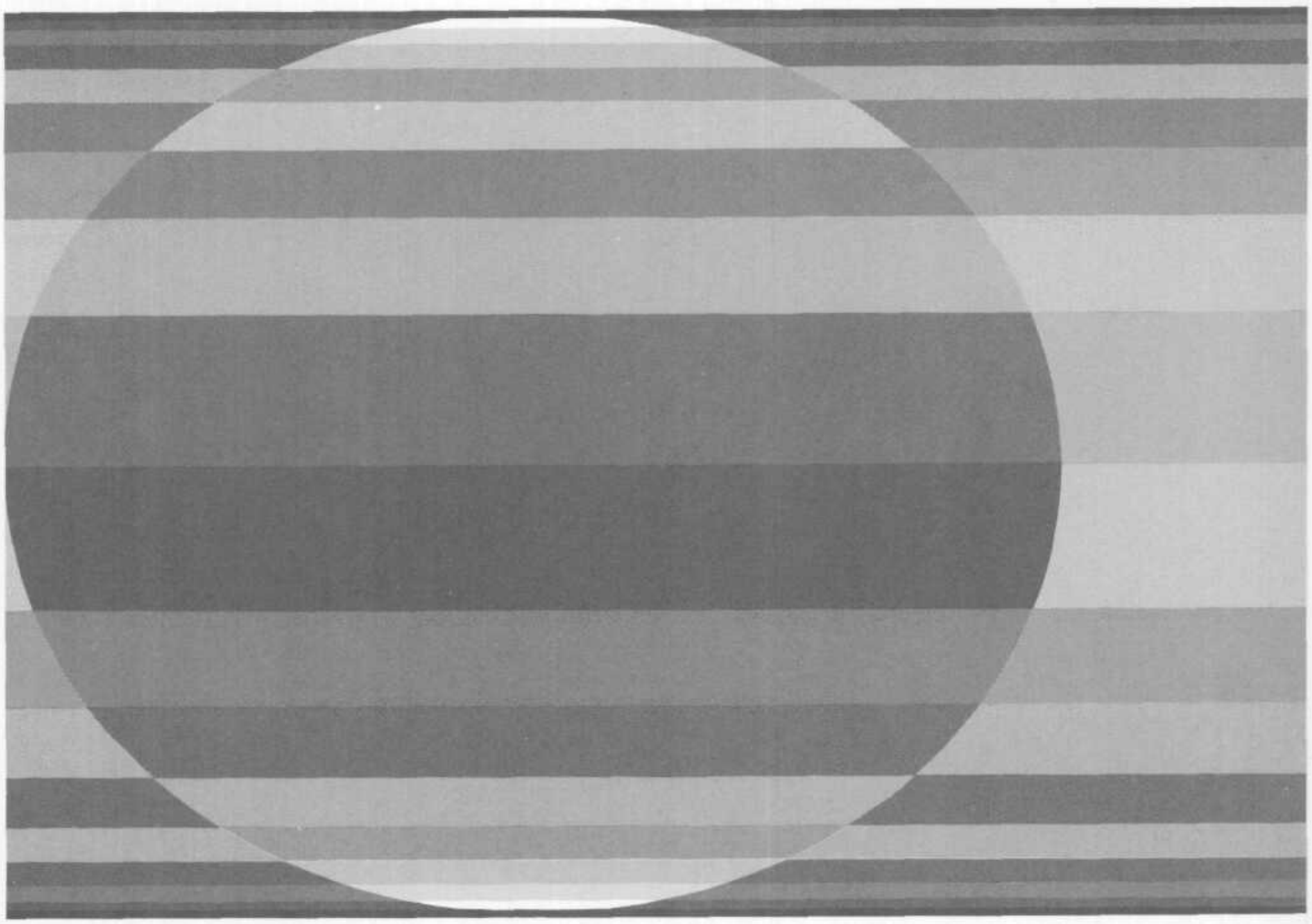
BACKGROUND PAPER

U.S. Airlift Forces: Enhancement Alternatives for NATO and Non-NATO Contingencies

April 1979



Congress of the United States
Congressional Budget Office

U.S. AIRLIFT FORCES:
ENHANCEMENT ALTERNATIVES FOR NATO
AND NON-NATO CONTINGENCIES

The Congress of the United States
Congressional Budget Office

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PREFACE

The U.S. government owns and maintains a large fleet of military cargo planes. These transports are essential for almost every possible contingency involving U.S. ground forces--from a major reinforcement of NATO in a war with the Warsaw Pact to the deployment of small fighting units to remote locations. The Department of Defense has given major attention in recent years to programs that would improve the current capability of airlift forces. This year the Congress faces critical decisions on almost all of these airlift improvement programs. This paper, prepared at the request of the Senate Committee on the Budget, examines the current airlift system and the improvement programs before the Congress this year. It evaluates the improvement programs in terms of their contribution to airlift operations in NATO and non-NATO contingencies. In accordance with CBO's mandate to provide objective analysis, this paper offers no recommendations.

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Director

April 1979

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SUMMARY

The U.S. government owns and maintains a large fleet of specially designed military cargo planes. These transports are essential for almost every possible contingency involving U.S. ground forces--from a major reinforcement of NATO in a war with the Warsaw Pact to the deployment of small fighting units to remote locations to support friendly nations. The Department of Defense (DoD) has given much attention in recent years to programs that would improve the current capability of airlift forces. This year the Congress faces critical decisions on almost all of these airlift improvement programs. The 1980 budget provides for the following changes to the strategic (intertheater) airlift fleet:

- Initial procurement of components for a new wing for the C-5 transport. This program could eventually lead to modification of the entire fleet of C-5 aircraft, at an estimated cost of $1.1 billion.

- The start of a major program to modify new civilian passenger aircraft at government expense to enable them to carry military cargo in an emergency. This year DoD proposes to modify nine commercial aircraft, at a cost of $91 million. It proposes eventually to modify more than 65 aircraft under this program.

- Continued procurement of a new advanced tanker/cargo aircraft, the KC-10. Two of these aircraft were authorized last year, and four have been requested in the fiscal year 1980 budget, at a cost of $190.1 million. Eventually, DoD proposes to purchase a fleet of 20 KC-10s, with total program costs expected to reach $1 billion.

- Continued modification of the C-141 military transport. This program involves "stretching" the C-141 by installing additional sections of fuselage in order to increase its potential payloads. The fiscal year 1980 budget includes $130 million for this program.

In addition, one program concerning tactical (intratheater) airlift will be considered:

- o Continued evaluation, at limited funding, of an advanced tactical transport. Although the Air Force had proposed to replace the current fleet of C-130s with a new transport, the AMST, the Department of Defense has decided not to purchase this plane. The Congress must decide if it wants to pursue development of a replacement aircraft for the C-130 and, if so, at what pace.

Though many of these airlift enhancement programs were initially proposed in 1974, their implementation has been delayed, in large measure because of questions raised by the Congress. In choosing among the contending alternatives, the Congress faces two primary issues:

- o What types of contingency requirements should guide airlift improvement, and what amount of enhancement is needed?

- o If not all programs are necessary, do some have advantages over the others?

Answers to these questions depend on an analysis of the structure of the current airlift system and its ability to meet anticipated airlift requirements in the future.

STRUCTURE OF THE AIRLIFT SYSTEM

The airlift system is characterized by a distinction between organic transports (planes owned and operated by the U.S. Air Force) and civilian reserve aircraft under the CRAF program (commercially owned planes that would be used to transport military cargo and personnel during time of war). Currently, organic transports and civilian reserve aircraft make roughly equal contributions to airlift capacity. Each component has its respective advantages and limitations.

Organic Transports

The principal advantage of the organic component is its flexibility. Organic aircraft are immediately available at the direction of the President to respond in emergencies. They are specially designed to operate in rugged areas under combat conditions. They are built specifically to carry military cargo and small numbers of troops who would operate the equipment upon arrival. Government ownership of those planes permits continual training of air and ground crews so that they can function effectively in emergency and combat situations.

The primary disadvantage of organic assets is their expense. The existing fleet of intertheater airlift transports--C-5s and C-141s--cost $5.9 billion to procure. Annual operation and maintenance costs for the fleet exceed $1.1 billion.

Civilian Reserve Augmentation

The primary advantage of civilian aircraft augmentation is that it does not incur costs to the government during peacetime. Civilian reserve aircraft would be an effective supplement to organic assets during wartime, available at almost no cost to the federal government. Also, when activated, civilian airlift costs less to operate than comparable military air transportation.

The primary disadvantage of civilian reserve augmentation is its inflexibility. In fact, at no time in the 25-year history of the program have civilian reserve assets been mobilized, even at the lowest level of mobilization. Mobilization of commercial planes could be very disruptive to the domestic economy. It could also send important, and perhaps undesirable, signals to both allies and potential adversaries. Further, commercial planes cannot operate under the potentially restrictive conditions (small, rough airfields, for example) that can routinely be handled by military cargo planes. Moreover, airline companies might be hesitant to commit planes to military operations if they feared their future commercial relations with other countries might be jeopardized or if they felt their routine domestic business would be disrupted too severely.

AIRLIFT OPERATIONS IN NATO AND NON-NATO CONTINGENCIES

Requirements for airlift capabilities depend upon the nature of contingencies for which airlift is demanded. Current DoD planning focuses on two types of contingencies as part of the "one-and-one-half war" strategy: a major NATO/Warsaw Pact conflict centered in Europe and a lesser contingency occurring simultaneously elsewhere, notably the Middle East or the Persian Gulf region. These contingencies vary in their requirements for airlift support. Choices among alternative airlift improvement programs will, therefore, be affected by which contingency is emphasized when formulating airlift needs.

Airlift in a NATO/Warsaw Pact War: What Amount of Improvement Is Needed?

Reinforcement objectives currently outlined by DoD call for the delivery of an equivalent of five divisions to Europe within ten days of mobilization, as well as some 1,300 tactical fighter aircraft within a week. These objectives could not be met by airlift forces alone, even with implementation of the enhancement programs noted above. Meeting these objectives would depend on the pre-positioning of combat equipment in Europe for U.S. ground force units that would deploy there in time of war. Airlift resources would then be free to move troops, residual cargo, Marine units, and tactical fighter squadrons upon mobilization. If equipment was pre-positioned for all divisions and support units expected to be in Europe at the outbreak of war, current airlift resources might be able to satisfy reinforcement objectives, so that further airlift enhancement might not be necessary.

Other delivery objectives (those relating to tactical fighter squadrons, for example) might not be met without airlift enhancement. Yet the programs pending before the Congress would improve delivery rates by only a few days. Moreover, alternatives other than airlift, such as pre-positioning more Air Force support equipment, might be considered. Therefore, the additional capability that these airlift improvements would provide might not be commensurate with their cost. Tactical airlift requirements, if considered in the context of a NATO war, also do not appear to justify procurement of a new fleet of tactical transports.

Airlift in a Limited Contingency: What Amount of Improvement Is Needed?

There are no formal delivery objectives for a limited contingency, comparable to those for a NATO conflict, against which the adequacy of the existing airlift fleet and requirements for enhancement can be easily measured . This study examines requirements that might be associated with the deployment of two divisions to the Persian Gulf area. This contingency was chosen because it presents a demanding deployment objective and parallels current Department of Defense planning. Assuming full availability of existing airlift resources, including CRAF, as many as five weeks might be required to deploy a two-division force to the Persian Gulf region, although smaller elements of the force could be delivered within a few days. Airlift improvement programs (CRAF modification and the C-141 stretch) could potentially reduce delivery time by as much as 20 percent for lighter divisions and by a smaller percentage for heavier units.

Potentially serious constraints on existing airlift resources could substantially prolong delivery of forces in a limited contingency. It is uncertain that the CRAF fleet would be fully activated in a limited contingency, though some civilian augmentation could be expected. Programs that increase the capacity of organic transports would compensate for the possible lack of available civilian reserve assets, thus improving the capability of airlift forces to meet limited contingency objectives.

Requirements for tactical airlift in a limited contingency could potentially justify procurement of an advanced tactical transport, such as the AMST. Tactical airlift could be particularly valuable in non-European areas, which lack the sophisticated ground transportation network of Western Europe.

ALTERNATIVE AIRLIFT FORCES FOR THE FUTURE

Airlift forces are a vital component of the U.S. conventional force structure. They are also an expensive component. In choosing among the airlift enhancement programs proposed in the fiscal year 1980 budget, the Congress may wish to evaluate the programs in terms of alternative assumptions about future airlift requirements.

Airlift Improvements to Meet NATO Reinforcement Objectives

The Congress may determine that NATO reinforcement should be the primary planning objective for airlift improvement. Several current reinforcement objectives can largely be met with existing resources, assuming continuation of the program to pre-position equipment in Europe for combat troops. Other delivery objectives that cannot be met at this time could be met with improved airlift. They could also potentially be met by other alternatives, such as further pre-positioning of equipment for support units. Therefore, significant expenditures on airlift enhancement might not be necessary at this time.

Only modest funding might be needed for other airlift enhancement programs. In particular, the CRAF modification program might not be necessary. The C-5 must be retained in the fleet, though a more limited wing modification program than is currently being proposed by the Department of Defense could be sufficient. The C-141 stretch program has progressed to the point that termination at this time would probably not produce substantial savings. Tactical airlift modernization could be limited to replacement of older C-130s with newer models. Restricted to these programs, airlift improvements would cost approximately $422 million in fiscal year 1980 and $2.9 billion to complete the total program.

Airlift Improvements to Meet Limited Contingency Objectives

Alternatively, the Congress may determine that airlift programs should improve the ability of the current system to meet the demands of a limited contingency operation. It could then select improvement programs that enhance the inherent flexibility of the existing organic system. Such programs could include a full wing modification of the C-5, completion of the C-141 alteration program, and replacement of older model C-130s with newer models. These improvement programs would cost $423 million in fiscal year 1980 and $3.5 billion to complete the program. They would not substantially alter delivery rates. They would, however, improve the flexibility of existing organic resources.

An Expanded Airlift System for Limited Contingencies

The Congress might also choose to expand current airlift forces, judging that current resources--even with the improvements outlined above--would be inadequate to meet the demands of limited contingencies. Two substantially different alternatives are available:

- The Congress could choose to improve strategic deployment capabilities by procuring additional outsize transports such as the C-5. Procurement of 50 C-5s would cost $4.6 billion.

- Alternatively, the Congress could choose to improve tactical airlift capabilities, replacing existing C-130s with the AMST. The primary contribution of tactical airlift modernization would be to improve capabilities to reposition units within a theater, though some modest improvement in deployment rates could be expected as well. Procurement costs for a fleet of 277 AMSTs could reach $8.3 billion.

CONCLUSIONS

The Congress must make several important decisions this year concerning airlift resources. The budgetary effect of these decisions will be substantial and immediate, as shown in the following table. These decisions will also determine the structure and capabilities of airlift forces in future years.

Requirements for airlift capabilities and choices among airlift improvement programs depend upon the nature of contingencies for which airlift is needed. The Congress can choose to emphasize NATO reinforcement objectives and thereby avoid substantial budgetary costs associated with the fiscal year 1980 budget. Such a decision, however, would limit the flexibility of airlift forces in the future. Alternatively, the Congress can authorize funds for improvements to the current airlift system to make it more responsive to non-NATO contingencies. In doing so, the flexibility of existing airlift forces would be increased, but at substantially increased costs.

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ALTERNATIVE AIRLIFT FORCES FOR THE FUTURE: IN MILLIONS OF FISCAL YEAR 1980 DOLLARS

Alternative Airlift Forces	Fiscal Year 1980	Total Program Costs (Fiscal Year 1980 and Beyond)
Department of Defense Program Baseline a/		
Full wing modification of C-5s	91	1,087
CRAF modification program	74	554
C-141 stretch program	130	269
KC-10 Advanced Tanker/Cargo Aircraft	190	754
Replace 208 C-130 models A/B/D with model H	202	2,096
Total, DoD Baseline	687	4,760
NATO Reinforcement Airlift Force		
Fastener change on existing C-5s	90	543
Replace 208 C-130 models A/B/D with model H	202	2,096
Continue C-141 stretch program	130	269
Total, NATO Reinforcement	422	2,908
Limited Contingency Airlift Force		
Full wing modification of C-5s	91	1,087
Replace 208 C-130 models A/B/D with model H	202	2,096
Continue C-141 stretch program	130	269
Total, Limited Contingency	423	3,452
Expanded Airlift Force		
Enhanced strategic airlift force		
Procurement of 50 new C-5s	30	4,604
Fastener change on existing C-5s	90	543
Replace 208 C-130 models A/B/D with model H	202	2,096
Continue C-141 stretch program	130	269
Total, Enhanced Strategic	452	7,512
Enhanced tactical airlift force		
Procurement of 277 AMSTs	5	8,256
Full wing modification of C-5s	91	1,087
Continue C-141 stretch program	130	269
Total, Enhanced Tactical	226	9,612

a/ The Department of Defense baseline includes those programs listed in the fiscal year 1980 posture statement. Since DoD has no current plans for tactical airlift modernization, CBO has selected the least expensive option (that is, replacement of 208 C-130 models A/B/D with new model H) for inclusion in the baseline airlift force.

CHAPTER I. INTRODUCTION

The United States government owns and operates the largest fleet of transport airplanes in the western world. Consisting of more than 900 aircraft, the fleet is managed principally by the Military Airlift Command (MAC) of the U.S. Air Force. Military airlift forces permit the rapid delivery of U.S. combat forces in a wide range of potential emergencies.

To enhance the capability of airlift mobility forces, in 1974 the Secretary of Defense proposed a major program of airlift improvements. The Congress has raised questions about portions of this program; 1/ consequently, many of the proposals remain active budgetary issues today. In considering the fiscal year 1980 budget, the Congress will be asked to decide on the following airlift enhancement proposals:

- Continued development and initial production of a new wing for the C-5 military transport.
- Continued procurement and installation of airframe sections to lengthen the fuselage of the C-141 transport.
- Installation of cargo features in new civilian passenger aircraft.

