The views expressed in this paper are those of the author and do not necessarily reflect the views of the Department of Defense or any of its agencies. This document may not be released for open publication until it has been cleared by the appropriate military service or government agency.

STRATEGY RESEARCH PROJECT

AN OVERVIEW AND ASSESSMENT OF U.S. STRATEGIC AIRLIFT

BY

LIEUTENANT COLONEL TOBEN I. ROWER
United States Air Force Reserve

USAWC CLASS OF 2001

U.S. ARMY WAR COLLEGE, CARLISLE BARRACKS, PA 17013-5050

USAWC STRATEGY RESEARCH PROJECT

AN OVERVIEW AND ASSESSMENT OF U.S. STRATEGIC AIRLIFT

by

Lt Col Toben I. Rower
USAFR

Colonel Michael Mestemaker
Project Advisor

U.S. Army War College
CARLISLE BARRACKS, PENNSYLVANIA 17013

ABSTRACT

AUTHOR: Lt Col Toben I. Rower

TITLE: An Overview and Assessment of U.S. Strategic Airlift

FORMAT: Strategy Research Project

DATE: 20 December 2000 PAGES: 74 CLASSIFICATION: Unclassified

This paper will analyze the evolution and defining of strategic airlift requirements from the 1980s forward as examined in multiple Congressional and DOD level studies and reviews. An analysis of the current strategic airlift fleet and force structure will be included. A historical perspective will show the importance and critical nature of strategic airlift. A look will be taken at multiple airlift studies to date to compare and contrast the results and evaluate the present situation to answer the question: Is there an overall strategic airlift shortfall? This paper concludes that modifications to improve C-5 reliability are necessary now. Based on the current national military strategy and the present C-17 buy, current U.S. organic airlift capability falls short of requirements, even under optimistic conditions and assumptions. Army transformation will increase airlift requirements. Other aspects of the airlift equation such as material handling equipment, support personnel, thru-put capability, and infrastructure, etc. are acknowledged to be equally critical components of air mobility, and it is not the intent of this paper to marginalize them.

TABLE OF CONTENTS

ABSTRACT III

LIST OF ILLUSTRATIONS VII

LIST OF TABLES IX

LIST OF ABBREVIATIONS XI

AN OVERVIEW AND ASSESSMENT OF U.S. STRATEGIC AIRLIFT 1

HISTORICAL PERSPECTIVES 2

THE "HUMP" 2

THE BERLIN AIRLIFT 3

VIETNAM 3

OPERATION NICKEL GRASS 4

OPERATIONS DESERT SHIELD AND DESERT STORM 4

STRATEGIC AIRLIFT AIRCRAFT 5

THE C-141 STARLIFTER 7

THE C-5 GALAXY 9

THE C-17 GLOBEMASTER 12

C-17 Airdrop 16

THE KC-10 EXTENDER 17

THE CIVIL RESERVE AIR FLEET 18

CRAF Concerns 20

STRATEGIC AIRLIFT FORCE STRUCTURE 21

THE AIRCRAFT 21

THE PEOPLE 21
DEPARTMENT OF DEFENSE STUDIES AND REVIEWS 23
CONGRESSIONALLY MANDATED MOBILITY STUDY (CMMS) 23
MOBILITY REQUIREMENTS STUDY (MRS) 24
MOBILITY REQUIREMENTS STUDY BOTTOM-UP REVIEW UPDATE (MRS BURU) 26
MOBILITY REQUIREMENTS STUDY FOR FISCAL YEAR 2005 (MRS-05) 27
ARMY TRANSFORMATION 32
ANALYSIS 34
CHANGING STRATEGY? 38
CONCLUSION 38
ENDNOTES 41
BIBLIOGRAPHY 53

LIST OF ILLUSTRATIONS

FIGURE 1. GATM COMPLIANCE TIMELINE 6

FIGURE 2. STRATEGIC AIRLIFT FLEET SIZE TO 2010 8

FIGURE 3. C-5 HISTORICAL MISSION CAPABLE RATE 10

FIGURE 4. C-5 BASELINE & RE-ENGINING AND RELIABILITY ENHANCEMENT PROGRAM (RERP) MODIFICATIONS 11

FIGURE 5. C-17 ERFCS IMPROVEMENT 15

FIGURE 6. AMC AIRCRAFT PAYLOAD-RANGE COMPARISON 16

FIGURE 7. CHRONOLOGY OF REQUIREMENTS VERSUS CAPABILITY 25

FIGURE 8. OPTIMUM ASSUMPTIONS OF MRS-05 29

FIGURE 9. LEVELS OF MOBILIZATION MTM CAPABILITY 30

FIGURE 10. ALTERNATIVE AIRLIFT SOLUTIONS 31

FIGURE 11. ARMY TRANSFORMATION 33

FIGURE 12. CARGO CLOSURE REQUIREMENT VS. CAPABILITY 34

LIST OF TABLES

TABLE 1. STRATEGIC AIRLIFT AIRCRAFT 5

TABLE 2. GATM TIMELINE 7

TABLE 3. C-17 BUY PROFILE 13

TABLE 4. CRAF AIRCRAFT CONTRIBUTION 19

TABLE 5. CREW RATIO BY AIRCRAFT AND SERVICE 22

TABLE 6. SUMMARY OF STRATEGIC AIRLIFT PLANNING FACTORS 34

LIST OF ABBREVIATIONS

AC – Active Component

AFB – Air Force Base

AFRES – Air Force Reserve

AMC – Air Mobility Command

AMP – Avionics Modernization Program

ANG – Air National Guard

AOR – Area of Responsibility

APOD – Aerial Port of Delivery

ARC – Air Reserve Component

ARNG – Army National Guard

ATC – Air Traffic Control

BCT – Brigade Combat Team

BDE – Brigade

BRNAV – Basic Area Navigation

BURU – Bottom Up Review Update

CA – Counter Attack

CENTCOM – Central Command

CINC – Commander in Chief

CMMS – Congressionally Mandated Mobility Study

CNS/ATM – Communications, Navigation, Surveillance/Air Traffic Management

CONUS Continental United States

CRAF – Civil Reserve Air Fleet

CVBG – Carrier Vehicle Battle Group

DOD – Department of Defense

DRB – Division Ready Brigade

ERFCS – Extended Range Fuel Containment System

eSB – Enhanced Brigade

FAA – Federal Aviation Administration

FEDEX – Federal Express Corporation

FOC – Full Operational Capability

FUE – First Unit Equipped

GAO – General Accounting Office

GATM – Global Air Traffic Management

GPS – Global Positioning System

HF – High Frequency

IBCT – Interim Brigade Combat Team

ICAO – International Civil Aviation Organization

IOC – Initial Operational Capability

INS – Inertial Navigation System

JCS – Joint Chiefs of Staff

MAC – Military Airlift Command

MADARS – Maintenance and Data Acquisition Recording System

MANPADs – Man Portable Air Defense Systems

MLG – Main Landing Gear

MC – Mission Capable

MRS – Mobility Requirements Study

MRC - Major Regional Contingency

MTM – Million Ton-Miles

MTW – Major Theater War

NDAA – Non-Developmental Airlift Aircraft

NMS – National Military Strategy

NSS – National Security Strategy

OBCT – Objective Combat team

OBJ – Objective

PNAF – Primary Nuclear Airlift Force

POE – Port of Embarkation

POM – Program Objective Memorandum

PSRC – Presidential Select Reserve Call-Up

QDR – Quadrennial Defense Review

RERP – Re-Engining and Reliability Improvement Program

RNP – Required Navigation Performance

RVSM – Reduced Vertical Separation Minimums

SBA – Strategic Brigade Airdrop

SKE – Station Keeping Equipment

SLEP – Service Life Extension Program

SOLL – Special Operations Low-Level

SSC – Small Scale Contingency

TCAS – Traffic Alert and Collision Avoidance System

TDMA – Time Division/Demand Multiple Access

TPFDD – Time-Phased Force Deployment Data

USAF – United States Air Force

USTRANSCOM – United States Transportation Command

UTE – Objective Utilization Rate

VHF – Very High Frequency

VISA – Voluntary Intermodal Sealift Agreement

WBE – Wide-Body Equivalent

WMD – Weapons of Mass Destruction

AN OVERVIEW AND ASSESSMENT OF U.S. STRATEGIC AIRLIFT

> Any nation in building an air force cannot think of its fighting planes alone. This air transportation service for troops, supplies, ambulances and medical service, and for the transport of artillery and heavy equipment is a necessary adjunct to the maintenance of any efficient fighting force in the field. The speed and range of modern air forces makes it imperative that they be self-sustaining. The speed of the modern mechanized forces makes it distinctly advisable that at least a portion of their supply columns and agencies travel through the air.
>
> — General Henry H. Arnold, 1941

This is as true today, if not more so. Strategic mobility today is a critical part of the joint force equation. Ongoing changes in U.S. military strategy increasingly have stressed force projection and the important supporting role of air mobility forces.[1] Timely global reach is crucial to meeting the requirements of the current national military strategy (NMS). Joint Publication 5-0 states "The availability of strategic mobility resources to respond to deployment and sustainment requirements is a primary consideration in establishing a course of action and its execution planning."[2] Post Cold War force level reductions and the subsequent reduced U.S. forward presence necessitates an ability get there quickly and with enough. Strategic airlift is the key means to project combat forces long distances rapidly during the initial stages of a conflict. It can also be especially effective in humanitarian efforts and other military operations other than war.[3] From Basic Air Force Doctrine "Airlift is viewed as a foundation of U.S. national security at the strategic level and as a crucial capability for operational commanders within a theater. Therefore, airlift is not only a vital component of U.S. defense policy but is critical to support of overall national policy and objectives."[4] U.S. Airlift forces provide the National Command Authorities (NCA) with this critical capability. Airlift forces can be employed across the full spectrum of operations, from peacetime to contingency operations to major theater war.[5] There are many types of airlift missions in addition to basic wartime airlift, including but not limited to channel (scheduled runs), special missions supporting government agencies other than DOD, no-notice contingency, aerial delivery, training, aeromedical evacuation, humanitarian, Presidential support, and nuclear airlift.

This paper will focus upon the strategic airlift portion of the mobility equation. Some historical examples of where airlift made the difference will provide a perspective as to the

importance of its capability during war and as an instrument of national power. The current and projected airlift fleet will be presented along with force structure. The Civil Reserve Air Fleet (CRAF) will be discussed.

