prior to the outbreak of hostilities and without any empirical data, the Army developed its initial estimates of up to a fivefold increase in the usage rate. Its Aviation Systems Command reviewed the initial estimates after some limited, actual data became available and concluded that the initial estimates might have been understated. To the extent that actual usage exceeded the initial estimates, the sustainability of Army aviation systems would have been an even bigger problem than originally believed.

Unlike the Army, the Navy and the Marine Corps generally had sufficient inventories of spare and repair parts to last the duration of Operation Desert Shield/Desert Storm. Officials told GAO, however, that certain parts had to be monitored closely to ensure a continued, uninterrupted supply. Officials also pointed out that the Navy was unique in

that its forces deploy with 90 days of supplies and are continually resupplied to maintain combat capability. In addition, deployed naval forces maintain full intermediate repair capability, thereby enhancing sustainability and reducing resupply requirements. Air Force officials said that, like the Navy and the Marine Corps, the Air Force had sufficient inventories of spare parts. However, the Air Force, too, had certain parts that caused it problems from time to time. Even so, the problems were not long term or systemic.

Problems With Operating in a Desert Environment Should Have Been Anticipated

Many of the problems associated with operating equipment in a desert environment—in heat and sand—have been known for several years. In fact, the Army had undertaken product improvement programs to deal with many of these problems. However, because of funding priorities and because the focus of defense efforts were oriented toward the European scenario, many of these improvement efforts were canceled or never completed. For example, a 1981 study pointed out the engine problems that could be expected from operating helicopters in a desert environment unless the engines were equipped with particle separators.[2] The Army initiated, but never completed, a product improvement program for many of these problems. After deployment in Operation Desert Shield/Desert Storm, some of the helicopters began to experience engine problems as a result of sand ingestion. The Army had to develop corrective actions, but by the outbreak of hostilities the Army had not fixed all its helicopters. The Marine Corps and the Air Force experienced similar operating problems with their helicopters due to the severe desert environment. Like the Army, the Marine Corps had to develop a number of corrective actions to prevent serious equipment degradation. Although the Air Force experienced some desert-related problems with its rotary-wing aircraft, the problems were resolved, and operations were not impeded.

Agency Comments

The Department of Defense fully concurred with GAO's findings. The Department also provided some updated statistics concerning mission capability rates and other editorial suggestions, which GAO incorporated into the report.

[2]Army Helicopter Desert Operations, May 7, 1981.

Contents

Abbreviations

CSSA	Central Air Force Command Supply Support Activity
GAO	General Accounting Office
LANTIRN	Low Altitude Navigation Targeting Infrared Night System
PIP	product improvement program

Introduction

Between August 1990 and mid-February 1991, the United States undertook a massive mobilization and deployment effort that included moving 503,000 troops, 3,500 fixed- and rotary-wing aircraft, and 4,200 tanks and armored personnel carriers to the Persian Gulf region. In addition, over 6.7 million tons of cargo were moved by ship, and over 405,000 tons were airlifted to the Persian Gulf. This deployment effort required more than 12,600 strategic airlift missions by military and civilian aircraft and 31,800 ship steaming days.

Even though a large number of weapon systems were deployed to the Persian Gulf, in the Air Force's case, the number deployed represented a relatively small percentage of the total systems that could have been deployed. Table 1.1 shows, for the systems in our review, the numbers and percentages of the total fleet that were deployed to the Persian Gulf.

Table 1.1: Numbers and Percentages of the Total Fleet Deployed to the Persian Gulf for the Systems in Our Review

System	Total fleet	Number deployed	Percentage of fleet deployed
Army			
AH-64	532	237	45
UH-60	924	359	39
OH-58D	154	89	58
CH-47D	301	118	39
M-1	3,066	1,831	60
M-2	3,239	1,760	54
M-3	2,039	1,205	59
Navy/Marine			
AH-1	98	79	81
A-6	332	126	38
M-60	581	314	54
Air Force			
A-10	635	144	23
F-15	600	144	24
F-16	1,424	209	15
C-141	[a]	[a]	[a]

[a]The C-141 was not deployed to the theater as were tactical aircraft. The C-141s operated from U.S. bases, delivering cargo and personnel and then returning to U.S. bases. Because these aircraft do not deploy in the same way as fighter aircraft, comparable data could not be developed for this table.

Considering the environment and the distances involved, the services demonstrated extraordinary efforts in developing a logistics support base in the Persian Gulf. At the same time, however, the mobilization

and deployment efforts would have been more difficult had the United States not had 5 months to accomplish these tasks. Furthermore, the forces were not involved in hostilities at the same time that they were setting up an infrastructure support base from which to conduct defensive and offensive operations.

Objectives, Scope, and Methodology

Concerned about the stress that the deployment placed on the services' logistics system, the Chairman of the House Armed Services Committee asked GAO to provide the Committee a "snap shot" of the mission capability rates of selected Army, Navy, Air Force, and Marine Corps air and ground weapon systems deployed to the Persian Gulf in support of Operation Desert Shield. He also asked us to determine

- whether these rates had been achieved at the expense of the non-deployed forces,
- what logistics actions the services had taken to ensure high mission capability rates for the deployed systems,
- whether the services had anticipated sustainability problems, and
- whether the services had planned for or anticipated the types of problems that arise in a desert environment.

The specific systems selected for review were identified by the Committee based on the perceived importance that the systems would play in a Persian Gulf conflict. The Army weapons we reviewed were the AH-64, UH-60, OH-58D, and CH-47D helicopters; the M1A1 Abrams tank; and the M-2 and M-3 Bradley Fighting Vehicles. The Navy and Marine Corps systems we reviewed were the A-6 aircraft, the AH-1 helicopter, and the M-60 tank. Air Force systems were the A-10, F-15, F-16, and C-141 aircraft.[1] The Committee decided not to include naval ships in the review because the Navy routinely operates in a forward-deployed environment.

To determine the mission capability rates, we obtained and analyzed data showing the mission capability rates for the selected systems for the periods prior to and after the initiation of Operation Desert Shield. Using this data, we could determine the trend of the mission capability

[1]We selected for our review Air Force units (1) that were initially deployed; (2) that gave us a sample of all Air Force aircraft, i.e., the F-15, the F-16, and the A-10; and (3) for which the Tactical Air Command had compiled mission capability data.

rates for the deployed and non-deployed systems. We accepted the mission capability data as reported and did not independently test the data to determine its accuracy or reliability.

We held discussions with logistics and operations officials to determine what added logistics measures had been taken to ensure that the deployed forces continued to experience high mission capability rates. Our discussions also included determining whether logistics or operational support to the non-deployed forces had been reduced in order that the deployed forces would benefit.

To determine whether the services could logistically sustain the deployed forces in a protracted conflict, we obtained listings of items the Army Aviation Systems Command and the Tank-Automotive Command had identified as critical to sustainability. We then analyzed the inventory status of these items at 30-, 60-, and 90-day intervals based on expected usage rates, as well as inventory items expected to be received from procurement and repair. To determine what actions were being taken to improve the sustainability of the critical items, we also discussed this issue with logistics officials and reviewed pertinent documents. The Air Force, the Navy, and the Marine Corps did not consider any items applicable to the systems included in our review as having sustainability problems.

Our review also covered various reports and studies on previous military exercises to identify the types of problems that the services could expect to encounter while operating in a desert environment. During our analysis, we determined that many of the problems being experienced during the early phases of Operation Desert Shield—particularly by the Army—were problems that had previously been identified in after-action reports on exercises conducted in a desert environment. Using this information, we held discussions with knowledgeable officials and reviewed internal service documents to determine what actions had been taken in regard to these earlier identified problems and why these problems continued to exist.

Our review was performed primarily at the following Army, Navy, Air Force, and Marine Corps locations.

Army Locations

- Office of the Deputy Chief of Staff for Logistics, the Pentagon;
- Office of the Deputy Chief of Staff for Operations, the Pentagon;
- Headquarters, Army Materiel Command, Alexandria, Virginia;

- Army Aviation Systems Command, St. Louis, Missouri; and
- Tank-Automotive Command, Warren, Michigan

Navy/Marine Corps Locations

- Headquarters, Department of the Navy, the Pentagon;
- Headquarters, Marine Corps, the Pentagon;
- Headquarters, Naval Air Systems Command, the Pentagon;
- Headquarters, U.S. Atlantic Fleet, Norfolk, Virginia;
- Headquarters, Fleet Marine Force, Atlantic, Norfolk, Virginia;
- Headquarters, Naval Air Force, Atlantic, Norfolk, Virginia;
- Naval Aviation Supply Office, Philadelphia, Pennsylvania;
- Marine Corps Logistics Base, Albany, Georgia;
- Marine Corps Readiness, Acquisition, and Development Command, Quantico, Virginia;
- Marine Corps Base, Camp Pendleton, California;
- Marine Corps Base, Twentynine Palms, California;
- Marine Corps Base, Camp Lejuene, North Carolina;
- Naval Air Station, San Diego, California;
- Naval Air Station, Oceana, Virginia;
- Marine Corps Air Station, Cherry Point, North Carolina; and
- Marine Corps Air Station, New River, North Carolina.