1/ In 1976, the Senate Committee on Armed Services, concerned with the apparent lack of coordination in planning of mobility programs, directed the Department of Defense to undertake a thorough review of mobility requirements and operations. At approximately the same time, the General Accounting Office suggested a framework for evaluating strategic airlift. As a consequence, the Joint Chiefs of Staff were commissioned to conduct a study on mobility requirements and programs. An unclassified summary of that study may be found in *The Posture of the U.S. Military Airlift*, Hearings before the House Committee on Armed Services, 95:1 (September 1977), pp. 25-44.

- Procurement of four additional DC-10s, modified to function as tankers.

- Development of a new tactical aircraft capable of landing on very short and rough fields under combat conditions.

C-5 Wing Modification. The C-5 "re-wing" program is intended to extend the plane's currently projected service life to the original 30,000-hour goal. The fiscal year 1980 budget provides $12.7 million in continued development funds and $78.6 million for initial production of wing components for seven planes. Total program costs are estimated to reach $1.1 billion ($1.3 billion in current year dollars) by fiscal year 1986. 2/ The Congress must decide this year whether to proceed with the re-winging program as proposed by the Department of Defense (DoD) or to pursue instead a less extensive, and less costly, modification.

C-141 "Stretch" Program. The C-141 "stretch" program, which also includes installation of aerial refueling equipment, will increase the plane's potential cargo capacity by as much as 30 percent. The fiscal years 1978 and 1979 budgets provided funds for modification of 17 planes. The fiscal year 1980 budget proposes to modify an additional 65 planes, at an estimated cost of $130 million. Unlike other enhancement alternatives, most of which are still in the initial development or procurement stage, the C-141 stretch program is substantially underway. The Congress will be asked to decide this year whether to extend the modification to the remaining 255 of the fleet of 272 C-141s at a cost of $269 million.

CRAF Modifications. This program would increase the amount of cargo capacity in the civilian sector that could be marshalled for military operations in a national emergency. The fiscal year 1980 budget includes $73.6 million for the installation of cargo features in nine new passenger planes. DoD proposes ultimately to modify at least 65 new planes over the next five years. The Congress authorized funding for a pilot program last year; it must now decide whether or not to proceed in full with the modification program.

2/ All cost figures presented in this paper are in fiscal year 1980 dollars, unless otherwise specified.

Advanced Tanker/Cargo Aircraft. The fiscal year 1980 budget provides $190.1 million for procurement of four DC-10s, which will be modified to function as tankers. Funds for procurement of the first two such planes--designated the KC-10--were authorized in the fiscal year 1979 budget. The total program cost for the proposed remaining fleet of 18 KC-10 tankers would exceed $750 million. Since the program is still in its initial stages, the Congress must decide this year whether to continue procurement and, if so, at what pace.

Tactical Airlift Modernization. A new tactical transport (AMST), capable of landing in very short and rough fields under combat conditions, has been under development for several years. Although the President recommended against procurement two years ago, the question of tactical airlift modernization has persisted. The Air Force is expected to decide between two prototypes this summer, and $5 million has been set aside in the fiscal year 1980 budget for the program. The Congress has an opportunity to decide this year whether to continue the advanced tactical transport program beyond the prototype competition stage. Procurement costs for 277 of these planes could potentially reach $8.3 billion. If the Congress decides not to pursue AMST procurement, it must determine the pace at which older tactical transports should be replaced.

REQUIREMENTS FOR AIRLIFT IMPROVEMENT

Requirements to improve airlift mobility forces are based on their potential use in two possible contingencies: a NATO/Warsaw Pact conflict and a limited contingency occurring elsewhere.

Requirement to Reinforce NATO

Airlift improvement programs have traditionally been justified on the basis of the need to reinforce American ground forces deployed in Europe in the event of a Warsaw Pact attack against NATO. Modernization of Soviet ground forces in Eastern Europe in recent years has led defense planners to conclude that the Warsaw Pact would be able to mobilize and launch a massive attack in Europe in a much shorter period than previously believed. 3/

3/ See Congressional Budget Office, Assessing the NATO/Warsaw Pact Military Balance, Budget Issue Paper (December 1977), especially pp. 20-21.

Under such a short-warning scenario, military airlift would play a crucial role in delivering U.S. reinforcements to NATO.

The current reinforcement objective of DoD mobility programs is to enable the doubling of U.S. ground forces currently deployed in Europe in about 10 days and the delivery of more than 1,300 tactical fighters within one week. 4/ The first objective would involve transporting approximately five divisions, currently based in the United States, to Europe. The only program now underway that can satisfy this requirement involves the advanced positioning of combat equipment in Europe for U.S.-based troops who would deploy there in time of war. 5/ Equipment for approximately two divisions is presently stored in Europe; the Department of Defense has proposed to pre-position equipment for an additional three divisions over the next several years. With advanced positioning of equipment, airlift forces would be used only to transport troops and the small proportion of division equipment that will not be pre-positioned.

Without pre-positioning equipment, DoD's NATO reinforcement objectives could not be met, even with the airlift enhancement programs noted above. If, on the other hand, equipment for five divisions was pre-positioned in Europe, as proposed by DoD, the current airlift system--without the enhancement programs--could meet the 10-day delivery requirement for ground combat units. 6/ Without airlift enhancement, however, some tactical fighter squadrons would arrive several days after their desired delivery, as would some support units for ground combat forces. There are alternatives to airlift improvement, however, that might allow these objectives to be met. Further, it should be noted that the delivery schedules are planning objectives that are subject to evaluation as well.

4/ U.S. Department of Defense, Annual Report, Fiscal Year 1978, p. 201.

5/ The advanced positioning of combat equipment in Europe is discussed in Congressional Budget Office, Strengthening NATO: POMCUS and Other Approaches, Background Paper (February 1979).

6/ This question is discussed at greater length in Chapter IV.

If NATO reinforcement is judged to be the primary requirement for which airlift forces are improved, it is questionable whether all of the programs envisioned under the enhancement program are necessary.

Mobility Requirements in Limited Contingencies

While NATO reinforcement has dominated defense planning of mobility forces in recent years, the primary advantage of airlift is its ability to respond to a broad range of circumstances in virtually any location. This capability has been appreciated by every President since the end of World War II, and airlift forces have been a critical element in many operations during this period. 7/ Indeed, if American forces were required to assist in the defense of South Korea, or were to be deployed to the Middle East or Persian Gulf areas to aid a friendly country, airlift forces would be indispensible. 8/

These projected limited contingencies place different, and in some instances greater, demands on airlift forces than does the reinforcement of NATO. For example, equipment for U.S. ground forces is pre-positioned only in Europe. In the event of a contingency elsewhere in the world, deployment of combat forces would require that equipment as well as troops be airlifted. While current airlift forces are capable of carrying out such an operation, it is uncertain whether all elements of the airlift system would be available in a limited contingency. The current airlift system relies heavily on commercial transports to supplement military operations. Civilian augmentation is questionable in limited contingencies. Airlift improvements could be made that would help overcome that limitation, however.

7/ Few of these operations have been taxing. The Military Airlift Command was called upon to deliver emergency supplies to Israel in 1973, to evacuate Americans and Vietnamese from Southeast Asia in 1975, and to deliver goods and combat troops to the Shaba province in Zaire in 1977 and 1978. "Humanitarian" missions, such as the evacuation of American dead from Jonestown, Guyana, are more recurrent, though less demanding.

8/ U.S. Department of Defense, Annual Report, Fiscal Year 1980, p. 202.

PURPOSE OF THIS STUDY

The two types of contingencies discussed above suggest different goals for airlift improvement. If NATO reinforcement is judged to be the primary requirement for which airlift forces are structured, the objective of an airlift improvement program would be to store, as inexpensively as possible, wartime airlift capacity. If, on the other hand, airlift improvements are intended to strengthen U.S. capability to meet limited contingencies, wartime flexibility should be the primary goal of an improvement program.

A number of airlift improvement proposals will be considered by the Congress this year. Decisions on these programs will substantially affect the nature of airlift forces in the future and their ability to respond to future requirements. In choosing among contending alternatives, the Congress will have to examine two primary questions:

- What types of contingency requirements should guide airlift improvement, and what amount of enhancement is needed?
- What margin of flexibility should be maintained in the future airlift system to meet those requirements?

This paper examines the current airlift mobility system in terms of those factors that have relevance for upcoming decisions on airlift improvement programs. Chapter II describes the current airlift system in terms of its components and types of missions. Chapter III examines the system in terms of its performance. Specific attention is given to the effect of each of the improvement programs on performance, as well as to the advantages and disadvantages of each enhancement program. Chapter IV examines the major types of airlift contingencies that could be used to evaluate the need for and extent of airlift improvement. The chapter concludes by considering several alternative airlift improvement programs.

CHAPTER II. THE AIRLIFT SYSTEM

This chapter introduces and analyzes the basic features of the structure of U.S. airlift mobility forces. The chapter begins with a description of the components of the existing airlift system. It then outlines the mission requirements of airlift forces and examines the factors that affect their operation.

BASIC FEATURES OF THE AIRLIFT SYSTEM

The features of the U.S. airlift system parallel and reflect the basic determinants of defense planning in the post-World War II period. Defense planning is dominated by the prospect of war with the Soviet Union, either in a strategic nuclear conflict or in a conventional war between NATO and Warsaw Pact forces in Central Europe. The magnitude of Soviet military capability imposes tremendous pressure to increase U.S. defense capabilities. A strong national defense, it is argued, will serve to deter Soviet aggression.

Defense spending reflects the tension between providing military resources sufficient to deter Soviet aggression while keeping American defense expenditures as small as possible. The pressure to find less expensive ways to store war-fighting capacity during peacetime has only been amplified in recent years by the massive and continuing modernization of Soviet conventional forces. The structure of the U.S. airlift system--particularly the distinction between organic and civilian reserve aircraft and between active-duty and reserve manpower--reflects this dual objective of improving war-fighting capability while minimizing annual peacetime operating costs.

Organic Transports vs. Civilian Reserve Aircraft

The U.S. airlift system consists of two distinct components: (1) planes owned and operated by the U.S. government and managed by the Military Airlift Command and the Air National Guard (organic airlift transports); and (2) commercially owned jet aircraft which, during time of war, could be used to augment organic resources. The commercial planes are organized into the Civil

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Reserve Air Fleet (CRAF), 1/ created in 1951 by executive order to meet emergency airlift requirements in excess of MAC organic capability. The primary advantage of civilian reserve aircraft is that they can provide an effective supplement to organic airlift at almost no peacetime cost. When activated, CRAF costs less than comparable military air transportation. Commercial airlines have subscribed 262 passenger planes and 113 cargo planes to the CRAF program. These are long-range aircraft that would be assigned to augment organic military assets in intertheater airlift operations. 2/ CRAF planes are mobilized in three stages. Stage I can be activated by the Commander of MAC and currently consists of about 15 percent of all planes in the CRAF program. Stage II is activated by the Secretary of Defense to provide airlift capability for a major contingency requirement not warranting national mobilization. Full mobilization of CRAF--Stage III--is activated only after a national emergency is declared by the President or the Congress.

As late as 1970, the Department of Defense contended that CRAF "cannot be used in the combat airlift role." The primary mission assigned to CRAF was the replacement of long-range military airlift capability withdrawn from worldwide logistics operations to support specific deployment emergencies. 3/ By contrast, current DoD mobility studies envision full CRAF participation

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1/ The CRAF program is but one of three programs planning for the use of civilian airplanes during wartime. The Civil Aeronautics Board (CAB) manages the War Air Services Program (WASP); the Federal Aviation Administration (FAA) oversees the State and Regional Defense Airlift (SARDA) plan. These two programs are intended to provide a means of controlling airlift assets during wartime to meet priority domestic requirements. The SARDA plan affects small planes in civil aviation; the WASP program includes all CAB-licensed planes not assigned to the CRAF program.

2/ An additional 95 planes in the CRAF fleet would be assigned to domestic and short-range international missions, such as supplying forces in Alaska. These planes are intended to assume routine domestic supply operations during wartime.

3/ Military Airlift, Hearings before the Subcommittee on Military Airlift, House Committee on Armed Services, 91:2 (January and February 1970), p. 6284.

in airlift operations in a NATO war. 4/ This reflects the increasingly important contribution of CRAF as a source of emergency airlift capacity.

By way of contrast, the MAC organic fleet consists of 353 long-range airplanes--77 C-5 Galaxies and 276 C-141 Starlifters--that are designed specifically to operate in a broad range of potential situations, including hostile conditions. 5/ Organic transport aircraft are expensive to procure and operate. There are two components to the costs of organic airplanes. One involves the performance penalties associated with aircraft designed for military operations. Because of their unique design features and extra weight, their operating expenses are approximately 14 percent higher than those of commercial planes. 6/

Far larger is the cost associated with owning organic aircraft, regardless of airplane design. Acquisition of the current fleet of C-5s and C-141s cost $5.9 billion in then year dollars and $12.8 billion in fiscal year 1980 dollars. Annual operating expenditures exceed $1.1 billion. To minimize operating costs, the C-5 and C-141 are flown only at rates necessary to meet

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4/ See written statement of General William G. Moore in The Posture of the U.S. Military Airlift, Hearings before the House Committee on Armed Services, 95:1 (September 1977), p. 11.

5/ Organic airlift assets are designed to operate in rough areas under combat conditions and share similar design characteristics. The cargo floor is at the bottom of the plane (rather than in the middle, as is the case with civilian jetliners) to facilitate loading and unloading. The wings are at the top of the fuselage, and the tail is swept up so that cargo can be loaded through a rear drive-in door and ramp. This also makes it possible to parachute cargo from the plane so that the aircraft need not land in hostile territory. Landing gear of organic transports is sturdier than comparable civilian equipment.

6/ For example, the C-5 carries approximately 40,000 pounds of dead weight caused by its sturdier landing gear, reinforced floors, built-in cargo handling systems, and so on. Also, the wing design of the C-5 forces it to fly at a slightly lower cruising speed than comparable commercial aircraft.

minimum requirements for air crew training and proficiency. Currently, the C-5 averages a 1.8-hour utilization rate per day 7/ and the C-141, 3.23 hours per day.

Organic transports have many advantages over civilian reserve planes. They are designed to carry virtually the full inventory of military cargo, including many items too large or too heavy for commercial transports. 8/ Military transports have built-in cargo handling equipment and, unlike commercial freighters, are not restricted to airports with such equipment in place. 9/ Organic assets also provide greater certainty in planning. Their availability in a national emergency is assured, and they can respond to DoD direction without significantly disrupting the civilian economy. Similarly, detailed loading plans can be developed and rehearsed. Since only a small portion of the cargo airlifted in time of war will be on pallets, 10/ familiarity with Army equipment and loading configurations is necessary for efficient wartime operations.

7/ A utilization rate is a planning concept that reduces airplane operating rates, on a system-wide basis, to a single figure expressed in terms of daily flying hours. Three factors largely determine the utilization rate: the number of air crews, the number of maintenance crews, and the availability of spare parts. The utilization rate thus expresses system-wide performance, subsuming in the figure the many complex factors that affect a plane's performance at any one time.

8/ Substantial modification of the B-747 would be required, for example, to enable it to carry the main battle tank--the M-60--or the new XM-1. The plane's flight deck would have to be raised in order to accommodate a larger nose door. See The Posture of Military Airlift, Hearings before the Subcommittee on Research and Development, House Committee on Armed Services, 94:1 (November 1975), pp. 335-36.

9/ Special equipment is needed to elevate cargo for loading onto commercial transports. The cargo floor of a military transport can be as low as five feet off the runway, whereas a B-747's cargo floor is 16 feet from the ground.

10/ Bulk cargo is generally loaded on pallets, which are in turn loaded on planes by fork-lift trucks.

Besides lacking the design advantages of military transports, civilian reserve planes have other significant disadvantages. Mobilization of the CRAF fleet could be disruptive to the domestic economy--acceptable, perhaps, only in the event of a substantial national emergency. 11/ Mobilization could also send important, and perhaps undesirable, signals both to allies and to potential adversaries that might exacerbate international tension and, perhaps, even lead to preemptive military action. Equally important, airline companies might be reluctant to commit planes to military operations if they feared their future commercial relations with other countries could be jeopardized or if they felt their routine business would be disrupted too severely. 12/

The division of military airlift into organic and civilian reserve assets has evolved over the years and has become a central feature of the airlift system. As will be seen, it has direct relevance to the range of potential budgetary options that might be appropriate for varying contingency requirements.

Active-Duty vs. Reserve Manpower

Reliance on both active-duty and reserve manpower for airlift operations is similarly a product of efforts to reduce peacetime costs of wartime capacity. Accordingly, MAC relies heavily on reserve forces. Half of the C-5 and C-141 air crews are now, or are scheduled to be, filled by reservists, as are 35 percent of maintenance crews and 50 percent of aerial port personnel.

11/ Nearly 80 percent of all civilian international cargo transports are in CRAF, as are 55 percent of all wide-body international passenger aircraft. See Civil Aeronautics Board, War Air Service Program (WASP), Resource Report, Calendar Year 1978, Tables 3 and 7.

12/ During the Israeli airlift in 1973, for example, CRAF carriers were hesitant to commit airplanes, in part because they risked a potential loss of landing rights in Arab countries. It should be noted, however, that CRAF planes operated extensively under contract during the Vietnam War, though without formal mobilization. Two contending interpretations of CRAF reliability in times of emergency are found in statements by General William G. Moore and Admiral Thomas Moorer in The Posture of the U.S. Military Airlift, Hearings, pp. 43, 142.