Multiple Congressional and DOD airlift and mobility studies have been conducted over the last twenty years. Today the Mobility Requirements Study for Fiscal Year 2005 (MRS-05), which began October 1998, is in the review cycle and nearing closure. Another study at the same stage as the MRS-05 is the Air Mobility Command (AMC) Outsize and Oversize Cargo Airlift Capability Analysis of Alternatives (O&O AoA). These studies attempt to determine what overall mobility requirements are, assess current capability, and determine how best to eliminate any capability shortfalls. This paper will compare and contrast what these studies have to say regarding strategic airlift and conclude with an assessment of where strategic airlift capability stands today and what needs to be done to address problems or shortfall. Army transformation implications will be addressed.

Possibilities for modification to the NMS are being debated today, which if implemented would have a direct effect on strategic airlift requirements. Some of these proposed options will be presented along with possible implications.

HISTORICAL PERSPECTIVES

Several historical cases of strategic airlift in action illustrate the impact of air mobility forces. These include the World War II "Hump" operation, the Berlin Airlift, Vietnam, Operation Nickel Grass, and "the mother of all airlift operations"... Desert Shield/Storm.

THE "HUMP"

During World War II, the Air Transport Command provided critical support to Allied forces around the world, but nowhere did this support reach the size of the "Hump" Airlift over the Himalayan Mountains in the China-Burma-India Theater. In February 1942, President Roosevelt's commitment to aid the Chinese in their fight against more than a million Imperial Japanese troops precipitated the most extensive airlift ever undertaken by the United States.[6]

Over half of the commands transport accidents and fatalities occurred on the Hump Airlift. Aircrews aptly referred to the air route as the "aluminum-plated trail."[7] The Hump operation began a new era of air power. No other air operation, civil or military, ever before had attempted to keep a fleet of aircraft in operation around the clock under such demanding and extreme weather conditions and altitudes. The airlift kept U.S. Army and

Air Forces in China logistically supplied and supported the Chinese in defense of their country as well. The three-year aerial pipeline made 167,285 trips and delivered 740,000 tons of war material.[8]

THE BERLIN AIRLIFT

The Berlin Airlift was a defining moment in Air Force history-one in which airmen and airlift changed the course of world events without firing a shot. The Cold War started with the Berlin blockade in June 1948.[9] The Soviets blockaded all food supplies and cut off electricity to Berlin on 24 June. The allies answered, in lieu of war, with an airlift to keep the city alive, at first thought to be absolutely impossible. The Berlin airlift was a demonstration of phenomenal teamwork between the allies. Together, they achieved an extraordinary victory, winning the first battle of the Cold War. The blockade ended on 12 May 1949 and the airlift continued until 30 September 1949, stockpiling needed supplies as a precautionary measure.[10] Although the distances flown were shorter, this operation demonstrates the flexibility airlift provides as an element of national power. Tons delivered: 2,323,067 on 276,926 flights. The total million ton-miles flown (MTM), the measurement used to quantify an airlift effort, on the Berlin airlift was 697.5 MTMs. This is quite impressive considering the limited capacities of the aircraft of that era.

VIETNAM

Although the Vietnam conflict will be remembered for many things, of which many are unpleasant, air mobility came of age during this period. As the war progressed, the U.S. role expanded and air mobility forces extensively supported virtually every air and ground operation that took place in Vietnam. The record of the airlift forces during the war in Southeast Asia is impressive. They transported approximately two million tons of material and two million passengers between the U.S. and theater of operations.[11] The U.S. learned valuable lessons about the use of inter- and intra-theater airlifters, the force-enhancement capability of the tanker force, and the importance of centralized command and control. These lessons enabled the United States to organize its air mobility forces into a dynamic team that can support U.S. strategy and policy anywhere in the world.[12] Jet strategic airlift with the new C-141 began during this conflict.

OPERATION NICKEL GRASS

On 6 October 1973, Egyptian and Syrian military forces launched a full-scale invasion against Israel. Based on the outcome of the 1967 war between the Arabs and the Israelis, the Nixon administration assumed that Israel would again achieve victory very quickly. The U.S. assessment was wrong, however. Israeli air forces proved unable to defeat the Soviet-supplied surface to air missiles and Israeli tanks suffered unanticipated breakdowns caused by the long distance they had to travel across the desert to engage the enemy. Israeli forces quickly started running out of ammunition. The situation looked grim for an important ally of the United States. At first commercial airlift was tried jointly both on the part of Israel and the U.S but collapsed due to liability issues precluding U.S. carriers entering Israel and the small size of the Israeli effort. The only choice left was U.S. military airlift. Just nine hours after President Nixon had committed U.S. airlift to re-supply Israel, MAC C-5s and C-141s were en route with urgently needed materials.[13] Over the next 30 days, MAC aircraft flew 567 missions and delivered 22,318 tons of material to Israel. 136.6 MTMs were flown. The efforts of the U.S. airlift paid off when a cease-fire agreement was signed on 2 November 1973. Several major lessons were learned from this operation. Only airlift could provide the rapid response needed in a crisis like this one. The first sealift ship arrived after the cease-fire. Lajes was and remains an extremely important strategic location as the logical en route support base for air operations anywhere in the Mediterranean area. Portugal was the only U.S. ally in the region to allow U.S. use of its territory in support of the operation. Less this option, the operation may have failed. Aerial refueling capability was essential for all inter-theater airlift forces. C-5 crews were as of yet untrained in aerial refueling. This operation motivated the C-141A to C-141B conversion, which added 23 feet of fuselage capacity and aerial refueling capability, effectively adding 90 more C-141s.[14]

OPERATIONS DESERT SHIELD AND DESERT STORM

After the 2 August 1990 Iraqi invasion of Kuwait, the first C-141 arrived within 24 hours of President Bush's order to deploy several days later. There were two very critical differences in this airlift operation. For the first time ever, the airlift demand was so immense that the use of the CRAF was essential. General Hansford T. Johnson, Commander of U.S. Transportation Command (USTRANSCOM), activated Stage I on 17

August 1990.[15] On 17 January 1991, when the air war began, there was a tremendous backlog of cargo in the United States. CRAF Stage II was activated bringing 78 additional wide–body international aircraft along with the 38 Stage I wide-body aircraft. Throughout the operation civilian operators flew more than 5,000 missions. The second major difference was the use of the Air Reserve Component (ARC), consisting of the Air National Guard and the Air Force Reserve. By the time Operation Desert Storm ended, all 7 ARC C-5 squadrons and 11 of 15 C-141 squadrons were activated and used extensively.[16] Although the total tonnage of cargo flown was 610,000, much less than the Berlin Airlift, the distance part of the equation makes all the difference. Based on the aerial port of debarkation, it is 7,500-10,000 miles from the CONUS to the CENTCOM AOR and 2,500-3,000 miles from Europe. During operations Desert Shield/Storm from 7 August 1990 to 7 August 1991 4,430 MTMs were delivered on 19,600 missions. With the on-going operations in Southwest Asia, reliance on air mobility will continue well into the twenty-first century.

These are but a few of many operations in which airlift played a crucial role and illustrate how critical this capability is for the United States. Next will be a current status and assessment of U.S. strategic airlift aircraft of today, along with future plans.

STRATEGIC AIRLIFT AIRCRAFT

	Entered Service	Unit Cost Millions in 96 $	Inventory as of May 00	Average Age (Years)	Max Payload (Lbs)/Pallet Positions	1999 Msn Capability Rate 1999	Departure Reliability Rate 1999	Man/HR MX Per HR Flt Oct 00
C-141	May 64	41	155	33.1	68725 13	72.2	89.9	8.7
C-5	Jun 70	184	126	21.6	216000 36	63.3	81.9	21.5
KC-10	Mar 81	87	59	14.7	170000 27	82.6	92.9	8.1
C-17	Jun 93	180	55	3.3	170900 18	81.9	94.7	11.6

TABLE 1. STRATEGIC AIRLIFT AIRCRAFT

USTRANSCOM and its Air Force component, Air Mobility Command (AMC), provide common-user strategic airlift for DOD.[17] AMC strategic airlift aircraft are the C-141, C-5, C-17, and the KC-10. The KC-10 is an aerial refueling and cargo aircraft, in

which AMC planning has more than half these aircraft dedicated to pure airlift. Table-1 shows that other than the C-17, this is an aging fleet. The aggregate average age of all these aircraft is 22.5 years, and the half-life of a strategic airlifter is 20 years.[18] From Defense Secretary Cohen's 2000 annual report to the President and the Congress "Modernization of the Air Force's mobility assets is integral to the daily execution of our National Security Strategy."[19] Yet the Pentagon, in the FY 2001 budget submittal, slashed many of its aviation projects. To make up for a $450 million increase in the F-22 program which was caused by a congressionally ordered year's delay in approving production of the stealth fighter, among three programs cut was the C-17. The number of FY2001 purchases was reduced from 15 to 12. However, the badly needed C-5 Avionics Modernization Program (AMP) is included in the budget.[20]

Avionics modernization is being driven by rapid technological advances in communication, navigation, and surveillance equipment. This evolutionary process is known as Global Air Traffic Management (GATM). With ever-increasing air traffic, the International Civil Aviation Organization (ICAO) and Federal Aviation Administration (FAA) are upgrading air traffic management systems with a global navigation system, digital data communications, and advanced automation over oceanic airspace. The basis of most air traffic upgrades is a digital satellite data link between aircraft and air traffic controllers. Satellite and high frequency (HF) data link with Global Positioning System (GPS) provides effective air traffic coverage worldwide without reliance on ground-based radar.