Air Force Locations

- Headquarters, United States Air Force, the Pentagon;
- Tactical Air Command, Langley Air Force Base, Virginia;
- 1st Tactical Fighter Wing, Langley Air Force Base, Virginia;
- 4th Tactical Fighter Wing, Seymour Johnson Air Force Base, North Carolina;
- 354th Tactical Fighter Wing, Myrtle Beach Air Force Base, South Carolina;
- 363rd Tactical Fighter Wing, Shaw Air Force Base, South Carolina;
- Military Airlift Command, Scott Air Force Base, Illinois;
- 437th Military Airlift Wing, Charleston Air Force Base, South Carolina;
- Air Force Logistics Command Headquarters, Wright-Patterson Air Force Base, Ohio;
- Oklahoma City Air Logistics Center, Tinker Air Force Base, Oklahoma;
- Warner Robins Air Logistics Center, Robins Air Force Base, Georgia; and
- Air Force Reserve Headquarters, Robins Air Force Base, Georgia.

Our review was performed from January to March 1991 in accordance with generally accepted government auditing standards.

High Mission Capability Rates for Systems Deployed in Support of Desert Shield

During Operation Desert Shield, the services reported high mission capability rates for 11 of the 14 deployed air and ground systems included in our review.[1] During the initial stages of the deployments, the mission capability rates for some of the Army, Navy/Marine Corps, and Air Force non-deployed systems declined. However over time, the mission capability rates of the non-deployed systems generally increased to a level comparable to that attained prior to Operation Desert Shield.

Army Aircraft

During Operation Desert Shield, the Army generally exceeded its mission capability goals for three of the four systems we reviewed. These rates were achieved primarily because priority was given to the deployed units by decreasing the operating tempo of the non-deployed systems. This action had the effect of conserving spare parts that could be used to sustain the deployed forces. As shown in figures 2.1 through 2.4, the mission capability rates applicable to the deployed and non-deployed Army systems achieved parity over time, even though the rates for the non-deployed systems were initially degraded. While there was some degradation in the mission capability rates of the non-deployed systems after the beginning of Desert Shield, the short duration of the Persian Gulf conflict prevented the possibility of a long-term negative impact on the non-deployed forces.

[1] After the outbreak of hostilities, some of the services did not always report mission capability rates for all of their systems. However, the mission capability rates that were reported were relatively high.

Figure 2.1: Mission Capability Rates for the AH-64 Apache Helicopter in 1990

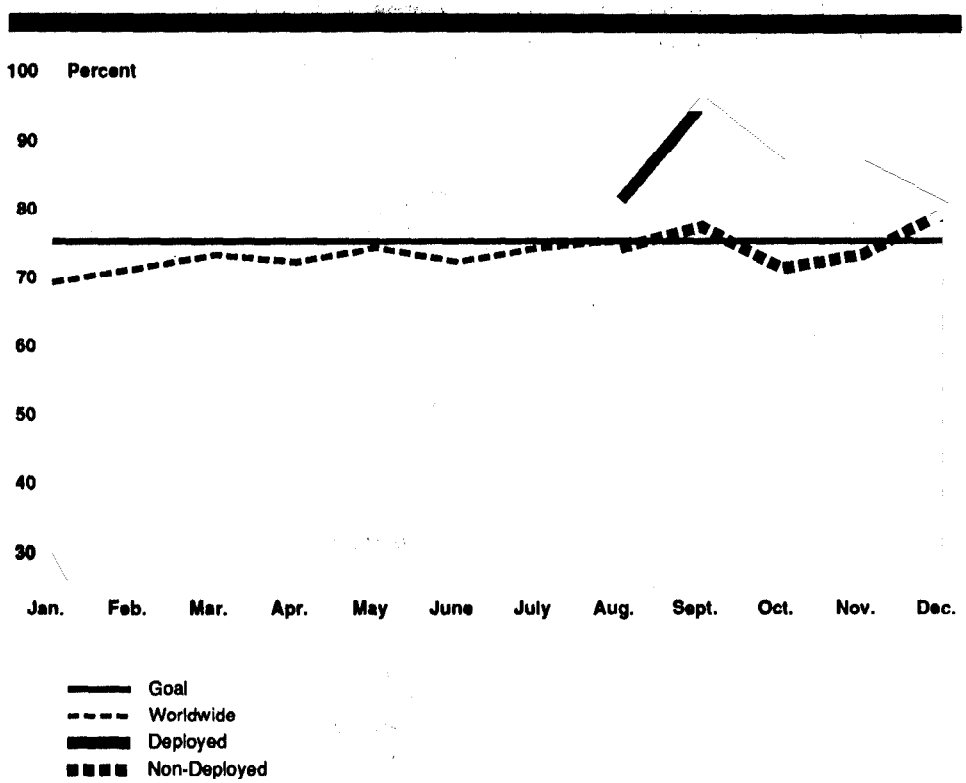


Figure 2.2: Mission Capability Rates for the CH-47D Chinook Helicopter in 1990

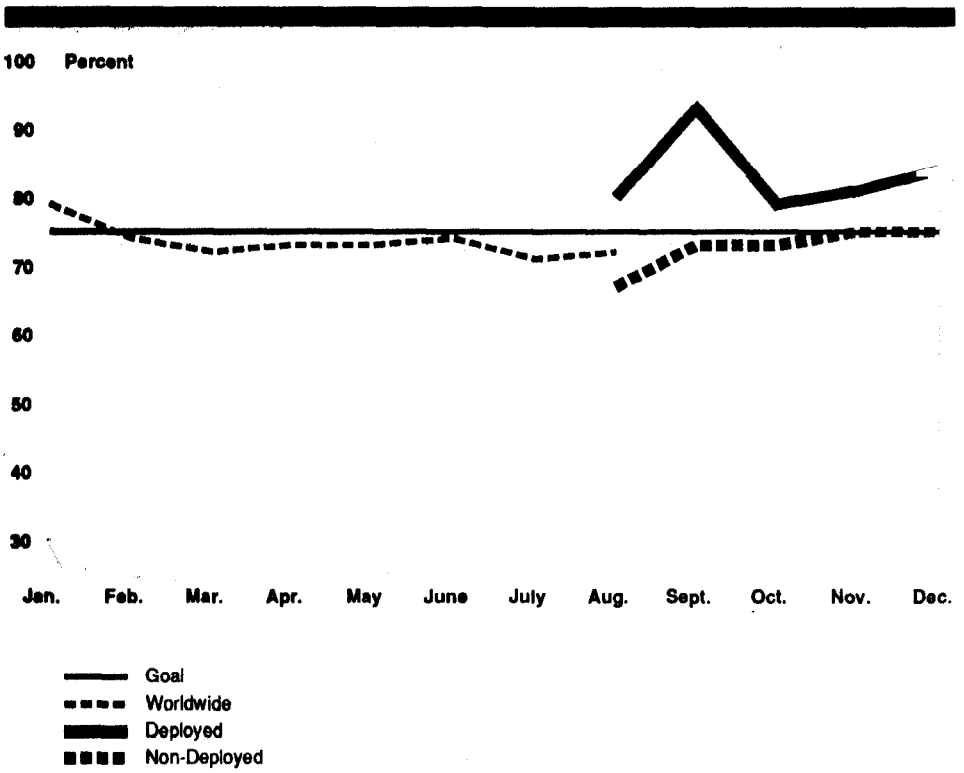


Figure 2.3: Mission Capability Rates for the UH-60 Black Hawk Helicopter in 1990

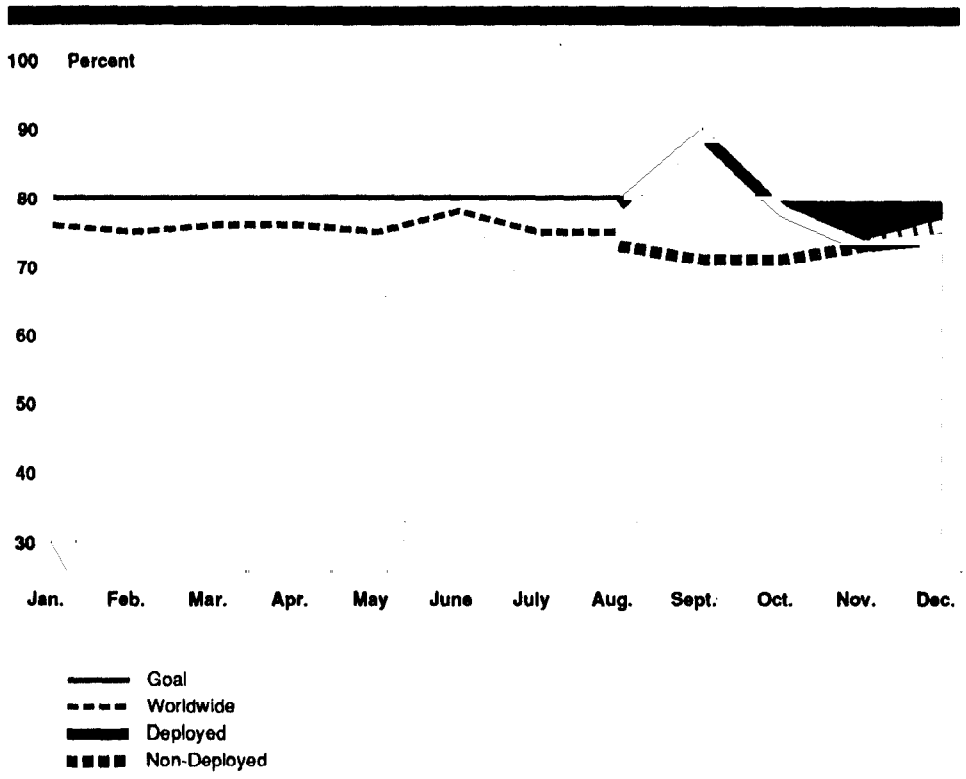
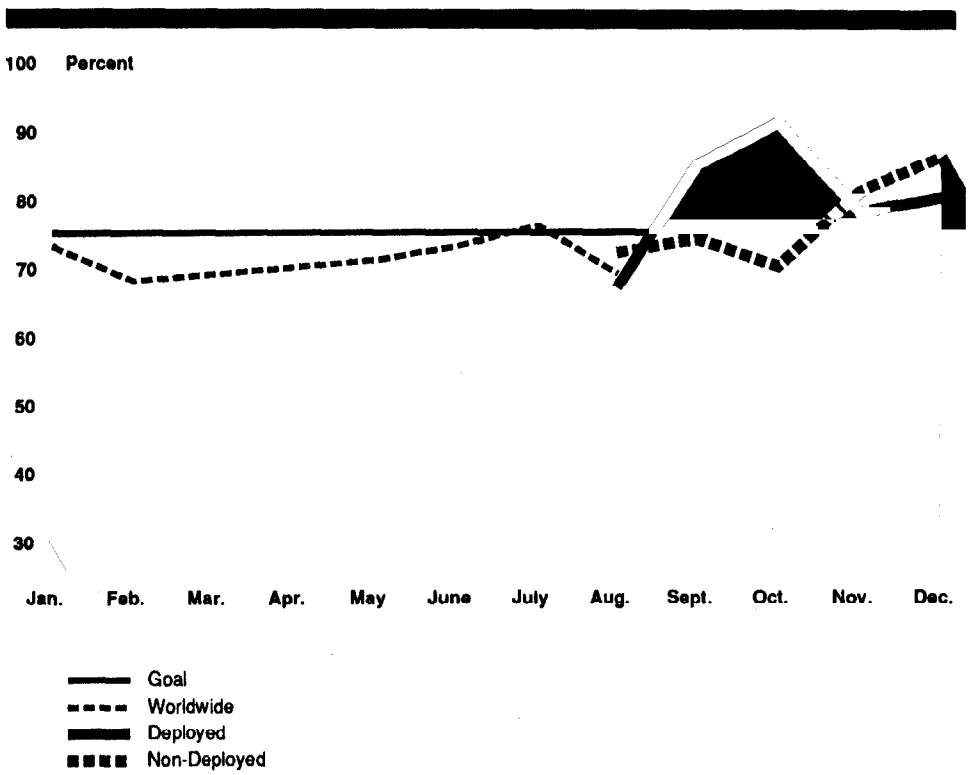