The use of reserve units substantially reduces annual operating costs of organic airlift assets. As can be seen in Table 1, the operating costs of a C-141 squadron and a C-5 squadron would increase by 53 percent and 21 percent, respectively, if current reserve manpower were replaced by active-duty personnel.

TABLE 1. ANNUAL SQUADRON OPERATING COSTS AT CURRENT MANNING AND ALL ACTIVE-DUTY MANNING: IN MILLIONS OF 1978 DOLLARS

	Current Manning	All Active-Duty Manning	Percent Increase
C-141 Squadron			
Personnel	19.1	23.8	25
Direct operating	26.8	46.3	73
Indirect support	0.3	0.5	67
Total	46.2	70.6	53
C-5 Squadron a/			
Personnel	30.0	41.0	37
Direct operating	68.4	77.7	14
Indirect support	0.5	0.9	80
Total	98.9	119.6	21

SOURCE: Information provided to CBO by U.S Air Force (January 10, 1979).

a/ These figures reflect reduced utilization rates because of the C-5 wing-life preservation program. As such, personnel and direct operating costs are lower because crews are currently at a 3.25 ratio rather than the four-crews-per-plane ratio for the C-141. They will increase when the four-to-one crew ratio is established for the C-5 as well.

According to the Air Force, four air crews per plane are required to sustain programmed wartime utilization rates. 13/ If reservists were not called up, only half the airlift capacity of the organic fleet would be available for emergency requirements. It is doubtful that the President would order deployment of a substantial combat force without calling up some Air Force reservists, however. It is important to note that the President has the statutory authority to call up as many as 50,000 reservists selectively without a general mobilization. Only approximately 13,500 reservists would be required to reach programmed wartime operating rates for MAC, however.

AIRLIFT OPERATIONS AND THE AIRLIFT SYSTEM

Military airlift has traditionally been characterized by the dichotomy between strategic (intertheater) and tactical (intratheater) airlift operations and assets. In 1974 the Secretary of Defense directed the consolidation of all strategic and tactical airlift operations under the Military Airlift Command. Prior to that time, MAC was responsible only for strategic mobility, which was defined as long-distance transportation between theaters of operation or from the continental United States to a combat theater. Tactical airlift, previously a function of the Tactical Air Command and under the control of local commanders, was used to move troops and materiel within a given combat theater. Although this distinction between strategic and tactical operations is becoming somewhat blurred by current and prospective enhancement programs, it is useful to note the factors that have traditionally distinguished these two categories.

The Military Airlift Command and the strategic airlift mission had their origins in the Military Air Transport Service (MATS). MATS was, for all practical purposes, an air transportation agency for the Department of Defense in the 1940s and 1950s, equipped with aircraft similar to those operated by the commercial airlines. Renewed emphasis in the 1960s on general purpose forces contributed to an evolution in MATS, especially with the introduction of jet technology to air transport. The procurement of the C-141, and later of the C-5, reflects the shift from an air transport mission to a strategic, long-range

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13/ See testimony by Brigadier General Charles C. Irions in The Posture of the U.S. Military Airlift, Hearings, p. 22.

deployment mission. Strategic airlift now involves the deployment of entire air and ground combat and support units, together with their equipment and initial supplies, directly from the continental United States to a combat theater. Through advance planning, those units can arrive as an integrated fighting force, requiring only minimal preparation time. 14/

The evolution of tactical airlift has been less dramatic. Traditionally, the primary function of tactical airlift has been to provide an air line of communication, bringing small critical quantities of cargo--often ammunition or important spare parts--directly to a combat unit. Only 3 to 5 percent of logistical resupply is airlifted; most supplies are delivered by ground transportation. Tactical airlift can also conduct airborne operations, such as parachute airdrops of men and equipment. Such missions comprise less than 5 percent of all aerial delivery, however. 15/ During the Vietnam War, a large portion of tactical airlift missions consisted of routinely scheduled passenger flights. With the exception of the Tet offensive, emergency resupply missions comprised only a small fraction of total missions.

Aircraft used for strategic and tactical airlift missions reflect the different requirements of those missions in their design and size. Strategic transports--the C-5 and C-141--are designed to carry large cargoes over long distances, as shown in Table 2. More importantly, because of the differences in distance between tactical and strategic missions, the C-5 and C-141 can fly at higher utilization rates than can tactical transports. 16/

14/ The requirement to transport troops together with their equipment was reflected in specific procurement designs of the C-141 and C-5. Both aircraft can carry small numbers of troops in addition to cargo. The C-141 can carry six troops in addition to its cargo payload; the C-5, as many as 71. Through a full deployment operation by air, troops can thus be delivered at approximately the same time as their equipment.

15/ Military Airlift, Hearings, p. 6366.

16/ In strategic missions, more time is consumed in actual flying, thereby increasing system-wide utilization rates.

TABLE 2. STRATEGIC AND TACTICAL AIRCRAFT PERFORMANCE DATA

	Payload a/ (pounds)	Range b/ (nautical miles)	Speed c/ (nautical miles per hour)	Programmed Utilization Rates d/ (hours)	Number in Fleet e/
Strategic					
C-5	215,339	5,900	428	12.5/10	70
C-141	67,620	5,175	407	12.5/10	234
Tactical					
C-130E	41,892	4,030	260	4.0	474
C-123	14,500	2,400	132	2.5	64
C-7	6,000	1,175	107	2.5	48

a/ Payload is expressed in terms of allowable cabin load (ACL), the maximum payload by weight. ACL will rarely equal lift potential achieved, however, since critical distance requirements could lower payloads.

b/ The range is the maximum distance a plane can fly with no payload, known as the "ferrying" range. The ranges given for the C-123 and C-7 require external fuel tanks.

c/ Speed is expressed in "block-in" speed, which averages cruising speed with slower speeds during approaches and take-offs. Block-in speeds and cruising speeds converge as mission distances increase.

d/ Utilization rates are fleet-wide averages of flying time. For strategic transports, the first number reflects the utilization rate for the first 45 days of an airlift operation. For deployments requiring more than 45 days, an aircraft will operate at the lower number for the duration of the deployment. If the utilization rate for an aircraft is doubled, it will take half as long to perform the same mission. Utilization rates are determined by the number of air crews, maintenance crews, and the quantity of spare parts. Shorter-distance missions always lower overall utilization rates.

e/ Primary Aircraft Authorization (formerly Unit Equipment). These figures reflect the number of planes assigned to authorized active or reserve airlift units. Additional planes are held for other purposes.

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A distinction between strategic and tactical airlift operations can also be made in terms of operational conditions. Strategic transports like the C-5 and C-141 require long runways with substantial load-bearing capabilities. 17/ The high volume of traffic in an emergency operation would require airports with large unloading ramps. These characteristics limit the number of airports available for strategic operations. Tactical transports like the C-130 are rugged airplanes, designed to land on rough surfaces very close to the combat area. Of total usable airfields in Europe, for example, there are six times as many "tactical" as "strategic" airfields. 18/

A final factor that affects airlift operations is the type of cargo to be moved. Military cargo falls into one of four categories. The first, called "not air transportable" (NAT), consists of items that, for reasons of size or weight or both, cannot be carried by any currently available airplane and must be transported by overland carriers or ships. Only a very few items--such as locomotives, barges, and rockcrushers--fall into this category.

Equipment that can be transported by air falls into one of three categories: bulk, oversize, or outsize. Bulk cargo is loaded onto freight pallets (104 by 84 inches) which can be carried by any organic or civilian CRAF airplane. Oversize

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17/ The C-5 was designed to land on *a* relatively short runway of 5,000 feet. While this is still technically possible, such missions are rarely attempted. Structural problems with the C-5's wing have imposed constraints that significantly increase required runway length. In addition, few day-to-day missions are of sufficient importance to risk the expensive C-5 in short field operations.

18/ So-called "strategic" fields are those that, because of combinations of runway length, load-bearing capability, ramp area, airport lighting, instrument landing equipment and so on, can be used as airports of debarkation (APODs), which are major terminals of an airlift operation. "Tactical" fields are those usable fields that do not meet the above criteria guidelines. Currently, the C-130 can operate in about half of the tactical fields in Europe and in all APOD fields. The C-5 and C-141 can operate in less than 25 percent of European airfields.

cargo is too large to be loaded on pallets but can be carried by organic transports, such as the C-130, C-141, C-5, or by wide-body CRAF planes like the DC-10 or B-747. 19/ The five-ton truck is an example of "oversize" cargo. Outsize cargo (for example, tanks and self-propelled guns) cannot be carried on the C-141 and, because of weight or size, can only be transported by the C-5 Galaxy.

The proportion of bulk, oversize, and outsize cargo varies by type of combat unit. An armored division has more than 40 times as much outsize equipment (expressed in terms of weight) as an airborne division and two and a half times the oversize equipment. All divisions have approximately the same amount of bulk equipment, although the proportion of bulk equipment to total divisional cargo is higher in the so-called "lighter" divisions than in armored or mechanized divisions. As discussed in Chapter III, the mix of cargo to be transported has a direct impact on strategic airlift performance.

19/ The C-130 and the C-141 have the same cross-section cargo compartment. The C-141's cargo compartment is longer than that of the C-130, however. Some equipment that can be carried intact by the C-141 must be disassembled to be transported on the C-130.

CHAPTER III. OPERATIONAL PERFORMANCE OF THE AIRLIFT SYSTEM

This chapter examines the current capabilities of the airlift system and the effect that different improvement programs would have on its performance. The chapter begins with a discussion of the overall system in terms of airlift capabilities, outlining the relationship of the various structural components. The chapter concludes with an examination of the contribution of various enhancement programs currently before the Congress.

CAPABILITIES OF THE CURRENT AIRLIFT SYSTEM

Organic transports and civilian reserve aircraft make roughly equal contributions to total airlift capacity, as shown in Table 3. The real capability of the airlift system, as well as limitations on its ability to meet airlift requirements in the future, is a function of several complex factors beyond the number of planes available and their lift potential. In any given contingency, the distance that must be flown is a major determinant of the time--frequently known as "closure time"--required to complete a mission. Equally important is the nature of the contingency and the mission assigned to American combat units. Some missions and combat environments require a "heavy" force, consisting of armored and mechanized units. At other times, "lighter" combat units--such as the 82d Airborne Division or the 6th Air Cavalry Combat Brigade--might satisfy combat mission requirements. A mechanized or armored division might be preferable if similar units would be confronted in combat, but that obviously would require more airlift capacity over a longer period of time. Table 4 illustrates the distribution of bulk, oversize, and outsize cargo among the five basic types of Army divisions. As the table indicates, a mechanized division weighs more than three times as much as the 82d Airborne Division. Since bulk cargo for the two divisions is relatively equal, the difference is attributable primarily to the amount of outsize and oversize unit equipment fielded by the two types of divisions.

TABLE 3. PROGRAMMED AIRLIFT CAPABILITIES BY TYPE OF AIRCRAFT

	Million Ton-Miles Per Day	Million Passenger-Miles Per Day	Percent of Total
Organic Airplanes			
C-5	11.5	--	21
C-141	11.1	--	20
CRAF			
Wide-body cargo	4.8	--	9
Narrow-body cargo	5.6	--	10
Passenger	--	146.7 a/	40 a/
Total	33.0	146.7	100

SOURCE: See Appendix A.

a/ Passenger-miles are converted to ton-miles for purposes of comparison, by assuming that the average weight of each passenger and his gear is 300 pounds.

TABLE 4. ESTIMATED AIRLIFT REQUIREMENTS BY TYPE OF DIVISION: IN SHORT TONS FOR 1976

Division Type	Outsize		Oversize		Bulk		Total
	Short Tons	Percent	Short Tons	Percent	Short Tons	Percent	
Armored	27,658	50	21,704	39	5,979	11	55,341
Mechanized	21,213	44	21,577	44	5,778	12	48,568
Airmobile	1,702	11	8,345	55	5,182	34	15,229
Airborne	593	4	8,814	60	5,226	36	14,633
Infantry	7,760	26	16,395	55	5,596	19	29,751

SOURCE: Information provided to CBO by U.S. Air Force.

The density (that is, the weight per unit volume) of cargo to be transported also varies among division types. Density determines the payload an aircraft can carry, subject to the overall constraint of maximum take-off weight. The higher the density, the greater the payload. Average payloads for the five types of Army divisions are shown in Table 5. While a mechanized division might weigh three times as much as an airborne division, it might take only twice as long to deploy, since planes carrying equipment of a mechanized division can average payloads 60 percent greater than those carrying an airborne division.

Figure 1 illustrates the relationship among the many variables that determine airlift capacity. The curves in the figure relate distance to closure time by type of unit. It should be noted that these curves are highly approximated and indicate transit time only. They are useful in demonstrating relationships, however, since important variables and assumptions are held constant throughout. 1/

Three types of divisions are shown: the 82d Airborne Division, a hypothetical infantry division, and a hypothetical mechanized division. 2/ Lines parallel to the horizontal axis indicate distances of various possible destinations from U.S. ports of embarkation. As distance increases, so does the length of time needed to deliver the respective types of combat forces.

Because of variations in airplane characteristics and in cargo weight, density, and composition, delivery curves for each type of division have differing slopes. 3/ Since airlift forces are procured and maintained primarily to ensure rapid delivery

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1/ See Appendix A for a discussion of the methodology used in this paper.

2/ Mechanized and infantry divisions vary slightly in weight; therefore, "average" divisions are used. Since the Army has only one airborne division, specific tonnages are given.

3/ The delivery rates relate the change in closure time to changes in distance, assuming that cargo and lift variables are held constant.

TABLE 5. AVERAGE PAYLOADS FOR ORGANIC AND CIVILIAN RESERVE PLANES: BY TYPE OF DIVISION, AVERAGED OVER A CRITICAL LEG OF 3,100 NAUTICAL MILES a/

Division Type	Average Payload in Tons, by Type of Plane C-5	C-141	CRAF 707 b/	CRAF 747 c/
Armored	68.5	20.8	30.0	72.9
Mechanized	68.5	20.8	30.0	72.9
Infantry	68.5	17.8	30.0	72.9
Airborne	54.6	13.9	30.0	72.9
Airmobile	30.1	12.9	30.0	72.9

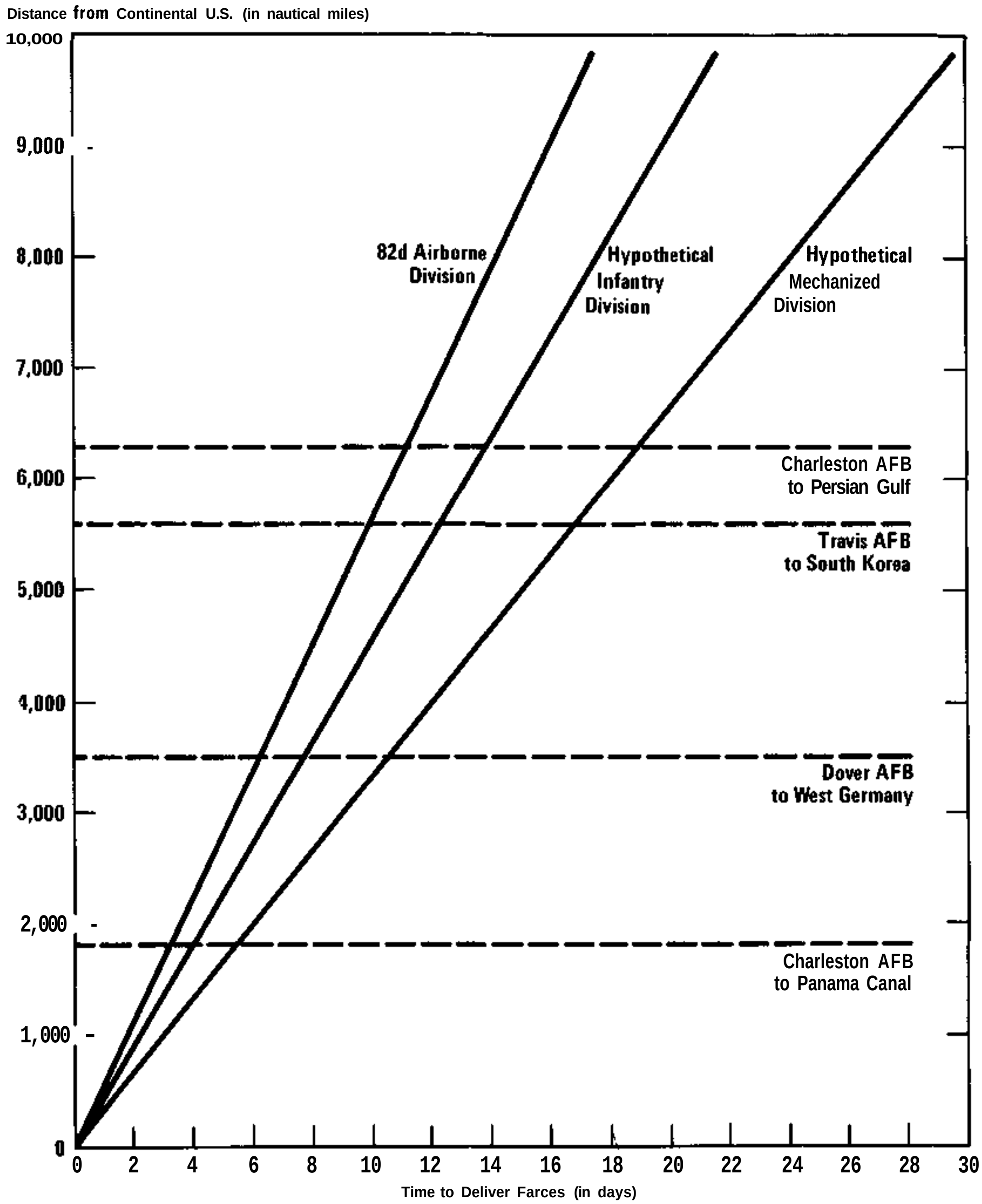
SOURCE: Air Force Regulation 76-2.

a/ Distance from Elmendorf Air Force Base, Alaska, to Yokota, Japan.

b/ Narrow-body commercial transports are converted to a common unit, characterized as B-707 equivalents. Differing speeds, payloads, and volume factors for each type of plane are indexed against the B-707. These aircraft can transport bulk cargo only.

c/ This refers to B-747 equivalent units. The average payload for the 747 is computed as 75 percent of maximum allowable cabin load over distances comparable to those used to compute payloads in the first two columns. While wide-body aircraft can transport oversize cargo, not all of the usable volume of the cargo compartment can carry oversize equipment. For purposes of these calculations, it is assumed that 75 percent of the payload is oversize and the remaining 25 percent is bulk cargo.