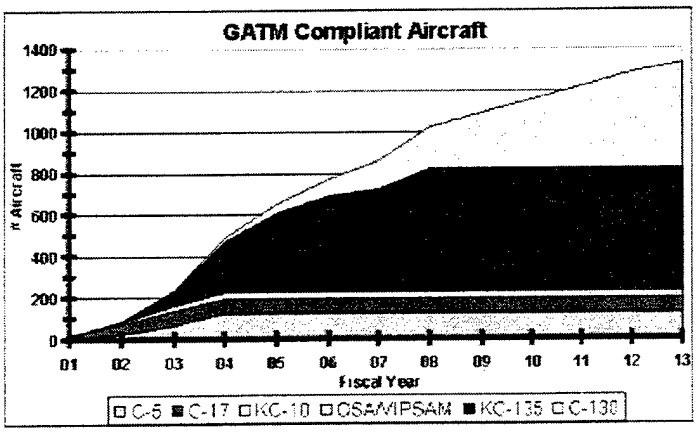


Figure 1. GATM Compliance Timeline

Upgrading the fleet will be expensive but the alternative will be extensive re-routing, lower altitude clearances, increased fuel consumption and costs, reduced cargo loads, and lack of force closure for combat operations to the warfighting CINCs.[21]

Region	1997	1998	1999	2000	2001	2003	TBD	2010
Atlantic	RVSM					CNS/ATM	RNP-1	Free Flight
Pacific		RNP-10		RVSM		CNS/ATM	RNP-1	Free Flight
Europe		BRNAV	8.33 Radio	TCAS Mode S	RVSM Protected ILS	Datalink	RNP-1	Free Flight
CONUS	TCAS Mode S (1994)					RVSM VHF TDMA	RNP-1 Datalink	Free Flight

TABLE 2. GATM TIMELINE

Figure-1 shows the worldwide regional implementation schedule for GATM.[22] Table-2 depicts the compliance with GATM timeline for the airlift fleet less the C-141.[23]

Increased demand for airspace, especially in oceanic areas, is leading to a reduction in vertical separation of aircraft, called Reduced Vertical Separation Minimums (RVSM). RVSM allows a reduction in vertical separation of aircraft from 2,000 to 1,000 feet. New standards in vertical navigation accuracy of avionics are required. Noncompliance has similar implications as noncompliance with GATM. All the strategic airlift fleet is RVSM compliant. The KC-135 is approximately 60% compliant.[24]

Another modernization issue is the vulnerability of airlift aircraft to air defense and asymmetric threats. General Robertson, current USTRANSCOM Commander during October 1999 hearings at the House Armed Services Committee said:

> The hostile skies over Kosovo presented a threat to air mobility aircraft and crews that we have only recently begun to recognize... the "tip of the iceberg" of a threat we see growing in significance in future contingencies. In short, a highly effective air defense system coupled with the proliferation of Man Portable Air Defense Systems (MANPADs) forced air mobility planners to seek alternative, inefficient routings around threats due to lack of on-board defensive systems to combat the threat.[25]

THE C-141 STARLIFTER

Mainstay of the strategic airlift fleet for over the last 30+ years, the C-141 still represents a sizable portion of the total strategic airlift capability. In FY'99 the C-141 accounted for 23% of the total military organic airlift capability (5.93 of 25.9 MTM/Day).[26] Two hundred-eighty five C-141A models were built from 1963-1967. From 1979-1982, 271 C-141As were stretched 23 feet and aerial refueling capability was added, thus being re-designated the C-141B. The equivalent capacity of 90 additional C-141As resulted

from this modification. As seen in Figure-2, it is being replaced by the C-17 at an approximate rate of one C-17

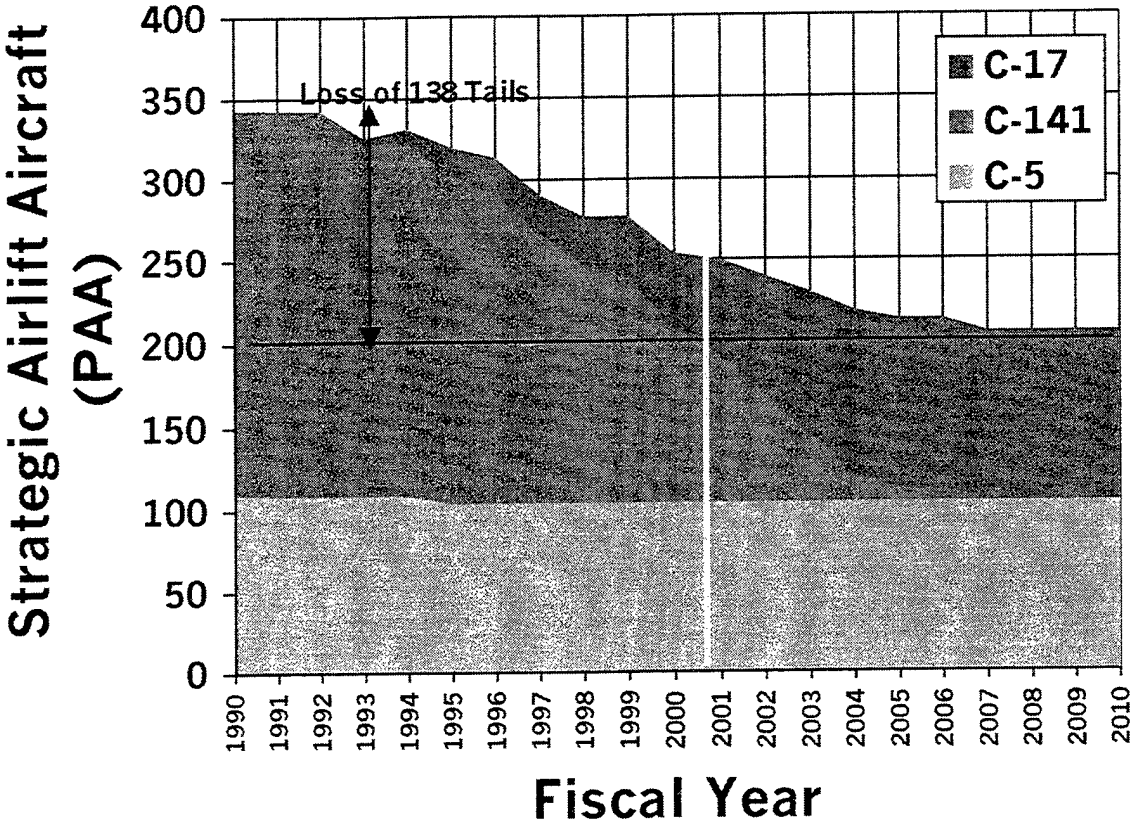


FIGURE 2. STRATEGIC AIRLIFT FLEET SIZE TO 2010

for every two retiring C-141s. As of May 1999 the fleet has been retired to a size of 155. The C-141B is slated for retirement from the active component in 2003, but is still the primary Special Operations Low Level (SOLL II) weapons system and airdrop platform.[27] It still flies all the scheduled aeromedical evacuation missions. The C-17 is scheduled to assume partial SOLL II mission capability July 2001 and full mission capability April 2002.

The C-141B is being modified to the C-141C with the installation of a new All Weather Flight Control System and Global Positioning System Enhanced Navigation System with "glass cockpit" avionics displays. This plan keeps 63 of the C-141C models flying until 2006 in unit-equipped Air Force Reserve and Air National Guard units only, and the new avionics complies with GATM and RVSM requirements. The C-141 has been retro-fitted with a Countermeasures Dispensing and Defensive System, an onboard infrared sensor and flare dispensing system to combat heat seeking anti-aircraft missiles such as MANPADs.[28]

The C-141 is an old and "tired" aircraft at an average age of over 33 years. Aerial refueling and low-level airdrop operations put higher than normal stresses on the airframe. The Persian Gulf War usage of the C-141 accelerated its aging process further. Over the last decade there have been problems with wing cracks, weep hole cracks, cracks in the aft cockpit window area, and currently T-tail cracks, all causing temporary grounding for repairs and operational flight restrictions. Barring a major Service Life Extension Program (SLEP), these types of aging related problems are likely to continue occurring. At this time there is no plan to SLEP the C-141.

THE C-5 GALAXY

The C-5 is the largest strategic airlift aircraft with the mission to provide strategic delivery of outsized/oversized cargo and passengers. It also supports SOLL II. The C-5 fleet represents 50% of the FY99 organic airlift capability (13.0 of 25.9 MTM/Day).[29] From an age standpoint, it is a mixed fleet. Of the 126 C-5s, 76 are older 'A' models delivered from 1969-1973. They underwent a SLEP modifying the wing, which extended the service life by 30,000 hours. The C-5B is similar to the 'A' version but embodies all the improvements introduced since completion of C-5A production, including the strengthened wings, improved turbofans, and updated avionics, with color weather radar and triple inertial navigation systems (INS). Fifty C-5Bs were delivered from 1986-1989. All C-5s are funded to undergo a complete AMP, similar to the C-141 modification that will install a state-of-the-art cockpit and ensure GATM compliance. A number of C-5s have been equipped with a prototype missile defense system.[30]

Developmental testing in 1972 demonstrated the C-5s capability to airdrop heavy equipment platforms up to 42,000 pounds. Follow-on test and evaluation in 1988 determined the C-5 could successfully airdrop heavy equipment platforms in a two-ship formation under visual conditions. In 1995, an Operational Feasibility Test and Evaluation evaluated C-5 formation capabilities in 3 and 6 ship formations using 2,000 foot visual spacing and 4,000 foot simulated instrument conditions spacing. Based on test results in April 1996, the C-5 proved it could drop the Army's Division Ready Brigade (DRB) heavy equipment from 6-ship formations under visual or simulated instrument conditions. It was also determined the C-5 could airdrop 70 paratroopers and a single platform weight of 60,000 pounds, or a total equipment payload of 240,000 pounds.[31] Plans to implement the C-5 fully into the Strategic Brigade Airdrop (SBA) program were cancelled with renewed confidence in the C-17 due to fixes for its airdrop shortfalls. The C-5 is too maintenance

intensive and its reliability rate is unacceptable. Twenty-one and one half man-hours of maintenance per hour of flight is excessive and costly. At a composite capability/departure rate of just over 50%, the effective size of the fleet is reduced to roughly 65 aircraft. Even with a redefined (liberalized) mission capable (MC) rate as shown in Figure-3, C-5 MC rate remains well below the objective of 75%, with a downward trend during the last several years.[32]