Figure 2.4: Mission Capability Rates for the OH-58D Kiowa Warrior Helicopter in 1990



When the Army aviation systems were initially deployed, their average operating tempo was increased slightly from about 14.5 to 16.8 hours per month to orient the crews to the desert terrain. However, due to the operating environment, the usage rate for parts increased dramatically—as much as three times the normal rate.

The Army realized that it could not continue to logistically support the deployed aircraft at the increased rates of parts consumption and at the same time support the flying hour rates of the non-deployed aircraft. To conserve the aircraft and the spare and repair parts, the Army decided to reduce the number of flying hours available to the non-deployed systems from an average of 15 hours per month to 6 to 10 hours per month, depending on the type of aircraft.

Table 2.1 shows the estimated numbers of flying hours, based on a projected operating tempo, that would have been required to support Operation Desert Shield to the end of fiscal year 1991; the numbers of flying hours required for the non-deployed systems, based on the normal training operating tempo; and the numbers of flying hours that the

Army could support with spare parts. Also shown are the numbers of flying hours that were required for the non-deployed aircraft and could not be supported with spare parts. These estimates took into consideration not only the parts on hand but also what was due in from contractors and repair facilities.

Table 2.1: Projected Flying Hours Available and Required for Operation Desert Shield and the Non-Deployed Systems for Fiscal Year 1991

System	Hours required in Desert Shield	Hours required for non-deployed forces	Total required hours	Hours supported by parts	Hours not supported by parts
AH-64	44,250	53,556	97,806	78,681	19,125
OH-58D	19,720	12,300	32,020	26,882	5,138
UH-60	78,729	103,713	182,442	173,639	8,803
CH-47D	21,120	31,922	53,042	45,813	7,229

As shown in table 2.1, for example, 97,806 flying hours were required for the AH-64 aircraft in fiscal year 1991. This requirement included 44,250 hours for Operation Desert Shield and 53,556 hours for the non-deployed aircraft. However, the Army had only enough spare parts to support 78,681 flying hours. Therefore, there was a requirement for 19,125 flying hours the Army could not support with spare parts.

Army Ground Systems

As shown in figures 2.5, 2.6, and 2.7, during the initial deployment phases, the reported mission capability rates for the M1A1 tanks and the M2 and M3 Bradley Fighting Vehicles dropped below the Army's mission capability goal of 90 percent. According to Army officials, low mission capability rates were experienced during the initial deployment phase because of part shortages and because supplies did not keep abreast of troop movements. However, by December 1990, the mission capability rates had increased and were near or above the goal rate. Also, the mission capability rates for the non-deployed systems were initially degraded, and the rates continued to decrease during Operation Desert Shield. Nevertheless, the capability rates for these systems remained close to the Army's mission capability goal.

Figure 2.5: Mission Capability Rates for the M1A1 Abrams Tank for June Through December 1990

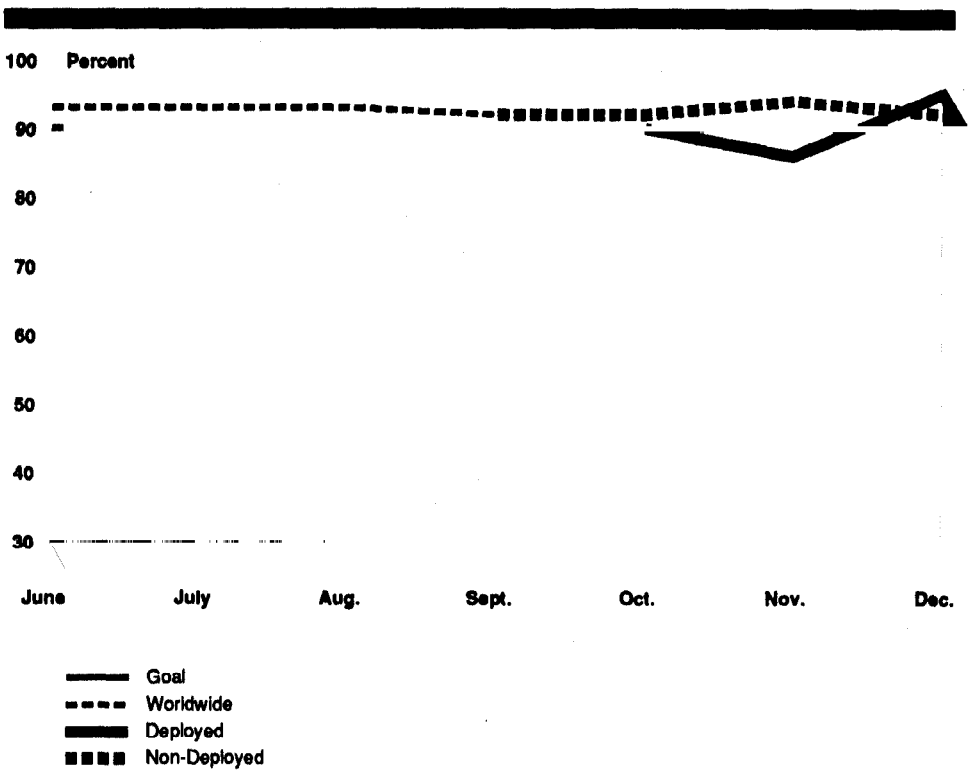


Figure 2.6: Mission Capability Rates for the M2 Bradley Infantry Fighting Vehicle for June Through December 1990