Figure 1.
Delivery Time as a Function of Distance, by Type of Division[a]



[a] Divison includes initial support increment.

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of combat units, it is of primary interest to examine the slopes of these lines, the factors that affect those slopes, and how they might be altered by the varying enhancement programs currently before the Congress or expected to be considered in the near future.

Table 6 provides delivery rates (more technically, slope coefficients) for the three types of divisions, relating the contribution of the various elements of the airlift system discussed in the preceding chapter to closure time. Higher numbers indicate faster delivery rates. Several observations can be offered. First, a heavy division takes roughly half again as much time to deploy as the lightest division, the 82d Airborne. Since the proportion of outsize cargo in a mechanized division far exceeds that of the 82d Airborne, the C-5 must carry more outsize cargo and cannot carry as much bulk and oversize cargo as it can when transporting a lighter division. Indeed, an airlift enhancement program that does not increase outsize capacity will only minimally improve overall closure times for heavy divisions.

Second, full CRAF augmentation cannot compensate for the absence of reservists flying organic transports. Because CRAF aircraft lack outsize cargo capacity, loss of organic lift can be compensated for by CRAF augmentation only to a limited extent. Indeed, if a mission called for delivery of a mechanized division, full CRAF augmentation could not compensate for the outsize capability lost because of lower utilization of the C-5.

Third, if neither CRAF augmentation nor reserve components were available during an airlift operation, closure times for airborne, infantry, and mechanized divisions would be increased by 150 percent, 150 percent, and 120 percent, respectively. If an airlift operation was conducted over a very long distance (6,300 nautical miles to the Persian Gulf, for example), it might take as long as three weeks to deliver a mechanized division and as long as seven weeks if no CRAF augmentation and lower organic asset utilization compounded airlift problems. 4/

4/ Ships could potentially reach a Persian Gulf port in five weeks.

TABLE 6. AIRLIFT PERFORMANCE AT FULL AND REDUCED SYSTEM OPERATIONS

	Delivery Rate by Type of Division a/		
	82d Airborne	Hypothetical Infantry	Hypothetical Mechanized
Full Organic/ Full CRAF b/	.55	.45	.33
Full Organic/ No CRAF c/	.39	.32	.27
Partial Organic/ Full CRAF d/	.35	.27	.17
Partial Organic/ No CRAF e/	.22	.18	.15

SOURCE: See Appendix A.

a/ Expressed in thousand miles of distance per day for each type of division. For example, ".55" for the 82d Airborne Division indicates that, for each day of delivery time permitted, the division can be transported approximately 550 miles.

b/ All organic assets at programmed utilization rates; full CRAF augmentation; strategic augmentation by tactical airlift.

c/ All organic assets at programmed utilization rates; no CRAF augmentation; strategic augmentation by tactical airlift.

d/ Organic planes flown at reduced rates because of absence of reservists; full CRAF augmentation; strategic augmentation by tactical airlift.

e/ Organic planes flown at reduced rates because of absence of reservists; no CRAF augmentation; strategic augmentation by tactical airlift.

THE EFFECT OF ENHANCEMENT PROGRAMS ON AIRLIFT PERFORMANCE

This section examines the effect of various enhancement programs on airlift performance. Since the different elements of the airlift system contribute in varying measure to airlift performance, enhancement programs will also have different effects, depending on which element of the system is altered.

Aircraft Conservation: C-5 Wing Replacement

The C-5 wing modification program is not in itself an enhancement initiative, since it will not increase airlift capacity. It will, however, conserve a crucial element of the current system. The C-5 was initially intended to have a service life of 30,000 hours. 5/ Numerous structural problems were uncovered during production and testing, many of which were corrected by a formal system of engineering changes. Despite these modifications, surface wing-panel cracking (occurring at fastener holes where panels were spliced together) persisted, leading to a major engineering review program. This review concluded that structural components of the wing will have to be replaced if the C-5 is to achieve a service life of 30,000 flying hours.

The C-5 re-winging program, proposed by the Air Force, would involve the manufacture and installation of a new wing at an estimated cost of $1.1 billion in 1980 dollars. A Defense System Acquisition Review Council (DSARC) is scheduled to meet in September 1979 to determine whether or not to proceed with production and installation of a new wing. If that review is favorable, the modification program will begin in 1981. The fiscal year 1980 budget proposal provides $78.6 million to manufacture components for seven wings. The Congress must decide this year whether to proceed with the program as proposed by the

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5/ Actually, the 30,000-hour service life objective was not formalized in the C-5 contract. Nonetheless, it was understood to be a design objective. This analysis relies heavily on a Rand Corporation study of strategic airlift alternatives for the future. See W.E. Hoehn and others, Strategic Mobility Alternatives for the 1980s: Volume 3, Technical Appendixes (Santa Monica: The Rand Corporation, March 1977), especially Appendixes B through H (unclassified).

Department of Defense. Air Force spokesmen have labeled the C-5 wing modification program as their first priority among all airlift enhancement programs. 6/ Without the alteration, they contend, the C-5 will have to be retired from service by the mid-1980s.

While the C-5 contributes only 21 percent of total airlift capacity, it is the only transport--civilian or organic--currently in the fleet that can carry outsize cargo. The importance of the C-5 to strategic airlift capability is demonstrated in Table 7. The impact of losing C-5 capability differs by type of division.

TABLE 7. CLOSURE TIME AS A FUNCTION OF C-5 AVAILABILITY

	Delivery Rate by Type of Division a/		
	82d Airborne	Hypothetical Infantry	Hypothetical Mechanized
Full Organic/Full CRAF	.55	.45	.33
25 Percent Reduction in C-5 Fleet Capacity	.51	.40	.25
50 Percent Reduction in C-5 Fleet Capacity	.42	.27	.17
75 Percent Reduction in C-5 Fleet Capacity	.21	.14	.08
No C-5 Contribution	---	---	---

SOURCE: See Appendix A.

a/ Expressed in thousand miles of distance per day for each type of division. For example, ".55" for the 82d Airborne Division indicates that, for each day of delivery time permitted, the division can be transported approximately 550 miles.

6/ See The Posture of Military Airlift, Hearings before the Subcommittee on Research and Development, House Committee on Armed Services, 94:1 (November 1975), p. 225.

Light divisions would not be affected as dramatically as heavier divisions by a reduction in outsize cargo capacity. Nonetheless, total division closure time is directly related to the availability of C-5s. As can be seen, closure times increase as the number of C-5s decreases. If no C-5s were available, however, no outsize cargo could be transported. The 82d Airborne Division could probably function as a combat unit under such circumstances, but a mechanized or armored division could not.

Since it would cost $1.1 billion to modify the C-5, the decision merits close examination. There certainly is no question that the C-5 is indispensable to current strategic airlift capabilities. It is equally clear that the current wing will not attain a 30,000-hour service life. The Congress may, however, wish to question whether a 30,000-hour service life is still a necessary design goal for the C-5.

The C-5 service life of 30,000 hours was based on initial plans to fly each plane 1,800 hours a year. Currently, utilization rates are held to 1.8 hours a day, which, over a year, totals 657 hours. Even with a new wing, MAC intends to operate the C-5 fewer than 800 hours a year. 7/ The C-5 was originally intended to have an active life span of 17 years. If the new wing does permit a 30,000-hour service life, and the remainder of the airframe can perform to that goal as well (which is questioned by some), the plane would potentially remain in the active fleet 38 years after modification. Within that time period, an entirely new generation of military/civilian cargo transports is anticipated. 8/ Since 14 years will have elapsed between the end of

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7/ Information provided to CBO by the U.S. Air Force (March 26, 1979).

8/ The Air Force has been examining the possibilities of a follow-on cargo transport. NASA and USAF Systems Command have contracted with a Washington area research corporation to examine technical and cost questions associated with any proposed C-XX. (XX stands for the numerical designation of the new plane.) Central to the idea of a new transport is the prospect for designing an aircraft that would be commercially feasible and yet have a militarily useful design configuration. In the past, all commercial transports were modified passenger planes. See "USAF Plans Cargo Aircraft for the 1990s," Flight International (August 12, 1978), p. 461.

production of the C-5 and the completion of the wing replacement program, it could be questioned whether an additional 30,000 hours, or 38 years, is necessary. If the Congress determines that a service life of fewer than 30,000 hours is acceptable, several options--costing considerably less than the wing replacement proposal--might be considered.

One such alternative would limit modification to a relatively simple fastener change. This modification, in conjunction with a less conservative estimate of the safe service life, 9/ could produce substantial fleet life extension at far less cost than the DoD program. As Table 8 indicates, a fastener change on low-damage aircraft, combined with a 10,000-hour service limit, would extend the useful life of the C-5 fleet until the end of the century. The Rand Corporation has estimated that this adjustment could be made at about one-third the cost of the re-winging program proposed by the Air Force. 10/ Modifications more extensive than a fastener change, though less extensive and less costly than full re-winging, could also be made. A Congressional decision on the desired service life of the C-5 should be made in the context of related enhancement programs. Alternative airlift improvement objectives, having differing policy implications for the C-5, are outlined in Chapter IV.

Aircraft Alteration; The C-141 Stretch Program and CRAF Modification

The second type of improvement program involves modification of existing aircraft to increase their productivity. A distinction should be made between programs involving organic transports and the CRAF program, which affects commercial aircraft.

9/ The Air Force projects an 8,000-hour service life for the C-5 without re-winging. This is not the point at: which wing failure can be expected, however. Rather, it is a calculation based upon engineering estimates of the rate of crack growth and the optimal time for replacement of faulty components. Thus, a less conservative estimate of safe service life could result in a 2,000-hour service life extension (see last column of Table 8).

10/ CBO has updated the earlier Rand estimate to account for inflation and several additional costs (see p. 60).

TABLE 8. AN OVERVIEW OF OPTIONS FOR EXTENDING THE SAFE SERVICE LIFE OF THE C-5 WING a/: GIVEN UTILIZATION RATES (HOURS PER YEAR) OF 700 HOURS AND 500 HOURS

Description of Structural Modification Options	Cost (millions of 1975 dollars)	8,000-Hour Safe Service Limit		2,000-Hour Service Limit Extension	
		700 hours b/	500 hours b/	700 hours b/	500 hours b/
No Change	--	1983	1986 c/	1987	1991
Fastener Change on 62 Low-Damage Aircraft	267	1989	1994	1992	1999
Alter Current Wing on 15 High-Damage Aircraft	239	1986	1990	1990	1996
Complete Wing Modification on 15 High-Damage Aircraft	480	1989	1995	1993	2000
Alter Current Wing on All 77 Aircraft	610	1997	2006	2004	2016
Complete Wing Modification on All 77 Aircraft	910	2014	2030	2018	2035

SOURCE: Adapted from W.E. Hoehn and others, Strategic Mobility Alternatives for the 1980s: Volume 3, Technical Appendixes (Santa Monica: The Rand Corporation, March 1977), p. G-12 (unclassified).

a/ Calculations assume a 25 percent life extension because of the Active Lift Distribution Control System (ALDCS), which is an engineering change that reduces wing stress.

b/ Based on 1976 mission use. Subtract 1.5 to 2.0 years for the equivalent life-reducing effect of each NATO deployment of eight division equivalents.

The C-141 Stretch Program. According to Air Force studies, C-141 payloads are almost always limited by available floor space or cabin volume. Since space limits are generally reached before weight limits, 11/ excess lift capacity goes to waste. To use that capacity fully, the Air Force has proposed to manufacture and insert an additional 23 feet of fuselage on the fleet of C-141s. This would increase their potential payload by as much as 30 percent, with only an insignificant increase in annual operating and personnel costs. 12/ The C-141 modification program, which includes adding aerial refueling capability, is estimated to cost $505 million. Proponents contend that a comparable increase in organic capacity could be achieved only by adding 90 new C-141s to the fleet at an initial procurement cost of more than $2.4 billion as well as additional operating costs over their lifetime. 13/

The C-141 stretch program clearly provides increased lift capacity at less cost than procuring new organic planes. The program has been challenged on cost grounds on the basis of other criteria, however. Other mobility alternatives have been suggested as less costly means of improving airlift performance. As noted in the next chapter, however, more effective alternatives at equal or less cost might not be available for

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11/ The primary reason for this is that the density of bulk and oversize cargo is frequently less than the optimal density of cargo in which lift potential equals volume limits (known as the cross-over cargo density) in the C-141. By increasing volume capacity without changing lift potential, the cross-over cargo density is lowered, bringing it more in line with actual cargo densities. Ironically, stretching the C-141 would decrease its maximum airlift potential because of the added weight of the two fuselage inserts. Productive airlift would increase, however, because remaining lift could be used more efficiently.

12/ The actual increase in productivity varies by type of cargo. A light unit, like the 101st Airmobile Division, would still fill out the cargo compartment before reaching payload limits. Nonetheless, the proportionate increase in payload with the modification is greater for lighter divisions than for heavier divisions.

13/ See The Posture of Military Airlift, Hearings, p. 361.

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non-NATO contingencies, a factor which certainly should weigh in any evaluation of the program by the Congress.

CRAF Modification. A second aircraft alteration plan involves civilian reserve airplanes under the CRAF program. The Air Force proposes to modify, at government expense, commercial wide-body passenger planes by equipping them with cargo features. B-747s and DC-10s (and possibly L-1011s) would be equipped with cargo doors and given stronger floors. In a CRAF mobilization, seats, overhead luggage racks, and kitchen and lavatory units would be removed from the planes. Cargo equipment such as floor rollers and side rails, stored by the airlines at depot facilities, would then be installed.

The CRAF modification program was first proposed by the Air Force several years ago; the Congress, however, has not yet authorized full implementation of the program. The House of Representatives passed authorizing legislation in the 95th Congress for the CRAF modification program, 14/ but the measure was not taken up by the Senate. 15/ Instead, $7.5 million was appropriated

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14/ This legislation, H.R. 2637, provided statutory authority for the Secretary of the Air Force to establish a program to encourage civil air carriers to acquire additional cargo capacity in their future fleets and to modify existing airplanes by installing militarily acceptable cargo features. The bill would have accomplished this by (a) funding the installation of cargo features in new passenger planes and compensating the airlines for lost revenue potential as a consequence, (b) funding the installation of similar features in existing passenger planes, and (c) contributing to purchase costs of new cargo planes or planes with cargo-convertible features.

15/ The CRAF program has been unevenly received in the Congress. The House Committee on Armed Services strongly favors the concept. See Amending Title 10, United States Code, H. Rept. 95-776, 95:1 (1977). The Subcommittee on Defense of the House Committee on Appropriations, however, recommended termination of the entire program. See Department of Defense Appropriations Bill. 1977, H. Rept. 94-1231, 94:2 (1976), pp. 152-53. Both the Senate Committee on Armed Services and the Senate Committee on Appropriations favor CRAF modification, though only for new passenger planes.

in fiscal year 1979 to fund a demonstration program under which one new commercial jet would be modified as a test of potential program costs and performance. The DoD budget for fiscal year 1980 proposes to modify nine new commercial aircraft at a cost of $73.6 million. Eventually, as many as 88 planes could be altered under the program. 16/

The CRAF modification program builds on the intrinsic cost advantages of civilian reserve augmentation. Like the CRAF system itself, the program would impose no additional peacetime operation and maintenance costs once the cargo features have been installed and compensation and incentive payments have been made. The costs of a CRAF modification program, and the resulting increase in airlift capacity, would depend on the type of aircraft modified. DoD expects to modify about 65 planes in the next five years, adding 10.0 million ton-miles per day capacity, at a cost of $550 million.

C-141 Stretch vs. CRAF Modification. The C-141 stretch and CRAF modification programs are frequently compared, since both are designed to increase oversize cargo capacity. Table 9 compares the effect of these programs on airlift performance.

Comparisons of the effect of the C-141 stretch and CRAF modification programs are generally made on the basis of system performance, given full organic and CRAF augmentation. Comparing the last two lines of Table 9 with the third line shows that, except for heavy divisions, the CRAF modification program provides greater airlift performance improvement than the C-141 stretch program. The stretch program increases performance by less than 5 percent, compared to the 25 percent improvement for airborne and infantry divisions achieved by the CRAF modification program. 17/

16/ DoD hopes to modify a sufficient number of planes to equal the capacity of 65 B-747s. It could take as many as 88 of the smaller DC-10s to equal that capacity.

17/ The delivery rates for heavy divisions are artificial in that performance for Table 9 was computed for the transportation of only one division and its support units. If resupply is taken into account, both the C-141 stretch and CRAF modification programs will increase performance. Measured by gross tonnage delivered, the CRAF program provides greater cargo capability at less cost than the C-141 stretch program.