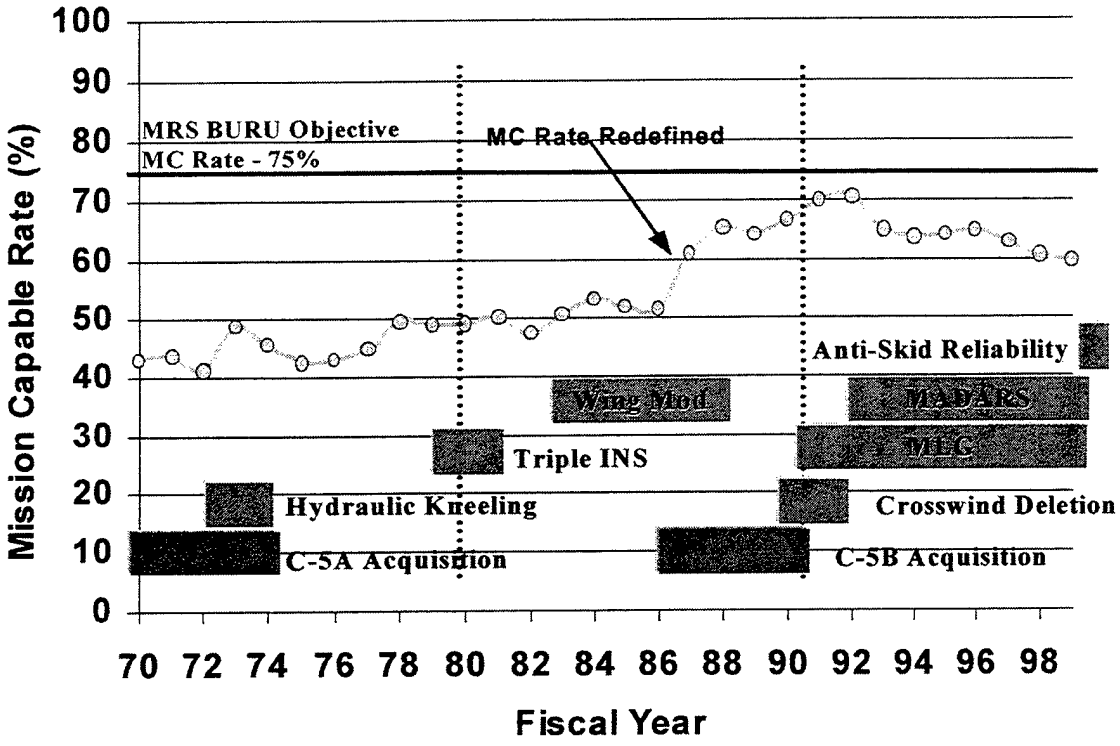


FIGURE 3. C-5 HISTORICAL MISSION CAPABLE RATE

As of December 1999, due in part to the great demands placed on airlift assets during the Kosovo crisis the mission-capable rate of the C-5 dropped to 56%, and under current funding levels, the rate is unlikely to improve for several years.[33] The NMS cannot be supported at these levels. Accordingly the Reliability Enhancement and Re-Engine Program (RERP) depicted in Figure-4 is being proposed to modernize multiple systems on the C-5.[34] At this time different options for the RERP program are part of the pending MRS-05. Modernizing the C-5 has not enjoyed consistent support on the part of past AMC

commanders. General Rutherford, AMC and USTRANSCOM commander from October 1994 to July 1996 said in October 1996:

> After we get the C-17 on board, we need to look at – based upon our mission, and not necessarily the condition of the airplanes – the C-5. We are heavily dependent upon those airplanes and they're just not meeting our reliability

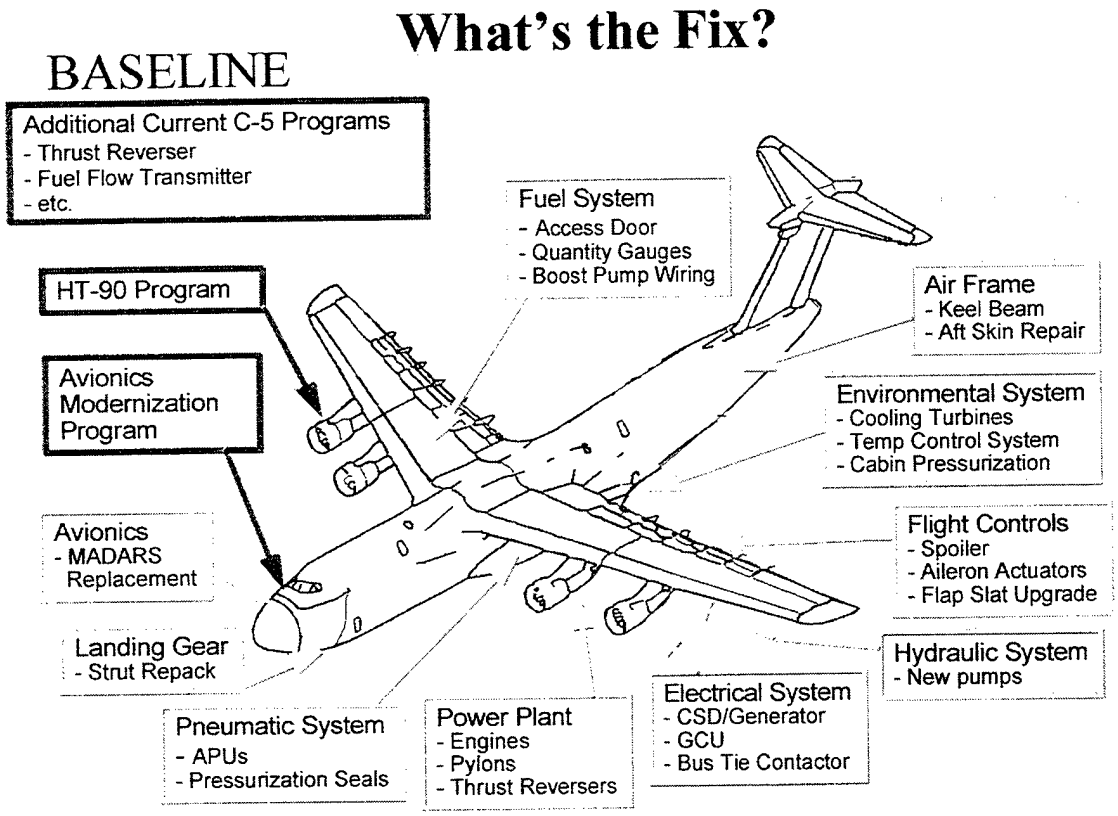


FIGURE 4. C-5 BASELINE & RE-ENGINING AND RELIABILITY ENHANCEMENT PROGRAM (RERP) MODIFICATIONS

expectations. We've been working that problem for some time, and I don't see any easy solutions. You can spend megabucks to re-engine the airplane, which is the aircraft's biggest problem right now, and you might gain 3% of additional reliability. We need machines that are at least 90% reliable in terms of departure reliability and when you're talking about 65-70-75% reliability for the C-5, it's very troubling. So, we need to replace the C-5 next. I don't think you can SLEP the airplane and improve its reliability. The 'B' model is not much better than the 'A'.[35]

Yet from General Kross, next USTRANSCOM commander from July 1996 to August 1998 at the September 1997 Air Mobility Symposium:

> God bless the C-5. I love it. I was a wing commander for three years. We need to improve it for reliability. We have been operating this plane for 25 years, carrying it around with ownership difficulties which no corporation in America should ever have to carry... Here is an airplane that has 80% of its structural life ahead of it. We don't walk away from airplanes that have that kind of structural life. Not with box size like a C-5.Thirty-six pallets-remember the C-17s only got 18 pallets. Another airplane has got to go land on a dirt strip and spin around. We need those 126 C-5s. We need to know exactly how to make them better. The two biggest maintenance drivers on those planes are the engines and the avionics.[36]

THE C-17 GLOBEMASTER

A re-evaluation of U.S. strategic mobility posture during the final months of the Fiscal Year 1980 budget preparation cycle (late 1979) led DOD Secretary Brown and his advisors to the conclusion that additional airlift is needed to increase force projection capability. Specifically, they determined that a high priority should be assigned to the procurement of a new strategic cargo aircraft.[37]

The Air Force had several airlift enhancement programs underway at that time including the C-141 stretch modification, CRAF enhancement, the Advanced Medium Short Takeoff and Landing Transport (AMST), and the C-5 wing modification; but none of these solved what has been identified as the most critical airlift shortfall, the long-range movement of heavy, outsize equipment. With the strong emphasis being placed on additional intertheater lift capability, Secretary Brown directed the Air Force to terminate the AMST program and initiate a new long-range transport program-the C-X.[38] The concept and eventual selection of McDonnell Douglas for the C-17 August 1981 resulted from the C-X study.

The C-17 is the follow-on core military airlifter to replace the C-141. It is a hybrid aircraft in terms of its capabilities regarding inter- and intratheater airlift. From "Air Force Magazine" February 1980:

> A new airlifter designed to carry outsize cargo in both strategic and tactical missions, the C-X, is needed to help close the gap: "The air-refuelable C-X would vastly improve our capability to support Army and Air Force theater and contingency operations. We envision that it would be used for strategic airlift in the early stages of a deepening crisis...then shifted as necessary to assist intratheater requirements as sealift began to ease the burden of long-range mobility needs." The C-X aircraft, in the Air Force view, should be provided with a short-field takeoff capability, General Allen (then Air Force Chief of Staff) said.[39]

Airfield availability and the ability to get a transport into as many airports as possible was a primary C-X specification, to allow future operational commanders the greatest flexibility.[40] From "Airlift Operations Review" January 1981:

> The high rates of munition consumption demonstrated in recent conflicts (the Yom Kippur War being the best example) may create a whole new justification for C-X. In a dynamic combat situation where aerial resupply becomes a key factor, the 4 to 1 productivity advantage of C-X over the C-130 into small, austere airfields could prove decisive.[41]

The first initial operational capability target was 1987. This was discarded when full-scale development was called off January 1982 and replaced July 1982 by a slow-paced preliminary development order.[42] The first flight finally occurred on 15 September 1991. The first order of 210 C-17s was cut to 120 in 1991 with the end of the Cold War. Table-3 shows the current buy plan to acquire 135 C-17s, along with the initiative for an additional purchase.[43] Cutting the order from 15 to 12 in FY'01 despite a long-term contract between Boeing and the Air Force will have a cost impact.[44] Boeing also hopes to secure about $300 million in advance procurement funds for the C-17 in the FY'02

	Prior FY's	FY00	FY01	FY02	FY03	FY04	FY05	FY06	FY07	Total
Original	**70**	**15**	**12**	**15**	**8**					**120**
Plus 14					**1**	**5**	**8**			**14**
POM Unfunded						**1**				**1**
POM Initiative						**1**	**-1**	**8**	**8**	**16**
TOTAL	**70**	**15**	**12**	**15**	**9**	**7**	**7**	**8**	**8**	**151**

TABLE 3. C-17 BUY PROFILE

budget to avoid a disruption in the production line.[45] Secretary of the Air Force Whitten Peters notes September 2000 :

> My understanding is some of the early pieces of the production cycle for the C-17 over the next year and a half will be finishing. The current orders, which are booked out to 2003, do not have a full 15 aircraft in 2003. People in the next year and a half or so will begin finishing production lines. We want to try to keep production at all levels of subcontracting running... There's no doubt in my mind we will need some additional money for C-17s.[46]

The mid-1990s was a turbulent period for the aircraft. The C-17 program has been beset by cost increases and technical problems such as range and airdrop capability. The program survived multiple studies by Congress and the General Accounting Office (GAO)

to buy a civilian Non-Developmental Airlift Aircraft (NDAA) in lieu of some of the C-17s. The C-33, derived from the Boeing 747-400, was proposed as a cost saver.[47] Another option forwarded by the GAO was to buy only 100 C-17s and fulfill the airdrop mission with a combination of C-17s and C-5s.[48] Yet another GAO addressed congressional concern about whether the C-17 is the most cost-effective aircraft to meet the Air Force's airlift requirement.[49] Cost savings was a common attribute in these studies. They also questioned assumptions regarding C-17 employment.

