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

March 1987

MILITARY AIRLIFT

Air Force Analysis Supports Acquisition of C-17 Aircraft

GAO/NSIAD-87-97

GAO

United States
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National Security and
International Affairs Division

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March 20, 1987

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

Dear Mr. Chairman:

This report responds to your request that we evaluate the Air Force's analysis leading to its decision to develop and produce the C-17 aircraft, rather than buy additional C-5 aircraft, to reach its long-range airlift goal. The report discusses airlift requirements and capabilities, the alternatives considered to alleviate the airlift shortfall, the criteria and assumptions used by the Air Force to evaluate the alternatives, and our evaluation of the Air Force's analysis.

As requested, we plan no further distribution of this report until 30 days from its issue date, unless you release its contents earlier. At that time, we will send copies to the Chairmen, House and Senate Committees on Appropriations; the Chairman, Senate Committee on Armed Services; the Director, Office of Management and Budget; the Secretaries of Defense, the Army, and the Air Force; and other interested parties.

Sincerely yours,

Frank C Conahan

Frank C. Conahan
Assistant Comptroller General

Executive Summary

Purpose

To provide additional long-range airlift, the Air Force is developing and plans to buy 210 C-17 aircraft at a cost of about $26 billion (in fiscal year 1986 dollars). Since this acquisition was proposed, there has been much debate about the validity of the Air Force's analysis, which shows the C-17 to be the most cost effective way for the Air Force to meet its airlift requirements.

The Chairman, House Committee on Armed Services, asked GAO to review the Air Force's analysis leading to the decision to buy the C-17 aircraft.

Background

In 1981, the Department of Defense (DOD) identified a need for additional long-range airlift capability. A fiscally constrained goal of being able to airlift 66 million ton-miles per day (MTM/day) was established. At that time, the Air Force's long-range airlift capability was about 29 MTM/day.

To increase its airlift capability, the Air Force took a number of steps in 1983, including buying 50 C-5 and 44 KC-10 aircraft. When these steps are completed around 1989, the Air Force expects to have a long-range airlift capability of about 49 MTM/day.

In 1983, the Air Force also analyzed alternatives to further increase its long-range airlift capability to reach the 66 MTM/day goal. The alternatives involved buying either additional C-5s or the C-17 aircraft. The Air Force concluded that the C-17, which is still in the research and development stage, was the more cost effective. The Air Force based its decision not only on the life-cycle costs of the alternatives, but also on how well each alternative met mission requirements and affected manpower levels, force stabilization, and force modernization.

The Air Force has continued research and development on the C-17 and, through fiscal year 1986, has obligated almost $600 million for the program.

The Air Force received an initial $50 million to produce the C-17 in fiscal year 1987, and over the next 5 years, plans to request about $14 billion to develop and buy it.

Results in Brief

Assuming the C-17 comes close to meeting its cost and performance objectives and is used for routine direct delivery in wartime, it should

provide overall advantages to the Air Force over the C-5, including lower life-cycle costs.

However, to reach the established airlift goal, total acquisition and life-cycle costs will likely exceed the amounts estimated by the Air Force, regardless of whether it adopts the C-5 or the C-17 alternative.

Principal Findings

Life-Cycle Costs

Higher C-17 acquisition costs could be more than offset by lower operating and support costs, resulting in lower C-17 life-cycle costs over the C-5 alternative. The C-17 is expected to be more fuel efficient than the C-5 and to require significantly less maintenance. Warranty provisions in the C-17 development contract could help to ensure that the C-17 will achieve projected reliability and maintainability requirements. However, most of the C-17's life-cycle cost advantage results from its expected capability to routinely direct deliver to forward operating locations and perform some intratheater shuttle missions. With that capability, some older C-130s to be retired would not have to be replaced under the C-17 alternative as they would under the C-5 alternative.

Military Utility

The C-17 offers the potential to provide greater military utility than the C-5. While the C-5 is a very capable aircraft, it cannot match the C-17's expected capability to land and operate at a wider range of airfields closer to the battle area. This flexibility could reduce the time it takes to position forces to meet wartime needs. The Air Force says it will routinely use the C-17 for direct deliveries, including deliveries to potentially hostile areas. This use is key to achieving the full potential benefits from the C-17.

Personnel Requirements

The C-17 alternative could require about 12,900 fewer personnel than the C-5 alternative. About 60 percent of the estimated personnel savings would result from not replacing some older C-130s as they are retired. The remainder is expected to result from lower C-17 maintenance requirements.

Increases in Capability

Because the C-5 is now being produced and the first C-17 is not planned for delivery until 1990, the C-5 alternative could allow the Air Force to increase its airlift capability more quickly. However, in its analysis, the Air Force has programmed a higher peak production rate for the C-17 as compared to the C-5 so that both would reach the 66 MTM/day goal at about the same time. With similar production rates, the C-5 alternative would reach the 66 MTM/day goal about 5 years earlier than the C-17 alternative.

Cost Estimates

To reach the 66 MTM/day goal, the life-cycle cost of either the C-17 or the C-5 alternative will likely exceed the Air Force's estimates. This underestimation is due to optimistic assumptions concerning the wartime utilization rates for both aircraft. If it continues with the C-17 program, the Air Force, in addition to the 210 C-17s it plans to buy, may need to buy 29 more at a cost of about $2.3 billion (in fiscal year 1986 dollars). If it selects the C-5 alternative, the Air Force may need to buy 46 more C-5s than the 181 currently projected, at an additional cost of about $3.6 billion (in fiscal year 1986 dollars).

Agency Comments and GAO's Evaluation

In its comments on a draft of GAO's report, DOD agreed with most of GAO's analyses and conclusions (see app. I). However, DOD disagreed with some of GAO's adjustments to the Air Force's life-cycle cost analysis as well as GAO's conclusion that the C-17 wartime utilization rate may be too high. After further discussion with DOD, GAO modified its life-cycle cost adjustment on the number of C-130s to be retired and replaced under the C-5 alternative. However, GAO continues to believe that (1) its other life-cycle cost adjustments are valid and (2) the C-17 surge utilization rate may be too high.

Contractor Comments and GAO's Evaluation

A draft of this report was provided to the Lockheed Corporation and the McDonnell Douglas Corporation for their review and comment.

In its comments, Lockheed stated that it believes the number of aircraft to be acquired under the C-5 alternative could be reduced because the C-5's average payload has been understated by the Air Force. That, coupled with its belief that the operating and support costs for the C-5 have been overstated by the Air Force, would result in a significantly lower life-cycle cost for the C-5 alternative. In addition, Lockheed believes that the operational utility given to direct delivery by the Air Force is overstated.

These issues were carefully evaluated during GAO's review and are discussed in its report. However, GAO continues to believe that (1) the direct delivery concept could be militarily significant, (2) the C-5's average payload has been only slightly understated and would not significantly affect the number of C-5s to be acquired, and (3) the C-17 alternative should provide lower life-cycle costs over the C-5 alternative.

McDonnell Douglas agreed with the conclusions contained in GAO's draft report.

Contents

Abbreviations

CMMS	Congressionally Mandated Mobility Study
CRAF	Civil Reserve Aircraft Fleet
DOD	Department of Defense
GAO	General Accounting Office
JCS	Joint Chiefs of Staff
MAC	Military Airlift Command
MMH per FH	maintenance manhours per flying hour
MTM/day	million ton-miles per day

Introduction

To achieve national security objectives, the Department of Defense (DOD) has developed a military strategy based on a mix of forces stationed in the United States and overseas. The strategy depends on having the capability to rapidly deploy and sustain U.S. forces on a worldwide basis. The ability to move forces with sufficient equipment and supplies to distant locations may make military action by opposing forces less likely and, should deterrence fail, may decrease the force size needed for victory. A balanced mobility program, consisting of airlift, sealift, and pre-positioning, is considered essential for this purpose.

Airlift is fast and flexible and may be the only viable option when land or sea access is limited, forces are required deep inland, or timeliness is vital. However, it has a limited capacity and, for most force deployment, is airfield dependent. Sealift has a greater capacity and some flexibility, but is slow and seaport dependent. Pre-positioning reduces overall long-range movement requirements, but it has limited flexibility and may be more vulnerable.

The Air Force's Military Airlift Command (MAC) is responsible for airlift within DOD. MAC's peacetime mission is to maintain an airlift system in a constant state of readiness to provide air mobility to U.S. forces, military assistance programs, and disaster relief operations. In wartime, MAC provides airlift resources on a global basis to deploy combat forces and their equipment and to resupply those forces once in place. MAC is also charged with coordinating and developing airlift doctrine, strategy, and operational plans under the direction of the Joint Chiefs of Staff (JCS).

The Air Force airlift system includes the active-duty Air Force, U.S. Air Force Reserve, Air National Guard, and the Civil Reserve Air Fleet (CRAF). MAC operates C-5, C-141, KC-10, and C-130 aircraft in the United States, Europe, and the Far East. Air Force Reserve and National Guard forces also operate C-5, C-141, and C-130 aircraft. The CRAF program is made up of U.S. air carriers who voluntarily commit to provide aircraft, crews, support personnel and equipment, and facilities to MAC under specified emergency conditions.[1]

Types of Aircraft

Airlift is normally classified as either intertheater (from one theater of operation to another) or intratheater (operations within a theater).

[1]For more information on the CRAF program, see Emergency Airlift: Responsiveness of the Civil Reserve Air Fleet Can Be Improved, GAO/NSIAD-86-47, Mar. 24, 1986.

Intertheater airlift is generally between main operating bases and is usually transoceanic. Currently, intertheater airlift operations would be conducted by C-5, C-141, KC-10, and CRAF aircraft. After troops and equipment arrive in the theater via airlift, sealift, or pre-positioning, surface transportation or intratheater airlift—currently C-130 aircraft—transport them between main operating bases or seaports and forward operating locations. Intratheater airlift, under the control of the theater commander, also provides for, among other things, movement within the forward areas and for evacuation of casualties.

Intertheater Airlift Requirements

To determine the mix of airlift, sealift, and pre-positioning that would provide an acceptable U.S. response to military contingencies in the 1990s, the Defense Authorization Act of 1981 required DOD to better define overall U.S. mobility requirements. The resulting study published in April 1981, entitled the Congressionally Mandated Mobility Study (CMMS), and prepared by the services, the JCS, and DOD compared existing and planned increases in airlift capabilities with the projected needs in different conflict situations. The study concluded that DOD needed an intertheater airlift capability of 66 million ton-miles per day (MTM/day). This capability was considered a minimum goal, constrained by fiscal pressures; it did not fully satisfy the projected requirements of any of the conflict situations that were studied.

MTM/day, the measure of capability commonly used for long-range airlift, is a function of an aircraft's speed, utilization rate, and payload and a standard productivity factor. The goal of airlift, however, is to deliver combat troops and equipment as close to their final destination as possible, while maintaining unit integrity. In light of this goal, the CMMS concluded that DOD's intertheater airlift capability was lacking not only in quantity, but also in quality. For example, little or no intertheater airlift capability existed to deliver military cargo and personnel to small airfields, which are more likely to be closer to the final destinations. Further, neither existing intertheater nor intratheater aircraft could routinely deliver outsize cargo, such as tanks and helicopters, to smaller forward operating airfields. Therefore, as will be discussed later, an aircraft's MTM/day capability was only one of several considerations in the Air Force's analysis of alternative airlift force structures.

Intratheater Airlift Requirements

After arriving in a theater by airlift and/or sealift, equipment and troops often must be reshipped by intratheater transportation, such as aircraft, rail, or truck, to a location where they can be organized into

fighting units. Similarly, pre-positioned materials may have to be transported within the theater to where they are needed. In some scenarios, such as in a Southwest Asian conflict, the primary intratheater movement would be by airlift.

DOD considers the current inventory of C-130s to be inadequate to support its intratheater deployment and resupply requirements. DOD's analyses also show that the requirement to transfer cargo from intertheater to intratheater aircraft causes main operating base saturation, which delays delivery to the users.

Until now, the need for more intratheater airlift has been well documented, but not well quantified. Since 1983, DOD has been attempting to quantify the total intratheater mobility requirement. However, that effort, entitled the Worldwide Intratheater Mobility Study, is not expected to be completed until mid-1987. Upon completion of this study, DOD plans to update its intratheater mobility plans.

Matching Intertheater Airlift Capabilities to Requirements

Following the CMMS, the Air Force began to analyze how best to increase its intertheater airlift capability to meet the 66 MTM/day goal. That effort, culminating in the publication of the Airlift Master Plan in 1983, included an assessment of DOD's existing and projected airlift capabilities.

DOD's airlift capabilities include contributions from both the military airlift fleet and CRAF. As shown in table 1.1, the Air Force computed the total intertheater airlift capability available in fiscal year 1983 as 28.7 MTM/day, or 37.3 MTM/day short of the 66 MTM/day goal. Intertheater airlift aircraft included 234 operational C-141s designed to carry bulk (military pallets) and oversize (non-palletized) cargo and 70 operational C-5As designed to carry all types of cargo, including outsize (cargo that exceeds the capabilities of the C-141). The C-141 and C-5 capabilities, however, were considered to be less than optimal because of shortages of spare parts and crews. In addition, none of the CRAF aircraft were capable of carrying outsize cargo.