TABLE 9. AIRLIFT ENHANCEMENT: EFFECTS OF C-141 STRETCH VS. CRAF MODIFICATION PROGRAMS

	Delivery Rate by Division Type a/		
	82d Airborne	Hypothetical Infantry	Hypothetical Mechanized
Full Organic/ No CRAF b/	.39	.32	.27
Full Organic/ No CRAF plus C-141 Stretch	.42	.34	.28
Full Organic/ Full CRAF	.55	.45	.33
Full Organic/ Full CRAF plus C-141 Stretch	.58	.47	.33 c/
Full Organic/ Full CRAF plus CRAF Modification Program	.70	.55	.33 c/

SOURCE: See Appendix A.

a/ Expressed in thousand miles of distance per day of time for each type of division. For example, ".39" for the 82d Airborne Division indicates that for each day of delivery time permitted, the 82d can be transported approximately 390 miles.

b/ Organic transports operated at programmed utilization rates.

c/ The closure rate of a heavy division does not improve with either the C-141 stretch or CRAF modification program since outsize cargo capacity--provided by the C-5 alone--remains unchanged. For lighter divisions, the C-5 will carry oversize cargo, even with these two enhancement programs.

Such comparisons do not take into account the full range of benefits offered by the C-141 stretch program, however. The CRAF modification program would improve airlift performance only when the CRAF fleet was activated, and then only at a Stage III mobilization. The stretch program, on the other hand, would increase airlift performance even when no CRAF augmentation was available. The first two lines of Table 9 indicate that the stretch program could increase airlift performance by as much as 8 percent even without CRAF augmentation.

This conclusion has important implications. The CRAF fleet has never been activated in its entire history. While it undoubtedly would be activated in the event of a major conflict, it is questionable whether CRAF augmentation would be available for lesser contingencies. Mobilization of the fleet could have a disruptive effect on the domestic economy and, short of a full war, it is doubtful that full CRAF augmentation, with or without modified planes, would be available. Aircraft modified under such a program must be committed to CRAF, but only at a Stage III mobilization. This reflects a fundamental assumption of the CRAF modification program: the program is largely designed to meet airlift requirements associated with a NATO/Warsaw Pact war. The cost advantages of the CRAF modification program compared to the C-141 stretch program might be less distinct in situations in which a full CRAF mobilization is unlikely. Thus, it can be argued that the C-141 stretch program is the preferable alternative if airlift improvement is designed primarily to satisfy future non-NATO contingencies.

Aircraft Procurement

Aircraft procurement introduces more complicated (and more expensive) considerations. A large fleet of organic planes already exists. Since these aircraft would be augmented by CRAF planes in the most demanding contingencies, decisions regarding procurement of new organic transports must consider the economic advantage of civilian reserve augmentation. There are clear instances, however, when civilian counterparts would not be available to augment organic transports. Recently, the Air Force has sought procurement of two organic systems--the Advanced Tanker/Cargo Aircraft (ATCA) and the Advanced Medium Short-Takeoff-and-Landing Transport (AMST)--neither of which has a civilian counterpart.

The Advanced Tanker/Cargo Aircraft. The ATCA is essentially a commercial wide-body jet--the DC-10--modified to incorporate aerial refueling equipment. The lower cargo compartments of the aircraft contain fuel tanks for aerial refueling operations. The upper compartments contain seating for 80 crew members and passengers; cargo storage space is provided to the rear of the small passenger compartment.

The procurement concepts underlying acquisition of the ATCA represent a compromise between organic and civilian reserve airlift assets. Aerial refueling does not require unique military design features, except for a refueling boom that can be installed on many existing airframes. 18/ The ATCA program, therefore, presents an opportunity to adapt an existing commercial aircraft for military application, thus avoiding the research and development costs normally associated with procurement of new weapons systems. 19/ Further, ATCA procurement assumes that the Air Force will provide only minor routine maintenance, with any heavy maintenance provided by commercial contractors at commercial facilities, thus avoiding the indirect support costs associated with active-duty and reserve maintenance manpower and facilities.

The ATCA (formally designated the KC-10) was initially intended to succeed the aging KC-135, which first entered the fleet in 1956. 20/ (The KC-135 was a developmental prototype of

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18/ On a per-plane basis, ATCA's unique military features will account for less than 16 percent of its total cost. See Military Posture and H.R. 10929 (Department of Defense Authorization for Appropriations for Fiscal Year 1979), Hearings before the House Committee on Armed Services, 95:2 (February, March, and April 1978), Part 2, p. 468.

19/ The Air Force also found that substantial savings could be realized if procurement followed schedules suggested by the contractor. The contractor is prepared to discount its prices if procurement fits its production schedules.

20/ In 1975 and 1976, DoD decided to cancel plans for development of a new tanker, adopting instead the current proposal to modify an existing airplane. See Military Posture and H.R. 11500 (Department of Defense Authorization for Appropriations for Fiscal Year 1977), Hearings before the House Committee on Armed Services, 94:2 (February 1976), Part 2, p. 237.

the Boeing 707 series.) Compared with the KC-135, the ATCA reflects the performance improvements generally associated with wide-body jets in comparison with the first family of commercial jet aircraft. For example, at 2,500 nautical miles, the KC-10 can unload nearly three times as much fuel as the KC-135. 21/ Thus, on a flight to Europe, a KC-135 can refuel only two fighter aircraft, whereas a KC-10 can refuel four aircraft and transport 30,000 pounds of support equipment as well. 22/

In 1978 the Department of Defense stated that the KC-10 would be procured not to replace the KC-135, but rather to supplement anticipated shortfalls in tanker capacity. DoD expects demands for aerial refueling to increase because of anticipated increased use by strategic airlift and by tactical fighters within theaters of operation during wartime. 23/ DoD currently justifies procurement of the KC-10 in terms of its potential use as a tanker in limited contingencies. 24/

Aerial refueling improves airlift performance in two ways. First, it reduces total flight time by eliminating ground refueling stops. Second, by removing "critical leg" constraints, it permits greater payloads. 25/

21/ Ibid., p. 239.

22/ Ibid.

23/ Military Posture and H.R. 10929, Hearings, Part 2, pp. 469-70.

24/ U.S. Department of Defense, Annual Report, Fiscal Year 1980, p. 20.

25/ An airplane can lift a given amount of weight, consisting of the plane itself, its cargo, and its fuel. At some distance unique to each type of plane, a direct trade-off exists between the quantity of fuel and the quantity of cargo; to fly beyond that distance without refueling requires carrying more fuel, which in turn lowers the amount of lift capacity that can be allocated to cargo. The longest unrefueled distance a plane must travel on any given trip--termed its "critical leg"--determines the payload for the entire trip. If the "critical leg"

Aerial refueling can have substantial benefits if an airlift operation must be conducted over a long distance without intermediate refueling facilities. During the 1973 airlift to Israel, for example, overflight and refueling rights were denied by most European and Mediterranean littoral states. Fortunately, intermediate refueling was available at Lajes Field in the Azores. Had that not been the case, transports would have had to fly 5,500 nautical miles without refueling. At that distance, the C-5 could have carried only 33 tons of cargo and the C-141 could not have made the trip at all. Aerial refueling would have permitted larger payloads for both planes. 26/ The experience of the Israeli airlift has been cited frequently as a justification for providing aerial refueling capability for the C-141 and for procuring the KC-10.

It is important to introduce a qualification at this point. If overflight rights are assured and intermediate ground refueling is available (as it was in 1973), the value of aerial refueling is substantially diminished. Aerial refueling provides only an inconsequential improvement in airlift performance in such favorable circumstances. 27/ The 1973 airlift did demonstrate the potentially adverse effect of political restrictions, such as denial of overflight and ground refueling rights. Nonetheless,

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is beyond the optimal fuel/cargo point and ground refueling stops are unavailable, payloads must be reduced so that extra fuel can be carried. For example, if a C-5 must travel 3,800 nautical miles without refueling, it has an allowable cabin load (ACL) of 86 tons. If it must fly 5,240 nautical miles without refueling, its allowable cabin load drops to 42.5 tons. Aerial refueling permits a plane to fly with a maximum payload, unconstrained by the "critical leg."

26/ The Air Force has calculated that aerial refueling during the Israeli airlift could have saved 44 C-5 missions and 57 C-141 missions, out of a total of 145 C-5 missions and 421 C-141 missions. See The Posture of Military Airlift, Hearings, p. 32.

27/ A DoD computer simulation of an airlift operation, run specifically for this study, indicated that if route and refueling restrictions are eliminated, aerial refueling improves delivery performance by less than 1 percent.

the nature of Arab-Israeli hostilities and third-party fear of Arab economic retaliation combined to make this an unusual case. While similar or parallel conditions could develop in the future, it would be difficult to assign a specific level of plausibility to such an event. So long as aerial refueling capacity can be added to airplanes at a modest cost, it is probably a useful hedge in anticipation of such situations. 28/

The procurement cost of a fleet of 20 KC-10s would be approximately $1 billion. Since this is a substantial expenditure, the Congress will want to be certain that the extra tankers are needed. The Air Force has concluded that as many as 1,000 KC-135 equivalent tankers (the United States currently has 615 KC-135s) would be needed to meet projected wartime tanker requirements by the mid-1980s. 29/

The Air Force study assumes that those requirements--aerial refueling of strategic bombers, deploying and employing fighters, and refueling transports--are additive, however. The Congress may wish to question the assumption that all tanker requirements would coincide. 30/ CBO has previously concluded that a total of 250 KC-135s would satisfy aerial refueling requirements for a full

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28/ Installation of refueling receptacles in the C-141, in conjunction with the stretch program, increased the modification costs by less than 10 percent. W.E. Hoehn and others, Strategic Mobility Alternatives for the 1980s: Volume 2, Analysis and Conclusions, p. 35 (information cited is unclassified).

29/ See Military Posture and H.R. 10929, Hearings, Part 2, p. 469-70.

30/ Current plans call for procurement of 20 KC-10s, even though as many as 91 planes were proposed in previous years, with no apparent increase or decrease in assumed refueling requirements. Indeed, the most recent study, suggesting a mid-1980s requirement for more than 1,000 KC-135s, coincided with the decision to reduce the proposed procurement from 91 planes to 20. Those 20 planes, assuming their maximum productivity advantage over the KC-135, will satisfy little more than 25 percent of the assumed tanker deficiency. It is certainly not clear that a consistent assessment of requirements has determined the extent of tanker replacement or addition.

airlift operation to the Persian Gulf. 31/ Although this would present one of the most demanding tanker requirements for airlift operations, it still would only take roughly 40 percent of the KC-135 fleet. And if intermediate refueling stops were available, aerial refueling would not be necessary. Since the KC-10 program involves an existing airplane with production expected well into the 1980s, there is no urgency to proceed with further procurement now. Indeed, in light of the apparent uncertainty about the role of the KC-10 in meeting assumed tanker requirements, the Congress may wish to examine the ATCA program at greater length before authorizing additional procurement.

The Advanced Short-Takeoff-and-Landing Transport. The second aircraft procurement program involves modernization of the tactical (or intratheater) airlift fleet. Until last year, it was assumed that this modernization would be through acquisition of the Advanced Medium Short-Takeoff-and-Landing Transport (AMST). The AMST emerged as a candidate for the tactical airlift fleet of the future as a result of two major factors. First, the Vietnam War imposed a significant toll on the main tactical transport, the C-130, in terms of usable lifetime. In 1970, the Congress directed MAC to investigate a follow-on aircraft to the C-130 that would incorporate jet and short-takeoff-and-landing technologies. Second, accompanying the development of Air Force design specifications, the Army strongly argued for a need to acquire tactical transports that could carry outsize equipment. 32/ The design specifications, therefore, called for a tactical transport capable of carrying outsize cargo and operating in a short, rough field environment.

Central to the debate over procurement of the AMST is the nature of tactical airlift modernization and the mission of tactical airlift in the future. The Air Force states that tactical airlift modernization should be judged by the capacity of

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31/ Congressional Budget Office, U.S. Projection Forces: Requirements, Scenarios, and Options, Budget Issue Paper for Fiscal Year 1979 (April 1978), especially Appendix D.

32/ As originally envisioned by the Air Force, the proposed new medium tactical transport was not designed to carry outsize cargo. That requirement evolved during the program development stages. See Military Airlift, Hearings, p. 6393.

the air fleet of the future to move combat units by air. This is consistent with previous Air Force design goals, though it differs substantially from previous applications of tactical airlift. Tactical transports have most frequently been used to move emergency cargo, and only rarely to deliver combat-equipped fighting units. This limited role could have developed, however, because there were no tactical transports in the fleet capable of carrying all the equipment of a combat unit. Air assault operations were rare even when aircraft were able to transport most equipment. Tactical airlift modernization can thus be considered on the basis of two opposing assumptions about battlefield airlift requirements in the future. If tactical airlift is to be restricted to traditional air logistics operations and to the resupply of bulk and oversize cargo, modernization could most economically be achieved by replacing aging C-130s with newer versions or by extending the service life of older C-130s. 33/ If, on the other hand, tactical airlift is to be expected to transport combat units, acquisition of an outsize cargo carrier would be essential. 34/

33/ The Air Force estimates that, if tactical airlift modernization is limited to transport of bulk and oversize cargo, a fleet of C-130s (model H) over a 15-year life cycle would cost $12.8 billion to procure and operate. A fleet of AMSTs, providing similar capacity (measured in bulk ton-miles), would cost $17.4 billion over the same period.

34 Proponents of the AMST base most justifications for the plane on the stated requirement for a so-called "unit move," which would involve the air delivery of a combat unit and its equipment within a tactical theater. Proponents of the unit-move requirement contend that air delivery saves critical time, as reflected in casualty figures and battleline changes calculated through sophisticated war-gaming models. Opponents of the requirement contend that the redundancy of the current transportation network in Europe assures ground transportation availability. Further, they argue that, in the magnitude of an expected conflict, air delivery of a battalion or a brigade is inconsequential, given the cost associated with that capability. This argument raises a very complex problem with respect to war planning. The AMST might conceivably cost $8.3 billion. The equipment for a combat division

The AMST as currently designed is probably the least expensive system that could meet outsize cargo requirements, if such a capability is determined to be necessary.

Funding for procurement of the AMST was deleted from the fiscal year 1979 budget, following a determination by the Secretary of Defense that the cost of procuring a fleet of AMSTs large enough to satisfy assumed tactical airlift requirements was not justified by those requirements. 35/ Nonetheless, $5 million is provided in the fiscal year 1980 budget submission for continued evaluation of the aircraft. The procurement cost for a fleet of AMSTs was estimated to be $8.3 billion in fiscal year 1980 dollars.

The decision to terminate AMST procurement reflects an assessment that the current tactical transport fleet can meet wartime requirements and that future tactical airlift will be limited to air resupply of bulk and oversize cargo and troops, rather than a unit move of combat troops and their equipment. The Air Force, however, continues to argue that future tactical airlift operations will require procurement of a wide-body transport like the AMST. 36/ It should be noted that replacement of C-130s with newer models would limit tactical

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costs slightly more than $1 billion. With comparable expenditures over time (lifetime costs for the AMST and for the combat division could conceivably narrow substantially), which would make the greatest contribution to the security of NATO?

35/ Central to the debate on the AMST was the Army's stated requirement to move outsize cargo by tactical airlift, since the C-130 cannot transport outsize cargo. That requirement is based on two specific needs: the need to replace equipment lost during combat and the need to move entire combat units and their equipment, much of which is outsize. DoD has acknowledged the potential need for tactical airlift of outsize cargo but apparently has not accepted the claim that the need is as urgent as the services seem to believe.

36/ It is unlikely that this disagreement will be resolved, since it is more a function of the assumptions of the proponents than of their calculations.

transport capability at the turn of the century to operational capabilities of the 1960s. 37/

Strategic Airlift Augmentation by Tactical Transports. A major theme to emerge from the debate on tactical airlift modernization is the role of tactical transports in supplementing strategic airlift operations. In the opening days of a deployment, before battlefield airlift requirements begin, tactical transports would be available to supplement strategic transports. Use of the C-130 for deployment operations could potentially improve delivery rates by 11 percent for an airborne or infantry division, as can be seen in Table 10. Closure time improvement is much smaller for heavier divisions, since the C-130 cannot transport outsize cargo, which comprises a major portion of the cargo of a heavy division. This can be contrasted with closure time improvement produced by AMST augmentation. Since the AMST can transport outsize cargo, delivery rates improve by from 16 to 18 percent for all types of divisions, including heavy divisions. 38/ Delivery rates show a dramatic improvement if the AMST supplements strategic transports that have been improved through the C-141 stretch and CRAF modification programs, as shown in the bottom line of Table 10.

The primary factor limiting strategic augmentation is the relatively short range of tactical transports. This can be compensated for either by frequent ground refueling (called "island-hopping") or by aerial refueling. 39/ The AMST has a

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37/ While Army equipment is becoming larger and heavier, it is not certain that every piece of Army equipment--or, for that matter, most of it--must be transported by tactical airlift.

38/ While the AMST can transport outsize cargo, its range decreases substantially with very heavy payloads. When carrying the M-60 tank, for example, the AMST is limited to a range of less than 700 miles, which is a major limitation in long-distance operations.

39/ Either option has unique limitations. Ground refueling could cause congestion problems at intermediate bases. Aerial refueling would impose additional requirements on a tanker force that might have more pressing duties in the early days of a mobilization.