The Air Force and DOD stood by the C-17, and it has survived the questions and doubts. General Fogleman, USTRANSCOM commander from August 1992 to October 1994 before becoming the Air Force Chief of Staff, said of the C-17:

> The C-17 greatly improves our capability to move the Army's outsize and large oversize equipment directly to where the Army wants it. These are all core airlift capabilities needed to support the national military strategy of "Global Reach, Global Power." They are capabilities not possible with a commercial freighter design. Presently the aging C-141 is our core airlifter, but its capabilities must be replaced and enhanced. Not only is the C-17 twice as productive as the C-141 at about the same operating cost, it also provides multiple new and much needed capabilities, especially as we focus more and more on rapid force projection from the CONUS. With the C-17 we can access more airfields, put more aircraft on small parking aprons, and get more cargo through those congested airfields, which have become commonplace during contingencies.[50]

He went on to note that although critics of the C-17 have put forth the argument that a commercial transport could fulfill the role of a military airlifter and save the government billions of dollars, it cannot do the core military missions of the C-17. The commercial freighter can't refuel in the air nor do they have a roll-on/roll-off capability. It can't access small, austere airfields.[51] And finally from General Kross: "For us to have Boeing 747s in the organic fleet would be silly, because we can buy that capability on the market place. It flies in the face of the whole concept of outsourcing: only keeping what you need to keep."[52]

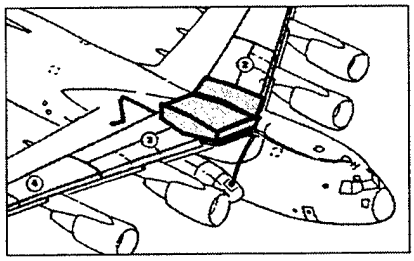
Initial squadron operations began June 1993 with the delivery of the first aircraft to Charleston AFB, and AMC declared initial operational capability on 17 January 1995. The C-17 brings to life the concept of direct delivery: the air movement of cargo and/or personnel from an airlift point of embarkation to a location as close as practical to the customer's final destination. It is the only aircraft capable of routine delivery of outsize cargo to small, austere airfields. It is also capable of aerial delivery, night vision goggle operations, nuclear weapons transportation, and aeromedical evacuation. The C-17

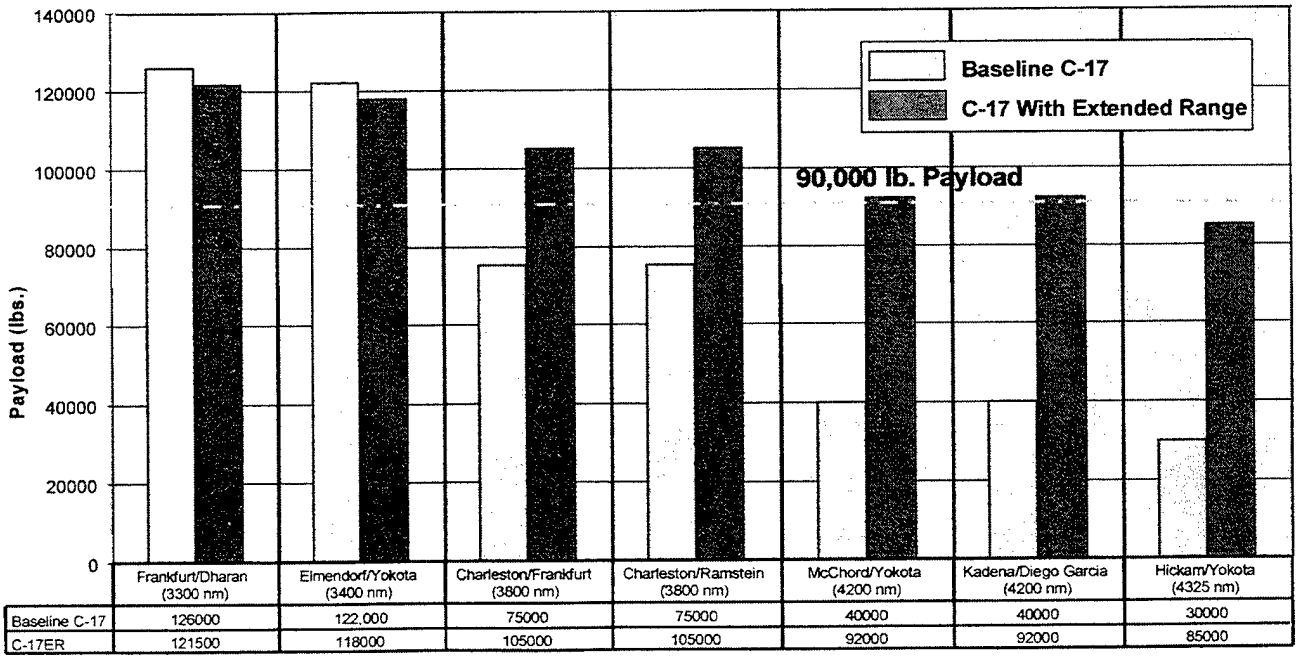
provides the flexibility to support both intertheater and intratheater missions and allows AMC to significantly improve throughput during contingencies.[53]

An Extended Range Fuel Containment System (ERFCS) has been designed to overcome range deficiency with the C-17. As shown in Figure-5, the system is in the center wing area and adds approximately 65,000 pounds of fuel.[54] It allows an increased payload of 30,000 pounds on a typical flight across the Atlantic. Figure-6 depicts the improved performance area with the ERFCS.[55] This system is incorporated into the design with production aircraft #71 and the rest of the fleet is funded to get the ERFCS modification

ERFCS PAYLOAD-RANGE COMPARISON

ERFCS increased full capacity (~65K lbs) extends range and increases payload





	Frankfurt/Dharan (3300 nm)	Elmendorf/Yokota (3400 nm)	Charleston/Frankfurt (3800 nm)	Charleston/Ramstein (3800 nm)	McChord/Yokota (4200 nm)	Kadena/Diego Garcia (4200 nm)	Hickam/Yokota (4325 nm)
Baseline C-17	126000	122,000	75000	75000	40000	40000	30000
C-17ER	121500	118000	105000	105000	92000	92000	85000

FIGURE 5. C-17 ERFCS IMPROVEMENT

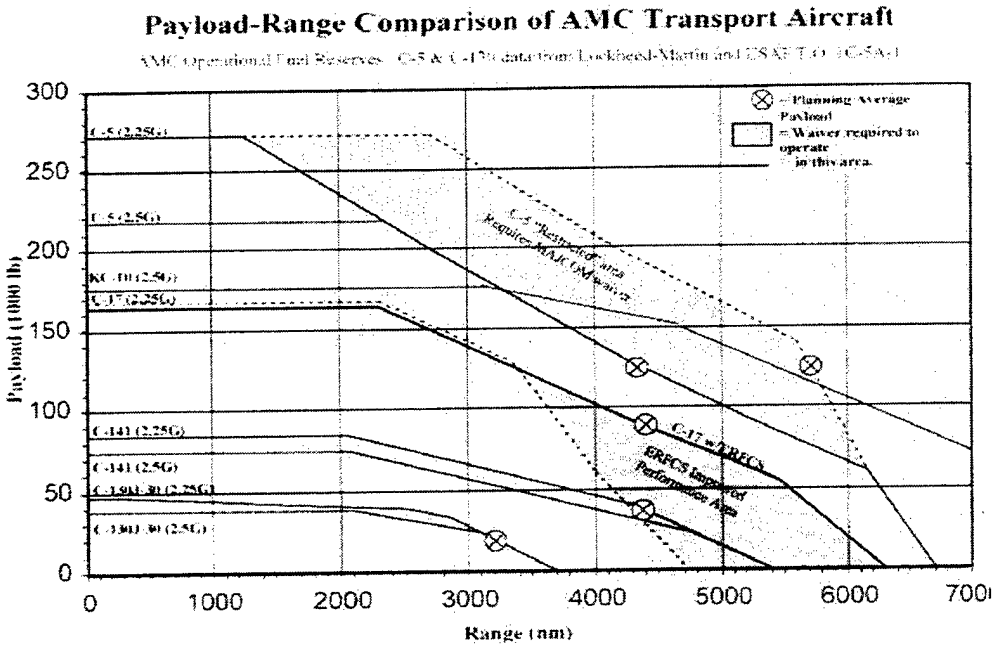


FIGURE 6. AMC AIRCRAFT PAYLOAD-RANGE COMPARISON

C-17 Airdrop

Army Field Manual 10-500-1, Airdrop Support on the Battlefield states "The basic tenants of Airland Battle are initiative, agility, depth, and synchronization. Airdrop supports these tenants. As a rule, the airdrop of supplies and equipment is a joint Army and Air Force effort.[56] And from Air Force Doctrine Document 2-6.1, Airlift Operations, "Airdrop allows commanders to project and sustain combat power into areas where a suitable landing zone or a ground transportation network may not be available. This delivery method maximizes the principles of surprise and maneuver."[57] It follows that the C-17 must have unquestionable airdrop capability. The requirement for the SBA is to complete the drop in a maximum of 30 minutes. The brigade consists of about 3,250 troops and 3,450 tons of equipment. The Globemaster has had aerodynamic problems with the personnel drop. One problem was a "vacuum effect," caused by the draft of a wide body aircraft's wake and design which tends to "suck" paratroopers into a single file behind the aircraft where they could bump into each other. To avoid this effect, paratroopers now jump at a 90-degree angle to the airplane and their parachute static lines are now 20 feet long (an additional 5 feet).[58]

The other problem is the wake turbulence of formation aircraft interacting with jumpers, which has necessitated an in-trail aircraft spacing of 40,000 feet, much longer and time consuming than the 12,000 feet used by the C-141.[59]

Three initiatives will drop the SBA pass time from approximately 51 minutes to 27 minutes:

Dual Row Airdrop. By doubling the airdrop volume of the C-17, the number of C-17s in the heavy equipment role can be reduced, eliminate the need for the C-5 as an airdropper, and reduce pass time by a minimum of 6 minutes. Initial development testing is complete.

Station Keeping Equipment (SKE) Follow On. A new SKE system that will allow up to 100 C-17s to fly in formation up to 100 nautical miles apart. This is a mission essential system that is needed for the C-17 to take over the SBA mission in FY 2004.