The need for additional intertheater airlift prompted a number of immediate actions. In addition to providing additional spare parts and crews to increase the capabilities of the existing C-141s and C-5s, the Air Force bought 50 C-5B (44 operational and 6 trainers/backups) and 44 KC-10 aircraft (41 operational and 3 trainers/backups). The acquisition of 16

additional KC-10s was in process at that time. The Air Force also initiated a CRAF enhancement program to increase its capability. These initiatives are expected to be completed in fiscal year 1989 at a cost of over $10 billion. However, because of changes taking place within the airline industry, the Air Force projected that the existing CRAF capability would decline—nearly offsetting the effect of the CRAF enhancement program. Nevertheless, the Air Force projected that these actions, when completed in fiscal year 1989, would increase its airlift capability to 48.5 MTM/day, 17.5 MTM/day short of its 66 MTM/day goal.

Starting in the late 1990s, the Air Force plans to retire 54 C-141s. To prolong the service lives of the remaining C-141s, the Air Force plans to reduce the aircraft's use. (The Air Force rationale for these actions is discussed on p. 36.) The net result of these proposed actions was projected to be a loss of 9.5 MTM/day in airlift capability by fiscal year 1998. Combined with the 17.5 MTM/day shortfall discussed above, the total intertheater shortfall was projected to be 27 MTM/day by fiscal year 1998.

Table 1.1: Actual and Projected Intertheater Airlift Capabilities and Shortfalls

Figures in MTM/day

	Fiscal year		
Aircraft type	1983 (Actual)[a]	1989 (Projected)[a]	1998 (Projected)[a]
C-141	10.9	14.2	4.7[b]
C-5	6.9	18.5	18.5
CRAF	10.9	11.3	11.3
KC-10	0	4.5	4.5
Total	**28.7**	**48.5**	**39.0**
Goal	66.0	66.0	66.0
Shortfall	(37.3)	(17.5)	(27.0)

[a]Reflects a reduction of about 10 percent for airlift withheld for potential use by the Joint Chiefs of Staff

[b]Reflects Air Force proposals to retire some C-141s and reduce use of remaining C-141s

To obtain the 66 MTM/day, the Air Force recommended in its 1983 Airlift Master Plan that the C-17 be developed and produced. The C-17, being developed by the McDonnell Douglas Corporation, is expected to modernize the airlift fleet and improve U.S. capability to rapidly project, reinforce, and sustain combat forces worldwide. It will be a multi-engine turbofan wide-body aircraft capable of airlifting a substantial payload over intercontinental distances without refueling. It will be specifically designed to deliver outsize combat equipment and cargo to small, austere airfields and will be capable of in-flight refueling to increase its range and payload.

Through fiscal year 1986, the Air Force has obligated almost $600 million for research and development on the C-17. The Air Force received an initial $50 million in C-17 procurement funding for fiscal year 1987 as well as $650 million for continuing research and development. For fiscal years 1988 through 1992, the Air Force plans to request about $13.9 billion in additional C-17 program funding—about $2.8 billion for research and development and about $11.1 billion for procurement.

Objectives, Scope, and Methodology

Our review was requested by the Chairman of the House Committee on Armed Services. Our objective was to determine whether the Air Force's analysis and underlying assumptions, which led to the selection of the C-17, were reasonable.

We examined how the Air Force formulated its Airlift Master Plan and identified the specific assumptions used. We assessed the reasonableness of the assumptions that were influential to the decision. We determined if better or more current data were available and evaluated that data's impact on the Air Force's analysis. On a selective basis, we tested the sensitivity of the results of the analysis to various changes in the assumptions.

We did not evaluate the reasonableness of the 66 MTM/day intertheater airlift goal[2] or attempt to define other alternative force structures. Our analysis focused on the Air Force's two major alternative force structures presented in the Airlift Master Plan: the C-5 force structure (option C) and the C-17 force structure (option D).

We conducted our review in accordance with generally accepted government auditing standards from May through December 1986. During our review, we gathered and analyzed data from a wide range of sources and held discussions with officials at the following locations:

- Headquarters, Office of the Secretary of Defense, Washington, D.C.
- Headquarters, Department of the Air Force, Washington, D.C.
- Headquarters, Department of the Army, Washington, D.C.
- Military Airlift Command, Scott Air Force Base, Illinois.
- Air Force Systems Command's Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio.
- Air Force Logistics Command, Wright-Patterson Air Force Base, Ohio.

[2]DOD has a study underway with the goal of revalidating or revising intertheater airlift requirements.

- McDonnell Douglas Corporation, Washington, D.C., and Long Beach, California.
- Lockheed Corporation, Washington, D.C., and Marietta, Georgia.

We also interviewed individuals from the Congressional Budget Office, the Heritage Foundation, and the Institute for Foreign Policy Analysis, who have studied strategic airlift issues.

Alternative Airlift Force Structures Analyzed by the Air Force

In September 1983, the Air Force, responding to the results of the Congressionally Mandated Mobility Study, published its Airlift Master Plan. Developed jointly by MAC and Air Force Headquarters, it represents the Air Force's plan to increase its intertheater airlift capabilities and to modernize its airlift forces. The Secretary of Defense and the Joint Chiefs of Staff subsequently endorsed the Air Force's plan to procure the C-17, which was the preferred alternative identified in the Airlift Master Plan.

Air Force Objectives

The Air Force evaluated alternative ways to meet the intertheater airlift requirements against the following objectives:

1. Minimize life-cycle costs (which include acquisition costs and operating and support costs for 30 years).

2. Achieve intertheater airlift requirement of 66 MTM/day, while not reducing existing intratheater airlift capability.

3. Maximize military utility. Considerations included (a) capability for direct delivery to forward operating locations, (b) ability to operate into small airfields with limited facilities, (c) ease of cargo onloading and offloading, (d) ability to carry all major types of combat equipment, (e) ability to airdrop combat equipment and troops, and (f) ability to be refueled in flight.

4. Consider pressures to reduce manpower costs as well as the diminishing size of the available manpower pool.

5. Achieve force stability and avoid costly site activations and deactivations by maintaining, as much as possible, the then-current airlift force size and unit structure.

6. Modernize the airlift force.

Alternative Force Structures Analyzed

The Air Force evaluated six alternative force structures, which were all equal in terms of their intertheater airlift capability. Alternatives A, C, and E were based on buying additional C-5s, and alternatives B, D, and F on developing and buying the C-17. Table 2.1 shows the changes each alternative would have on the projected fiscal year 1989 airlift force structure.

Table 2.1: Changes to Fiscal Year 1989 Airlift Force Structure Under Airlift Master Plan Alternatives

	Number of operational aircraft[a]						
		Option					
Aircraft type	Fiscal year 1989 force structure	A	B	C	D	E	F
KC-10	57	0	0	0	0	0	0
C-141 (Active)	234	0	0	−234	−234	−234	−234
C-141 (Reserve)	0	0	0	+180	+180	0	0
C-130 (older models)	522	0	0	−180	−180	−180	−180
C-130 (new aircraft)	0	0	0	+180	0	+180	0
C-5	110	+101	0	+156	0	+191	0
C-17	0	0	+115	0	+180	0	+220
	923	**+101**	**+115**	**+102**	**−54**	**−43**	**−194**

[a]Does not include aircraft used for training purposes or aircraft unavailable because of maintenance

Options A and B: Additive Forces

This analysis added airlift aircraft to the number programmed to exist in fiscal year 1989 so as to reach the 66 MTM/day capability. No consideration was given to retiring any of the aging C-141 or C-130 aircraft. Option A involved the acquisition of 101 operational C-5s (see fig. 2.1), and option B involved the acquisition of 115 operational C-17s (see fig. 2.2).

The Air Force rejected both options because, although they met the 66 MTM/day delivery requirement, they did not meet its life-cycle cost, manpower requirements, or force modernization objectives. The Air Force found that both options cost at least $13 billion (fiscal year 1982 dollars) more and required at least 10,000 more personnel than option D—the alternative force structure eventually recommended by the Air Force. In addition, the Air Force concluded that the C-5 alternative (option A) provided no capability to routinely deliver outsize cargo to forward operating locations. Finally, because no C-130s or C-141s were to be retired or have their use curtailed, the Air Force found that neither option would modernize the existing airlift force.

Figure 2.1: C-5B Aircraft

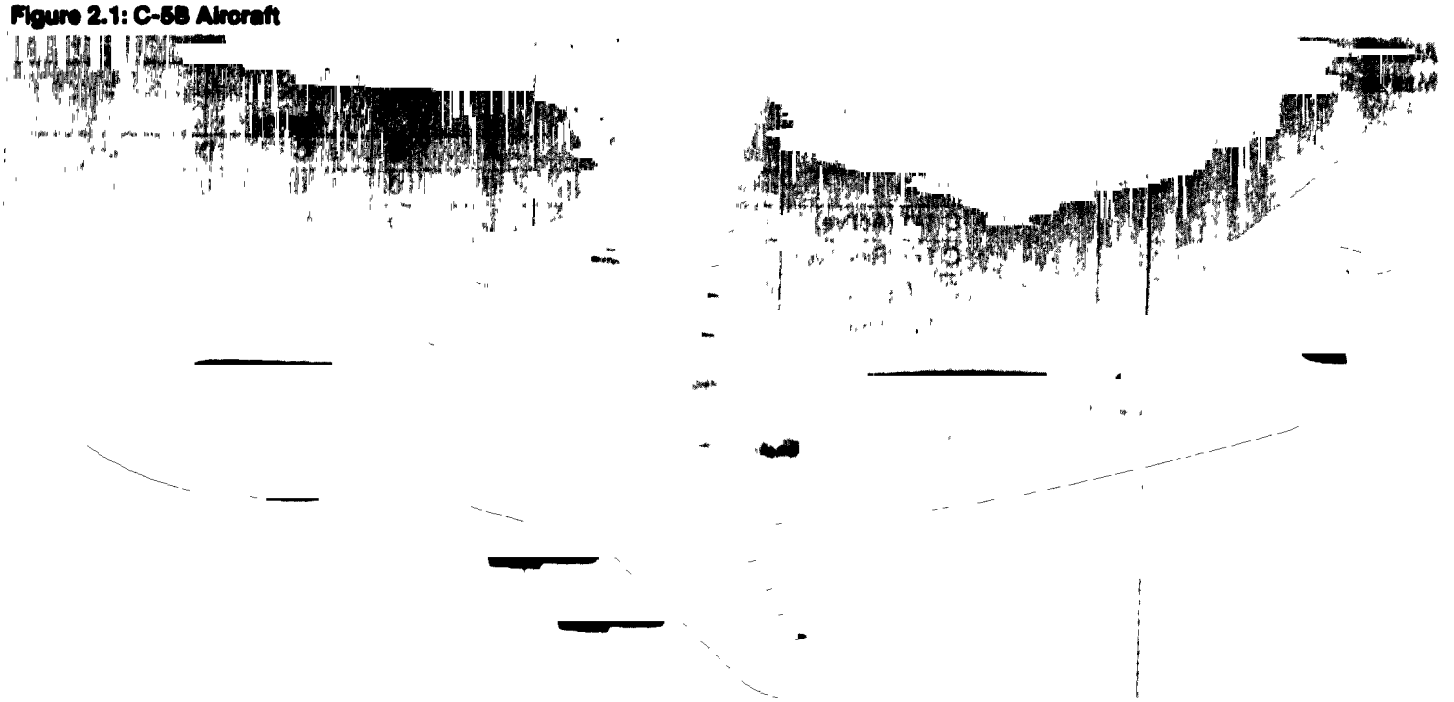
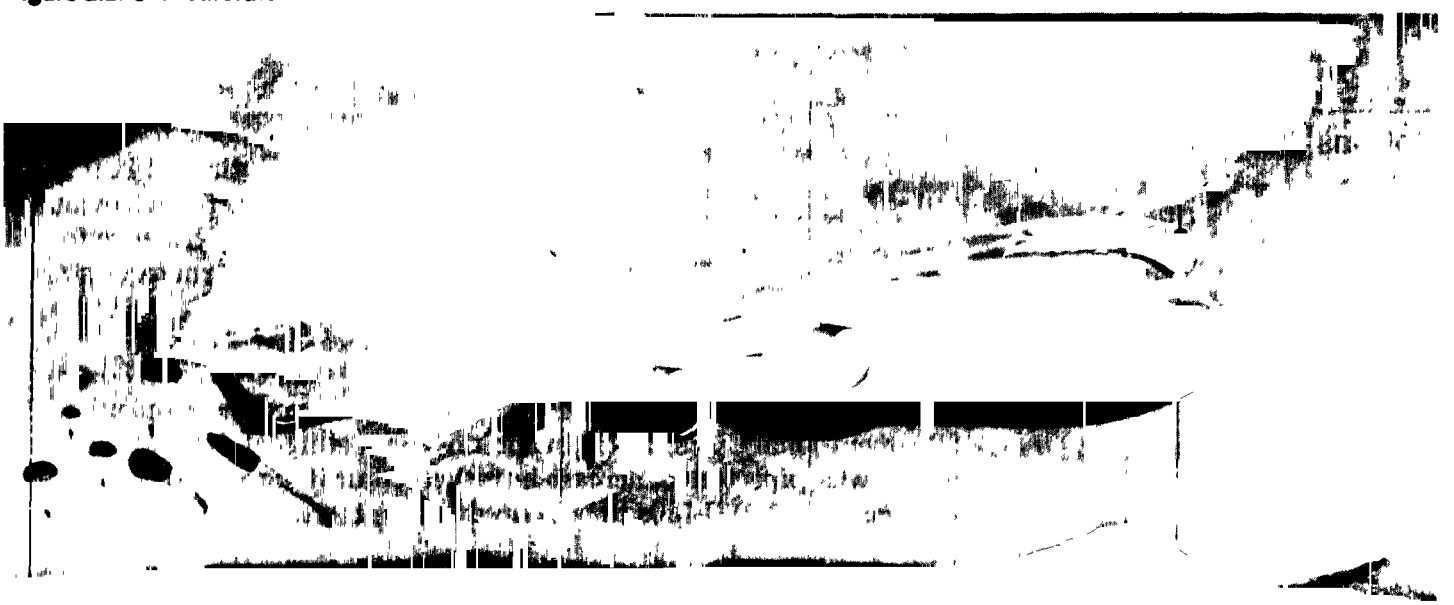


Figure 2.2: C-17 Aircraft



Options C and D: Modernized Forces

This analysis assumed the use of the fiscal year 1989 programmed force, while anticipating the major force structure changes that would need to occur in the 1990s. Both alternatives assumed that 54 C-141s would be retired and the remaining 180 C-141s transferred to the Reserves with fewer crews per aircraft and that 180 C-130s would be retired. Option C involved the acquisition of 156 operational C-5s and 180 new C-130s to replace the C-130s to be retired. Option D involved the acquisition of 180 operational C-17s. In this option, no replacement was projected for the 180 C-130s to be retired as in option C because the C-17 was assumed to be capable of picking up the workload of those C-130s.