TABLE 10. CLOSURE TIMES AS A FUNCTION OF TACTICAL TRANSPORT AUGMENTATION

	Delivery Rate by Type of Division a/		
	82d Airborne	Hypothetical Infantry	Hypothetical Mechanized
Current Airlift/ No C-130 Augmentation b/	.50	.40	.32
Current Airlift/ C-130 Augmentation c/	.55	.45	.33
Current Airlift/ AMST Augmentation d/	.58	.48	.38
Improved Airlift/ AMST Augmentation e/	.76	.62	.48

SOURCE: See Appendix A.

a/ Expressed in thousand miles of distance per day for each type of division. For example, ".50" for the 82d Airborne Division indicates that, for each day of delivery time permitted, the division can be transported approximately 500 miles.

b/ All organic planes flown at wartime utilization rates; full CRAF Stage III augmentation.

c/ Same as above, though with augmentation by 218 C-130s.

d/ Same as a/, plus augmentation by 141 AMSTs. The number of AMST transports was calculated to provide equal bulk transport capacity as provided by a fleet of 218 C-130s in theater operations. It is assumed that the number of AMSTs would be determined by tactical transportation requirements. Hence, AMST fleet size is assumed to equal C-130 fleet size on the basis of bulk capacity. The C-130 can transport only bulk and oversize cargo; the AMST can transport outsize cargo as well.

e/ Improved system assumes implementation of the C-141 stretch program and the addition of 65 B-747 aircraft under the CRAF modification program.

clear advantage over the C-130 in that *it* can be refueled aerially and has a greater range and payload than the C-130. The primary advantage of the AMST, however, is its capacity to transport outsize cargo.

As is the case with other airlift improvement alternatives, tactical airlift modernization proposals should be evaluated in the context of alternative enhancement programs, consistent with underlying assumptions about future airlift requirements. This question is examined more directly in Chapter IV.

CHAPTER IV. ALTERNATIVE AIRLIFT FORCES FOR THE FUTURE

Military airlift is a valued element of the U.S. conventional force structure. It is also expensive. Any decision to increase airlift capabilities must balance cost considerations against assumed requirements for airlift in the future. In considering the fiscal year 1980 defense budget, the Congress will decide on several airlift improvement programs. In choosing among the alternatives, it will have to address two questions:

- o What types of contingency requirements should guide airlift improvement, and what amount of enhancement is needed?

- o What margin of flexibility should be maintained in the future airlift system to meet those requirements?

Different contingencies suggest different criteria for assessing airlift improvement. If the Congress evaluates airlift improvement in terms of the NATO reinforcement requirement, the extent of airlift improvement and the types of programs needed would differ from those that would be appropriate for non-NATO contingency requirements.

AIRLIFT IN A NATO/WARSAW PACT WAR

Reinforcement Objectives and Airlift Improvement Requirements

Reinforcing NATO in the face of a Warsaw Pact attack could potentially present the most demanding requirement for military airlift. Reinforcement objectives call for a doubling of in-place ground forces within 10 days of mobilization and delivery of at least 1,300 tactical fighter aircraft within one week. 1/ Currently, the equivalent of five divisions is deployed in

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1/ U.S. Department of Defense, Annual Report, Fiscal Year 1980, pp. 47, 201.

Europe. 2/ Equipment for two U.S.-based divisions is now stored in Europe under the POMCUS program. 3/ The Department of Defense has proposed to pre-position equipment for three more divisions in Germany. If this proposal is implemented, a total of five division sets of combat equipment and supplies would be in place by the end of fiscal year 1982. In wartime, airlift would be used primarily to transport troops and that small portion of equipment that would not be pre-positioned. 4/

While airlift would play an important role in any NATO reinforcement operation, it must be supplemented by advanced positioning of combat equipment if DoD's reinforcement objectives are to be met. As Table 11 indicates, if no equipment was pre-positioned and airlift was the sole means of reinforcement, it could take as many as ten weeks to transport five mechanized divisions, together with their unit and support equipment, from the continental United States to Europe. 5/ If, on the other hand, equipment was pre-positioned for three divisions and airlift was required to transport only two divisions, deployment would take approximately one month. By contrast, if equipment for five divisions and their support units was pre-positioned, transportation time could be reduced to approximately two days. Nearly five days would be required to transport the equivalent of 55 tactical fighter squadrons.

2/ Four armored or mechanized divisions and two armored cavalry regiments are located in Germany. Three brigades, formally assigned to the divisions currently in the POMCUS program, are also deployed in Europe. See Ibid., p. 140.

3/ See Chapter 1, footnote 4 for a discussion of the POMCUS question.

4/ Those items not pre-positioned in Europe generally consist of a limited number of very expensive items (computers, for example), or combat equipment difficult to maintain (helicopters), or equipment that is transported by the individual troops themselves, such as small arms and personal gear.

5/ Obviously, airlift would never be the only transportation source available. Sealift would begin to carry the largest proportion of cargo after the first month of mobilization.

TABLE 11. TIME REQUIRED TO DELIVER FIVE MECHANIZED DIVISIONS AND 55 TACTICAL FIGHTER SOUADRONS TO EUROPE, ASSUMING DIFFERING LEVELS OF PRE-POSITIONED EQUIPMENT a/

	Days to Deliver Forces	
	Current Airlift b	Improved Airlift c/
No Pre-positioning	68.1	68.1 d/
Equipment for Three Divisions Pre-positioned/ Airlift of Two Divisions Required e/	27.6	27.6 d/
Equipment for Five Divisions Pre-positioned/ Residual Cargo Airlift Required	2.1	1.6
55 (Equivalent) Tactical Fighter Squadrons	4.2	3.2

SOURCE: Calculated from public planning factors. See Appendix A.

a/ Cargo includes unit equipment of the divisions and support units (see Appendix A). These calculations assume that 95 percent of bulk and oversize cargo and 99 percent of outsize cargo in combat and support units is pre-positioned.

b/ Organic transports at programmed utilization rates; full CRAF augmentation; strategic augmentation by C-130s.

c/ Enhancement includes C-141 stretch and CRAF modifications equivalent to 65 additional B-747s in CRAF.

d/ Delivery time paced by arrival of outsize cargo, which is not affected by improvement programs.

e/ In actual practice, equipment for three and one-third divisions has been pre-positioned or will be in place by the end of fiscal year 1980. For consistency, however, calculations are limited to five hypothetical mechanized divisions.

These are very general calculations, 6/ and they consider transit time only. Additional time would be required after arrival in Europe for troops to draw equipment from storage sites and move to assembly areas. In light of these calculations, several observations can be offered. First, without advanced positioning of unit and support equipment for ground forces, DoD's NATO reinforcement objectives could not be met. If equipment was not pre-positioned, airlift enhancement programs would offer only insignificant improvement in reinforcement performance. The improvement programs would, however, mean that bulk and over-size cargo could be delivered sooner. Since there would be no increase in outsize cargo airlift capacity, however, overall closure time would remain unchanged.

Second, current airlift capabilities--without enhancement--would be sufficient to meet the ten-day reinforcement objective set for Army units by the Department of Defense so long as unit and support equipment was pre-positioned. A division requires four or five days after arrival in Europe to draw its equipment and move to assembly areas. Thus, the last units would have to arrive on the fifth or sixth day of mobilization in order to meet the ten-day objective. Current airlift resources are capable of meeting this deadline.

Third, demand on airlift resources would be greatest during the first week of mobilization, since ground combat units are expected to be delivered within ten days and tactical fighter squadrons within seven. Because two or three days of the first week would be needed to transport cargo for ground units, it is doubtful that all tactical fighter squadrons, which require four or five days to transport, could be delivered by the end of the seventh day. 7/ Given current airlift resources, some tactical fighter units would arrive after the DoD objective deadline.

The airlift enhancement program, while not necessary for meeting DoD's reinforcement objectives for ground forces, would

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6/ See Appendix A for method used to compute calculations presented in the study.

7/ It is probable that several days would be required to mobilize the entire airlift system in an emergency. Some CRAF planes would have to return to the United States; planes undergoing maintenance might take several days to be repaired.

potentially ensure that tactical fighter squadrons could be delivered to Europe by the seventh day after mobilization. It might also be possible to meet the seven-day delivery objective for tactical fighter squadrons if the ten-day delivery objective for ground forces was relaxed by a day or two. It should be noted, however, that these dates are planning objectives, even though they are frequently framed as "requirements." 8/ The current airlift system appears capable of largely meeting those objectives, as long as pre-positioning of combat and support equipment continues as proposed by the Department of Defense. Thus, if the justification for airlift improvement programs is limited to NATO reinforcement objectives, it is questionable whether further improvements to airlift resources are necessary.

Flexibility of the Airlift System in a NATO/Warsaw Pact War

The capability of the current airlift system to meet the demanding objectives of a NATO/Warsaw Pact war is the product of several factors unique either to the European environment or to the U.S. political commitment to the NATO alliance.

The European Environment. The facilities needed to sustain major air transit operations in a NATO/Warsaw Pact war are abundant. A large number of European airports are capable of supporting massive airlift operations. 9/ Similarly, the distance between Europe and the United States would permit relatively high payloads. For example, Dover Air Force Base is 3,540 nautical

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8/ The two delivery objectives are derived from sophisticated mobilization models that are based on plausible assumptions and estimates of Soviet capabilities and intentions. It is impossible to predict the outcome of a battle if 90 percent, 100 percent, or 110 percent of the ground forces expected to be in Europe on the tenth day were indeed there. What can be said is that it is better to have 100 percent than 90 percent, or 110 percent than 100 percent. None of these numbers can be considered a "requirement," though each can be considered an "objective."

9/ See discussion on p. 16. There is concern about airport vulnerability and congestion, however. Both questions are currently being studied by DoD.

miles from Frankfurt, Germany. At that distance, the C-5 can carry approximately 86 tons and the C-141 about 32 tons, permitting relatively high utilization of maximum payloads, without intermediate refueling.

Political Commitment to the NATO Alliance. Perhaps of greater importance are the political considerations that would play a substantial role in any NATO contingency. The U.S. commitment to defend Western Europe in the face of a Soviet attack is firm. A war between NATO and the Warsaw Pact is, perhaps, the only contingency in which an American response with combat forces is certain. This political commitment has several important ramifications for airlift operations. It ensures that no administrative or financial constraints would limit the number of military transports that could fly or the number of hours a day they would operate. It assures that there would be a full mobilization and that reserve manpower resources would be available to join active-duty forces. A national emergency declaration would also guarantee that civilian aircraft would be available. Finally, a NATO war would remove peacetime environmental or political restrictions on airlift operations in allied countries.

These factors have a direct effect on airlift operations. The full range of civilian and organic aircraft would be available in a NATO/Warsaw Pact war. Organic transports could be flown at wartime utilization rates. Civilian aircraft, which are restricted to the relatively sophisticated facilities of modern airports, could operate at high efficiency. In short, those features of the existing airlift system that could potentially prove most constraining in more limited contingencies would not appear to be serious problems in a NATO war.

Tactical (Intratheater) Airlift in a NATO War

The decision by the Administration to delete procurement funds for the Advanced Medium Short-Takeoff-and-Landing Transport (AMST) was based on an evaluation of the aircraft's potential contribution in a NATO conflict. The performance advantages of the AMST over the existing C-130 were not considered by the Secretary of Defense to be sufficient to justify its cost. The primary factor contributing to the decision was that Europe possesses a sophisticated and redundant local transportation system that would permit "surface transportation to compete favorably with the speed and responsiveness of tactical airlift." 10/ Only if that network suffered enormous damage would the AMST be required to supplement ground transportation of outsize cargo. It is reasonable to assume that airfields would suffer similar damage, however, jeopardizing the conduct of all airlift operations. Nor would the AMST appear to be justified as a means of improving strategic airlift capacity. Table 12 indicates that, when full pre-positioning is pursued, the contribution of AMST augmentation would be negligible. Moreover, as is the case with other airlift enhancement programs, the AMST could not meet reinforcement objectives in the absence of advanced equipment positioning.

TABLE 12. CURRENT AND IMPROVED TACTICAL TRANSPORT CONTRIBUTION TO THE TIME REQUIRED TO DELIVER FIVE DIVISIONS AND 55 TACTICAL FIGHTER SQUADRONS TO EUROPE, ASSUMING DIFFERING LEVELS OF PRE-POSITIONED EQUIPMENT

	Days to Deliver Forces	
	Current (Includes C-130s)	With AMST (No C-130s)
No Pre-positioning/ Five Mechanized Divisions Airlifted	68.1	58.8
Equipment for Three Divisions Pre-positioned/ Two Divisions Airlifted	27.6	24.7
Equipment for Five Divisions Pre-positioned/ Residual Cargo Airlifted	2.1	1.9
55 (Equivalent) Tactical Fighter Squadrons	4.2	3.9

SOURCE: See Appendix A.

10/ U.S. Department of Defense, Annual Report, Fiscal Year 1980, p. 210.

AIRLIFT IN A MIDDLE EAST/PERSIAN GULF CONTINGENCY

The Department of Defense has considered it prudent to plan for the concurrence of a major war and a lesser contingency. The "one and one-half war" strategic concept represents both a planning artifact and a reasonable (though conservative) assessment of actual situations that might develop in the future. During most of the 1960s and early 1970s, the most demanding "minor" contingency for planning purposes was the defense of South Korea against an attack by North Korea supported by either China or the Soviet Union. More recently, and certainly since the Arab-Israeli war in 1973 and the emergence of the politics of petroleum, a conflict in the Persian Gulf or Middle East regions has supplanted Northeast Asia as the "minor contingency" for force planning purposes. 11/

One of the inherent difficulties associated with force planning for a minor contingency is the absence of a consensus as to the nature of a possible conflict and the threat posed to American interests. With respect to a NATO/Warsaw Pact war, there is general agreement concerning the probable factors associated with a Warsaw Pact attack--its possible size, probable military objectives, plausible invasion routes, and so on. No comparable agreement exists regarding a Middle East/Persian Gulf contingency. All planning contingencies share a common theme, however: American forces would be deployed to a region to assist a friendly power defend itself against an attack by a neighbor supported by Soviet forces. The Secretary of Defense has indicated that a force consisting of several Army divisions, Marine amphibious forces, and several air wings could be required in such a circumstance. 12/ Table 13 presents relative delivery times required for various divisions in a deployment to the Persian Gulf. With

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11/ While Korea continues to be a focus of contingency planning, developments in Northeast Asia have contributed to its decline as the "limited contingency" for force planning. See Congressional Budget Office, Force Planning and Budgetary Implications of U.S. Withdrawal from Korea, Background Paper (May 1978), pp. 7-12.

12/ Statement of Secretary of Defense Harold Brown in Department of Defense Authorization for Appropriations for Fiscal Year 1979, Hearings before the Senate Committee on Armed Services, 95:2 (February 1978), Part 1, p. 100.

TABLE 13. TIME REQUIRED TO DELIVER COMBAT UNITS TO THE PERSIAN GULF AREA WITH VARYING AIRLIFT RESOURCES, BY TYPE OF DIVISION

	Days to Deliver Forces		
	82d Airborne	101st Airmobile	Hypothetical Mechanized
Full Organic/Full CRAF a/	13.4	12.9	22.1 b/
Full Organic/No CRAF	18.7	18.0	27.6
Organic Lift/No CRAF/ C-141 Stretch	17.4	16.7	25.7
Full Organic/ C-141 Stretch/ CRAF Stage I	14.9	14.4	22.1
Full Organic/ C-141 Stretch/ CRAF Stage I/ AMST Augmentation c/	13.9	13.3	20.6

SOURCE: See Appendix A.

a/ Includes full CRAF mobilization and augmentation by C-130s.

b/ Closure is limited by pace of outsize cargo deliveries.

c/ Excludes any C-130 augmentation.

current airlift resources, it could take as long as 26 days to deploy the two lightest divisions in the Army--the 82d Airborne and the 101st Airmobile--to the Persian Gulf. If both a light and a heavy division were to be deployed, closure times could potentially reach five weeks. Small elements of the 82d Airborne Division could be delivered within two days, though their contribution would be more political than military until the remainder of the force had arrived.

Flexibility of the Airlift System in a Persian Gulf Contingency

Since there is no firm agreement as to the nature of a military threat in the Persian Gulf region, no reinforcement objectives have been set against which the adequacy of existing airlift resources can be measured. As Table 13 indicates, however, it could take as long as five weeks to deliver a light and a heavy division to the Persian Gulf region by airlift alone, assuming that all airlift resources were available for the deployment. The existing airlift system might not be uniformly available, however.

A demanding Persian Gulf contingency assumes Soviet involvement. Should such a situation precede a NATO/Warsaw Pact war, many factors could combine to limit airlift operations. In such a political climate, it is questionable that a declaration of national emergency, necessary for a full CRAF mobilization, would be made, since such an action could potentially send unacceptable signals to the Soviet Union. Since it is probable that the President would want to insulate a Persian Gulf contingency to prevent escalation into a NATO/Warsaw Pact war, it is probable that he would avoid mobilization (or delay its announcement), thereby limiting the amount of civilian reserve aircraft available for a Persian Gulf deployment. Also, as has already been noted, mobilization of CRAF would disrupt the domestic economy, which the President would probably want to avoid except in the most severe emergencies. Table 13 indicates that, if no CRAF planes were available for airlift operations, it could take as many as 10 additional days to deliver a two-division force. It is possible that the Department of Defense would resort to a limited civilian reserve mobilization. This, in combination with the C-141 stretch program (line four of Table 13), would improve delivery times substantially, though not as much as would a full mobilization of the CRAF fleet. Further augmentation by the AMST would offer additional improvement, especially for heavy divisions.

It is important to note that major procurement of new organic planes would be required to reduce delivery time substantially. Table 14 indicates that it would take a very large procurement of new aircraft--as many as 400 AMSTs or 100 new C-5s--to reduce closure times by a week for one division or two weeks for a two-division force. Such procurement produces substantial improvement in delivery times, particularly for heavy divisions.