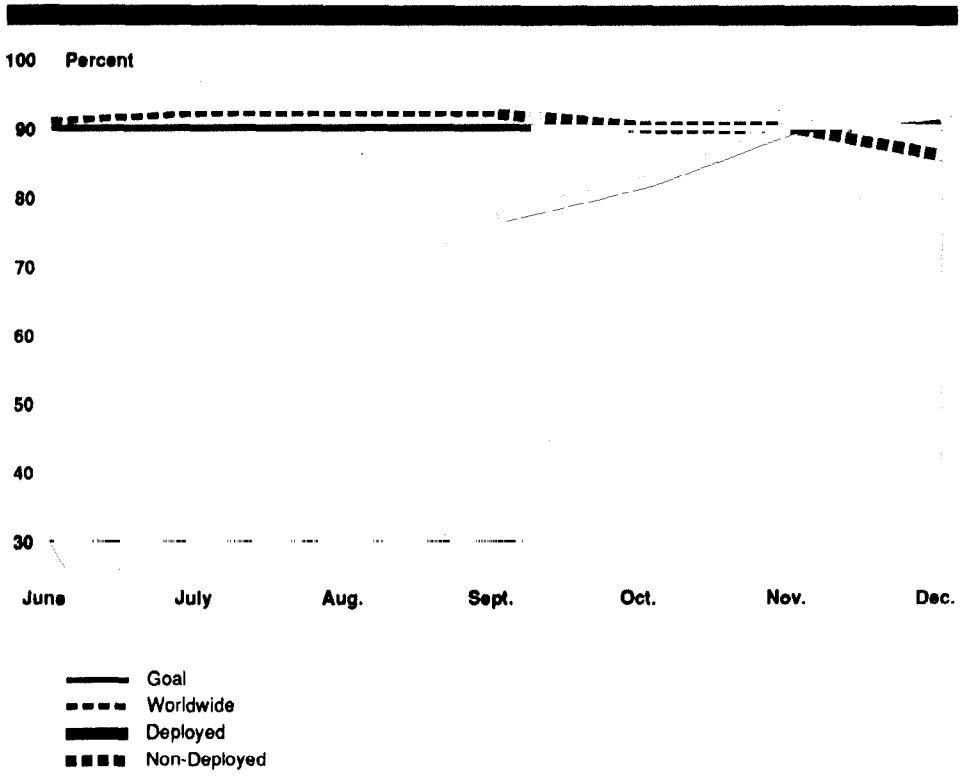
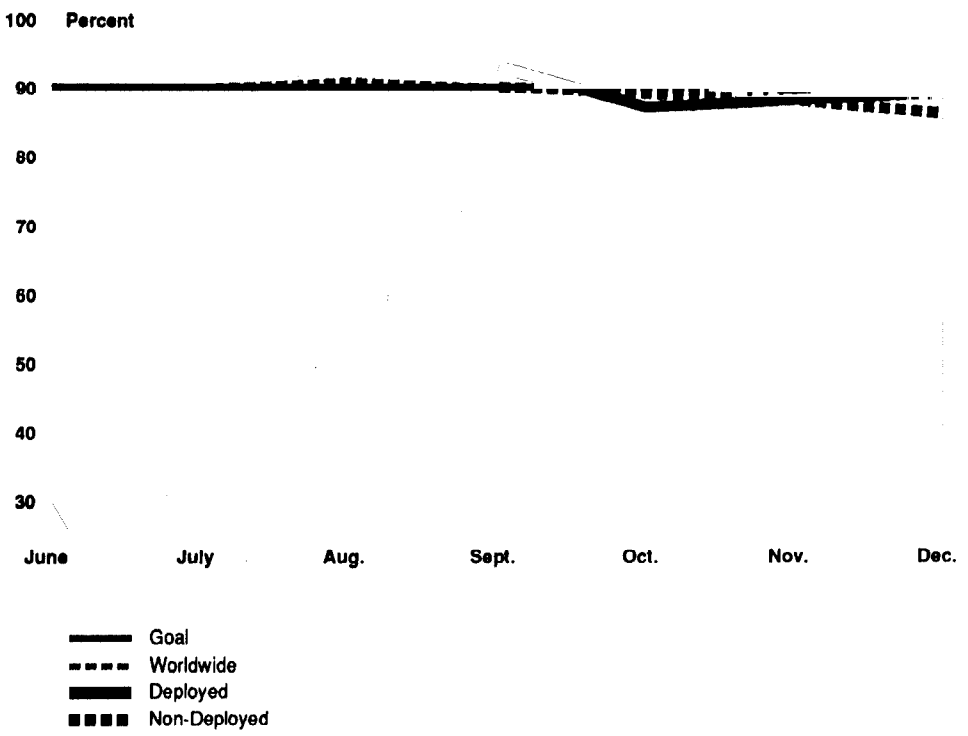


Figure 2.7: Mission Capability Rates for the M3 Bradley Cavalry Fighting Vehicle for June Through December 1990



Navy/Marine Corps Aircraft

The Navy and the Marine Corps exceeded their mission capability goals for their deployed A-6 aircraft during most of Operation Desert Shield. They were able to do so primarily because of the amount of spare and repair parts they had on hand, because of logistics efforts undertaken in the United States and in the theater of operation to ensure continued combat readiness, and because of the short duration of combat. Although AH-1 aircraft did not meet their mission capability goal, their rates remained consistent with or exceeded peacetime rates. According to Navy officials, the AH-1 was unable to achieve its mission capability goal because of an historic lack of spare parts, not because of wartime requirements.

The mission capability rates for the non-deployed A-6 and AH-1 aircraft were degraded as a result of actions taken to ensure that the deployed systems received the needed parts, equipment, and maintenance. The mission capability rates for these aircraft gradually improved during Operation Desert Shield.

Navy officials stated that the Navy did not operate significantly different from the way it did in peacetime, except that its Desert Shield deployment was larger. Because of the maintenance and repair support that always accompanies deployed Navy and Marine Corps forces and the additional support provided by intermediate- and depot-level maintenance facilities in Europe, mission capability rates remained consistent with those recorded prior to Operation Desert Shield.

The Navy and Marine Corps did not report the mission capability rates for the non-deployed forces during Operations Desert Shield and Storm. The rates for these forces were included in the mission capability rates for the total force, as shown in figures 2.8 and 2.9.

Figure 2.8: Mission Capability Rates for the A-6E Intruder Aircraft for February Through December 1990

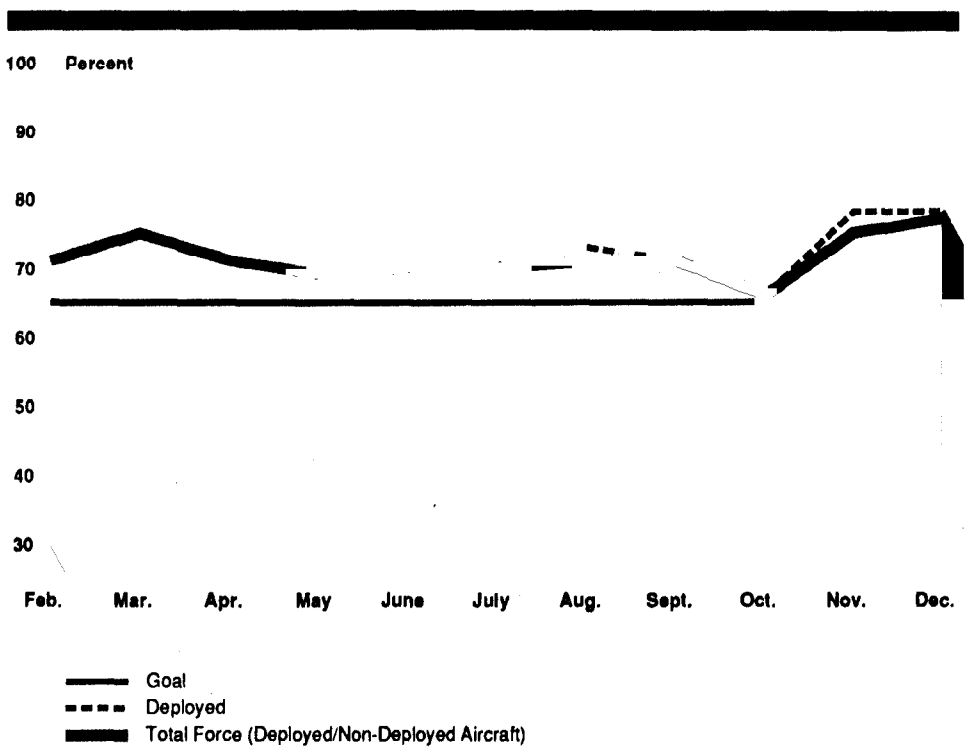
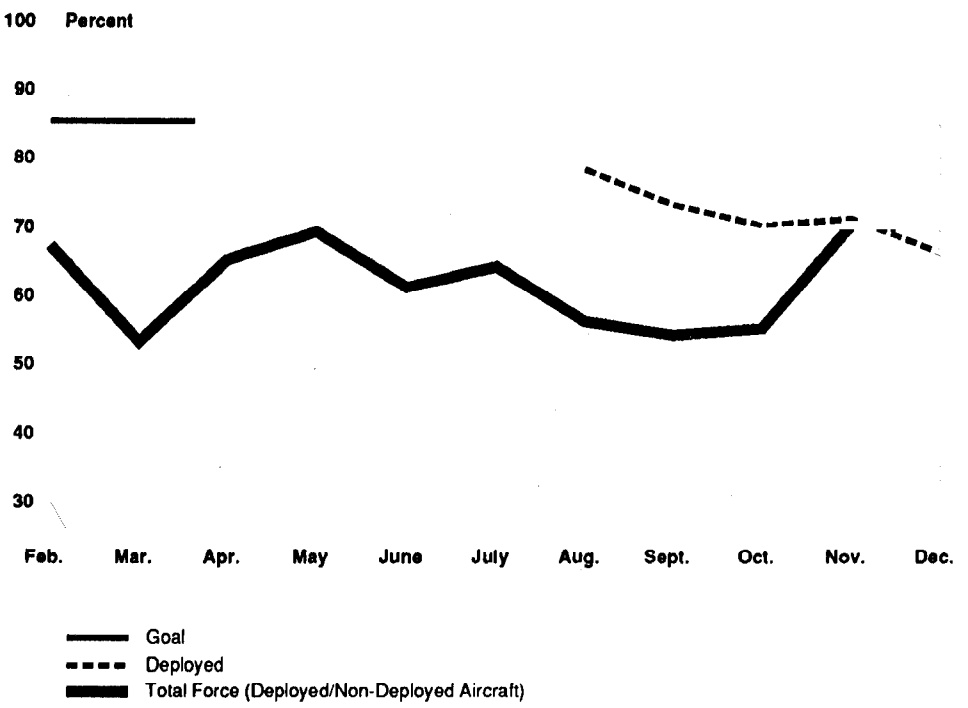


Figure 2.9: Mission Capability Rates for the AH-1W Cobra Helicopter for February Through December 1990



Marine Corps M-60 Tanks

The Marine Corps deployed virtually all of its M-60 tank battalion personnel to the Persian Gulf, where they joined with the M-60A1 tanks prepositioned on the Maritime Prepositioned Ships. According to Marine Corps officials, the mission capability rates for these tanks were maintained at the Marine Corps' goal of 85 percent or higher throughout Operation Desert Shield.