The Air Force analysis concluded that both options C and D met the 66 MTM/day delivery requirement and satisfied the force modernization and stabilization objectives. However, the Air Force concluded that the C-17 alternative (option D) was superior to the C-5 alternative (option C) in military utility, life-cycle cost—$16.1 billion (fiscal year 1982 dollars) less on a 30-year life-cycle basis—and manpower demands (option D required 14,800 fewer personnel). In addition, the Air Force analysis showed that the C-17 alternative (option D) provided 7,000 tons per day

more in intratheater capability than the C-5 alternative (option C) even with the retirement of the 180 older C-130s.

Options E and F: Long-Term Forces

The third phase of the evaluation was to determine the best force structure to meet airlift requirements while replacing the entire C-141 fleet. All C-141s were scheduled to be retired no later than 2015. This evaluation was intended to ensure that the recommended force structure for 1998 would provide for a smooth transition to a longer term force structure that did not include the C-141.

Option E involved the acquisition of 191 operational C-5s and 180 new C-130s to replace 180 older C-130s. Option F involved the acquisition of 220 operational C-17s which, in addition to meeting intertheater airlift needs, was expected to increase intratheater airlift capabilities without replacing the 180 C-130s to be retired in the 1990s.

The Air Force analysis showed that, although the C-5 alternative (option E) met the 66 MTM/day delivery requirements, it would not provide for the routine delivery of outsize equipment to forward operating locations. On the other hand, the C-17 alternative (option F) not only met the delivery requirements and the military utility objective, but, compared to the C-5 alternative (option E), cost $17.9 billion (fiscal year 1982 dollars) less on a 30-year life-cycle basis and required 16,500 fewer personnel. Neither alternative was viewed as a realistic option for the 1998 time frame, however, because 180 C-141s would still be operational. Nonetheless, the Air Force considered the C-17 alternative (option F) to be the preferred framework on which to build the airlift force structure of the future.

Recommended Force Structure

Satisfied that the C-17 alternative (option D) best met its criteria, the Air Force selected this plan to be its airlift force structure for the 1998 time frame. This option envisions that, as the remaining C-141s are retired, they will be replaced with additional C-17s in the 2010 to 2015 time frame.

The assumptions used by the Air Force played a crucial role in the results of the analyses, and, by extension, the choice between the C-17 and C-5 alternatives. In the following chapters, we discuss the key assumptions as well as the sensitivity of the "bottom line" to changes in some of those assumptions.

Air Force Analysis of C-5 and C-17 Alternatives

The Air Force believes that the C-17 is the clear and obvious choice over the C-5 to be the backbone of its future intertheater airlift force structure because it is expected to fully meet or exceed all of its objectives while the C-5 does not. In arriving at its conclusion, the Air Force assumed that the C-17 will achieve all of its performance requirements; that its capabilities, including direct delivery, will be fully utilized; and that the cost of the C-17 program will not exceed current estimates.

The Air Force believes that the C-17 program involves low technical risk because it uses proven commercial aircraft engines and other previously demonstrated capabilities. However, the C-17 is still in full-scale engineering development, and a significant amount of design and engineering work remains. The first C-17 will not be assembled for testing until January 1990, and flight testing is not planned until September 1990. As a result, the actual capabilities of the C-17 and the total cost of the program may not be known until the early to mid-1990s. On the other hand, the C-5's capabilities are known, based on years of Air Force operational experience with the aircraft.

Using the Air Force's stated objectives (see p. 16), this chapter discusses the Air Force's analysis of the C-5 and C-17 alternatives (options C and D) as originally structured. It also discusses the results of an October 1986 updated life-cycle cost analysis, prepared by the Air Force at our request.

Military Utility

The Air Force compared its experience in operating the C-5 with the projected performance of the C-17 and concluded that the C-17 would meet or exceed all aspects of the military utility objective while the C-5 would not. A major advantage is that the C-17 is being designed to routinely deliver the full range of military cargo into small airfields with limited facilities. According to the Air Force, this direct delivery capability will be militarily significant when achieved and utilized.

Direct Delivery

Rather than delivering cargo in the traditional manner to main operating bases and then moving it by intratheater airlift or by ground transportation to its final destination, the C-17 is being designed to routinely deliver all types of cargo directly from the United States to airfields closest to their final destinations. Such deliveries could also be made to staging areas where forces would be assembled before final delivery near the combat area. The specific distance of the delivery area from the battle area would depend on the scenario, but it would generally be

within 62 to 124 miles and could be within 12 to 19 miles. While the C-5 is capable of performing direct deliveries to larger airfields, only the C-130 can now routinely deliver to smaller airfields. However, the C-130 cannot move outsize cargo. The C-130s have been used for many years to deliver small forces to forward airfields; however, the routine direct delivery of larger units to smaller airfields has not been done.

While a relatively large airfield may be nearby the final destination, it is more likely that the closest usable airfield will be relatively small and have limited facilities. Deliveries directly from the United States to where they are needed would eliminate some intratheater delivery requirements (by air or land) at a savings of time and an increase in productivity. The Air Force believes that, if properly implemented, direct delivery could

- reduce congestion at the main operating bases where airlift forces must share available space with several other types of forces;
- improve unit integrity, which means a cohesive fighting force of personnel and their full array of equipment; and
- facilitate a faster force closure rate, which is the speed with which a fully equipped fighting force becomes available for deployment against the enemy.

The Air Force strongly believes that the C-17 will permit it to more fully employ the direct delivery concept than the C-5 would permit. The direct delivery concept is a driving force in the design and development of the C-17 because, in representative combat scenarios, the Air Force expects a high percentage of C-17s to direct deliver. The C-17's projected capabilities to land on short airfields and to maneuver within restrictive and crowded facilities are keys to its direct delivery capability.

Landing Distances

Over the past several years, there has been considerable debate concerning the comparative capabilities of the C-5 and the C-17.[3] The Air Force and Lockheed disagree over whether the C-5 can routinely and safely operate into and within small airfields. Lockheed maintains that the C-5 was designed to do this and, although never fully demonstrated, should be able to do it today. The Air Force has restricted the C-5 fleet to airfields greater than 5,000 feet in length. The Air Force believes that

[3]For more details on that comparison, see Performance Capabilities of the C-5 and C-17 Cargo Aircraft, GAO/NSIAD-84-119, July 9, 1984.

the C-5 cannot routinely and safely land or take off from small airfields. The Air Force states that such operations would require operating near the limits of aircraft and aircrew capability with very little margin of safety.

We do not expect to see agreement anytime soon between the Air Force and Lockheed on what constitutes routine and safe operation of the C-5 or on what the C-5 can and cannot do. However, the C-17's capabilities to land in and take off from small airfields, although not demonstrated, are expected to be slightly better than the capabilities even Lockheed attributes to the C-5 and significantly better than the small airfield capabilities attributed to the C-5 by the Air Force.

The Air Force has specified that the C-17 should be able to deliver outsize cargo into airfields at which only the C-130 could previously operate. The C-17 is being designed to routinely and safely operate into airfields with runways as short as 3,300 feet in length and 90 feet in width with 166,965 pounds of cargo—virtually its maximum payload. McDonnell Douglas officials believe that, based on completed wind tunnel test data, the C-17 will be able to routinely deliver a 172,200-pound payload into runways as short as 2,600 feet. This C-17 capability is attributed to the use of powered lift technology, which permits steeper descent angles and slower approach speeds. The use of a heads-up display—which presents flight information on a transparent screen at eye level—is expected to help the pilot accurately land the C-17 close to a specific point on the runway. The ability to touch down close to the beginning of the runway is a key feature to safely landing and stopping on a short runway.

Ground Maneuvering

Runway length and width are not the only factors affecting an aircraft's ability to efficiently use small airfields. Such airfields may also have small taxiways and parking areas. These factors limit the number of aircraft that the airfield can handle at one time and, therefore, the quantity of cargo that can be delivered in a given period of time. Also, the Air Force does not plan to routinely operate either the C-5 or the C-17 on unimproved airfield surfaces because there are over 10,000 airfields worldwide that have prepared surfaces and the probability of aircraft damage increases when operated on other than prepared surfaces.

The Air Force believes that the C-17 will be more capable than the C-5 in operating within restrictive and crowded airfields and in staying on the prepared airfield surfaces because of its smaller size (wingspan, length,

etc.) and its routine capability to back up. For example, those features are expected to permit the C-17 to make a 180-degree turn within a smaller area than the C-5 can. The C-17's turning radius should also permit it to turn onto a narrow taxiway without going off the prepared surface while the C-5 may have to. While Air Force tests have shown that the C-5 does have some capability to back up, that capability is more limited than that expected of the C-17.

The C-17's smaller physical size and improved ground maneuverability should also enable it to more efficiently use the available parking areas. One DOD analysis, for example, using a Southwest Asian scenario, showed a clear advantage for the C-17 in total cargo delivered by virtue of, among other things, its more efficient use of available ramp space and its reduced ground turnaround time. Even where the C-5's access to an airfield is not restricted (as was assumed in this analysis), the C-17's expected maneuverability, backup capability, and faster turnaround times should enable the Air Force to deliver more cargo per day to a location than can be expected with the C-5. Those qualities would also help to prevent airbase saturation and diversion situations.

Use of C-17 in Potentially Hostile Areas

Crucial to achieving the full direct delivery potential of the C-17 is the willingness of the Air Force to risk landing such an expensive aircraft at forward operating locations during wartime. Air Force officials state that the C-17 would be used for such roles when required. They added that the forward operating locations near the forward edge of the battle area are expected to be fairly secure when airlift operations are conducted there. The Air Force also states that C-17 design features—acceleration, deceleration, climb and descent rates, and redundant systems—are intended to increase its survivability.

The issue of using the C-17 or other airlift aircraft in potentially hostile areas is likely to remain unresolved until the need for such aircraft arises. In selecting aircraft for each mission, military leaders will need to make judgments as to the risks and alternatives involved when operating in potentially hostile environments. Nevertheless, because of potential airfield congestion problems and the possibility that an enemy may focus its attention on such lucrative targets as main operating bases, the flexibility of the C-17 to routinely use a greater number of alternative and potentially less vulnerable airfields may prove not only desirable but also vital.

Airdrop Capabilities

Another aspect of military utility that favors the C-17 is its planned ability to airdrop troops, equipment, and supplies from high altitudes and to extract equipment and supplies from low altitudes. These capabilities are highly regarded by the biggest user of airlift—the Army. The C-5 was not designed for low altitude parachute extraction, and although the Air Force has never fully tested or used the C-5's airdrop capability, it does acknowledge that it exists.

Other Aspects of Military Utility

An analysis prepared for the Office of the Secretary of Defense shows that the C-17 could be used effectively for certain periods of time exclusively for intratheater shuttling. However, using the C-17 in this manner would reduce its intertheater airlift capability. Intratheater shuttling may be needed, for example, when sealift cargo arrives in the theater or when deployed forces need to be repositioned quickly. The C-17 may also be capable of augmenting the C-130 fleet when the use of the C-17's larger capacity is justified in cases such as the resupply of bulk ammunition or fuel or in longer range intratheater missions, such as those anticipated in Southwest Asia.

Increasing Airlift Capability

Because the C-5 is now in production and the first C-17 is not planned for delivery until 1990, selecting the C-5 option would allow the Air Force to increase its airlift capability more quickly. At the same time, the way the Air Force has structured its acquisition plans, both options would reach the 66 MTM/day goal by the year 2000:[4] the C-5s would be produced at a rate of 18 per year while the C-17 would be produced at a peak rate of 29 per year.