TABLE 14. IMPROVED DELIVERY RATES TO PERSIAN GULF WITH AMSTs OR ADDITIONAL C-5s, BY TYPE OF DIVISION

	Days to Deliver Forces		
	82d Airborne	101st Airmobile	Hypothetical Mechanized
Organic Lift/ C-141 Stretch/ CRAF Stage I/ C-130 Augmentation a/	14.9	14.4	22.1
With 141 AMSTs b/	13.9	13.3	20.6
With 277 AMSTs c/	12.1	11.5	18.0
With 400 AMSTs	10.8	10.3	16.2
or			
With 50 C-5s	11.7	11.4	17.5
With 100 C-5s	9.7	9.4	14.5

SOURCE: See Appendix A.

a/ Additions of AMST transports supplant C-130 aircraft.

b/ 141 AMSTs produce approximately the same bulk cargo capacity in tactical airlift operations as the 218 C-130s used in the base estimate. (See Table 10 in Chapter III.)

c/ The previous Air Force proposal for AMST procurement.

While CRAF unavailability would be the major complication for airlift operations in a non-NATO contingency, additional problems might be anticipated with organic transports. The delivery rates in Tables 13 and 14 assume that organic aircraft would be flown at wartime utilization rates. Over the course of a Persian Gulf deployment, this would substantially deplete reserve inventories of spare parts. Since a deployment to the Persian Gulf would be accompanied by a continuing possibility of conflict in Europe, flying rates might be held down in order to avoid consumption of spare parts in anticipation of a major NATO airlift operation.

These factors present an airlift contingency requirement substantially different from that posed by a NATO/Warsaw Pact war. Civilian reserve assets might not be available for a Persian Gulf contingency, or at least not at full CRAF Stage III levels. Administrative constraints might impose flying limits on organic transports. While there are no clear objectives by which the need for additional airlift resources can be evaluated, airlift programs that improve the capacity of organic transports could help compensate for the questionable availability of civilian augmentation.

Tactical (Intratheater) Airlift in a Persian Gulf Contingency

The ground transportation network in the Middle East and Persian Gulf areas is not nearly as sophisticated or redundant as is the European network. Thus, tactical airlift could be expected to play a larger role in battlefield logistics in a Persian Gulf contingency than it would in a NATO war. A tactical transport like the AMST would have important advantages over the C-130, since it could transport outsize cargo and operate on shorter runways. DoD analysts have recognized this potential contribution, though they evidently have concluded that it is not feasible to procure a major weapon system that is not justified primarily by its utility in a NATO/Warsaw Pact war. Also, as Tables 13 and 14 indicate, a major procurement of AMSTs would be required in order to make a substantial contribution to delivery schedules if used for strategic augmentation.

ALTERNATIVE AIRLIFT FORCES FOR THE FUTURE

Congressional decisions concerning airlift improvement programs this year will affect the structure, capabilities, and system flexibility of airlift forces for many years to come. Naturally, the Congress will want to ensure that airlift forces are capable of meeting future requirements. Three alternative approaches might be considered:

- The Congress could assume that the defense of NATO is the only plausible or compelling contingency to be expected in the future and that airlift improvement programs should be justified strictly in terms of their potential contribution to meeting NATO reinforcement objectives. The corollary assumption is that all future non-NATO contingencies would require less airlift than a NATO war.

- o Alternatively, the Congress could assume that current airlift forces, while adequate for operations in a NATO conflict, would be significantly constrained in a non-NATO contingency. It might then wish to approve enhancement programs that were designed to compensate for those constraints.

- o Finally, the Congress could conclude that airlift resources will be relied on more heavily in the future as the primary means of rapidly projecting American combat forces abroad. Given that assumption, procurement of additional organic aircraft would be necessary. This proposition rests on the assumption that future requirements for airlift would rarely allow as much preparation and execution time as current airlift forces require. With greater airlift capabilities, more time could be devoted to evaluating developments and directing military responses. Further, since events rarely unfold as expected, improved airlift would provide a crucial element of flexibility.

These three perspectives suggest alternative options regarding airlift improvement programs before the Congress.

Airlift Improvements to Meet NATO Reinforcement Objectives

If airlift improvement programs were designed to meet NATO reinforcement objectives only, the Congress would be concerned primarily with finding the least expensive means to store wartime airlift capacity. The following choices would be best suited to meet this objective.

The C-5 Wing Modification Program. It would be feasible to adopt a modification program that extended the service life of the C-5 for fewer than the 30,000 hours requested by the Department of Defense. A NATO reinforcement deployment of five mechanized divisions could consume approximately 900 service-life hours, less than one and one-half years at current peacetime utilization rates. With pre-positioning of combat equipment in Europe, only a limited amount of outsize capacity would be required. A limited fastener change on the C-5, in conjunction with slightly lower peacetime utilization rates, would extend the useful life of the plane until 1995 and still permit at least one full NATO airlift operation.

This improvement could be made for $543 million, or about one-half the cost of the full re-winging program proposed by the Air Force. 13/ This alternative would entail some risks, however. Without a new wing, the C-5 could not conduct some wartime maneuvers safely, and its operations would be restricted to fewer airports. On the other hand, it is doubtful that the C-5 would ever operate under the conditions originally envisioned for it. Administrative prudence and a desire to protect so expensive a plane would probably limit some types of missions, even with a new wing. It should also be noted that the Department of Defense would face a difficult decision about employing the C-5 for minor contingencies because it could potentially reduce eventual capacity of the plane to respond safely to a future NATO deployment requirement. If, on the other hand, one assumed that no contingency would emerge that would make such substantial demands--or that, if one did, it would probably evolve into a general war in Europe--then such constraints might be acceptable in light of the substantial cost savings.

The C-141 Stretch Program. The improvement in delivery rates produced by stretching the C-141 is small. Termination at this point would save the $269 million required to finish the program, less any penalties associated with such a cancellation. However, terminating the stretch program would also involve cancelling the installation of aerial refueling capability in the aircraft. At this point, it is unclear how much of the possible savings would be consumed by just installing aerial refueling--which is of great potential value in certain limited contingencies.

The CRAF Modification Program. The CRAF modification program is clearly the least costly way to increase airlift capacity. If evaluated in the context of the NATO reinforcement requirement, however, the modification program might not be necessary, assuming that equipment is pre-positioned for all the divisions and support units that are expected to be in Europe by the tenth day of

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13/ CBO update of a Rand Corporation estimate of the cost of a fastener change, adjusted for inflation and incorporating some items not included by Rand.

mobilization. As noted above, current reinforcement objectives for ground forces could be met without improving current airlift resources if DoD's pre-positioning program was implemented. Delivery of tactical fighter squadrons to Europe within a week, which is currently problematical, could be assured if the CRAF modification program was implemented. That objective might also be met, however, if ground forces delivery schedules were relaxed by a day or two. The Congress might want to question whether the one- or two-day improvement in meeting a planning objective that the CRAF modification program would provide is worth the estimated $550 million cost of achieving that capability.

Tactical Airlift Modernization. If the Congress decides that a NATO war should guide tactical transport modernization, procurement of the AMST does not appear warranted, either for battlefield mobility or for strategic augmentation. If, however, a decision is made not to procure the AMST, continued procurement of the new C-130 (model H) would be necessary to replace older models. This replacement of old C-130s would cost $2.1 billion.

Airlift Improvements to Meet Limited Contingency Objectives

The primary concern of an airlift improvement program designed to meet future limited contingency objectives is to overcome potential limitations in the existing airlift system.

The C-5 Wing Modification Program. If non-NATO contingencies guide airlift improvement, a 30,000-hour service life would be an important goal for the C-5 wing modification program. Since no equipment is currently pre-positioned for U.S. forces outside the NATO region, the C-5 would be more vital to the conduct of operations in a non-NATO contingency than it would be in a NATO conflict. Perhaps of greater value, a full wing modification program would remove the performance restrictions that currently limit C-5 operations. With full modification, the C-5 could routinely operate on shorter runways with heavier payloads. Such performance might be crucial in limited contingencies in areas such as the Persian Gulf. The C-5 re-wing program would cost $1.1 billion.

The C-141 Stretch Program. As with the C-5 modification program, the C-141 stretch program should continue in order to meet the requirements of non-NATO contingencies. The added airlift capability of the C-141 would be useful in limited contingencies in which full CRAF augmentation might not be guaranteed.

Of potentially greater significance is the addition of aerial refueling capability, which makes this an attractive program for meeting limited contingency objectives, since refueling stops might be denied for political reasons. The cost of this program would be $269 million.

The CRAF Modification Program. The CRAF modification program suffers from the same limitations as the CRAF system itself. Planes modified under the program would be available for airlift operations only upon a full mobilization. While this could be expected in a NATO/Warsaw Pact war, it is less certain in a non-NATO contingency. Some CRAF augmentation, perhaps at Stages I and II, would be available, however. Full mobilization is certainly questionable, which would exclude the benefits of the CRAF modification program.

Tactical Airlift Modernization. While the AMST presents distinct performance improvements over the C-130, it is not certain that the current tactical transport fleet would be a bottleneck in limited contingencies. The primary advantage of the AMST is its capacity to transport outsize cargo and operate on short runways. This would be a particular advantage in a Middle East contingency. Yet, in Saudi Arabia, for example, the C-5 can operate in only four fewer airports than the AMST, and the C-130 can operate in virtually the same number of fields as the AMST. Further, the potential contribution of the AMST in strategic augmentation operations, while better than that of the C-130, would make a relatively small difference in delivery time. Neither tactical transport requirements nor strategic augmentation appear to justify procurement of the AMST for limited contingencies.

The Advanced Tanker/Cargo Aircraft. The Department of Defense has argued that the ATCA is needed primarily to satisfy tanker requirements during limited contingencies. The performance of the KC-10 is clearly superior to that of the KC-135, especially on long-distance deployments such as those that would be encountered in a Persian Gulf contingency. Nonetheless, the Congress might want to assess the need for further procurement of ATCA in light of two considerations. First, if a limited contingency did not lead to, or was not accompanied by, a reinforcement of NATO, it appears that the current tanker force would be capable of meeting refueling requirements. 14/ While the number of KC-135

14/ See discussion on pp. 39-40.

tankers required would be much larger--and less efficient--than a comparable force of KC-10s, the requirement could be met. Second, procurement of an advanced tanker for strategic airlift has been justified most strongly on the basis of the experience of the Israeli airlift in 1973, during which intermediate ground refueling was in question and overflight rights were denied. This could be a possibility again in the event of an Arab-Israeli war. It is difficult to imagine comparable developments elsewhere, however.

Thus, it appears that the justification for ATCA rests almost exclusively on its potential application in a Middle East/Persian Gulf contingency, for that is the one clear circumstance in which existing tanker resources might be committed to a more pressing set of requirements (for example, keeping the strategic bomber force at highest readiness) and in which intermediate refueling bases might be denied to airlift operations. The value of the ATCA would not be nearly so significant in other limited contingencies, such as the reinforcement of South Korea. In light of significant political changes in the Middle East/Persian Gulf region, the Congress could forego further ATCA procurement at this time, especially since the program involves adapting a commercial airplane that will be in production well into the 1980s.

An Expanded Airlift System for Limited Contingencies

If the Congress decides that airlift forces should be able to deliver combat units faster in future contingencies than is currently possible, it would have to procure more organic transports. The C-141 stretch and CRAF modification programs would improve delivery times for lighter units but not for heavier units, which have no combat equipment pre-positioned. 15/ Further, since CRAF availability might be uncertain in future non-NATO contingencies, procurement of additional organic aircraft would provide the most assurance that future airlift forces would be able to respond to demanding airlift requirements in those situations.

Current outsize cargo capacity limits overall delivery time for heavier divisions. Further, no CRAF planes can carry outsize cargo. To shorten delivery times, any airplane added to the fleet should be capable of carrying outsize cargo.

15/ See Table 9, p. 34.

Two substantially different alternatives--procurement of the AMST or of additional C-5s--might be considered. 16/ If the Congress is interested primarily in improving strategic airlift forces at the least cost, procurement of additional modified C-5 transports would be the preferable alternative. Table 14 indicates that 50 additional C-5s would achieve a greater improvement in delivery time than a fleet of 277 AMSTs. At a cost of $92 million for each C-5 modified transport, a fleet of 50 C-5s would cost $4.6 billion, compared to $8.3 billion for 277 AMSTs.

If 50 new C-5s were procured, only a limited fastener change on existing C-5 aircraft would be necessary to ensure continued operation of the fleet. The new C-5s could absorb the flying hours required to maintain training for the air crews of all 120 C-5s, thereby conserving service life of the older C-5s.

Alternatively, the Congress could choose to expand current airlift capabilities by modernizing the tactical transport fleet with procurement of the AMST. A fleet of 277 AMSTs would cost $8.3 billion, though $2.1 billion would be saved if no replacement C-130 transports were ordered. The primary advantage of AMST procurement would be an improvement in tactical capabilities for operations in regions such as the Middle East in which local transportation networks might be limited. The AMST could not achieve the same efficiency as the C-5 in the strategic transport role, however. The C-5, on the other hand, would not improve tactical transport forces.

It should be noted that both the C-5 and the AMST are currently being evaluated by the Department of Defense as possible delivery vehicles for future ICBM missiles and air-launched cruise missiles. Each plane has advantages and disadvantages for these purposes. The C-5 could potentially carry two ICBM missiles, substantially reducing the number of planes--and thereby the procurement and operating costs--of this type of airborne ICBM system. The AMST would be able to transport only one ICBM. The C-5 could potentially carry 64 cruise missiles, whereas the AMST--as currently designed--could hold only 16. The AMST would

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16/ The B-747 could be modified to enable it to carry outsize cargo. The Boeing Corporation, manufacturer of the B-747, has received substantial orders for its new wide-body intermediate range aircraft, potentially limiting its ability to manufacture many B-747s quickly.

have a distinct advantage over the C-5 since it could take off and land from thousands of U.S. airports, whereas the number of airports capable of accommodating the C-5 would be substantially lower. Further, if the airmobile missile was expected to be able to survive for a number of days or weeks, the AMST would have a distinct advantage over the C-5 in that it could be shuttled from airport to airport, thus lessening the chance that it could be destroyed on the ground by enemy attacks.

Procurement of either aircraft as a strategic delivery vehicle for missiles would have direct implications for airlift improvement. If either the C-5 or the AMST was procured as both an organic transport and a strategic missile delivery vehicle, unit costs could be reduced substantially as a result of a larger production run. 17/ Since the outcome of the DoD evaluation has not yet been announced, the AMST and C-5 options are presented here merely as alternatives, although a decision to procure either of them for strategic nuclear missions would have a substantial effect on their cost.

SUMMARY

Table 15 summarizes the programs and costs associated with each of the airlift improvement alternatives discussed above. They are not strict alternatives in that procurement programs in the expanded airlift category could be combined with enhancement programs for NATO reinforcement or limited contingencies. It is important to note, however, that decisions made by the Congress for fiscal year 1980 will determine the structure and capabilities of airlift forces for many years to come. The range of expenditures presented in Table 15--from $2.9 billion to $9.6 billion--indicates that airlift enhancement could be an area in which defense expenditures could be reduced or increased, depending on what the Congress anticipates to be the need for airlift forces in the future.

17/ Each of the first 50 C-5s purchased would cost $92.1 million. The average cost of the next 50 C-5s is estimated to be $61.3 million. Similarly, the average cost of the first 277 AMSTs is $29.8 million, while the average cost of the next 100 is $13.4 million.

TABLE 15. ALTERNATIVE AIRLIFT FORCES FOR THE FUTURE: IN MILLIONS OF FISCAL YEAR 1980 DOLLARS

Alternative Airlift Forces	Fiscal Year 1980	Total Program Costs (Fiscal Year 1980 and Beyond)
Department of Defense Program Baseline a/		
Full wing modification of C-5s	91	1,087
CRAF modification program	74	554
C-1A1 stretch program	130	269
KC-10 Advanced Tanker/Cargo Aircraft	190	754
Replace 208 C-130 models A/B/D with model H	202	2,096
Total, DoD Baseline	687	4,760
NATO Reinforcement Airlift Force		
Fastener change on existing C-5s	90	543
Replace 208 C-130 models A/B/D with model H	202	2,096
Continue C-141 stretch program	130	269
Total, NATO Reinforcement	422	2,908
Limited Contingency Airlift Force		
Full wing modification of C-5s	91	1,087
Replace 208 C-130 models A/B/D with model H	202	2,096
Continue C-141 stretch program	130	269
Total, Limited Contingency	423	3,452
Expanded Airlift Force		
Enhanced strategic airlift force		
Procurement of 50 new C-5s	30	4,604
Fastener change on existing C-5s	90	543
Replace 208 C-130 models A/B/D with model H	202	2,096
Continue C-141 stretch program	130	269
Total, Enhanced Strategic Force	452	7,512
Enhanced tactical airlift force		
Procurement of 277 AMSTs	5	8,256
Full wing modification of C-5s	91	1,087
Continue C-141 stretch program	130	269
Total, Enhanced Tactical Force	226	9,612

a/ The Department of Defense baseline includes those programs listed in the fiscal year 1980 posture statement. Since DoD has no current plans for tactical airlift modernization, CBO has selected the least expensive option (that is, replacement of 208 C-130 models A/B/D with new model H) for inclusion in the baseline airlift force.

A P P E N D I X

APPENDIX A. ASSUMPTIONS AND METHODOLOGY USED IN AIRLIFT CALCULATIONS

This appendix serves two purposes. First, it introduces the reader to the factors that are relevant to mobility planning calculations. Second, it substantiates the conclusions offered in the text of the paper. Planning variables fall into three categories: those specific to the means of transportation (aircraft variables); the cargo transported (cargo variables); and the routing used in an operation (route variables).

The methodology used in this paper provides a framework for evaluating airlift operations on the basis of general performance characteristics. Throughout the calculations, basic assumptions have been held constant so as not to prejudice performance of any particular component of the airlift system or of the enhancement programs. All of the planning variables used in the calculations are derived from public sources. As a result, the airlift system is evaluated on the basis of a public methodology similar (though far less sophisticated) to that used by the Department of Defense. This approach has also been used in earlier CBO studies. 1/ Of course, performance of the airlift system in a contingency may differ from the results of these calculations, since planning factors can only approximate the many variables that affect delivery schedules in actual operations.