Initially, the mission capability rates for the non-deployed M-60s were considerably lower because of an insufficient number of maintenance personnel and because parts were removed from tanks by the departing personnel. Over time, the mission capability of these tanks increased to 85 percent or better as parts became available and Marine Corps reserve maintenance personnel were able to perform the required maintenance. The mission capability rates are shown in table 2.2.

Table 2.2: Mission Capability Rates for Marine Corps M-60 Tanks
(July 1990 - February 1991)

	Percent mission capable			
M-60 tanks	**July**	**Nov.**	**Jan.**	**Feb.**
Deployed	[a]	[a]	90	87
Non-deployed	89	77	91	90

[a]Mission capability rates for these periods were not reported by the Marine Corps.

Air Force Aircraft

The Air Force sustained high mission capable rates for the A-10, F-15, and F-16 aircraft—typically above 90 percent—throughout Operation Desert Shield/Desert Storm. According to Air Force officials, logistical actions contributing to these high rates included (1) the prepositioning of materials designed to provide required support for a potential contingency in Southwest Asia, (2) the deployment of nearly full war readiness spare kits and an additional 30-day supply of follow-on spare kits for tactical aircraft, (3) the expediting of the resupply of needed parts, (4) the establishment of intermediate maintenance capabilities in the Persian Gulf region and Europe, (5) the dedicated efforts of support personnel in the theater of operation, and (6) the extraordinary efforts of stateside personnel in supporting Air Force needs in the theater.

Stateside squadrons' mission capable rates for Tactical Air Command units in our review (units with F-16, F-15, and A-10 aircraft) were initially degraded because the Command (1) cannibalized the aircraft remaining stateside to fill war readiness spare kits and (2) reassigned the most highly mission capable aircraft from non-deploying squadrons to deploying squadrons. Although these actions initially degraded the remaining stateside squadrons' mission capability, mission capability rates for all but one of the non-deployed squadrons met or exceeded the Command's mission capable standards by December 1990, as shown in table 2.3.

Table 2.3: Tactical Air Command's Mission Capability Rates for Selected Units During 1990

Aircraft	Tactical fighter wing	Deployed/ non-deployed	Mission capable goal	Mission capability rate			
				Sept.	Oct.	Nov.	Dec.
F-16	363rd	Deployed	85	89.7	91.1	94.2	94.2
		Non-deployed		83.3	84.3	88.7	89.6
	388th	Deployed		95.0	93.5	94.9	95.5
		Non-deployed		83.3	89.9	91.0	91.9
F-15	1st	Deployed	83	82.8	85.3	87.3	90.0
		Non-deployed		78.4	80.3	83.4	77.2
	33rd	Deployed		94.5	91.8	89.2	93.3
		Non-deployed		86.0	80.8	82.2	86.0
F-15E	4th[a]	Deployed	80	90.8	92.2	93.6	94.4
		Non-deployed		69.4	81.4	88.8	89.3
A-10	23rd	Deployed	85	93.6	93.5	96.1	95.9
	354th	Non-deployed		85.7	90.0	90.7	90.4

[a]The 4th Tactical Fighter Wing was converting from F-4s to F-15Es during this time.

As a general rule, the Tactical Air Command deployed two of the three squadrons in a wing. Because the early deploying squadrons expected to engage in combat soon after they arrived in theater, extensive efforts were made to fill the deploying squadrons' war readiness spare kits as close to capacity as possible. The tactical wings accomplished this by cannibalizing parts from aircraft that were not going to deploy and by taking the parts from the non-deploying squadrons' war readiness spare kits. For example, at the time of deployment, parts were cannibalized from the non-deployed F-15 squadron of the 1st Tactical Fighter Wing, leaving 8 of the 24 aircraft grounded and other aircraft with a total of 100 missing parts. By November 1990, as the F-15 aircraft in the non-deployed squadrons were being resupplied with parts, the number of missing parts had been reduced to nine, and the number of aircraft grounded had been reduced to three.

Another action that the Command took was to replace deploying squadrons' aircraft that were not mission capable with aircraft from the non-deploying squadrons. Officials of the 363rd Tactical Fighter Wing stated that missing parts and operational problems on aircraft initially assigned to deploying squadrons had resulted in the switching of one-third of the non-deploying squadrons' aircraft with aircraft in the two deploying squadrons. This switch improved the capability of the

deploying squadrons but degraded the non-deploying units' mission capability rates.

Tactical Air Command officials identified potential impacts of the lack of aircraft on training for non-deployed squadrons because these squadrons were expected to manage training for the new pilots assigned to the squadron as well as new pilots assigned to the deployed squadrons. At three of the four tactical fighter wings we visited, Command officials expressed concern about this situation. For example, as of January 1991, the non-deployed F-16 squadron at Shaw Air Force Base was hosting an additional 14 pilots and was having difficulty providing all the needed flight training for the new pilots to attain minimal qualifications.

Each tactical fighter wing had its own strategy for dealing with the increased demand for pilot flight training. At one wing, for example, all pilots shared training flights, with the more experienced pilots flying fewer hours. At another wing, newly arriving pilots were asked to wait for up to 8 weeks to begin flight training.

The C-141 aircraft, which were also included in our review, were not deployed to the Persian Gulf. They delivered cargo and personnel to the Persian Gulf and then returned to a U.S. base. Air Force statistics indicate that C-141 mission capability rates increased during Desert Shield airlift surges. During the first surge, the mission capability rate increased from about 78 percent in July to 89 percent in August 1990 and decreased to 81 percent in November 1990, as the airlift surge waned. During the second airlift surge in December 1990 and January 1991, the mission capable rate increased to between 88 and 90 percent.

Military Airlift Command officials said that there were four ways to cause C-141 mission capable rates to increase: (1) defer inspections, (2) ignore minor discrepancies discovered during routine maintenance, (3) increase the crew's willingness to overlook certain subsystems that would be required to function properly in peacetime, and (4) supply parts more effectively. According to officials, to some extent, all four of these methods were used during the Desert Shield airlift.

Logistics Initiatives to Support the Persian Gulf Deployment

The services developed and employed a full range of logistics initiatives to ensure that the deployed forces were able to maintain high mission capability rates. Some of the initiatives were an expansion of normal logistics functions (such as intensifying actions to expedite contract deliveries), while others (such as expedited deliveries of critical items to the theater of operation) were specifically developed for Operation Desert Shield/Desert Storm.

Some of the major initiatives undertaken by the services were (1) expediting the delivery of critical parts to the theater, (2) expediting deliveries under existing contracts and expediting contract awards, (3) reducing production lead time, (4) increasing and expanding depot repair programs, (5) increasing visibility of and expediting requisitions for spare and repair parts, (6) transferring end items of equipment and parts from other theaters, and (7) establishing in-theater stocks of spare and repair parts. Opportunities exist to institutionalize some of these initiatives as part of the services' logistics structures.

Expediting the Delivery of Critical Items

The U.S. Transportation Command established an overnight delivery service for spare parts and other high priority cargo needed in support of Operation Desert Shield/Desert Storm. It believed that the normal airlift system would become overloaded with cargo, some of it not the highest priority, and that the critical needs of the deployed units might not be satisfied.

The expedited delivery service, Desert Express, was initiated on October 30, 1990, and provided once-a-day delivery of items from Charleston, South Carolina, using a C-141 aircraft. Each service was allocated a number of pallet positions as well as a weight limit for its Desert Express cargo. The U.S. Transportation Command adjusted the allocations periodically during Desert Shield/Desert Storm to reflect each service's level of demand. The Desert Express C-141 flight consisted of 12 pallets (about 3,000 pounds a pallet). The Army was allocated 16,500 pounds; the Navy 4,500 pounds; the Marine Corps 1,500 pounds; and the Air Force 13,500 pounds. Effective February 13, 1991, the U.S. Transportation Command added a second daily flight to Desert Express, and the Army's allocation was increased to 28,000; the Navy's to 5,000; the Marine Corps' to 5,000; and the Air Force's to 22,000 pounds.

When a user in the field identified a critically needed item, it was requisitioned using a joint project code reserved for Desert Express. The requisitions were processed through the service's supply control point,

which had responsibility for obtaining air clearance authority for space on the next day's Desert Express flight. Space on the flight could only be reserved for the next flight, and the reservations were awarded on a first-come, first-served basis, except for some items of the highest priority, such as Patriot missile parts.

As of January 14, 1991, Desert Express had airlifted more than two million pounds of cargo from Charleston to Saudi Arabia. Desert Express's goal was to deliver the critically needed item to the requisitioner within 72 hours after the request. Army field commanders reported that they had received their requisitioned items in 5 to 6 days, while Air Force units, which were more centrally located, reported shorter response times.

Air Force and U.S. Transportation Command officials said that they were pleased with the results of Desert Express. While the other services were generally pleased with the Desert Express system, there were some problems. Cargo space was reserved on the flight on a first-come, first-served basis. As a result, there was no assurance that the most critically needed items got space on the flight. The Army experienced several cases when space for more critical items could not be reserved because all of the Army's allocation had been reserved for the next flight. Another problem, according to Army officials, was that 25 to 30 percent of the Army cargo arriving at Charleston did not have the proper clearance or documentation for shipment on Desert Express. As a result, it was likely to be diverted for shipment by other means.

The Navy and the Marine Corps did not use Desert Express to move the majority of their high priority aviation cargo to the Persian Gulf because the Desert Express origin of Charleston, South Carolina, and destination of Dhahran were not convenient to most Navy and Marine Corps units in the United States or the Persian Gulf. Instead, the two services used other Military Airlift Command aircraft to transport their cargo from Norfolk Naval Air Station to Bahrain. The Marine Corps did use Desert Express to move high priority cargo for its ground systems. During the duration of Operation Desert Shield/Desert Storm, over 200,000 pounds of cargo were transported by this means.