Army and AMC Joint Testing. Computer modeling of parachute-vortex interactions indicated potential to reduce formation element spacing to 32,000 ft, which would reduce pass time to 27 minutes. This testing proved successful, and 32,000 feet is now the spacing used.[60]

A major highlight for the C-17 airdrop program thus far took place September 1997 as eight C-17s conducted the longest large airdrop in history-20 hours. Eight C-17s, with the aerial refueling assistance of KC-135s and KC-10s, flew nearly 8,000 miles nonstop to Kazakhstan, delivering 600 soldiers on time and on target.[61]

THE KC-10 EXTENDER

The Extender is a modified McDonnell Douglas DC-10-30 and combines in a single aircraft the versatility of an aerial refueler and long-range transport. When first delivered in 1981, 88% of its design and components were in common with the DC-10-30. It is also aerial refuelable. The 59 KC-10s, delivered from 1981-1990, are relatively new with an average age of 14.7 years. Accordingly, the high reliability rates as seen in Table-1 reflect its age.

With the end of the Cold War and the stand down of the traditional alert bomber force, the need for aerial refueling was reduced. Accordingly, planning allocates the majority of the KC-10s for strategic airlift. The KC-10 is responsible for 12% of the total FY99 military organic airlift capability (3.1 of 25.9 MTM/Day).[62]

Along with the KC-135, the KC-10, which comprises approximately 10% of the tanker fleet, conducted 51,700 separate refueling operations and delivered 125 million

gallons of fuel without missing a single scheduled rendezvous during operations Desert Shield and Desert Storm.[63]

Current issues with the KC-10 include a need to replace wing pylon trusses, the aircraft has no defensive system, and GATM compliance. Avionics modernization and the pylon truss replacement are funded. Plans also call for the development of an integral airevac capability. A longer-term concern exists in regard to the out years, around 2010 when commercial DC-10s start to retire, that logistic support remains intact. Plans call for the KC-10 to fly well into the 21st century, to 2040 or beyond.

THE CIVIL RESERVE AIR FLEET

One of the lessons learned during World War II and confirmed during Korea was that the nation could not maintain enough airlift capability in its military to respond to wartime requirements. This provided the genesis for the inauguration of the CRAF, a partnership between the commercial airlines and military airlift to ensure that sufficient airlift was available for deployments in the event of contingencies or war.[64] Congress passed the Defense Production Act of 1950, which gave the president broad authority to deal with the allocation of "materials and facilities in such manner, upon such conditions and to such extent he shall deem necessary or appropriate to promote national defense." This act formally established the CRAF.

Throughout the 1950s, the government experienced great difficulty getting carriers to sign up the CRAF because the carriers were focused on expanding their domestic and international routes. It wasn't until 1959, when the Federal Aviation Act was passed, part of which required CRAF participation as a condition of getting DOD contracts, that Trans World Airlines (TWA) became the first to sign up. Most others soon followed suit.[65] President Regan bolstered the CRAF with National Security Directive 280, known as the National Airlift Policy. The National Airlift Policy calls for the military to rely upon the "commercial air carrier industry to provide the airlift capability required beyond that available in the organic military airlift fleet."[66]

Segment Type	Stage I Pax/Cargo	Stage II Pax/Cargo	Stage III Pax/Cargo
Domestic	N/A	0/0	68/0
Alaskan	N/A	4/2	4/2
Short range Intl	N/A	12/4	79/4
Long Range Intl	45/32	132/80	388/201
Aeromedical Evacuation	N/A	25	57
Total Acft	77	259	803
B-747-100 Equivalents:			
Aeromedical Evacuation	N/A	13.95	31.76
Long-Range Intl Pax	30.20	87.13	227.91
Long-Range Intl Cargo	30.67	75.02	163.83
MTM/Day Intl Cargo	5.23	12.79	27.94

As of 1 Oct 00

TABLE 4. CRAF AIRCRAFT CONTRIBUTION

The CRAF is activated in three stages. Stage I is for minor crisis, and only international long-range carriers are tasked to augment the military airlift force. Stage II is for major regional contingencies, and stage III for periods of national mobilization. The commander in chief of USTRANSCOM, with the approval of the Secretary of Defense, is the activation authority for all three stages. CRAF participation has grown. In 1980 total CRAF aircraft numbered 462, and as of 1 October 2000 this has grown to 803.[67] Total aircraft include all categories to include short and long range international cargo and passenger, aeromedical evacuation, domestic cargo and passenger, and Alaskan. The CRAF capability complements AMC's airlift capability and, when required, provides nearly 93% of the passenger and 41% of the international long range air cargo capacity today.[68] As of 1 October 2000 long range cargo capacity is 27.94 MTM/day.[69] Table-4 depicts the total current CRAF capability. The common measurement used is Boeing-747-100 equivalent aircraft.[70] In the MRS-05 study the stage III long range cargo assumption is 20.5 MTM/day.[71]

During the Gulf War, CRAF assets flew 27% of the cargo and 61% of the passengers on stage I and subsequent stage II activation status on 5,061 missions. There were problems, however, as some crews refused to fly into a "war Zone" or refused to fly into the AOR at night. Concern arose over SCUD missile attacks and questions regarding the contractual legality and liability of civilian crews flying into a potential chemical attack zone. The chemical defense program developed for CRAF crewmembers by MAC was inadequate. Before and after hostilities began crews were left on the ramp without

protective gear. MAC took a number of actions to improve the situation aimed at tactfully convincing the air carriers to return to a 24-hour-a-day operation, which was absolutely essential to the strategic airlift effort. Actions taken included emphasizing the importance of good military support to the CRAF missions at Aerial Ports of Disembarkation (APOD); reviewing other possibilities for strategic airlift APODs outside of SCUD range; improving chemical defense programs, and a lot of just plain salesmanship on the part of MAC executives.[72]

CRAF Concerns

Three underlying changes are occurring in the air transportation environment which, when taken together will limit DOD flexibility to activate the CRAF. These changes are:

- Greater use of "just-in-time" inventory methods creating higher potential for economic disruption to the commercial sector
- Continued consolidation as a result of deregulation of the U.S. airlines
- Greater outsourcing of DOD distribution functions

While these factors make activation of the CRAF more difficult, the following developments increase the possibility that CRAF may be needed more in the future. These include:

- Reduced military organic capability due to the retirement of the C-141
- Commercial demand for air transportation services crowding out the government customer
- A lower threshold for CRAF activation created by the precedent of activating the CRAF for the Gulf War[73]

CRAF cargo capability is heavily dependent upon a single carrier for the majority of its wartime cargo capability. Federal Express (FEDEX) allocates most of its wide body aircraft to the CRAF at stage III activation. These aircraft constitute nearly half of the wide–body equivalent (WBE) stage III CRAF total (As of 1 October 2000 this was 92 of 201 total international cargo aircraft).[74] The effect of removing most of FEDEX's wide body aircraft from commercial operations would create a high level of disruption to that vital transportation mode. Add the growing dependence of DOD's distribution operations as a result of outsourcing more of the transportation function to civil carriers like FEDEX, and it can be seen DOD is creating an "Achilles' heel" in its logistics infrastructure.[75]

STRATEGIC AIRLIFT FORCE STRUCTURE

The total force concept is a hallmark of the strategic airlift force. Perhaps greater than any other component of all the military services, in peacetime or wartime, is the role-played by the Air Force Reserve and Air National Guard in the strategic airlift equation. The Guard and Reserve are together referred to as the Air Reserve Component (ARC).

THE AIRCRAFT

The Reserve and Guard each have units equipped with both the C-141 and C-5. At this time there are no ARC units in possession of either the C-17 or the KC-10. In FY-2003, the Jackson, Mississippi Air National Guard unit, now flying the C-141C, will convert to the C-17 and become the first ARC unit to become equipped with the C-17. All the other AFRES wings share the four aircraft types with their active duty counterparts, on a daily basis on the same base, and are called reserve associate wings. The reserve associate wing concept began in 1968 and the AFRES unit at Andrews AFB became the first unit equipped ARC unit in 1985. Of the 126 C-5s, the AFRES owns 32 and ANG 13. Of the 155 C-141s, the AFRES owns 39 and ANG 15.[76] The C-141 fleet is currently programmed to leave the active duty forces by FY2003 prior to its complete retirement in FY2006.

THE PEOPLE

The people of the strategic airlift community have performed admirably during the sustained high operations tempo throughout the 1990s to date. The missions flown by the ARC every day help to relieve some of the stresses on the active component. Guard and Reserve personnel constitute a sizable percentage of the strategic airlift forces. In the C-5 61% of the aircrews come from the ARC, 43% of the KC-10 crews, 59% of the C-141crews, and 37% of the C-17 crews. These numbers will increase as the C-17 comes on line with the associated reserve wings and the C-141 retires from the active component. Most of the ARC personnel are prior service. Typical civilian airline flight crew schedules, ranging from 12-18 days per month of flying, allow for ARC pilots, many of whom are airline pilots, to participate at a level much higher than the standard monthly weekend and yearly two week active duty (annual) tour. In addition, due to the mission and training requirements, the annual tour can be accomplished in a piece-meal fashion, on non-consecutive days. This flexibility allows for more missions to be flown exclusively by the ARC.

ARC participation allows active duty crews flexibility in responding to short notice mission taskings. Active duty crews man the special forces alert force and normally fly the Presidential and U.S. Thunderbird support missions. In addition, the Primary Nuclear Airlift Force (PNAF) missions are flown by the active component only.

The ARC supports day-to-day peacetime operations. The Guard and Reserve continue to increase their availability and participation for strategic airlift. Historically, the ARC provides a minimum of 25% of the strategic airlift aircrews flying on a daily basis during peacetime operations. The ARC is ready to surge through volunteerism for a short duration if a contingency requires it. The Guard and Reserve have demonstrated the ability to support contingency operations in the past and has forecast availability against contingency time lines for planning in future contingency operations. As the Guard and Reserve become a larger share of air mobility, this availability will be key to AMC mission planning.[77]

Retention of active duty pilots is an issue of continuing concern. The present economic climate is one of pilot shortages in the civilian sector. Retirements are on the increase at most major airlines and there are more open pilot positions available than the amount of all the service's separation eligible pilots combined. Pilot shortages resulting from low pilot bonus take rates and pilot underproduction highlight AMC's rated officer readiness concerns. AMC has aggressively worked to maintain 100% rated manning in the line flying units. This has been accomplished by recapturing experienced AMC pilots and navigators from staff tours and flying billets outside AMC. Having exhausted that pool, AMC's ability to fully man line flying units may decline.[78] In addition, the pilot training active duty service commitment was increased to 10 years in FY'99. The seemingly perpetual high operations tempo is a constant strain on quality of life and continues to adversely affect pilot retention, despite a doubling of the pilot bonus over the last 3 years.