Because Lockheed has the necessary plant capacity, it is feasible to produce the 181 C-5s earlier than is projected by the Air Force. At a production rate of 24 C-5s per year, for example, the intertheater airlift goal would be reached by about fiscal year 1996 rather than 2000. On the other hand, concern has been raised during congressional hearings as to whether the assumed production rate for the C-17 is too high. If it were reduced to a maximum of 24 aircraft per year versus the currently

[4]Since the Airlift Master Plan was completed, the Air Force has decided to decrease the number of operational C-5s already in the inventory in order to increase the number of C-5s used as trainers/backups. Consequently, both alternatives will achieve less total airlift capability when fully implemented, and the C-5 alternative is expected to achieve only 65.33 MTM/day rather than 66 MTM/day In addition, while the Airlift Master Plan discussed achieving the long-range airlift goal by the year 1998, the updated Air Force analysis assumes the achievement of that goal by the year 2000.

projected maximum rate of 29, the intertheater airlift goal would not be reached until fiscal year 2001 rather than 2000.

In its review of a draft of this report, DOD commented that if a comparison were made at the maximum tooling capacity rate for each aircraft—30 for the C-5 and 36 for the C-17—each alternative would reach the goal more rapidly, with the C-5 alternative reaching the goal 3 years earlier.

Life-Cycle Costs

In its updated cost analysis, the Air Force concluded that the C-17 alternative would cost $29.3 billion (in fiscal year 1986 dollars) less on a life-cycle basis than the C-5 alternative. Table 3.1 summarizes the results of the updated analysis.

Table 3.1: Updated Air Force Comparison of Costs Under C-5 and C-17 Alternatives (Fiscal Year 1986 Dollars)

Dollars in billions

	Total acquisition cost	Annual operating and support cost[a]	30-year life-cycle cost[b]
C-17 alternative			
210 C-17s	$26.4	$1.25	$63 9
All other aircraft[c]	0	2.76	82.8
Total	**$26.4**	**$4.01**	**$146.7**
C-5 alternative			
181 C-5s	$15.9	$1.88	$72.3
198 new C-130s	3 8	0 35	14 3
All other aircraft[c]	0	2.98	89 4
Total	**$19.7**	**$5.21**	**$176.0**
Difference	$ 6.7	($1.20)	($29 3)

[a]When all aircraft are fully deployed

[b]Acquisition cost plus 30 years of operation and support cost

[c]Expected to be in the airlift inventory as of fiscal year 2000.

Our review of the Air Force's analysis showed that the C-17 alternative should be less costly than the C-5 alternative on a life-cycle basis, although the cost savings may not be as great as stated by the Air Force. As shown in table 3.2, our adjustments to the Air Force's updated estimates show that the C-17 alternative would still cost $16.7 billion less on a life-cycle basis than the C-5 alternative. Even if the older C-130s to be retired were replaced under the C-17 alternative, the C-17 alternative

would cost (after our adjustments) about $2.7 billion less than the C-5 alternative.

Table 3.2: Comparison of C-5 and C-17 Alternatives' Adjusted Life-Cycle Costs (Fiscal Year 1986 Dollars)

Dollars in billions

	Total acquisition cost	Annual operating and support cost[a]	30-year life-cycle cost[b]
C-17 alternative			
210 C-17s	$26.4	$1.34	$66 6
All other aircraft[c]	0	2.98	89 4
Total	**$26.4**	**$4.32**	**$156.0**
C-5 alternative			
181 C-5s	$15.9	$1.78	$69 3
198 new C-130s	3.5	0 35	14.0
All other aircraft[c]	0	2.98	89 4
Total	**$19.4**	**$5.11**	**$172.7**
Difference	$7.0	($0.79)	($16.7)

[a]When all aircraft are fully deployed

[b]Acquisition cost plus 30 years of operation and support cost

[c]Expected to be in the airlift inventory as of fiscal year 2000

Selected aspects of the Air Force's life-cycle cost analysis and our adjustments to it are discussed below.

C-17 Life-Cycle Cost Advantage Remains Even When Costs Are Discounted at Various Rates

In its analysis of the life-cycle costs of the alternative force structures for the Airlift Master Plan, the Air Force did not discount current dollars. The lack of a discounted life-cycle cost analysis has led to concern that the cost savings for the C-17 alternative may be overstated. Our preference is that, in performing life-cycle analyses, current dollars be discounted using the average yield on Treasury obligations maturing during the period of anticipated expenditures.

In its updated analysis, the Air Force computed the life-cycle costs of the C-5 and C-17 alternatives using a wide range of discount rates. This analysis showed the C-17 alternative to have lower life-cycle costs using a range of discount rates up to 30 percent, well beyond the average yield of Treasury obligations maturing during the period of anticipated expenditures.

Acquisition Costs

The Air Force's updated analysis estimated that 181 C-5s—156 operational and 25 trainers/backups—procured at the rate of 18 per year starting in fiscal year 1988 would cost $15.9 billion, or $87.8 million per aircraft in fiscal year 1986 dollars (see table 3.3). The cost to procure 198 C-130s to replace the 180 operational C-130s to be retired was estimated by the Air Force at $3.8 billion, or $19.3 million per aircraft in fiscal year 1986 dollars.

The Air Force estimated the acquisition cost for the 210 C-17s (180 operational and 30 trainers/backups) at $26.4 billion, or $125.5 million per aircraft in fiscal year 1986 dollars. No replacement for the retiring C-130s was programmed; it was assumed that C-17 direct delivery and intratheater shuttle capabilities would obviate the need to replace older C-130s.

Table 3.3: Updated Air Force Comparison of Acquisition Costs[a] For C-5 and C-17 Alternatives

Dollars in millions

	Fiscal year 1986 dollars		Then-year dollars	
	Total	Unit	Total	Unit
C-5 alternative				
181 C-5s	$15,891	$87.8	$20,166	$111.4
198 C-130s	3,811	19 3	4,837	24.4
Total	**$19,702**		**$25,003**	
C-17 alternative				
210 C-17s	$26,355[b]	$125.5	$33,736[b]	$160 6

[a]Do not include any costs incurred prior to fiscal year 1987 or any military construction costs

[b]DOD has subsequently informed us that the C-17's projected acquisition cost has increased by $414 million in fiscal year 1986 dollars We have not included this cost increase in our calculations, but it would not have a material effect on the outcome of the cost analysis

The number of aircraft to be acquired under each alternative was determined by the Air Force based on the expected MTM/day contribution of each aircraft, which in turn depends on their average payload and surge utilization rate. Because the C-5 is larger, its average payload is about 44 percent greater than the C-17's. On the other hand, the C-17's surge utilization rate (see p. 42) is expected to be about 22 percent greater than the C-5's because of its reduced maintenance requirements and ground-handling time. As a result, the capability of the C-5 is calculated to be 0.171 MTM/day, or 12.5 percent greater than the C-17's 0.152 MTM/day capability. Accordingly, 180 C-17s are needed to provide approximately the same MTM/day capability as 156 C-5s.

For the remainder of this chapter, we confine our discussion to the surge utilization rates and quantities of aircraft discussed above. In chapter 4, however, we discuss the likelihood that neither 156 additional C-5s nor 180 C-17s will allow the Air Force to reach its 66 MTM/day intertheater airlift goal because of likely reductions in both aircrafts' surge utilization rates. Although both alternatives will need more aircraft to achieve 66 MTM/day, the additional costs involved would not affect the results of the Air Force's analysis showing the C-17 to be more cost effective than the C-5. In fact, the cost advantage of the C-17 over the C-5 increases when additional aircraft quantities are considered.

Impact of Different Production Rates on C-5 and C-17 Acquisition Costs

As we discussed earlier, a higher C-5 production rate is feasible and would result in the C-5 alternative meeting the 66 MTM/day goal much earlier. Similarly, if the C-17 production rate were to decrease, the C-17 alternative would meet the 66 MTM/day goal later than currently anticipated. A higher C-5 production rate and a lower C-17 production rate may reduce the total acquisition cost of the C-5 alternative and increase that of the C-17, although the changes may be small when changes in tooling and other fixed production costs are taken into account. However, a higher C-5 production rate would increase that alternative's near-term acquisition costs.

Lower C-130 Unit Cost Could Reduce C-5 Alternative's Acquisition Costs

The Air Force estimated the unit acquisition cost of the C-130 at $19.3 million in fiscal year 1986 dollars. However, the estimated unit acquisition cost of 16 C-130s to be delivered in 1987 was about $16 million. Adding the 10 percent factor used by the Air Force for spares, support, and other costs, yields, in our view, a more appropriate C-130 unit acquisition cost of about $17.6 million. At that unit cost, the C-5 alternative's acquisition costs would be about $327 million less in fiscal year 1986 dollars than estimated by the Air Force.

Replacement of Older C-130s Could Be Delayed

The Airlift Master Plan discusses the need to retire and replace C-130s as they reach the end of their service lives. It shows the earliest date the retirements would occur as the early 2000s. For the C-5 alternative, however, the Air Force plans to start procuring new C-130s in fiscal year 1987. This replacement, based on their remaining service lives, appears to be at least 5, if not 10, years before it is necessary. Delaying the start of C-130 procurements until the mid-1990s would not affect the life-cycle cost of the C-5 alternative in fiscal year 1986 dollars, but it

would reduce near-term acquisition costs under that alternative. Nevertheless, DOD states that the near-term retirement of some older C-130s may be desirable in order to avoid the increasing cost to maintain them in the airlift fleet.

Operating and Support Costs

The Air Force estimates that, when fully implemented in fiscal year 2000, the C-17 force structure will cost $1.2 billion (in fiscal year 1986 dollars), or more than 20 percent, less to operate and support annually than the C-5 force structure (see table 3.1). That difference is a key factor in the C-17 alternative's life-cycle cost advantage over the C-5 alternative.

The Air Force's updated cost analysis made detailed estimates of the operating and support costs of the airlift force structures under the C-5 and C-17 alternatives. However, we do not fully concur with some of its assumptions. For example, the Air Force assumed that all 156 operational C-5s under the C-5 alternative would be assigned to Active/Reserve Associate squadrons while 48 of the 180 operational C-17s under the C-17 alternative would be assigned to Reserve squadrons. The net result favors, somewhat artificially in our view, the C-17 alternative. The following discussion compares the key components of the operating and support costs of the 180 operational C-17s in the C-17 alternative to the operating and support costs of the 156 operational C-5s and the additional 180 operational C-130s in the C-5 alternative.

Cost to Operate and Support Additional C-130s Under the C-5 Alternative

About $350 million of the $1.2 billion difference between the two force structures is attributable to the annual cost to operate and support the smaller number of C-130s in the C-17 force structure (see table 3.4). This smaller number is a direct result of the assumed capability of the C-17 to deliver directly to forward locations and to perform intratheater shuttles—obviating the need to replace some older C-130s as they retire.

The Air Force assumes that the retiring C-130s would have to be replaced under the C-5 alternative because it does not believe that the C-5 can routinely and safely operate into what is defined as a C-130 type airfield (3,000 to 3,500 feet in length). Lockheed believes the C-5 can routinely and safely land on runways that are less than 5,000 feet in length. If the Air Force were to relax its restriction on the C-5 landing on runways less than 5,000 feet in length, the C-5 could potentially be used for at least some direct deliveries to smaller airfields in the 4,000- to 5,000-foot length range. Some C-130s might, therefore, possibly be

retired without replacement under the C-5 alternative without reducing the existing intratheater capability.

C-5 Annual Operating and Support Costs May Be Slightly Overstated

When a C-17 and a C-5 are assigned to the same types of squadrons and are flown roughly equivalent numbers of peacetime flying hours, the Air Force estimates the annual cost to operate and support a C-17 to be $7.45 million versus $12.08 million for a C-5. The C-5 annual cost factor is based primarily on historical cost experience in operating the C-5A. However, these costs are higher than the Air Force currently expects the C-5B will cost to operate and support. Using current cost factors, the annual operating and support costs per C-5B would be $11.4 million, or about $0.7 million lower than the cost used in the Air Force analysis. The operating and support difference between the C-5 and C-17 is attributable primarily to the projected fuel efficiency and lower maintenance costs of the C-17.

Lockheed maintains that the annual operating and support cost used for the C-5 by the Air Force was too high because the number of peacetime flying hours used in its calculation was too high. Although the peacetime flying hours projected for the new C-5s to be acquired are higher than historical C-5 experience, the Air Force projected them on the basis of aircrew training requirements, the same basis used for projecting C-17 peacetime flying hours. We believe the Air Force's use of the same basis for projecting peacetime flying hour requirements for new aircraft to be procured under both the C-5 and C-17 alternatives provides the consistency needed to ensure a fair cost comparison of these alternatives.

In commenting on a draft of this report, DOD officials stated that, by focusing only on the annual operating and support costs of the new aircraft to be obtained under either alternative, we exclude another difference in operating and support cost between the two alternatives. That difference results from the Air Force assumption that the 70 C-5s already in the inventory would have to be flown much more each year under the C-5 alternative than under the C-17 alternative in order to meet annual training requirements. Although not considered by the Air Force, there are other less costly ways of meeting annual training requirements under the C-5 alternative. For example, additional C-130s could be assigned to active squadrons and used to provide aircrew training rather than increasing the hours for the 70 existing C-5s. We are not contending, however, that the C-5 flying hours should be held at the lower level but rather that they should be held constant under both

alternatives when computing operating costs for aircraft already in the inventory.