Another expedited airlift delivery service—European Desert Express—was initiated on December 7, 1990. According to U.S. Transportation Command officials, it provided express service for priority items from the European theater to Operation Desert Shield/Desert Storm. Mission-essential parts were first shipped through the existing transportation

network from a unit's home base in Europe to Rhein-Main Air Base, Germany. The cargo was then loaded aboard the C-141 European Express and delivered to Saudi Arabia about 8 hours later. As with Desert Express, each service was allocated a number of pallets on the flight.

Other Airlift Systems

For high priority cargo that did not qualify for Desert Express, another airlift system operated from Dover Air Force Base to the Persian Gulf. Dover had the capability to airlift about 1,500 tons a day, and at any one time the backlog averaged about 2,500 tons during January 1991 and about 1,700 tons during the first half of February 1991. Before the Army cargo was shipped to Dover, it was processed through the container consolidation point at New Cumberland Army Depot. New Cumberland had the capability to process about 127 pallets a day, and at any one time, there was generally a 3- to 4-day backlog of shipments waiting to be called forward by Dover for air shipment.

Another airlift effort occurred at the Westover Air Force Base, Massachusetts, home of the Air Force Reserve 439th Military Airlift Wing. From the onset of Operation Desert Shield, the Westover Air Force Base Command Post transitioned from a one-person operation handling approximately 10 C-5 aircraft movements weekly to a six-person, 24-hour-per-day staging operation controlling an average of 12 aircraft movements daily. The transition was accomplished with volunteers who had left their civilian jobs for up to 90 days to provide the necessary services.

Expediting Contract Deliveries and Contract Awards

To ensure an adequate and continued supply of needed items, the Army, the Navy, and the Air Force took actions to expedite deliveries under existing contracts and to expedite contract awards.

In the case of the Army's Aviation Systems Command and Tank-Automotive Command and the Naval Aviation Supply Office, officials wrote letters to the contractors asking them to expedite deliveries. In some cases, first article testing[1] was waived, and in other cases, items were delivered to the users from the contractor or from production lines.

While information on the extent of such actions was limited, Aviation Systems Command officials told us they had expedited deliveries on

[1]The testing of the first item made by a new producer to ensure that it complies with contract specifications.

about 1,100 of 1,600 contracts they reviewed. The officials were not able to tell us what additional costs were involved in making the expedited deliveries.

The Navy also expedited deliveries of ongoing contracts. For example, its contract with Grumman, the prime contractor on the A-6 aircraft, required that the contractor deliver four re-winged aircraft between January and March 1991. However, the Navy asked Grumman to expedite the delivery of these aircraft, and the contractor responded by delivering them in November and December 1990.

Likewise, the Air Force took actions to expedite deliveries under existing contracts. According to the Air Force Logistics Command, when an item manager determined that a needed item was not available, the item manager first looked for near-term deliveries under existing contracts that could be diverted from one shipping address to another to satisfy the urgent requirement. A significant portion of the Air Force's urgent requirements were satisfied in this manner. If this method was not possible, the item manager looked for existing contracts for which delivery schedules might be accelerated. For example, the F-15 directorate at the Warner Robins Air Logistics Center processed 40 accelerated delivery requests between November 1, 1990, and March 31, 1991, of which the delivery schedules for 32 were accelerated. According to Air Force Logistics Command officials, more than 80 percent of the accelerations were made without additional charge. If there were no open contracts, the item managers initiated emergency or urgent purchase requests and expedited them through the preparation and coordination process to ensure that the contract was awarded as soon as possible.

The Army also expedited the award of new contracts for critically needed items. At the Aviation Systems Command, for example, new spare parts requirements were computed for each type of aircraft deployed to the Persian Gulf based on anticipated flying hours and parts wear-out rates. This effort resulted in the identification of the need for 5,000 new contracts. As of January 24, 1991, the Command had awarded 2,777 new contracts valued at $354 million.

Air Force Headquarters also took action to expedite contract awards. In September 1990, the Air Force implemented the Rapid Response Process to streamline existing requirement validation, program approval, and acquisition processes to support the immediate requirements of Operation Desert Shield. As of March 25, 1991, 24 requests, with a contract

value of $98 million, had been approved using this process. These expedited actions affected many mission areas, from munitions to aeromedical evacuations. The objective was to field the needed items within 6 months of the time the need was first identified; this is a process that can take from 1 to 12 years during peacetime. At the time of the cease-fire in February 1991, 50 percent of the equipment had been totally fielded; 22 percent had been partially fielded; and 28 percent was being manufactured.

Reducing Production Lead Time

The Army, the Navy, and the Marine Corps took actions to reduce the production lead time for items already under contract. These actions included increasing personal contact between service officials and contractor representatives to encourage them to expedite the production process for needed items.

An initiative undertaken by the Army Aviation Systems Command involved visits by field teams to contractors' plants to identify production inefficiencies that extend the time required to produce and deliver items.

One of the examples cited by Aviation Systems Command officials concerned a part required for the AH-64 helicopter. The contractor's production lead time for the item was 25 months. On the basis of a review at the contractor's plant, the Command identified and eliminated production inefficiencies, thereby reducing the production lead time for the part to 12 months. Reducing production lead time can have a dramatic effect in expediting deliveries of needed items as well as reducing the quantity of such items that must be carried in inventory to meet requirements.

Although the Navy and the Marine Corps generally had sufficient stocks of needed aviation spare and repair parts, the services closely monitored, and intervened when necessary, to ensure an uninterrupted supply of these parts. Officials from the Naval Aviation Supply Office and the Air Systems Command wrote a number of letters and conducted personal follow-up visits to various contractors encouraging them to expedite the production of needed parts. For example,

- Bell Helicopter, the prime contractor for the AH-1 helicopter, reduced its average parts repair turnaround time from 100 days to less than 59 days, and

- Allied Signal, a major subcontractor to Bell Helicopter, reduced its parts repair turnaround time from about 45 days to 7 days.

Increasing and Expanding Intermediate and Depot Repair Programs

All the services increased either their intermediate or their depot repair capabilities for reparable components to ensure an adequate supply of repair parts for Operation Desert Shield/Desert Storm.

For Army aviation systems, the Aviation Systems Command expanded its repair capabilities for over 1,200 depot repair programs and added 589 new repair programs. On an Army-wide basis, the increased costs of expanding existing repair programs and adding new repair programs to meet the Operation Desert Shield/Desert Storm requirements for fiscal year 1991 are estimated at about $197 million.

The Navy and the Marine Corps increased the number of maintenance personnel and spare parts at their Sigonella, Italy, and Rota, Spain, facilities and maintained round-the-clock shifts to support Navy and Marine Corps helicopters and fixed-wing aircraft engines. The Navy's goal was to get a 30-day supply of engines in theater as replacements for those degraded by the harsh desert environment. In addition, the Naples, Italy, depot maintenance facility increased the number of personnel and sent maintenance teams to the aircraft carriers and to ground bases in theater. According to a Navy official, the Naples facility normally handles between 100 and 150 maintenance actions a year. During Desert Shield/Desert Storm, the depot handled about 650 actions, most of which were accomplished by maintenance field teams. The Naples facility also coordinated maintenance operations at Sigonella, Italy, and Rota, Spain.

To support its aircraft in the Persian Gulf, the Air Force established intermediate maintenance capability in the theater and Europe to repair avionics parts and engines. Avionics Intermediate Stations were deployed with tactical fighter squadrons to allow the troubleshooting and repair of aircraft line-replaceable units. However, because facilities were limited and there were personnel restrictions at a number of deployed locations in the Persian Gulf, some deploying Tactical Air Command squadrons did not deploy their intermediate-level engine maintenance capability. As a means of providing intermediate maintenance support, the Air Force employed an operation referred to as "Queen Bee" to provide comprehensive engine repair support.

The Queen Bee operation for Operation Desert Shield/Desert Storm was started in October 1990. Existing maintenance facilities in Europe were augmented with equipment and personnel to provide the intermediate-level repair of engines for the squadrons in the Persian Gulf that did not have this capability. Deployed squadrons removed engines requiring maintenance, replaced them with spare engines, and airlifted the faulty engine components to Queen Bee locations. According to Air Force officials, the Queen Bee operation resulted in an increase in the time it took to return engines to service. To compensate for the longer repair times, deployed squadrons required additional spare engines. For example, an additional 34 engines were required to support the Queen Bee operation for five deployed F-16 squadrons.

In addition to providing specialized intermediate maintenance capability, the Air Force also accelerated its depot repair production capabilities. Between August 2, 1990, and February 20 1991, Air Force depot maintenance centers accelerated the repair of engines and 65,024 parts for the different aircraft in support of Operation Desert Shield/Desert Storm. For example, maintenance for 265 F-15C and F-15E aircraft components was identified as needing to be accelerated. As of February 1, 1991, the five Air Logistics Centers were able to accelerate the repair of approximately 80 percent of the 265 required items.

In some cases, Air Force depots were not able to meet accelerated maintenance requirements because of a shortage of parts. The F-15E multipurpose display processor, which displays radar and targeting data, was one example of an item for which the accelerated requirement could not be met for this reason. The Air Force requirement was to accelerate the repair of 17 units for the first phase of Operation Desert Shield. As of February 1, 1991, only 12 of the 17 processors had been supplied because of a shortage of parts to repair the processors. Air Force officials noted that repair parts shortages were grounding F-15E aircraft longer than other F-15 models because the F-15E aircraft was in the early phases of fielding and adequate numbers of repair parts had not yet been provided.