	Active Duty	Associate Reserve	Unit Eqiup Reserve	Air National Guard
C-17	3.0	2.0	N/A	N/A
C-5	1.8	1.8	2.0	2.0
C-141	1.8	1.8	2.0	2.0
KC-10	2.0	1.5	N/A	N/A

TABLE 5. CREW RATIO BY AIRCRAFT AND SERVICE

Another area of concern is the crew to aircraft ratio. Table-4 shows the highest crew ratios are 2.0. Ten years ago, during the massive airlift of Desert Shield/Storm the crew ratios were at 4.0, and even then crewmembers were "maxing" out on 30 and 90 day flying time restrictions. The 30 day limit of 125 hours was waived to 150 hours and the 90 day limit of 330 hours remained intact. In today's planning one of the assumptions is the 30 day limit will be waived again to 150 hours and the 90 day limit to 400 hours.[79] This many hours in 90 days is an average of about 3.5 hours per day. Will this be a safety issue due to fatigue?

DEPARTMENT OF DEFENSE STUDIES AND REVIEWS

CONGRESSIONALLY MANDATED MOBILITY STUDY (CMMS)

During October-November 1978 a large command post mobilization exercise called Nifty Nugget took place. Nifty Nugget was the first government-wide mobilization exercise since World War II.[80] The exercise simulated a fast breaking attack by the Warsaw Pact on NATO. The conclusion was that strategic transportation resources were insufficient and the U.S. forces in Europe could not be sustained.[81] It was a successful failure-it succeeded in demonstrating the failure of an inadequate mobilization and transportation system.[82] Also during 1979 and 1980, events in Southwest Asia, the Persian Gulf, and Africa served to highlight the United States' painful inability to rapidly project U.S. military power to those areas of the world vital to U.S. national interests. During this period, the need for additional airlift to overcome the rapid mobility shortfall received long overdue attention in professional military journals and the public utterances of civilian and military defense leaders.[83] The 1979 Iranian revolution and the escalating Soviet threat roused Congress to commission a mobility study to investigate the military's ability to respond to various crisis throughout the world. The Congressionally Mandated Mobility Study, published by the DOD in April 1981, was an extensive effort to determine the proper mix of airlift, sealift, and prepositioning resources the United States required to respond to the various military contingencies of the 1990s. The CMMS examined four airlift scenarios: a regional conflict in the Persian Gulf, a Soviet invasion of Iran, a NATO-Warsaw Pact conflict, and a conflict in the Persian Gulf accompanied by a precautionary reinforcement in Europe.[84]

The CMMS recommended rebuilding American airlift capability.[85] Fiscal constraints reduced the CMMS intertheater MTM/Day requirement of as high as 150 MTM/Day to an

increase of 20 MTM/Day over the MAC 1986 projected capability of 46MTM/Day. In March 1983 MAC published a Master Airlift Plan. The Master Plan considered six options for reaching the strategic airlift goal of 66 MTM/Day while maintaining intratheater airlift requirements. The options fell into three categories: additive, modernize, and long range. MAC officials established the need to provide airlift after the retirement of all C-141s and C-130s and recommended purchasing 220 C-17s.[86] The crisis in airlift, disclosed in the CMMS, prompted Air Force leaders to look for immediate solutions as they considered future requirements. On 26 January 1982, Headquarters USAF recommended purchasing 50 C-5B and 44 additional KC-10s.[87]

MOBILITY REQUIREMENTS STUDY (MRS)

Fighting on short notice in unexpected places requires large amounts of mobility, as the U.S. learned in the Persian Gulf War. United States military airlift and sealift, operating under unrelenting time pressure, carried more than eight billion pounds of dry cargo to the Arabian peninsula-plus approximately six million tons of petrolium products. Nine divisions worth of U.S. troops were hustled to the Gulf, many on planes drawn from a CRAF never tested in war.[88]

Recognizing this reality, Congress in its Fiscal 1991 defense authorization bill told the Pentagon to take a hard look at future power projection requirements and come up with an integrated mobility plan. The result was the 1991 Mobility Requirements Study. The MRS analyzed threats, warning time, degree of allied participation, overseas bases-all the interrelated factors that affect the need for what might be termed "strategic agility."[89]

In the past, requirements sometimes were set in a crude way. Theater commanders listed all the airlift or sealift they felt they could use, and the Pentagon combined the lists. The results were frequently unrealistic. By contrast, the Joint Staff imposed top-down discipline in the analysts who conducted the MRS. The MRS set out to determine a Fiscal 1999 baseline for U.S. mobility capability. Officials involved in the study analyzed lift needs for fighting in a number of potential crisis zones-from the Persian Gulf to southeast Asia, from Europe to the western hemisphere.[90]

The study accepted what it terms "moderate risk" for U.S. troops in both the first weeks of a deployment, when thinly supported forces might be overrun, and in weeks three through eight, when aggressors might still have enough of an upper hand to cause unacceptable damage or lay waste to occupied territory. The MRS concluded this

moderate risk deployment capability would not be able to handle two simultaneous crisis.[91]

For airlift, the MRS laid out 57 MTM/Day as the 1999 requirement. Reaching that goal from the then 48MTM/Day capacity required the purchase of all 120 C-17s, the Air Force's plan.[92] In addition to the 120 C-17s, the MRS also required 109 C-5s and 230 C-141s.[93] It is interesting to note that actual 1999 capability was approximately 44.5 MTM/Day, as seen in Figure-7.[94]

The 1993 Bottom-Up Review called for "substantial enhancements to our strategic mobility-most of which were first identified in the 1991 Mobility Requirements Study (MRS)." It called for the U.S. to field forces sufficient to fight and win two major regional conflicts (MRCs) that occur *nearly* simultaneously.[95]

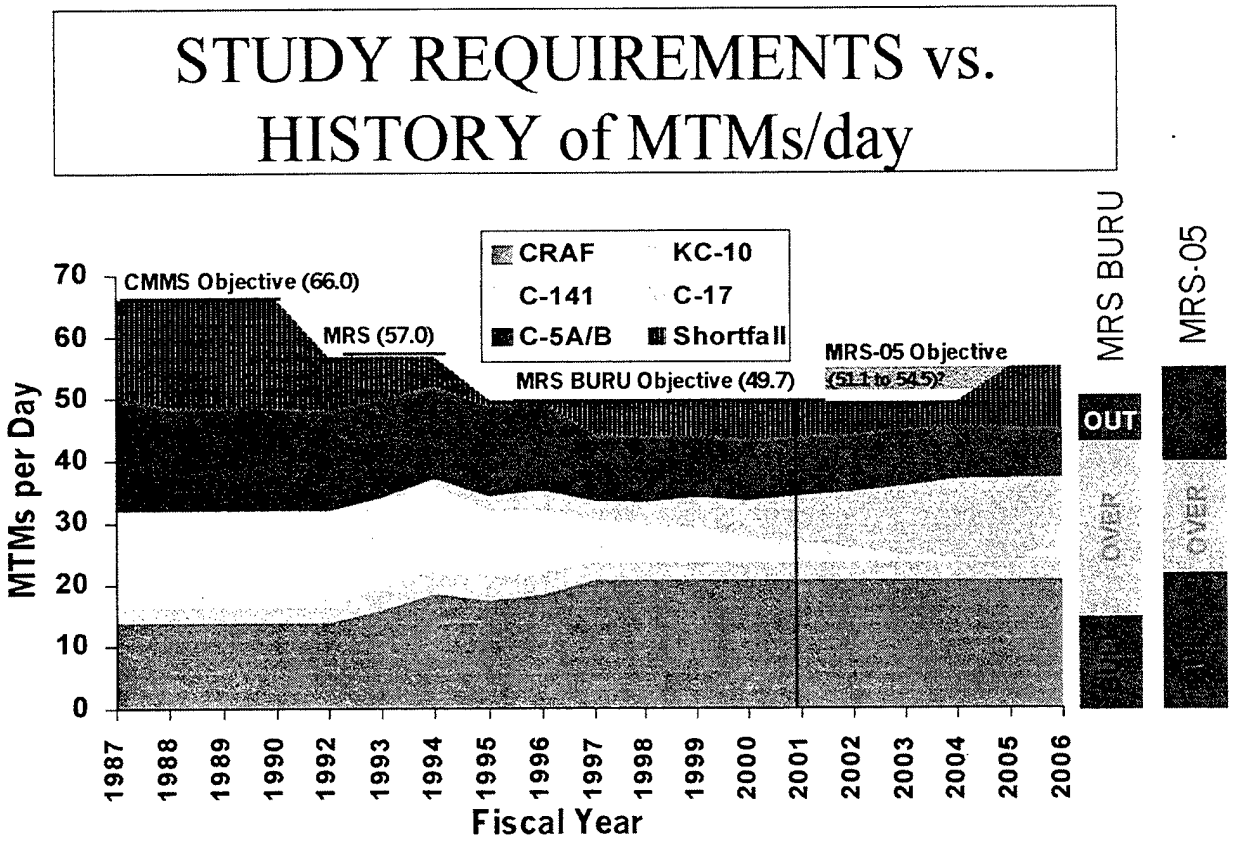


FIGURE 7. CHRONOLOGY OF REQUIREMENTS VERSUS CAPABILITY

In its FY 1994 Air Mobility Master Plan, the Air Force planned to reach a 57 MTM/Day airlift capability near 2005. This plan hinged on many factors, including the continued C-17 purchase, acquisition of a new commercial derivative freighter known as "C-XX," and full activation of the CRAF. AMC officials noted that the goal can be reached only under optimum conditions.[96] At the time (early 1994) the C-17 was on "heavy probation" due to cost, schedule, and technical problems, and its future was uncertain. The C-XX came to be known as the C-33, referenced earlier in the C-17 section.