Lower C-17 Fuel Consumption

Annual fuel savings of 180 C-17s compared to 156 C-5s are expected to be about $71 million. The C-17 is expected to consume 2,289 gallons of fuel per flying hour, versus 3,505 for the C-5. After factoring in the C-5's greater cargo capacity, the C-17 is projected to be about 27 percent more fuel efficient per MTM/day of airlift capability.

The Air Force's calculations were based on fuel consumption rates projected by the engine manufacturer for the C-17. The C-17 engine, made by Pratt and Whitney, is currently being used on commercial Boeing 757 aircraft. The commercial engine's fuel consumption rates for these aircraft are at or below Pratt and Whitney's initial estimates for commercial airline service.

Lower C-17 Maintenance Requirements

Most of the remaining difference in the two aircrafts' operating and support costs is attributable to the C-17's expected greater reliability and better maintainability, which translates into fewer maintenance inspections, actions, and personnel and fewer spare parts and other materials. The C-17 is being designed to be simpler, more reliable, and more easily maintained than the C-5. Reasons for the C-17's lower maintenance costs include the following.

- Interchangeable parts are to be used to the maximum extent to reduce supply requirements.
- Designed-in maintenance accessibility is expected to simplify maintenance procedures and reduce maintenance time.
- Built-in test features are to be used to reduce maintenance troubleshooting and fault isolation times as well as to reduce support equipment requirements.
- Modern, proven subsystems are to be used to take advantage of their high reliability.

The C-17 development contract has warranty clauses that, among other things, require the attainment of a fleetwide average of 18.6 maintenance manhours per flying hour (MMH per FH) when the cumulative fleet flying hours reach 100,000 hours. If the equivalent of 18.6 MMH per FH is not achieved during a 30-day demonstration under operational conditions, McDonnell Douglas can be required to make the necessary design

and equipment changes to satisfy that requirement with no increase in contract price.

The C-17 maintenance warranty requirements are more than 50 percent lower than currently being achieved on the C-5B (about 40 MMH per FH) and 25 percent lower than the operational experience of the C-141 (about 25 to 30 MMH per FH). Considering that a significant amount of design emphasis is being placed on the C-17's reliability and maintainability and the extensive reliability and maintainability warranties in the C-17 development contract, the Air Force appears to have reasonable assurance that C-17 maintenance costs will be much lower than those of the C-5.

Manpower Requirements

Despite the larger number of aircraft and additional crews per aircraft under the C-17 alternative, the total fleet of 180 operational C-17s is expected to require 17,348 personnel compared with 22,464 for 156 C-5s, a difference of 5,116 personnel. Presented another way, the C-17 is expected to require 634 personnel for each MTM/day of capability, while the C-5 requires 842 personnel, or 33 percent more for the same capability.

The significantly improved reliability and maintainability projected for the C-17 are key reasons for fewer maintenance personnel. In addition, the C-17 is being designed to be flown by a cockpit crew of two and to have its cargo managed by a single loadmaster, while the C-5 normally is required to have two pilots, two flight engineers, and at least two loadmasters. Finally, a savings of 7,788 personnel is expected with the retirement of older C-130s without replacement under the C-17 alternative. For the C-5 alternative, the Air Force assumed that those aircraft would have to be replaced and the related personnel retained.

Our calculations, using Air Force assumptions, show that 2,282 more personnel will be needed under the C-17 alternative than would have been assigned to the airlift force projected for fiscal year 1989. That number, however, is still 12,904 personnel fewer than required for the updated C-5 alternative. Other key factors in keeping force structure personnel needs down were the retirement of 54 C-141s and the reduced use of the remaining 180 C-141s, thus eliminating the need for about 7,300 personnel.

Force Stability

Although the primary goal of the Airlift Master Plan was to design a force structure to meet the intertheater airlift goal, the Air Force also wanted to stabilize the number of aircraft in its airlift force. The Air Force expected to avoid the costs of airbase activations, deactivations, and facility construction by maintaining a force size and unit structure comparable to that of the current active and reserve airlift units.

Since the Airlift Master Plan was prepared in 1983, changes have taken place. Based on congressional direction and budgetary considerations, some C-5s are being transferred to the Reserves and will be operated at lower peacetime rates. Some C-17s, as acquired, will be sent to the Reserve forces. In addition, 80 C-141s will be transferred to the Reserves instead of the planned 180—the other 100 will remain in the Active forces. However, in accordance with the Airlift Master Plan, all 180 C-141s are still expected to be used much less in order to conserve their remaining service lives. These actions reflect an Air Force policy of maintaining some of each airlift aircraft type in the Reserves.

As shown in table 3.4, the C-17 alternative calls for a force structure with 54 fewer aircraft than the updated fiscal year 1989 projection, while the C-5 alternative, including the replacement of older C-130s, calls for 102 more aircraft.

Table 3.4: Comparison of Aircraft Quantities Under C-5 and C-17 Alternatives

		Number of operational aircraft		
		Fiscal year 1989 force structure	Alternative	
Aircraft Type			C-5	C-17
C-5	(active)	70	226	70
C-5	(reserves)	40	40	40
C-141	(active)	218	100	100
C-141	(reserves)	16	80	80
C-17	(active)	0	0	132
C-17	(reserves)	0	0	48
KC-10	(active)	57	57	57
C-130	(active)	228	228	190
C-130	(reserves)	294	294	152
Total		**923**	**1,025**	**869**

Site Activations and Deactivations

Although the Airlift Master Plan cited the desirability of minimizing site activations and deactivations, no analysis was made at that time of the ability of the current airlift airbases to support the alternative force

structures. Under the C-5 alternative, there is a net increase of 102 aircraft. Because of the C-5's large size, Air Force officials indicated that additional sites might have to be activated; this potential cost has not been determined. On the other hand, the C-17 alternative involves a slight decrease in the total number of aircraft. Because the C-17 is similar in size to the C-141, Air Force officials suggested that the facilities used for the retiring C-141s could be used for some of the C-17s, and site activations and major renovations could be kept to a minimum.

Modernizing the Force

In its analysis leading to the Airlift Master Plan, the Air Force concluded that, if no actions were taken to manage their remaining useful lives, the entire fleet of 234 operational C-141s would have to be retired starting in the late 1990s. If this issue were not addressed, the Air Force would face the prospect of building up to an airlift capability of 66 MTM/day by the late 1990s and then having that capability reduced as the C-141s were retired. Instead, the Air Force decided to retire 54 operational C-141s in the late 1990s and to prolong the useful lives of the other 180 operational C-141s by reducing their annual rate of use.

Extending the Lives of C-141s

Over 90 percent of the C-141 fleet is expected to reach the end of its current service life—in terms of accumulated flying hours—by fiscal year 2004 if the Air Force continues to fly C-141s in excess of 1,100 hours per year. Although none are absolute, aircraft retirement decisions are based on many factors, including calendar age, number of accumulated flying hours, type of use, and aircraft condition. Such decisions also include consideration of the reliability of the aircraft's subsystems and the availability of replacement parts. The latter point becomes a key consideration for aircraft that are 20 or more years old.

If the Air Force could extend the useful service life of its C-141 fleet, fewer C-5Bs or C-17s would be needed to meet the 66 MTM/day goal. While it may be possible to extend the C-141's service life, no complete analysis of the necessary actions and costs has been done. Preliminary analyses have been made on extending the life of the airframe, but analyses on extending the service life of the aircraft's electronic, hydraulic, and propulsion systems will not be completed until May 1987. Even if the service lives were extended, a C-141 replacement would probably be needed no later than 2015 at current usage rates.

If it were cost effective to extend the useful lives of the C-141s, only 121 C-5s (104 operational) or 136 C-17s (117 operational) would have to be

acquired, rather than the 181 C-5s and 210 C-17s now planned to reach the Air Force's intertheater goal. As shown in table 3.5, using these assumptions, the C-17 alternative would cost about $13.4 billion less than the C-5 alternative. In this case, the C-17 option would require about 11,400 fewer personnel than the C-5 option.

Table 3.5: Cost Comparison of C-5 and C-17 Alternatives When All C-141 Aircraft Are Retained in the Airlift Inventory (Fiscal Year 1986 Dollars)

	Total acquisition cost	Annual operating and support cost[a]	30 year life-cycle cost[b]
C-17 alternative			
136 C-17s	$21.1	$0 87	$47 2
270 C-141s	[c]	0.60[d]	18 0
All other aircraft[e]	0	2 98	89 4
Total	**$21.1**	**$4.45**	**$154.6**
C-5 alternative			
121 C-5s	$11.2	$1.18	$46 6
198 new C-130s	3.5	0.35	14.0
270 C-141s	[c]	0 60[d]	18 0
All other aircraft[e]	0	2.98	89 4
Total	**$14.7**	**$5.11**	**$168.0**
Difference	$6.4	($0.66)	($13.4)

[a]When all aircraft are fully deployed.

[b]Acquisition cost plus 30 years of operation and support cost

[c]The Air Force has not completed its analysis of the feasibility and cost of further extending the C-141s' service lives.

[d]Additional operating and support cost for the increased use of all 234 operational C-141s

[e]Expected to be in the airlift inventory as of fiscal year 2000.

Comparing the above data with that shown in table 3.2, we find that the life-cycle cost of the C-17 alternative when all 234 C-141s are retained in the inventory and fully utilized is about $1.4 billion less than the life-cycle cost of the C-17 alternative chosen by the Air Force. The cost comparison, however, does not consider the as-yet-undetermined cost to extend the service lives of the C-141s. Nonetheless, the C-17 alternative chosen by the Air Force should provide advantages in terms of military utility and lower personnel requirements.

Conclusions

Assuming the C-17 comes close to meeting its cost and performance objectives and the aircraft is used for routine direct delivery in wartime,

it should provide overall advantages to the Air Force over the C-5, including lower life-cycle costs.

We believe the most critical assumption used in the Air Force's analysis involves the routine direct delivery concept. The Air Force (as well as the Joint Chiefs of Staff) believes that the capability to routinely direct deliver to forward airfields will provide significant military benefits and that it can be fully implemented only with the C-17. While concern remains outside DOD about whether the Air Force will use the C-17 in potentially hostile areas, Air Force officials state that the aircraft can and will be used in such areas when the situation dictates. The Air Force also believes that the C-17's flexibility to use alternative airfields is not just desirable, but necessary, because of main operating base congestion, among other things.

With the C-17's expected ability to routinely direct deliver all types of cargo as well as to perform intratheater shuttle missions, the Air Force should not require as many C-130 aircraft to move cargo within the theater under the C-17 alternative as under the C-5 alternative. Accordingly, older C-130s could be retired under the C-17 alternative without replacement and without degrading intratheater airlift capability. The life-cycle costs associated with those C-130s are a major contributor to the life-cycle cost advantage of the C-17 alternative as well as to its lower personnel requirements. However, even if the C-130s to be retired are replaced under the C-17 alternative, the life-cycle costs and personnel requirements for the 210 C-17s may be less than those for the 181 C-5s if the Air Force's projections prove to be reasonably accurate.

Agency Comments and GAO Evaluation

With the exception of the size of the C-17's life-cycle cost advantage, DOD concurs with the analyses and conclusions in this chapter. In the life-cycle cost area, DOD took issue with (1) the quantities of C-130s to be replaced in the C-5 alternative and (2) the annual flying hours—and the annual operating and support cost—assumed for the C-5s already in the inventory. Upon further discussion with DOD, we determined that the number of C-130s we used was accurately taken from the Air Force's updated cost analysis, but its inclusion in the analysis by the Air Force was not appropriate. We have adjusted our cost analyses to reflect the appropriate quantity. We disagree with DOD's rationale for assuming different annual flying hour programs for the same aircraft under the different alternatives being considered. As discussed earlier in this chapter, we believe it is essential to estimate the cost for existing C-5

aircraft the same under either alternative in order to ensure a fair cost comparison.

Additional Aircraft May Be Needed to Meet Intertheater Airlift Goal

Regardless of whether the Air Force buys the C-17 or the C-5 to meet its intertheater airlift goal, the cost to implement either alternative will most likely exceed the amounts reflected in the Airlift Master Plan or in the Air Force's updated cost estimates. This underestimation is due to optimistic assumptions concerning the wartime surge utilization rates of the two aircraft. If the Air Force continues with the C-17 program, it may need 29 additional C-17s to offset a likely reduction in its wartime surge utilization rate. This increase would raise the acquisition cost of the C-17 option by about $2.3 billion and raise its annual operating and support cost by about $186 million. On the other hand, if the Air Force buys the C-5 to alleviate its airlift shortfall, it may need 46 more C-5s than the 181 planned. This increase would raise the C-5 option's acquisition cost by about $3.6 billion and annual operating and support cost by about $455 million.

Reaching the 66 MTM/day Goal

The Air Force structured both the C-5 and C-17 alternatives to meet its intertheater delivery requirement of 66 MTM/day as well as an additional 4 MTM/day to be withheld for JCS contingency purposes,[5] as shown in tables 4.1 and 4.2.