In addition to increasing the depot repair of some aircraft parts, Air Force Logistics Centers were also asked to accelerate the repair of certain aircraft that had been programmed for depot maintenance activities. For example, of the 26 C-141s in programmed depot maintenance at the Warner Robins Air Logistics Center between August 17, 1990, and January 24, 1991, 17 were put on accelerated schedules. That is, the dates the aircraft maintenance was forecasted to be completed were

moved up. Of the 17 aircraft, maintenance for 8 was completed on or ahead of the accelerated schedules, and maintenance for 7 was completed before the originally scheduled dates. In addition, maintenance for four other aircraft was completed ahead of schedule, even though the scheduled completion dates had not been officially accelerated.

Warner Robins officials told us that they had been able to accelerate the programmed depot maintenance by working overtime. The total overtime cost for these actions during the first and second airlift surges was about $2.1 million.

Increasing Visibility and Expediting the Requisitioning of Repair Parts

The Navy initiated actions to improve its visibility of spare parts, and the Air Force took action to enhance its spare parts requisitioning process. The two services viewed these actions as necessary to improve their supply system responsiveness to the critical requirements of the deployed forces. The Army also had critical requirements to respond to, and it handled these needs by making adjustments to its existing systems rather than by developing new ones.

In January 1991, the Fleet Maintenance Office developed an automated system that provided visibility over consumable inventories at the inventory control points. This system enabled the Naval Aviation Supply Office to match back orders to the retail inventories and fill over 4,000 back orders.

The Air Force found that its normal process for requisitioning repair parts was not timely enough to meet the wartime demands. Air Force units in the area of responsibility initially had to rely on the Combat Supply System to link deployed units to their individual home stations. The system tracked the status of supplies in order to replenish needed war readiness spare kit items and other high priority mission support items such as follow-on spares kits. Because the Combat Supply System was not an on-line computer system, consumption data from Desert Shield operations had to be loaded onto computer disks and mailed back to units' home stations before supplies could be replenished. This means of requisitioning needed items was not effective or timely, and home stations were not getting timely information on the status of supplies from the deployed units.

To remedy the situation, the Tactical Air Command, in conjunction with other major commands, developed and implemented the Central Air Force Command Supply Support Activity (CSSA) in November 1990 at

Langley Air Force Base to support all deployed units. The CSSA provided one accounting and supply system for all the U.S. Air Force assigned to Operation Desert Shield/Desert Storm. CSSA served as the focal point for receiving high priority supply requests, locating and ordering supplies, tracking their delivery status to the requester, and tracking operation and maintenance funds. It also tracked all receipts and issues for fuel transactions.

To implement CSSA, computer terminals at sites in the area of responsibility were connected to Langley Air Force Base via satellite and leased commercial lines. At Langley Air Force Base, about 100 personnel monitored the receipt of requisitions from the deployed units and initiated transactions to locate the needed parts. As a result of the CSSA, requesters could communicate their requisitions to one centralized location, and responses to supply requests were improved. According to Air Force officials, requisitions for war readiness spare kit items were routinely filled in 6 to 7 days, versus 16 days with the Combat Supply System. Requisitions for items required to maintain a high level of mission capability were filled in 2 to 3 days, versus 5 days under the prior system. Air Force officials also told us that CSSA appeared to be the preferred contingency support concept of the future, and plans were underway to integrate it into the contingency planning process.

The Air Force also identified a need to have visibility of Desert Shield materials in the logistics pipeline. It needed the ability to portray both supply and transportation status with one query on a single screen. In response to this need, an Air Force Logistics team developed the prototype Air Force Logistics Information File system during December 1990. By January 1991, the system was being used to track parts bound for the Persian Gulf. Using a computer keyboard, the requester could find out what depot had shipped the part, the date it had been shipped, what container it had been shipped in, and the location of the container.

Transferring Equipment and Parts From Other Theaters

This initiative involved the Army and the Air Force. The Army moved over 800 M-1A1 tanks and over 600 Bradleys from prepositioned locations in Europe to the Persian Gulf in order to upgrade the armored vehicles of units that had deployed from the United States. The displaced tanks from units that received the more modern and capable M-1A1s were retained in theater as war reserve materiel.

In addition, large numbers of spare and repair parts from prepositioned and war reserve stocks and from units located in Germany were transferred to the Persian Gulf to fill existing shortages. In fact, the transfers reached such a proportion that when the units in Germany, from which the parts had been taken, were themselves transferred to the Persian Gulf, many had significant parts shortages. These shortages, in turn, had to be compensated for by other initiatives previously described.

The Air Force deployed 48 percent of its combat units in Europe to the Persian Gulf.[2] When these units were tasked to deploy to the Persian Gulf, a high priority mission support kit had to be built to provide 30 days of spare parts. Needed parts were obtained from non-deploying units in Europe and the United States. In addition, prior to Desert Shield, the Air Force had prepositioned in the Persian Gulf about 30 percent of its base equipment needs. These items included shelters, tents, aircraft hangars, power generator/distribution equipment, kitchens, vehicles, and airfield support equipment. In addition, the Air Force had munitions and supplies prepositioned on three ships in the Mediterranean Sea and the Indian Ocean.

Establishing In-Theater Supply Depots

To reduce the time required to fill theater requisitions, the Army established mini-depots in the theater of operation. The Aviation Systems Command and the Tank-Automotive Command positioned a limited quantity of aircraft and track vehicle repair parts at these depots. The Army's goal was to initially have 30 days of stock on hand at the depots for selected items. As this objective was achieved, the Army intended to increase the goal to 60 days, then 90 days.

By mid-February 1991, the Aviation Systems Command had 107 lines of intensively managed aviation items, with a total quantity of about 3,600 items on hand or en route to the theater depots. In addition, it had 798 lines of non-intensively managed aviation items, with a quantity of about 108,000 items on hand or en route to the depots. In both cases, the on-hand quantities represented at least a 30-day stock level.

[2]According to Air Force officials, war plans called for units in Europe to fight from their home bases. Therefore, the units did not have war readiness spare kits.

Institutionalizing the Logistics Initiatives

Some of the logistics initiatives the services undertook during the Persian Gulf war would be appropriate only in a crisis because of the added expense of implementing them. Others, however, could be institutionalized as routine logistics functions. For example, expediting the delivery of critically needed items, expediting deliveries under existing contracts, reducing production lead time, and increasing the visibility of repair parts inventories at the wholesale and retail levels all have the effect of reducing investment in inventories without adversely affecting operational capability. While the services do undertake some of these initiatives normally, the Persian Gulf conflict caused the services to intensify their use.

Service officials told us that after-action reports will likely identify other Desert Shield/Desert Storm logistics initiatives that will be incorporated into day-to-day logistics management. In another case, an Army general officer told us that, in his opinion, the current conflict had forced the services to be innovative and resourceful and that the services should apply the lessons learned from Operation Desert Shield/Desert Storm. He concluded by saying that the services would no longer be able to do business as usual and that it would be necessary to review the logistics measures that have been used to determine which ones could be incorporated into the logistics support structure.

Sustainability of Weapon Systems in a Protracted Conflict

Sustainability of deployed weapon systems in a protracted conflict could be the weakest link in the logistics chain. Army officials have identified shortages of spare and repair parts as a major impediment to sustained combat operations. Before the Persian Gulf conflict, these officials projected that combat in the Persian Gulf would require a three to fivefold increase in the usage of spare and repair parts over normal usage rates. They expected these increases because of the increased operating rates and the environmental complications involved in operating in a desert environment.

The Navy/Marine Corps and the Air Force did not experience any systemic problems with logistics sustainability, because these services generally believed that they had sufficient stocks of spare and repair parts in inventory and sufficient deployed repair capability to sustain their forces for an extended period. Nevertheless, they continued to monitor certain key items to make sure that sustainability problems did not develop and that an uninterrupted supply of these parts continued.

Army Systems

The Tank-Automotive Command projected a threefold increase in the usage rate of spare and repair parts over peacetime rates, and the Aviation Systems Command projected a fivefold increase. To compensate for the increased rates, the Commands, in conjunction with commanders in the Persian Gulf, identified what they considered to be items critical to the aviation and ground systems. The officials then reviewed the on-hand and due-in supply status of these items and estimated what additional stocks would be needed for different operating tempos.

As shown in table 4.1, the percentage of critical items with less than 30, 60, or 90 days of inventory ranged from 5 to 49 percent for Army aviation systems, depending on various operating tempos.

Table 4.1: Percentages of Critical Items With Less Than 30, 60, and 90 Days of On-Hand Stock

Numbers in percentages

	Days of stock on hand											
	AH-64			CH-47			OH-58			UH-60		
Operating tempo (hours)	30	60	90	30	60	90	30	60	90	30	60	90
Base[a]	14	24	29	6	13	15	14	28	33	5	20	25
50	17	27	31	8	14	17	16	30	35	7	22	27
75	23	31	39	14	17	20	28	35	44	16	27	34
100	27	36	41	14	20	24	30	42	47	22	32	41
120	30	39	44	16	20	26	30	44	49	23	36	46

[a]The base rate is 38.25 hours for the AH-64, 35.75 hours for the CH-47, 45.50 hours for the OH-58, and 45.25 hours for the UH-60.

For the M-1A1 and M-60 tanks and the Bradley Fighting Vehicles, the percentage of critical items with less than 30 days of inventory was 64 percent; the percentage for critical items with less than 60 and 90 days of inventory was 71 percent.