AIRLIFT PLANNING FACTORS

Aircraft Variables

Table A-1 presents five major categories of variables specific to aircraft used in these calculations. Each is described in turn.

1/ See Congressional Budget Office, U.S. Projection Forces: Requirements, Scenarios, and Options, Budget Issue Paper for Fiscal Year 1979 (April 1978).

TABLE A-1. AIRCRAFT VARIABLES USED IN COMPUTATION OF AIRLIFT CAPACITY

Aircraft Type	Number	Utilization Rate a/	Productivity Factor	Speed	Payload
C-5	70	12.5	.445	428	69.3
C-141	234	12.5	.445	407	21.0
B-747 (cargo)	17/31 b/	10.0	.470	450	72.9
B-707 (cargo)	30/83 b/	10.0	.470	440	30.0
B-707 (passenger)	430 b/	10.0	.470	440	165.0
C-130	218	8.0	.445	260	13.8
AMST	141	8.0	.445	400	18.4 c/

a/ These are programmed utilization rates.

b/ Expressed as equivalent units by indexing airplane characteristics to the B-707 or B-747, as appropriate for narrow-body and wide-body jets. The first number represents those planes in CRAF Stage I; the second, full CRAF mobilization.

c/ Payload for palletized cargo only.

Number. The number of military transports is the unit equipment (UE) number, recently relabeled the "primary aircraft authorization" (PAA). 2/

2/ Special attention should be given to the number used for AMST aircraft. This study compares the C-130 and the AMST in terms of strategic augmentation. The number of aircraft will be

The actual civilian fleet (CRAF) consists of many different types of planes. These types of planes are indexed against the B-747 (for wide-body jets) and B-707 (for narrow-body aircraft), using conversion factors developed by the Military Airlift Command. 3/ Thus, the three categories of civilian planes are expressed in terms of B-747/B-707 equivalent aircraft.

Utilization Rate. The utilization rate is a planning variable that expresses system-wide airlift performance for each type of plane in terms of daily flying hours. For example, a C-5 flying a 12.5-hour utilization rate means that over an airlift operation each plane will average 12.5 hours of flying time a day. At any given time, only about one-third of the planes will probably be flying but, when they are, they will operate (discounting intermediate refueling stops) for more than 12.5 hours at a time. A utilization rate of 12.5 hours will produce twice the potential lift for a fleet of planes than would be produced if that same fleet were operated 6.25 hours a day.

It is important to note that the utilization rate is a planning variable. Higher rates can be attained with greater inventories of spare parts, more flight crews, and more maintenance personnel. Civilian airlines routinely maintain 10-hour utilization rates. MAC plans to fly organic transports 12.5 hours a day for the initial 45 days of an airlift operation

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determined by tactical airlift requirements, however, and not by strategic augmentation requirements. Thus, the number of AMSTs used in these calculations was selected so that the AMST fleet and the fleet of 218 C-130s would provide roughly equal potential airlift of bulk cargo in tactical operations. The Air Force had actually proposed to purchase 277 of these aircraft. Specific conversion factors were provided by the Air Force Directorate of Concepts and Analysis.

3/ See The Posture of Military Airlift, Hearings before the Subcommittee on Research and Development, House Committee on Armed Services, 94:1 (November 1975), pp. 524-28. MAC refers to these conversion factors under the title "Mobilization Base Index."

and maintain 10 hours a day for the remainder of it. 4/ The CRAF contract calls for 10-hour utilization rates throughout a mobilization.

Productivity Factors. Planes that carry cargo to a destination must either return empty or return with wounded troops or equipment for repair in the United States. In terms of delivering a specified cargo to the theater, these return flights are not productive. The productivity factor lowers system-wide performance to account for those actions that are "non-productive." These numbers are specified in Air Force Regulation 76-2.

Speed. The speeds given here are technically known as "block-in" speeds, which average the cruising speed of an aircraft with the lower take-off and landing approach speeds. Obviously, the longer the distance of a flight, the greater the "block-in" speed, since less time of the total flight is consumed by take-offs and landings at lower speeds. The block-in speed and the cruising speed become very close over distances of more than 2,000 miles. At lesser distances, block-in speed can be substantially lower. The speeds given in Table A-1 assume a 3,500-nautical mile average distance. 5/

Payloads. The payloads presented in Table A-l were not necessarily those used in the calculations. This is described at greater length in the next section. They are provided here both for purposes of comparison and to introduce discussion of one of the most important and complicated aspects of airlift calculations.

Any airplane can lift a given amount of weight, consisting of the plane itself, its cargo, and its fuel. At some distance unique to each type of plane, a direct trade-off exists between the quantity of fuel and the quantity of cargo; to fly beyond that distance without refueling requires increased quantities of fuel,

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4/ The Air Force has reported that the C-141 could sustain a utilization rate as high as 15 hours a day. See Military Airlift, Hearings before the Subcommittee on Military Airlift, House Committee on Armed Services, 91:2 (January and February 1970), p. 6713.

5/ Speed factors are derived from Air Force Regulation 76-2.

which in turn lowers the amount of lift capacity that can be allocated to cargo. The C-5 can transport up to 104.4 tons of cargo for a little more than 3,000 nautical miles. Beyond that point, cargo capacity drops in relation to additional distance flown.

The longest unrefueled distance a plane must travel on any given trip--termed its "critical leg"--determines the payload for the entire trip. The payloads given in Table A-1 assume a critical leg of approximately 3,500 nautical miles, except for the C-130 and AMST, for which the critical leg distance is assumed to be 2,500 nautical miles. 6/

Cargo Variables

The second major category of variables affecting the time required to deliver combat forces and supporting equipment is the cargo of the units themselves. Cargo of combat units varies in three primary ways, as discussed below.

Gross Weight Differences. Some divisions are heavier than others. Table A-2 gives cargo data for the five types of divisions in the Army. The types of divisions are listed in descending order from heaviest to lightest. Mechanized and armored divisions are roughly similar in weight. The 82d Airborne and 101st Airmobile divisions also tend to be of similar weight.

Different Distributions of Cargo by Categories. Armored and mechanized divisions are not uniformly heavier than lighter divisions. The primary difference occurs in unit equipment in the oversize and outsize cargo categories. Bulk cargo tends to be relatively similar for each type of division. Similarly, support equipment cargo tends to be relatively similar (by tonnages, although not necessarily by inventories), regardless of division type. A heavy division takes longer to transport, not only because it weighs more than a lighter division, but also because more of its weight is concentrated in the outsize cargo category, which can be carried only by the C-5.

Density Differences by Division Type. The final planning variable associated specifically with cargo concerns the type

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6/ Payload variables are found in Air Force Regulation 76-2.

TABLE A-2. UNIT EQUIPMENT AND SUPPORT CARGO, a/ BY TYPE OF DIVISION: IN SHORT TONS

Division Type	Bulk	Oversize	Outsize	Passengers
Armored				
Unit equipment	5,979	21,704	27,658	16,460
Support equipment	8,440	25,059	13,442	17,642
Mechanized				
Unit equipment	5,778	21,577	21,213	16,152
Support equipment	8,534	25,059	13,442	18,110
Infantry				
Unit equipment	5,596	16,395	7,760	16,495
Support equipment	8,043	26,365	13,182	18,100
Airborne				
Unit equipment	5,226	8,814	593	14,914
Support equipment	7,977	26,283	13,182	17,969
Airmobile				
Unit equipment	5,182	8,345	1,702	17,668
Support equipment	6,907	24,126	10,936	16,021

SOURCE: Information provided to CBO by U.S. Air Force.

a/ The support cargo represents the "initial support increment" in previous force planning. This notion, which had its complement in the "sustaining support increment," has been replaced in recent years. The two support packages are now called the "non-divisional combat support" and the "tactical support increment." This was not merely a change in name, but involved a shifting of the various elements within these two packages. No unclassified data are currently available on the new breakdown of support units.

of equipment that is generally found in various units that require air transportation. Heavier units tend to have cargo items with greater density than lighter units, especially in the outsize cargo category. The M-60A1 main battle tank and the CH-47C cargo helicopter provide extreme but useful examples. The density of the M-60 is 25.3 pounds per cubic foot. The density of the CH-47C is 1.61 pounds per cubic foot. The tank is more than 15 times as dense as this particular cargo helicopter. Tanks are a major component of the cargo of heavier divisions. Conversely, helicopters are the backbone of the 101st Airmobile Division. As could be anticipated, Table A-3 shows that average payloads for each type of plane tend to be greater for heavier divisions. Cargo with greater density permits planes to fly with higher average payloads.

Routing Variables

There are two primary routing variables: the distance to the destination from the U.S. point of embarkation and the "critical leg," which is the longest distance the plane must fly without refueling. Because of the uncertainty associated with unique routing questions, the critical leg is assumed to equal approximately 3,500 nautical miles. At this distance, payloads are almost always limited by volume or floor space and not because of critical distance constraints. The payloads presented in Table A-3 were used in the calculations and reflect these limits.

COMPUTING AIRLIFT CAPACITY

Determining delivery rates for different types of units with different airlift resources essentially involves computing daily lift capacity for each type of aircraft, and then dividing the cargo by the daily lift capacity to determine the days required to deliver the units. Two separate formulas are required.

$$(1) \quad L_{ij} = \frac{N_i \times U_i \times S_i \times R_i}{\nu_i} \times P_{ij}$$

TABLE A-3. PAYLOAD PLANNING VARIABLES USED IN AIRLIFT COMPUTATIONS: IN SHORT TONS

Aircraft Type	Payload Category: Division Unit Equipment: Airborne	Airmobile	Infantry	Mechanized	Army Support: All Divisions	Air Force: All Cargo
C-5 a/	54.6	30.1	68.5	68.5	69.3	56.6 b/
C-141A c/	13.9	12.9	17.8	20.8	21.0	17.2 b/
C-141B d/	17.4	16.1	20.6	24.1	24.4	19.9 b/
B-747 (cargo) e/	57.4	31.7	72.1	72.1	72.9	59.6 b/
B-707 (cargo) f/	30.0	30.0	30.0	30.0	30.0	30.0
B-707 (passenger) f/	165.0	165.0	165.0	165.0	165.0	165.0
C-130 g/	13.8	13.8	13.8	13.8	13.8	13.8
AMST h/	25.0	25.0	25.0	25.0	25.0	25.0

SOURCES: See below.

a/ Air Force Regulation 76-2, p. 10.

b/ No public planning factors for Air Force payloads by type of plane are available. These payload factors were derived by reducing respective Army support payloads by the ratio 13.4/16.4, which is the density factor for Air Force cargo divided by the density of Army cargo. See Air Force Regulation 76-2, p. 42.

c/ Air Force Regulation 76-2, p. 13.

d/ No public planning factors are available for the stretched version of the C-141. The Air Force has reported that payloads will vary with unit cargo density, from 25 percent for low-density cargo to 16 percent for high-density cargo. Payloads for the airborne and airmobile divisions are increased by 25 percent; remaining payloads are increased by 16 percent.

e/ No public planning factors are available for unit equipment variances by division type for CRAF wide-body jets. These payload variables represent the same ratio of division equipment to Army support payloads as prevails for the C-5, for each type of division. The support figure is equal to 75 percent of maximum allowable cabin load for the B-747.

f/ Air Force Regulation 76-2, p. 14.

g/ Information provided to CBO by U.S. Air Force (December 1978).

h/ Air Force Regulation 76-2 update for generic AMST performance.

Where

L_{ij} = Strategic lift capacity of aircraft *i*, for a cargo of a force *j*, measured in tons/day

N_i = Number of aircraft *i*

U_i = Utilization rate of aircraft *i*

S_i = Block-in speed of aircraft *i*

R_i = Productivity factor for aircraft *i*

D_i = Distance traveled by aircraft *i*

P_{ij} = Payload of aircraft *i*, given cargo of force *j*

As an example, the following presents the lift capacity of the C-5 carrying unit equipment of a mechanized division over a hypothetical distance of 4,000 nautical miles:

$$\text{Daily C-5 lift} = \frac{70 \times 12.5 \times 428 \times 0.445}{4{,}000} \times 68.5$$

$$= 2{,}854 \text{ tons/day}$$

Expressed verbally, a fleet of 70 C-5 transports, averaging 12.5 flying hours a day, carrying the equipment of a mechanized division over a distance of 4,000 nautical miles could transport 2,854 tons per day. The same calculations are computed for each of the other types of aircraft, for each division, and for the support equipment of that division.

The next step involves computing the time required to deliver all of the cargo of the unit and its supporting elements. The time required to move that force may be expressed as:

$$(2) \quad T_j = \frac{U_j + x}{L_{(U)j}} = \frac{V_j - x}{L_{(V)j}}$$

Where

T_j = Time in days to move force j

U_j = Outsize tonnage associated with force j

V_j = Oversize/bulk tonnage associated with force j

$L_{(U)j}$ = Daily lift capacity for outsize cargo, computed from equation (1) 7/

$L_{(V)j}$ = Daily lift capacity for oversize/bulk cargo, computed from equation (1). That capacity is the sum of airlift generated by the C-141, C-130, and CRAF B-747. 8/

and

x = Total oversize/bulk cargo carried in aircraft capable of outsize cargo

It is necessary to make the following assumptions before computing delivery time using equation (2):

- All military transports are capable of carrying bulk and oversize cargo. Outsize cargo, however, can be carried only in the C-5 and the AMST.

- The distance of destinations from coastal ports of embarkation is increased by 1,000 nautical miles to account for flights originating inland.

7/ This is essentially the capacity of the C-5 and the AMST for those calculations in which the AMST was included.

8/ It has been assumed for purposes of these calculations that 75 percent of B-747 cargo capacity is oversize.

- CRAF planes can carry no outsize cargo. Narrow-body CRAF planes (B-707 equivalents) can carry bulk cargo only. Wide-body CRAF planes (B-747 equivalents) can carry bulk and oversize cargo. Since the unit of measure is a composite of several different planes, this analysis assumes that 75 percent of the allowable payload is oversize and the remaining 25 percent is bulk cargo. 9/

- The density of bulk and oversize cargo is assumed to be equal.

- Airlift capacity is not reduced by attrition.

- Airlift operations are perfectly efficient in that this analysis assumes no limitations on fuel availability, no loading and unloading constraints, and no limits on intermediate refueling or overflight rights.

The tables presented in the text of the paper are expressed in terms of delivery rates, which are defined to be that distance that a force can be transported for each unit of time. Delivery rates are expressed by the following formula:

$$(3) \quad C_j = \frac{D_j}{T_j}$$

Where

C_j	=	Delivery rate for force j
D_j	=	Distance traveled in deployment
T_j	=	Time in days to move force j (closure time) [derived from equation (2)]

9/ When the mix of various airlift resources is changed, there are times when bulk cargo exceeds the capacity of B-707s (and the 25 percent of B-747 capacity that is limited to bulk cargo). In those instances, the bulk cargo in excess of exclusive bulk lift capacity is transported along with oversize cargo.

QUALIFYING OBSERVATIONS

By using these formulas and planning variables, it is possible to determine generally the time required to transport a specified type of force to a certain location. It would be a mistake, however, to assert that this is the actual performance that can be expected by the airlift system in a real-life situation. Several qualifications should be specifically noted.

Transit Time Only. The calculations presented in the paper consist of transit time only. In actual operations, additional time would be required to ready units for loading in the United States and to reassemble in the destination area and move to the front lines. Some units take a good deal longer to prepare for loading than others. For example, the 101st Airmobile Division relies extensively on helicopters, which require several days of preparation time.

Support Units. Unclassified cargo data are limited to figures provided by the Air Force in 1977. Since 1977, there has been a change in the way support equipment is divided for planning purposes. The figures used in Table A-3 for Army support cargo reflect previous force planning, which utilized the concept of the "initial support increment" (ISI). The ISI consisted of hypothetical inventories of equipment, supplies, and units needed to support the unit in its initial deployment. Long-term support was dependent upon yet another echelon, known as the "sustaining support increment."

These two planning devices have been replaced by new planning categories, known as "non-division combat support" and "tactical support increments." These latter components are not just new labels for the previous support increments. Rather, the new support packages have somewhat different mission requirements. The relative ranking of types of units by weight and cargo distribution is similar to previous support packages.

Resupply. These calculations do not include cargo that consists of supplies needed to replenish and sustain combat units. Such resupply cargo calculations depend on assumptions about the intensity of combat and on consumption rates associated with different combat environments. These figures are not available in a public source. It can generally be said, however, that resupply cargo will delay deployments, particularly for deployments to non-NATO regions. Some war reserves are maintained in Europe. This is not the case in non-NATO areas, where some airlift resources will have to be devoted to resupply cargo. In addition, pre-positioning of equipment in Europe changes consumptions patterns in ways that might affect airlift. These considerations, while important to note, cannot he treated specifically in this analysis.

Deployment Schedules. Actual deployments consist of literally hundreds of missions from dozens of ports of embarkation. These calculations cannot represent the complexity of actual deployment schedules. Therefore, when the discussion indicates that a certain number of days is required to transport a given unit, it more appropriately means that transit time equivalent to that number of days of lift capacity must be devoted to the unit in question. Actual elapsed time in a contingency might differ--up or down--from this planning figure, depending on the specific deployment plan used.

Artificial Force Packages. Calculations generally relate to generic types of divisions and not, with the exception of the airmobile and airborne divisions, to actual divisions. Any deployment would also include tactical fighter squadrons, reconnaissance and observation aircraft, tactical transports, air defense units, and so on. Further, any airlift operation would depend on air traffic control units, aerial port personnel, and so forth, just to manage the transportation operation. In short, airlift deployment of a fighting force is far more complex than tonnage figures can portray.

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