Table 4.1: Intertheater Airlift Capability Under C-5 Alternative

Aircraft type	Number of operational aircraft	MTM/day per aircraft	Total MTM/day per aircraft type
C-5 (existing)	110	0.1710	18.81
C-141	180	0.0330	5.94
KC-10	57	0.0807	4.60
CRAF	86[a]	0.1546	13.30
Withheld for JCS	•	•	(4.00
C-5 (new)	156	0.1710	26.68
Total	**589**		**65.38**

[a]Equivalent wide-body aircraft

[5]As its airlift capability increases, the Air Force has opted to withhold 4 MTM/day rather than a full 10 percent of that capability for JCS contingencies.

Table 4.2: Intertheater Airlift Capability Under C-17 Alternative

Aircraft type	Number of operational aircraft	MTM/day per aircraft	Total MTM/day per aircraft type
C-5 (existing)	110	0.1710	18 81
C-141	180	0.0330	5.94
KC-10	57	0.0807	4.60
CRAF	86[a]	0.1546	13 30
Withheld for JCS	•	•	(4.00)
C-17	180	0.1520	27 36
Total	**613**		**66.01**

[a]Equivalent wide-body aircraft

The MTM/day contribution of each aircraft to the intertheater goal is calculated by multiplying its average airspeed, productivity factor, average payload, and utilization rate. The average airspeed is less than the aircraft's cruising speed because it takes into account taxiing, ascending, and descending. The productivity factor reflects the fact that an aircraft normally carries cargo to its destination and then returns empty. An average payload is used to recognize that most missions do not use the aircraft's full capacity. Among these factors, the utilization rates, or the number of hours per day that each aircraft is expected to fly, have been most controversial. Therefore, we focused our analysis on utilization rates.[6]

Each aircraft has three utilization rates: (1) the peacetime rate, based on the hours the aircraft is used in routine day-to-day operations (generally training) during non-emergency periods, (2) the surge rate, based on the projected hours of use during the first 45 days of a conflict, and (3) the sustained rate, based on the expected hours of use for resupplying operational forces after the initial 45-day surge period.

Peacetime utilization rates are usually based on the training hours required to maintain the capability to respond to wartime needs. On the other hand, both the surge and sustained utilization rates are based on projections of the time the aircraft will be available during wartime for

[6]In commenting on a draft of this report, Lockheed stated that, in its view, the C-5's average payload should be increased because of the results of Air Force testing conducted over the past few years. We found that the Air Force had successfully demonstrated that the C-5 could, under certain conditions, carry heavier loads. However, Air Force officials emphasize that most cargo loads reach the aircraft's volume capacity well before its maximum payload has to be considered. Therefore, even if the conditions were present to permit the C-5 to safely operate with a maximum payload, that would have only a small impact on the C-5's average payload.

intertheater airlift missions. Key factors in these calculations are airborne time, loading and unloading time, ground maneuvering time, servicing time, and the frequency and extent of required aircraft maintenance. Because the 66 MTM/day goal is based on the Air Force's surge requirement, the remainder of this discussion will focus on Air Force estimates of the surge utilization rate.

Surge Utilization Rates

Each aircraft's surge utilization rate is different because of different loading/unloading and ground maneuvering capabilities as well as different maintenance requirements. Because the C-17 and C-5 aircraft fly at approximately the same speed, the airborne time per sortie for each is about the same. However, a difference in an aircraft's ground time—for any purpose—can have a significant impact on utilization rates. For example, the C-17's surge utilization rate for intertheater airlift has been projected at 15.65 hours per day compared with the C-5's 12.5 hours. The C-17's higher rate is important because it partially offsets the C-5's greater payload capability—although each C-17 sortie may contain a smaller cargo load, the C-17 is expected to make more sorties per day than the C-5. The C-17's utilization rate is higher than the C-5's because of its expected better reliability and maintainability and ground maneuvering capabilities. As discussed below, even small changes in surge utilization rates have a significant effect on the number of aircraft needed to reach the 66 MTM/day airlift goal.

Additional C-5s May Be Needed to Meet Intertheater Airlift Goal

Although a C-5 surge utilization rate of 12.5 hours per day historically has been used for planning purposes, the Air Force has recently concluded, based on computer simulations, that a 11.0 hour rate is more realistic for the C-5 because of ramp space limitations at many airfields and its high maintenance requirements. The lower utilization rate reduces the intertheater contribution of each C-5 from 0.171 to 0.151 MTM/day. This reduction affects not only the intertheater airlift capability of C-5s now in the inventory but also the contribution of future C-5s in meeting the airlift goal of 66 MTM/day. Accordingly, the Air Force would attain only about 60 MTM/day under the C-5 alternative as reflected in the Airlift Master Plan's option C, and 40 additional operational C-5s will be needed above the 156 estimated to be needed to reach the 66 MTM/day goal, as shown in table 4.3.

Table 4.3: Impact of Reduced C-5 Utilization Rate on Intertheater Airlift Goal

Aircraft type	Number of operational aircraft	MTM/day per aircraft	Total MTM/ day per aircraft type
C-5 (existing)	110	0.1510	16.61
C-141	180	0.0330	5.94
KC-10	57	0.0807	4 60
CRAF	86[a]	0.1546	13.30
Withheld for JCS	•	•	(4 00)
C-5 (new)	156	0.1510	23.56
Subtotal	•	•	**60.01**
C-5 (additional needed)	40	0.1510	6 04
Total	**629**		**66.05**

[a]Equivalent wide-body aircraft.

In order to have 40 additional operational aircraft, the Air Force would have to buy 46 C-5s, including 6 trainers or backups. The additional aircraft, assuming they are procured following acquisition of the 181 C-5s in option C, would cost about $3.6 billion in fiscal year 1986 dollars. If they were used in Active/Reserve Associate squadrons, the additional operation and support costs for these C-5s would be about $455 million per year. More than 5,700 additional personnel would be needed to operate and support these aircraft.

Additional C-17s May Be Needed to Meet Intertheater Airlift Goal

Although the Air Force's projected surge utilization rate of 15.65 hours per day for the C-17 has been challenged by some as unrealistically high, such a rate has been achieved, at least for short periods of time, by civilian cargo aircraft operating under contract to DOD. Nonetheless, the Air Force does not plan to use the C-17 purely for intertheater airlift. By virtue of its direct delivery and intratheater shuttle capabilities, the C-17 is expected to provide an additional 7,000 tons per day to the existing intratheater airlift capability. In contrast, the 180 C-130s to be retired would have provided about 3,200 tons per day of intratheater airlift capability. However, time spent by the C-17 performing intratheater missions takes away from its intertheater airlift capability.

In their utilization rate projections, the Air Force assumes that about 70 percent of the C-17 fleet will make intertheater direct deliveries to forward operating locations and that about 80 percent of those aircraft will also make one intratheater shuttle mission. The intratheater shuttle would probably involve flying from the forward operating location,

where the initial intertheater delivery was made, to a main operating base to pick up additional cargo and then flying to a forward operating location to deliver the cargo prior to returning to the United States.

Intratheater Shuttle May Have Significant Impact on C-17 Intertheater Utilization Rate

Considering the additional distance to be flown for intratheater shuttle missions, the Air Force has reduced the C-17 utilization rate from 15.65 to 15.2 hours per day. (All of the Air Force calculations of the C-17's MTM/day capability were based on 15.2 hours per day.) However, it is likely that the C-17 intertheater utilization would be lower than 15.2 hours per day if the Air Force fully factored in the additional time, over and above the flying time, needed to perform intratheater shuttle missions. For example, additional time will be needed to (1) load the aircraft for the intratheater mission, (2) maneuver on the ground prior to takeoff, (3) maneuver on the ground at destination, and (4) unload the aircraft. This nonflying time would reduce the C-17's intertheater utilization rate.

Air Force officials also told us that the C-17's utilization rate of 15.2 hours per day may be too high, and the Air Force plans to recalculate it after some questions on the extent of the aircraft's role in intratheater airlift have been resolved. For example, one unresolved question is the extent to which the C-17 should be used for intratheater shuttle missions, such as moving sealift forces to forward operating locations or repositioning forces from one location to another. Such open questions may not be resolved and a new C-17 utilization rate determined until the Worldwide Intratheater Mobility Study is completed (see p. 12).

Impact of Lower C-17 Utilization Rate

Our analysis suggests that a more realistic utilization rate for the C-17 may be closer to 14.4 hours per day than the 15.2 hour rate. The difference is attributable to our use of different assumptions for unloading time and unscheduled maintenance time. In its calculations, DOD uses a minimum time to unload the aircraft while we believe it is more realistic to assume that the minimum time will not always be achievable and that an average time would be more appropriate. Also, because the takeoff and landing for each sortie are more stressful on the aircraft than the hours flown, the additional takeoff and landing involved in an intratheater shuttle will result in more unscheduled maintenance than would result from the additional flight time associated with the intratheater shuttle. Therefore, we estimated unscheduled maintenance time based on the number of sorties to be flown. In the Air Force's original calculation of the C-17's pure intertheater utilization rate of 15.65

hours per day, it estimated unscheduled maintenance time based on the number of sorties flown. However, in its recalculation of the C-17 utilization rate to reflect the impact of the intratheater shuttle, the Air Force estimated unscheduled maintenance time based on the number of hours to be flown.

At a 14.4 hour surge rate, the intertheater contribution per C-17 would be reduced from 0.152 to 0.144 MTM/day. With that change and the reduced utilization rate of the C-5s in the inventory, the Air Force would reach only about 62 MTM/day under the C-17 alternative as currently structured. Therefore, an additional 25 operational C-17s would be needed to reach the 66 MTM/day intertheater goal, as shown in table 4.4.

Table 4.4: Impact on Intertheater Airlift Goal of Reducing C-17 Surge Utilization Rate to 14.4 Hours Per Day

Aircraft type	Number of operational aircraft	MTM/day per aircraft	Total MTM/day per aircraft type
C-5 (existing)	110	0 1510[a]	16 61
C-141	180	0 0330	5 94
KC-10	57	0 0807	4 60
CRAF	86[b]	0 1546	13 30
Withheld for JCS	•	•	(4 00)
C-17 (original quantities)	180	0 1440	25 92
Subtotal	•	•	**62.37**
C-17 (additional needed)	25	0 1440	3 60
Total	**638**		**65.97**

[a]Revised based on 11 0 hour per day surge utilization rate

[b]Equivalent wide-body aircraft

To maintain 25 additional operational aircraft, the Air Force would have to buy 29 additional C-17s—including 4 trainers or backups. Assuming that these additional aircraft are procured following the acquisition of the 210 C-17s in option D, they would cost about $2.3 billion in fiscal year 1986 dollars. If these aircraft are deployed in Active/Reserve Associate squadrons, their additional operation and support cost would be about $186 million per year in fiscal year 1986 dollars. Also, an additional 2,400 personnel would be needed to operate and support these aircraft.

As shown in table 4.5, the reduction in utilization rates and corresponding increase in aircraft quantities have the effect of increasing the life-cycle cost advantage of the C-17 alternative.

Table 4.5: Comparison of C-5 and C-17 Life-Cycle Costs When Reduced Utilization Rates Are Considered (Fiscal Year 1986 Dollars)

	Total acquisition cost	Annual operating and support cost[a]	30-year life-cycle cost[b]
C-17 alternative			
239 C-17s	$28 7	$1.53	$74 6
All other aircraft[c]	0	2 98	89 4
Total	**$28.7**	**$4.51**	**$164.0**
C-5 alternative			
227 C-5s	$19.5	$2.23	$86 4
198 C-130s	3 5	0 35	14 0
All other aircraft[c]	0	2 98	89 4
Total	**$23.0**	**$5.56**	**$189.8**
Difference	$5.7	($1 05)	($25.8)

[a]When all aircraft are fully deployed

[b]Acquisition cost plus 30 years of operation and support cost

[c]Expected to be in the airlift inventory as of fiscal year 2000

Because of the unanswered questions on, among other things, the extent of the C-17's intratheater role, the intertheater utilization rate of the C-17 is uncertain. We estimate that the C-17 surge utilization rate that would result in the C-17 alternative's life-cycle costs equalling the C-5 alternative's life-cycle costs would be about 10.7 hours per day.

Uncertainty Concerning Use of KC-10s for Airlift Versus Aerial Refueling

According to the Airlift Master Plan, the Strategic Air Command would acquire and maintain a fleet of KC-10 aircraft, which are capable of carrying cargo, aerial refueling, or both. Although it has yet to be decided if, when, and/or how many KC-10s would be made available to MAC for airlift purposes, the Air Force expects the KC-10 fleet to have a cargo-carrying capability of 4.6 MTM/day.

To the extent that the KC-10s are used primarily for aerial refueling, however, the Air Force's intertheater airlift capability would be less than stated and the overall shortfall greater. If, for example, only half of the KC-10 fleet's projected airlift capability were made available to MAC, there would be an additional airlift shortfall of 2.3 MTM/day. To fill

such a gap, at least 14 C-5s, 16 C-17s, or 29 KC-10s (all operational aircraft) would have to be procured at a cost ranging from $1.3 to $2.0 billion (fiscal year 1986 dollars). Annual operating and support costs would increase by $119 million to $159 million. Also, approximately 1,200 to 2,000 additional personnel would be needed to support these aircraft.