The Commands, in an attempt to rectify shortages of critical items, undertook many of the logistics initiatives discussed in chapter 3. For instance, they increased repair capabilities and expedited contract awards and deliveries under existing contracts. In some cases, these actions helped to improve the status of the critical items inventory. In other cases, these actions would not have improved the inventory situation until after the on-hand inventory had been exhausted. For instance, on January 26, 1991, the Tank-Automotive Command had no Bradley 500-horsepower engines on hand and had back orders for 107 engines, including 53 for Operation Desert Storm. The Command estimated that it would need 50 engines a month to meet Operation Desert Storm requirements. On the basis of the Command's estimate of the number of engines it could expect to receive from repair facilities, it projected that demands could not be met until sometime in April 1991.

Navy and Marine Corps Systems

Navy and Marine Corps officials were generally satisfied that, even though demand for reparable and consumable items had increased 5 to 10 percent over normal usage because of the increased number of deployed forces, they had sufficient inventories on hand to sustain the deployed systems. Weapon system managers at the Naval Aviation Supply Office, however, had developed lists of high demand items of concern, which they closely monitored to ensure a continued supply for Operations Desert Shield and Storm.

Navy officials told us that carrier-based aircraft had deployed with 90 days of stock and that normal replenishment could maintain that level of supply for an extended period. In addition, deployed naval forces maintain full intermediate repair capability, which enhances sustainability and reduces its resupply requirement. Marine Corps land-based aviation squadrons deployed with as much as 120 days of stock, and tank battalions deployed with as much as 200 days. Both types of units were replenished as needed.

Air Force Systems

According to Air Force officials, the Air Force did not anticipate spare parts shortages during Operations Desert Shield and Storm because, prior to the initiation of combat operations, the Air Force had prepositioned approximately 60 days of spare and repair parts in the theater. Additionally, intermediate-level maintenance capability in the theater or in the European-based Queen Bee operations as well as the various dedicated express airlift operations contributed significantly to parts availability in theater. Despite the overall general availability of required parts, the Air Force did have parts that caused problems, and some of these problems could have been more difficult to overcome if the period of combat operations had been sustained for a much longer period.

Problems Associated With Operating Weapon Systems in a Desert Environment

The Army, the Marine Corps, and the Air Force experienced problems with operating aircraft in a desert environment due to the intense heat, high humidity, and blowing sand. The services had known about many of the problems for years. Operational difficulties with the aircraft were brought to light in a report prepared for the Army on the lessons learned from Operation Bright Star—a joint exercise conducted in 1981 in a desert environment involving U.S. and other allied forces. The report focused on 46 problems involving the five Army aircraft shown in table 5.1.

Table 5.1: Aircraft and Numbers of Problems Identified During Operation Bright Star in 1981

Aircraft	Number of problems
AH-1	9
CH-47	7
OH-58	6
UH-1	5
UH-60	8
All above aircraft	11
Total	**46**

The Army developed product improvement programs (PIP) to deal with 25 of these problems. For the remaining 21, the Army either determined that the problem could be resolved without developing a PIP or the problem applied to more than one type of aircraft in which case the problem would be addressed by the PIP for that aircraft.

The specific problems that led to the Army's development of PIPs are as follows:

- difficulty in distinguishing distance and altitude in a desert environment,
- difficulty in communicating during nap-of-the-earth flights,
- sand erosion of main and tail rotor blades,
- infiltration of sand into the aircraft and its components,
- difficulty in using night vision goggles in a desert environment,
- sand abrasion of windshields,
- sand erosion of engine compressor blades,
- difficulty navigating in a desert environment due to sameness of terrain, and
- sand ingestion in auxiliary power units.

The problems identified in 1981, and shown above, are the same type of problems the the Army, the Marine Corps, and the Air Force experienced during the early phases of Operation Desert Shield: for example, problems with the sand erosion of rotor blades, sand ingestion in engines and auxiliary power units, and sand abrasion of windshields.

Because of the similarity of the 1981 problems to the services' current experiences in Operation Desert Shield, we discussed these issues with officials and reviewed various studies and reports to determine exactly what had been done to correct the problems. Our analysis of the actions taken to resolve the 1981 problems showed that the PIPs for 3 of the problems had been completed; work was continuing on 6 others; and work on 15 others had been canceled. We were not able to determine the disposition of the remaining PIP. The following are examples of the types of problems for which the PIPs were canceled:

- One of the problems encountered during Operation Desert Shield had to do with sand ingestion in the auxiliary power unit on the UH-60. The 1981 PIP to resolve this problem was never implemented because "there was no user requirement for a UH-60 inlet particle separator."
- Another problem had to do with sand erosion of main rotor blades. The PIP to address this problem was also never implemented because "there was a plan to develop a special purpose kit to protect the blades."

In both of these examples, the problems had not been addressed or resolved at the initiation of Operation Desert Shield, and expedited corrective actions had to be developed. In the case of the inlet particle separators for the auxiliary power unit, the problem was still unresolved at the conclusion of Operation Desert Storm. To alleviate the blade erosion problem, a kit was developed and implemented after the initiation of Operation Desert Shield.

Army officials told us that, although many of the problems were known prior to Operation Desert Shield, actions had not always been taken to correct them because of other, higher priorities. The officials went on to say that at the time of the Bright Star exercise, the funding focus of the military was on the European scenario and that, as a result, funds were often not available to resolve the desert operating problems. Therefore, when the problems resurfaced during Operation Desert Shield, corrective actions had to be found.

In certain cases, such as the sand erosion of rotor blades and sand abrasion of windshields, the Army was able to correct the problems before

the outbreak of hostilities. However, in other cases, such as sand ingestion in the aircraft engines and auxiliary power units, corrective actions had not been completed before hostilities began, and to do so would have required the aircraft to be taken out of service for an extended period.

Marine Corps officials told us that they had not been prepared for the severity of the problems caused by operating helicopters in a desert environment. Their previous desert exercise experiences had been limited primarily to amphibious operations, and the use of helicopters in the exercises was of such short duration that many of the recently experienced problems did not develop.

Marine Corps officials also told us that to counteract the desert operating problems, they had to develop a number of corrective actions such as

- taping rotor blades to reduce sand erosion;
- washing exposed parts and components frequently;
- altering flying tactics by flying above 500 feet and landing on hard surfaces whenever possible;
- increasing the frequency of inspections and preventive maintenance; and
- expanding intermediate repair facilities in Rota, Spain, and Sigonella, Italy, to repair helicopter engines whose engine lives had been reduced from 1,200 to about 300 hours.

According to Air Force officials, the Air Force experienced similar operating problems with its helicopters due to the severe desert environment. They added, however, that the impact on Air Force helicopter operations might have been less adverse than it was on the other services because the Air Force operated from hard surfaces.

According to Air Force officials, their fixed-wing operations were not significantly impeded by the desert environment. An Air Force Logistics Command official also told us that continuous actions had been taken to monitor, prevent, and/or eliminate problems that could have caused some degradation in operations. The official further stated that it could be too soon to assess the total impact of desert operations on Air Force equipment and parts, because much of the equipment had not yet returned from the Persian Gulf.

The following two examples illustrate the early problems experienced as a result of the desert environment:

- During the first 2 months of Desert Shield, sand was scratching and pitting the forward-looking infrared window glass of the Low Altitude Navigation Targeting Infrared for Night (LANTIRN) system on the F-15E and F-16C/D aircraft. The abrasion of the LANTIRN windows seriously reduced the operational capability of the two fighter aircraft to seek out and destroy targets at night. In September 1990, the LANTIRN program office, working with the Tactical Air Command and the Warner Robins Air Logistics Center, began examining ways to resolve the problem, such as removing and polishing the windows or coating the windows with carbon. Polishing proved unsatisfactory; however, carbon coating appeared to be a promising solution. In December 1990, the LANTIRN program office sent two carbon-coated windows to the Persian Gulf for testing. Subsequently, 50 coated windows were purchased for testing. Thirty-five were scheduled to be sent to the Persian Gulf for additional testing, and the remaining 15 were scheduled to be sent to Luke Air Force Base, Arizona, for more formal testing and analysis. Twenty windows were sent to the Persian Gulf and installed in February 1991. This provided the aircraft with the ability to attack and destroy targets at night during Desert Storm air operations.
- The C-141 encountered problems with landing struts that might have been caused by the desert environment. Air Force Logistics Command officials told us that the number of landing gear struts being used by the C-141s during Desert Shield increased to the point that the entire supply at the Warner Robins Air Logistics Center was used up in November and December. Mechanics in the field attributed the problem to the fine sand, which adhered to the hydraulic fluid on the struts and ruined the seals. Engineers at the Air Logistics Center designed a strut cover made of a material that would keep sand and dirt out. The covers were tested at the Center, and a preliminary hazard analysis was conducted to make certain the strut covers could not cause an airplane to malfunction. The war ended before the strut covers could be deployed to the Persian Gulf and installed on the aircraft.

Comments From the Department of Defense

THE ASSISTANT SECRETARY OF DEFENSE

WASHINGTON, DC 20301-8000

PRODUCTION AND LOGISTICS

JUL 3 1991

(L/MD)

Mr. Frank C. Conahan:
Assistant Comptroller General
National Security and International
Affairs Division
U.S. General Accounting Office
Washington, DC 20548

Dear Mr. Conahan:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report entitled--"OPERATION DESERT STORM: Logistics Support For Selected Weapon Systems," dated May 13, 1991 (GAO Code 393437/OSD Case 8669).

The Department has reviewed the report and has provided verbal comments. The Department concurs with draft now that the verbal comments are incorporated in the report. Thank you for providing an opportunity to review the report in draft form.

Sincerely,

COLIN MCMILLAN
ASSISTANT SECRETARY OF DEFENSE
(PRODUCTION & LOGISTICS)

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