For carrying cargo, the KC-10 has some limitations in terms of military utility. Although it can carry more pallets than the C-17, the KC-10 can carry neither outsize equipment nor all oversize equipment. More important to the Air Force, the KC-10 is able to land only at large airfields, and unloading it is time consuming and requires specialized materials handling equipment, which may not always be available.[7]

Inability of CRAF to Provide Additional Intertheater Capability

The alternatives considered in the Airlift Master Plan appear unlikely to meet the intertheater airlift goal of 66 MTM/day. In commenting on DOD's ability to obtain additional intertheater airlift capability, a key DOD official on airlift matters told us that it is unlikely that additional airlift capability can be obtained from the CRAF program beyond that already expected. In fact, we were told that DOD may have some difficulty in achieving the currently projected annual intertheater airlift contribution of 13.3 MTM/day from the CRAF program. The airlines are replacing older aircraft that were in the CRAF program with more fuel-efficient aircraft that are smaller and less capable for the large volume, long distance cargo missions required.

Conclusion

The wartime surge utilization rates used by the Air Force for both the C-5 and C-17 appear to be too high. As a consequence, to reach its 66 MTM/day goal, the Air Force will probably have to acquire, operate, and support more aircraft under either the C-5 or the C-17 alternative.

Agency Comments and GAO Evaluation

DOD agrees that more C-17s will be needed to make up for the reduced utilization rate of the C-5s already in the inventory. However, DOD noted that we did not present any analysis in our draft report to support a reduced utilization rate for the C-17. We agree and have included an explanation in the report of the differences in assumptions used in our calculation of a reduced C-17 utilization rate.

[7]For a discussion of shortages of materials handling equipment, see Military Airlift: Improving Management of Aircraft Loading Operations, GAO/NSIAD-87-5, Oct. 23, 1986

We continue to believe that our basis for projecting the C-17's utilization rate (discussed on page 44) is reasonable. With the exception of our use of different factors for unloading and unscheduled maintenance time, we used the same basic methodology employed by DOD to calculate a different C-17 surge utilization rate.

Comments From the Under Secretary of Defense for Acquisition

Note: GAO comments supplementing those in the report text appear at the end of this appendix

THE UNDER SECRETARY OF DEFENSE

WASHINGTON, DC 20301

ACQUISITION

18 FEB 1987

Mr. Frank C. Conahan
Assistant Comptroller General
National Security and
International Affairs Division
United States General Accounting Office
441 G Street, N.W.
Washington, D.C. 20548

Dear Mr. Conahan:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "MILITARY AIRLIFT: AIR FORCE ANALYSIS SUPPORTS ACQUISITION OF C-17 AIRCRAFT," dated December 1986 (GAO Code 392206), OSD Case 7197. This letter and enclosure confirm the official oral comments provided to your staff at the January 30 meeting and by telephone on February 4.

The DoD concurs that "... the C-17 ... should provide overall advantages to the Air Force over the C-5, including lower life cycle costs." The DoD does not, however, agree with some of the data used to support several of the GAO findings. Specifically, the DoD differs with the number of replacement C-130s and C-5 flying hours in the C-5 alternative; the C-141 acquisition and operating and support costs in the C-141 life extension alternatives; the lower utilization rate and the number of additional C-17s required in the C-17 alternative; and difficulty in reaching the CRAF objective.

The enclosure provides the DoD comments in detail. In addition, on January 30 the Department separately provided your staff with an annotated copy of the draft report, indicating technical corrections and recommended clarifications.

Sincerely,

Enclosure

GAO DRAFT REPORT - DATED DECEMBER 31, 1986
(GAO CODE 392206) OSD CASE 7197

"MILITARY AIRLIFT: AIR FORCE ANALYSIS
SUPPORTS ACQUISITION OF C-17"

DEPARTMENT OF DEFENSE COMMENTS

* * * * *

FINDINGS

Now pp 2, 10-11, 13-14

- FINDING A: Types Of Aircraft. The GAO reported that airlift is normally classified as either intertheater (from one theater of operation to another) or intratheater (operations within a theater). The GAO noted that, currently, intertheater airlift operations would be conducted by C-5, C-141, KC-10 and the Civil Reserve Air Fleet (CRAF). The GAO also noted that after the troops and equipment arrive in the theater via airlift, sealift, or prepositioning, intratheater airlift--currently C-130 aircraft--transport them between main operating bases or seaports and forward operating locations. The GAO observed that the C-17 is needed for additional long-range airlift capability, and that over the next 5 years, the Air Force plans to request about $14 billion to develop and buy the C-17. (pp. 2-3, p. 10/GAO Draft Report)

  DoD POSITION: CONCUR

- FINDING B: Intertheater And Intratheater Airlift Requirements. The GAO noted that to determine the mix of airlift, sealift, and prepositioning, which would provide an acceptable U.S. response to military contingencies in the 1990s, the Defense Authorization Act of 1981 required the DoD to better define overall U.S. mobility requirements. The GAO also noted that a resulting study published in April 1981, known as the Congressionally Mandated Mobility Study (CMMS), concluded that the DoD needed an intertheater airlift capability of a minimum of 66 million-ton miles per day (MTM/day). The GAO reported that after arriving in a theater by airlift and/or sealift, equipment and troops often have to be reshipped by intratheater transportation (such as aircraft, rail, or truck) to a location where they can be organized into fighting units. The GAO also observed

ENCLOSURE

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that although the DoD considers the current inventory of C-130s to be inadequate to support its intratheater deployment and resupply requirements, the need for more intratheather airlift has not been well quantified. The GAO noted that, as a result, the intratheather mobility requirement is being studied but the study is not expected to be completed until Mid-1987. (pp. 11-12/GAO Draft Report)

Now on pp. 11-12

DoD POSITION: CONCUR

- **FINDING C: Matching Intertheather Airlift Capabilities and Requirements.** The GAO reported that following the CMMS study, the Air Force began to analyze how best to increase its intertheater airlift capability to meet the 66 MTM/day goal. The GAO noted that the study culminated in the publication in 1983 of the Airlift Master Plan, and included an assessment of existing and projected DoD airlift capabilities. The GAO reported that the study concluded shortfalls in intertheater airlift capability for FY 1983 to be 37.3 MTM/day, and projected shortfalls for FY 1989 to be 17.5 MTM/day and for FY 2000 at 27.0 MTM/day. The GAO also reported that to obtain the additional 27 MTM/day needed by FY 2000, the Air Force recommended in its 1983 Airlift Master Plan that the C-17 be developed and produced. The GAO observed that, according to the DoD, the C-17 is expected to modernize the airlift fleet and improve U.S. capability to rapidly project, reinforce, and sustain combat forces worldwide. (pp. 12-14/GAO Draft Report)

Now on pp 12-13.

DoD POSITION: CONCUR

- **FINDING D: Alternative Force Structures Analyzed.** The GAO reported that in September 1983, responding to the CMMS results, the Air Force published its Airlift Master Plan on how to increase its intertheater airlift capabilities and how to modernize its airlift forces. The GAO noted that the Air Force evaluated six alternative force structures, which were all equal in terms of their intertheater airlift capability, with three alternatives based on buying additional C-5s and three based on developing and buying the C-17. The GAO reported that the Air Force selected the C-17 alternative as its airlift force structure for the FY 1998 time frame. The GAO concluded that by the Air Force selecting this option, in effect, it envisions eventually replacing the remaining C-141s with additional C-17s as they are retired in the FY 2010 to 2015 timeframe. (pp. 17-22/GAO Draft Report)

Now on pp 16-20.

DoD POSITION: CONCUR

- **FINDING E: Military Utility.** The GAO noted that the Air Force compared and used its experience in operating the C-5 with the projected performance of the C-17. The GAO found that the C-17 offers the potential to provide greater military utility than the C-5. According to the GAO, although the C-5 is a very capable aircraft, it cannot match the C-17's expected capability to land and operate at a wider range of airfields closer to the battle area. The GAO also found that this capability to routinely direct deliver should reduce the time it takes to position forces to meet wartime needs. The GAO reported that, according to the Air Force, it will routinely use the C-17 for direct deliveries, including deliveries to potentially hostile areas and this is the key to achieving full benefits from the C-17. The GAO observed that while there remains concern about whether the Air Force will expose such an expensive aircraft to potential enemy fire, it is the Air Force stated position the aircraft will be used when and where the situation justifies the risk. The GAO reported it is also the Air Force position that the flexibility provided by the C-17 to use alternative airfields is not just desirable, it is necessary because of (among other things) main operating base congestion. The GAO concluded that perhaps the most critical assumption in the Air Force analysis involves the use of the C-17 for routine direct delivery to forward airfields during wartime, including its use in potentially hostile areas. Further, the GAO concluded that such use significantly contributes to the military utility advantage of the C-17, as well as to its life cycle cost and personnel requirements advantages. The GAO concluded that with the C-17's expected ability to routinely direct deliver all types of cargo as well as to perform some intratheater shuttle missions, the Air Force should be able to retire some older C-130 aircraft without replacement and without degrading intratheater airlift capability. (pp. 3-5, pp. 24-31, p. 50/GAO Draft Report)

Now on pp 2-3, 22-26.

DoD POSITION: CONCUR

- **FINDING F: Increases In Capability.** The GAO found that because the C-5 is being produced and the first C-17 will not enter the inventory until 1991, the C-5 alternative would allow the Air Force to increase its airlift capability more quickly. The GAO found, however, that in its analysis the Air Force programmed a higher peak production rate for the C-17 as compared to the C-5, so that both would reach

Now on pp 4, 26-27, 30.

the 66 MTM/day goal at about the same time. The GAO observed that because Lockheed has the necessary plant capability, it is feasible to produce the C-5 earlier than projected by the Air Force. The GAO also found that with equal production rates, the C-5 alternative would, in fact, reach the 66 MTM/day goal 5 years earlier than the C-17 alternative. (pp. 3-5, pp. 33-35, pp. 50-51/GAO Draft Report)

DoD POSITION: CONCUR. The GAO analyzed the case of equal production rates (24 per year for the C-5B and the C-17A). A more appropriate comparison would be at the maximum tooling capacity rate for each aircraft, 30 for the C-5B and 36 for the C-17A, which leads to each alternative reaching the goal more rapidly with the difference only being 3 years.

See Comment 1.

- FINDING G: Life Cycle Costs. The GAO noted that in the Air Force updated cost analysis, the C-17 alternative was $26.3 billion (in FY 1986 dollars) less costly on a life cycle basis than the C-5 alternative. Based on its review of the Air Force analyses, the GAO found that the C-17 alternative should be less costly than the C-5 alternative on life cycle basis, although the cost savings may not be as great as stated by the Air Force ($12.8 rather than $26.3 billion). Specifically, the GAO found that higher C-17 acquisition costs could be more than offset by lower operating and support costs, resulting in lower C-17 life cycle costs than the C-5 alternative. The GAO also found that the C-17 is expected to be much more fuel efficient than the C-5 and require significantly less maintenance, and the warranty provisions incorporated in the C-17 contract could help ensure that the C-17 will achieve projected reliability and maintainability requirements. The GAO observed, however, most of the C-17 life cycle cost advantage results from its expected capability to routinely direct deliver to forward operating locations and perform some intratheater shuttle missions. The GAO also reported that the Air Force's updated analysis shows a difference in C-130 quantities between the C-5 and C-17 alternatives of only 144 operational aircraft rather than the 180 operational aircraft referred to in the Airlift Master Plan. The GAO concluded that the Air Force plan to purchase 198 C-130s (18 are for trainers and backup) to replace 180 operational C-130s to be retired under the C-5 alternative is not appropriate. The GAO noted that, if 144 operational C-130s were replaced under the C-5 alternative, only 158 C-130s (includes 14 trainer/backup aircraft), rather than 198 C-130s, would have to be purchased. The GAO concluded that,

at current C-130 unit cost, the C-5 alternative's acquisition costs would be about $1 billion less in fiscal year 1986 dollars than estimated by the Air Force. The GAO further reported that the Air Force, in its updated cost analysis, went into great detail in estimating the operating and support costs of the airlift force structure under the C-5 and C-17 alternatives. The GAO, however, did not concur in some of the Air Force's cost estimating assumptions. In addition, the GAO found that with the routine direct delivery capability, some older C-130s would not have to be replaced under the C-17 alternative as they are retired. The GAO concluded that the life cycle costs savings associated with fewer C-130s are a major contributor to the life cycle cost advantage of the C-17, and to its lower personnel requirements. The GAO further concluded that even if the older C-130s needed to be replaced under the C-17 alternative the life cycle costs for the C-17 alternative would still be slightly less than for the C-5 alternative. The GAO also concluded that unless the Air Force cost and performance projections for the C-17 prove to be highly optimistic, lower operating and support costs should offset its higher acquisition costs. (pp. 3-5, pp. 35-44, pp. 50-51/GAO Draft Report)

Now on pp 3, 27-34

DoD POSITION: PARTIALLY CONCUR. The GAO reduction in the number of C-130s required under the C-5 alternative is not valid. The Airlift Master Plan (ALMP) requires that the intratheater airlift capability not fall below 9000 tons/day. To maintain this capability under the C-5 alternative, 522 C-130s are required, which necessitates procuring 198 new C-130s. The Air Force reduction of 40 C-130s (198 to 158) is an initial step in implementing the ALMP in anticipation of receipt of the C-17s and is not a valid basis for use in the C-5 alternative. Additionally, the GAO evidently used an inappropriately low C-5 flying hour rate for 70 of the existing C-5s in the C-5 alternative. Combined with the C-130 quantity matter, the $12.8 billion figure would become $22.8 billion, not much different than the Air Force $26.3 billion figure. It is to be noted that all cost analyses were done during the Fall of 1986 and do not reflect any changes that have subsequently occurred. Specifically, the DoD notes that the life cycle cost of the C-17 has increased by $0.4 billion in FY 1986 dollars. This increase results from an increase in acquisition costs, due primarily to a reestimate of recurring aircraft production costs. The increase has negligible effects on all calculations, observations, and conclusions reached in the GAO report.

See Comment 1

Now on pp 3, 34.

See Comment 1

Now on pp. 35-36

See Comment 1

Now on pp. 36-37.

- **FINDING H: Manpower Requirements.** The GAO reported that the C-17 alternative could require about 11,000 fewer personnel than the C-5 alternative. The GAO found that over one-half of the estimated personnel savings would result from not replacing some older C-130s as they are retired. The GAO observed that the significantly improved reliability and maintainability projected for the C-17 is the key reason for fewer maintenance personnel. (pp. 4-5, pp. 45-46, p. 51/GAO Draft Report)

  DoD POSITION: CONCUR. The DoD notes that based on the 180 vice 144 C-130s (see DoD position of Finding G), the C-17 alternative would require about 13,000 fewer personnel.

- **FINDING I: Force Stability.** The GAO found that while the primary objective of the Airlift Master Plan was to design a force structure to meet the intertheater airlift goal, the Air Force also wanted to stabilize the number of aircraft in its airlift force. The GAO also found that the Air Force expected to avoid the costs of airbase activations, deactivations, and facility construction by maintaining a force size and unit structure comparable to that of the current active and reserve airlift units. The GAO noted that the airlift master plan was prepared in 1983 and changes have taken place. The GAO observed that using an updated FY 1989 projection, the C-17 alternative results in a force structure of 869 aircraft--slightly smaller than the 887 aircraft in the FY 1989 projection made in the 1983 report. The GAO found that, on the other hand, the updated FY 1989 projection for the C-5 alternative, including the replacement of the older C-130s, results in 102 more aircraft to operate and support. (pp. 46-48/GAO Draft Report)

  DoD POSITION: CONCUR. The DoD notes that based on the 180 vice 144 C-130s, 138 more aircraft are required.

- **FINDING J: Modernizing The Force.** The GAO observed that the Air Force objective of modernizing its airlift force involves principally the need to retire a portion of the C-141 fleet while reducing the use of the remaining C-141s. The GAO noted that some have recommended that the Air Force extend the life of the C-141s, thereby reducing the number of C-17s or C-5s to be acquired. The GAO found that while it may be possible to extend the service life on the C-141, a complete analysis of the necesary actions and costs has not been done. The GAO concluded that even if the C-141 service life is extended, a C-141 replacement would still be needed in the 2010-2015 time frame at current usage rates. (pp. 48-49/GAO Draft Report)

See Comment 2

DoD POSITION: CONCUR. The DoD observes, however, that the cost calculations should have taken into account the acquisition and operating and support costs of the C-141 life extension. It would then have shown the increased life cycle cost due to retaining the C-141s in both the C-17 and C-5 alternatives vice the costs if the life had not been extended. Further, the C-17 alternative under the C-141 life extension option, still shows a considerable cost saving vice the C-5 alternative.

Now on pp 3-4, 40-42

- **FINDING K: Reaching The 66 MTM/Day Goal.**: The GAO found that regardless of whether the Air Force buys the C-17 or the C-5 to meet its intertheater airlift goal, the cost to implement either alternative will most likely exceed the amount reflected in the Airlift Master Plan or in the Air Force updated cost estimates. The GAO observed that the MTM/day contribution of each aircraft to the intertheater productivity factor, average payload, and utilization rate. The GAO concluded that among these factors, the utilization rates (or the number of hours per day that each aircraft is expected to fly) are the most controversial factors. (pp. 3-4, pp. 52-54/GAO Draft Report)

  DoD POSITION: CONCUR. The DoD notes that the GAO report shows the life cycle cost to fully achieve the 66 MTM/day goal under the C-5 alternative is $37.1 billion greater than to reach the same goal under the C-17 plan .

- **FINDING L: Surge Utilization Rates.** The GAO observed that each aircraft's surge utilization rate is different because of different loading/unloading and ground maneuvering capabilities, as well as different maintenance requirements. Because the C-17 and C-5 aircraft fly at approximately the same speed, the airborne time for each is about the same. The GAO found however, a difference in an aircraft's ground time--for any purpose--can have a significant impact on utilization rates. For example, the GAO noted that the C-17's surge utilization rate for intertheater airlift has been projected to be 15.65 hours per day while the comparable rate for the C-5 is 12.5 hours per day. The GAO found that the higher rate for the C-17 is important because it partially offsets the greater payload capability of the C-5. Although each C-17 sortie may contain a smaller cargo load, it is expected to make more sorties per day than the C-5. In addition, the GAO found that the utilization rate for the C-17 is higher than the C-5 because of its expected better reliability and maintainability and its better ground maneuvering capabilities. The GAO concluded, however, that the wartime surge utilization rates used by the Air Force

for both the C-5 and C-17 are too high. The GAO further concluded that, as a consequence, if it is to reach its 66 MTM/day goal, the Air Force will likely have to acquire, operate and support more aircraft under either alternative. (pp. 54-55, p. 62/GAO Draft Report)

Now on pp. 3-4, 42.

DoD POSITION: PARTIALLY CONCUR. There is no basis for stating that the C-17 utilization rate is too high. (Also see DoD position on Finding N.)

- **FINDING M: Additional C-5s May Be Needed To Meet Intertheater Airlift Goal.** The GAO observed that although a C-5 surge utilization rate of 12.5 hours per day has been historically used for planning purposes, the Air Force has recently concluded, based on computer simulations, that a 11.0 hour rate was more realistic for the C-5 because of ramp space limitations at many airfields and its high maintenance requirements. The GAO found that the reduction to the 11.0 hour rate affects not only the current intertheater airlift capability because of the C-5s in the inventory, but also the contribution of future C-5s to meeting the airlift goal of 66 MTM/day. The GAO also found that under the C-5 alternative as reflected in the Airlift Master Plan,the Air Force would attain only about 60 MTM/day and 40 additional operational C-5s will be needed above the 156 estimated to reach the 66 MTM/day goal. The GAO concluded that in order to have additional operational aircraft, the Air Force would have to buy 46 C-5s--the other six needed for training or as backup aircraft costing about $3.6 billion. (p. 4, pp. 55-56/GAO Draft Report)

Now on pp. 3-4, 42-43.

DoD POSITION: CONCUR. The DoD notes that the corresponding additional life cycle cost is $18.9 billion.

- **FINDING N: Additional C-17s May Be Needed To Meet Intertheater Airlift Goal.** Although the C-17's surge utilization rate of 15.65 hours per day projected by the Air Force has been challenged by some as unrealistically high, the GAO found that such a rate has been achieved by civilian cargo aircraft operating under contract to the DoD. The GAO observed, however, that the Air Force does not plan to operate the C-17 in a purely intertheater airlift role. The GAO found that by virtue of its direct delivery and intratheater shuttle capabilities, the C-17 is expected to provide an additional 7,000 tons per day of intratheater airlift capability. The GAO observed, however, time spent by the C-17 performing intratheater missions takes away from its intertheater airlift capability thus providing a net intertheater utilization rate of 15.2 hours. The GAO also

reported that, according to several Air Force officials, a 14.0 hours per day utilization rate for the C-17 may be more realistic than the 15.2 hour rate. The GAO found that at a 14.0 hour surge rate for the C-17 and the reduced rate for the C-5, the intertheater contribution per C-17 would be reduced from .152 to .140 MTM/day and an additional 31 operational C-17 aircraft would be needed to reach the 66 MTM/day intertheater goal, plus five needed for training or as backup aircraft, costing about $2.9 billion. The GAO concluded that because of the unanswered questions on (among other things) the extent of this intratheater role, there remains uncertainty as to the intertheater utilization rate that the C-17 will be able to achieve. (p. 4, pp. 56-60/GAO Draft Report)

Now on pp 3-4, 43-46

DoD POSITION: PARTIALLY CONCUR. There is no basis for the GAO assertion that a 14.0 hour utilization rate for the C-17 may be more realistic than the 15.2 hour rate. The GAO has not presented any analysis to support a reduced rate. The only additional C-17s required would be those needed to compensate for the lower utilization rate of the C-5B. Approximately 18 additional C-17s would be required at an additional cost of $1.5 billion for a corresponding life cycle cost addition of $4.8 billion, as compared to $18.9 billion for the C-5 alternative.

- FINDING O: Uncertainty Concerning Use Of KC-10s For Airlift Versus Aerial Refueling. The GAO observed that, according to the Airlift Master Plan, the Strategic Air Command would acquire and maintain a fleet of KC-10 aircraft, which are capable of performing a cargo carrying role, a refueling role, or both. The GAO found that although it has yet to be decided if, when, and/or how many KC-10s would be made available to the Military Airlift Command (MAC) for airlift purposes, the Air Force expects the KC-10 fleet to have a cargo carrying capability of 4.6 MTM/day. The GAO also found, however, that to the extent that the KC-10s are used primarily for aerial refueling purposes, the Air Force intertheater airlift capability would be less than stated and the overall shortfall greater. The GAO noted, for example, that if only one-half of the KC-10s were made available to MAC for the cargo role, an additional airlift shortfall of 2.3 MTM/day would exist. The GAO found that to fill such a gap, (1) at least 14-C-5s, 16-C-17s, or 29-KC-10s (all operational aircraft) would have to be procured at a cost ranging from $1.3 to $2.0 billion (FY 1986 dollars), (2) annual operating and support costs would increase by $119 to $159 million, and (3) from 1,200 to 2,000 additional personnel would be needed to support these aircraft. (pp. 60-61/GAO Draft Report)

Now on pp. 46-47

See Comment 3.

DoD POSITION: CONCUR. The DoD observes that KC-10s have been assigned to airlift missions in operational plans. Further the 4.6 MTM/day capability already takes into account that, on the average, only two-thirds of the fleet's cargo carrying capacity would be utilized. Thus the 2.3 MTM/day discussed would correspond to only one-third vice one-half of the fleet's capability being used for airlift.

- **FINDING P: Inability Of CRAF To Provide Additional Intertheater Capability.** The GAO found that the ability of the alternatives considered in the Airlift Master Plan to meet the intertheater airlift goal of 66 MTM/day appears unlikely. The GAO observed that in commenting on the ability of the DoD to obtain additional intertheater airlift capability, a key DoD official on airlift matters stated that it is unlikely that additional airlift capability can be obtained from the CRAF program. The GAO observed that, in fact, it was told that the DoD may have some difficulty in achieving the annual intertheater airlift contribution of 13.3 MTM/day from the CRAF program. (pp. 61-62/GAO Draft Report)

Now on p. 47.

See Comment 4.

DoD POSITION: PARTIALLY CONCUR. Since the time the GAO conducted its onsite audit work, additional CRAF capability has been obtained. The latest DoD estimate (as of November 1986) is that CRAF will reach 13.8 MTM/D by FY 1989.

RECOMMENDATIONS

- **None.**

The following are GAO's comments on the Department of Defense's letter dated February 18, 1987.

GAO Comments

1. During recent discussions, DOD officials recognized that the Air Force had inappropriately included in its life-cycle cost analysis the recent Air Force action to begin implementing the C-17 alternative by reducing the inventory of C-130 aircraft. As a consequence, the Air Force analysis understated the number of C-130s to be operated and supported in the C-5 alternative. We have changed our life-cycle cost and manpower assessments to reflect the proper number of C-130s that should have been used for the C-5 alternative. However, we adjusted both the quantity of C-130s projected for fiscal year 1989 as well as the number of C-130s to be retired and replaced in the C-5 alternative. The C-5 alternative still results in an increase of 102 aircraft over the fiscal year 1989 inventory projection, but the C-17 alternative would now result in a decrease of 54 aircraft.

2. For consistency and clarity, we have revised our cost calculations to include life-cycle costs associated with the entire airlift aircraft inventory, including the C-141 fleet. The inclusion of these costs does not affect life-cycle cost savings because they apply equally to each alternative.

3. We have modified the language used in our example to refer to one-half of the KC-10 fleet's cargo-carrying capability being made available to MAC rather than one-half of the KC-10s being made available to MAC for cargo carrying.

4. We have changed the language used in this section to clearly indicate that, although the current CRAF airlift capability is only about 10.0 MTM/day, we are not suggesting that the Air Force will not meet the CRAF goal used in its analyses (13.3 MTM/day) or the recently revised CRAF goal (13.8 MTM/day). However, we are pointing out that DOD would probably have difficulty meeting a significantly larger CRAF goal.

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