MOBILITY REQUIREMENTS STUDY BOTTOM-UP REVIEW UPDATE (MRS BURU)

Directed by Public law, the Joint Staff conducted a review and an update of the 1991 MRS to reflect the force changes directed by the 1993 Bottom-Up Review and changes that occurred since the MRS. Emphasis was on the two nearly simultaneous MRCs and changed sealift and airlift force structures, such as the delayed C-17 acquisition schedule. The MRS BURU was forwarded to Congress 28 March 1995.[97]

Overall risk was determined by the likelihood of failing to accomplish theater strategic objectives in three warfighting phases: halting, buildup, and counterattack. Essential objectives and key elements of the analysis for each phase were established. Moderate risk was achieved when all essential elements and some combination of key elements in each phase were accomplished. Airlift forces consisted of 88 C-141s, 55 C-17s, 104 C-5s, 37 KC-10s, 26 KC-135s, and no NDAAs.[98]

MRS BURU included many optimistic assumptions such as:

- Significant warning time
- Rapid decision to deploy forces
- Early call-up of ARC and CRAF I and II
- CRAF III used for a 2 nearly simultaneous Major Theater War (MTW) – MTW and MRC are used interchangeably
- Early Flexible Deterrent Options (FDOs) allow time to position mobility assets and fly in personnel to marry up with their prepositioned equipment

Study recommendations included increasing CRAF Stage II capacity to approximately 90 passenger WBEs for 20.5 MTM/Day, and for airlift, to acquire a range of 120 to 140 C-17 equivalents, for a total capability of 49.4 to 51.8 MTM/Day, depending on the amount of the shortfall that can prudently be regenerated. The capability requirement was refined to 49.7 MTM/Day a year later, defining the Air Force requirement of 29.2

MTM/Day.[99] The 1997 Quadrennial Defense Review (QDR) reaffirmed DOD's baseline requirements for intertheater mobility, as outlined in the MRS BURU, of approximately 50 MTM/Day.[100] The QDR went on:

> The burdens placed on U.S. strategic mobility forces will not become less demanding in the future. To the contrary, the potential demands of peacetime engagement, reduced infrastructure at overseas bases needed to support airlift en route to a crisis, the likelihood of smaller-scale contingencies worldwide, and the increased possibility of confronting nuclear, biological, and chemical (NBC) threats all pose challenges for mobility forces that were not accounted for in the mobility update. These and other key issues will be evaluated and will receive increased emphasis as DOD formulates upcoming budget requests for strategic mobility programs.[101]

The C-17 buy of 120 was increased to 135 (134 + 1 unfunded) in the 1998 POM submittal. The next mobility study (and most current) takes into account the QDR reference to NBC threats along with other new/updated considerations.

MOBILITY REQUIREMENTS STUDY FOR FISCAL YEAR 2005 (MRS-05)

Although the ability to prosecute two overlapping MTWs remains the cornerstone of the U.S. defense strategy, the past five years of experience has sharpened the DOD's focus on small-scale contingencies (SSCs), peacetime presence and engagement missions, and threats from weapons of mass destruction. All of these have implications for U.S. power projection capabilities. The evolution of the internal environment, coupled with changes in the U.S. military force structure, motivated a re-examination of the DOD's mobility system.[102]

The MRS-05, an update to the 1995 MRS BURU, will determine the mix of end-to-end mobility assets. Using MRS-05 data, AMC's Oversize and Outsize Analysis of Alternatives (O&O AoA) will determine the most cost-effective strategic airlift fleet mix to achieve the U.S. NMS from various postures of engagement.[103] MRS-05 continues in the tradition of its two predecessors, fulfilling its tasking to validate mobility requirements, to maintain the relevance of the MRS process and, maybe most importantly, to influence the Service's FY 02-07 POM submissions. MRS-05 officially began on 1 October 1998.[104] It does not take into account Army Transformation, announced October 1999. These studies are in the final briefing and screening process, and as such the information presented here is subject to change, although any changes at this late stage would probably be minor.

MRS-05 expands the scope of MRS BURU guidance with a baseline that considers the impacts of global postures of engagement, enemy use of WMD, and asymmetrical terrorist activities. It will conduct excursions that consider concurrent National Command Authority missions (Special Operations, Single Integrated Operation Plan, Presidential Support, etc.), and perform sensitivity analysis of variations in warning time, decision time, and C-Day separation. In addition it factors in the contributions, requirements, and vulnerabilities of host nation and coalition support forces. It also studies the impact of the Voluntary Intermodal Sealift Agreement (VISA).[105] The VISA is a CRAF-like program for sealift, which also has three stages of activation.

The strategic airlift assumptions for the study assumed: 126 C-5s operating at a 75% MC rate (104 mission/6 training/10 back-up), 120 C-17s operating at a 90% MC rate (102 mission/8 training/10 back-up), No NDAA, C-141 fleet fully retired, 37 KC-10s used in an airlift role, CRAF stage III at 20.5 MTM/Day (120 wide-body), and the global en-route infrastructure in place and funded. The MRS-05 foundation starts with policies first (allied support, early airlift apportionment, carrier battlegroup swing, early VISA III activation), then methods (sealift, use of intratheater assets, focus on halt only for airlift), and investment last (infrastructure recapitalization, ashore and afloat prepositioning, fast sealift, and strategic airlift).[106]

Initial indications of findings and recommendations suggest an increase in the MTM/Day strategic objective beyond the MRS BURU objective of 49.7 to a range of 51.1 to 54.5 MTM/Day; excursions and sensitivity analysis of assumptions raised moderate risk solutions as high as 67.0 MTM/Day.[107] The MTM increases come from the following considerations:

- MRS-05 begins with a 48.3 MTM/Day strategic foundation
- Adds the need for intratheater support of the warfighting CINC (51.1 MTM/Day – lowest consensus)
- Adds the need for the concurrent execution of a special operations mission (52.7 MTM/Day)
- Adds the requirement for Patriot missiles to protect allied interests (53.6 MTM/Day)
- Considers the Joint Chiefs of Staff (JCS) priority one demand for other global CINCs (54.5 MTM/Day – upper agreed range)
- Protection against assumed risk (as high as 67.0 MTM/Day)[108]

During March 2000 Senate Armed Services Committee FY01 budget hearings then U.S. Central Command CINC Marine General Anthony Zinni said:

> Strategic airlift in general is our number one concern and the area we place as our top requirement, and airlift as a whole. We're worried about the maintenance of the C-5 fleet. I certainly would like to see more C-17s. The key to success in our war plans is our ability to get the forces there right away. The initial stages in time are critical to us.[109]

Army General Wesley Clark, U.S. European Command CINC stated at the same hearings " In our mission to support regional stability within this area of responsibility, it is essential that we champion full funding for C-17 aircraft with required modifications and logistics sustainment, as well as specified C-5 aircraft modifications."[110]

Some of the optimistic assumptions in MRS-05 include those as shown in Figure-8.[111]

Early Warning, Perfect Intelligence, Rapid Decisions
Rapid POE Disengagement and No POE Support During Halt
CRAF, VISA, and PSRC Early and Rapid
C-5 MC Rate will Reach 65% by FY2005
Significant Organic Lift Swing at Ambiguous Warning
CVBG Swing at Ambiguous Warning
Significant Tonnage of Containerized Unit Equipment
Participation of Foreign Commercial Aircraft Exceeds CINC Assessment
Fewer Operational Withholds than MRS BURU
Limited Organic CINC Support Missions (about 13% of all CINC requirements) Outside Warfighting Arena
Limited Presidential Support (no shuttle diplomacy)
No Breaks in the System or No Delays (weather, ATC, other...)
Perfect Scheduling, Perfect C4I, 24/7/365 Ops

FIGURE 8. OPTIMUM ASSUMPTIONS OF MRS-05

Other significant factors include the loss of 138 tails in the system (Figure-2 illustrates), which represents a large loss of flexibility to respond in peace or war. At the same time, the day to day C-5 MC rate limits the availability of C-5s to less than 60 0f the 126 tails. Although MTM capability remains nearly equivalent over the next 5 years, it will be with much less flexibility. More CRAF won't work due to:

- CRAF will not fly in a chemically contaminated theater of operations
- CRAF cannot perform the Special Operations Mission
- CRAF cannot deliver Patriot launchers and missiles
- Many theater CINC support missions involve military unique payloads (outsize, classified, weapons, etc.), austere or politically sensitive destinations, or require specially trained crews that CRAF cannot accommodate
- CRAF tends to congest maximum on ground (MOG) constrained environments more than organic lift because of long ground times, material handling equipment requirements, less ramp maneuverability, and high fuel demands[112]

Figure-9 is a breakdown of the MTM capability with increasing levels of mobilization.[113] It is of interest to note for perspective that to move 8,000 tons/day a distance of 3,000 miles (24 MTM/Day), such as the CONUS to Hawaii or Grenada requires virtually all the active and organic airlift capability the U.S. possesses.

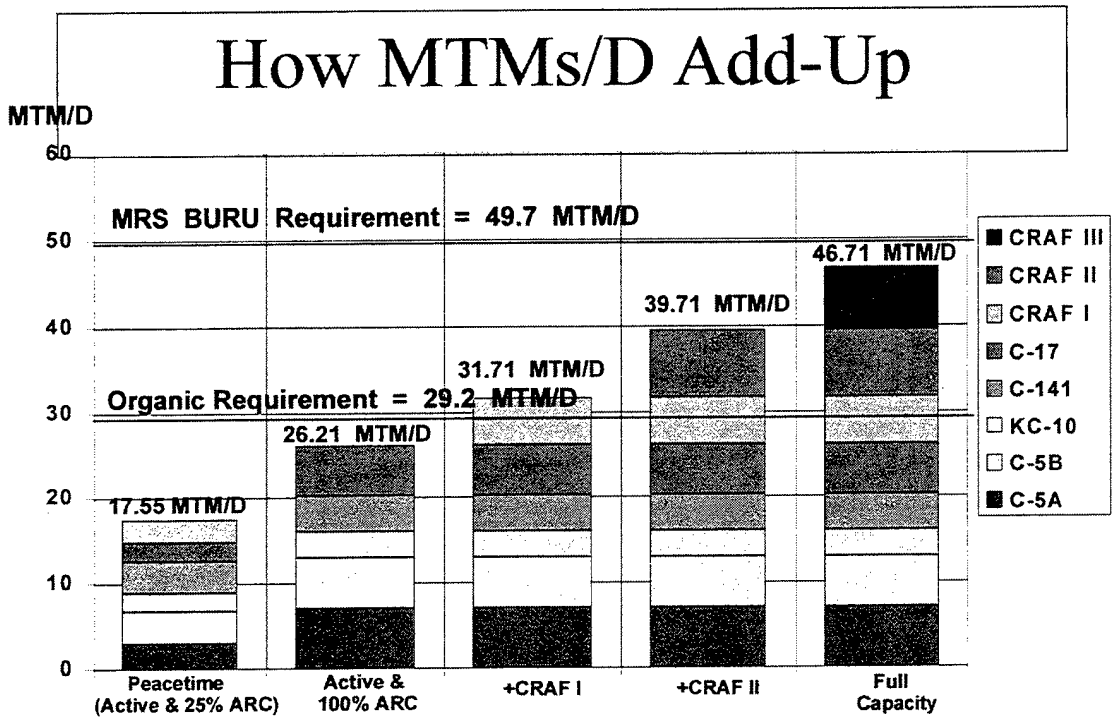
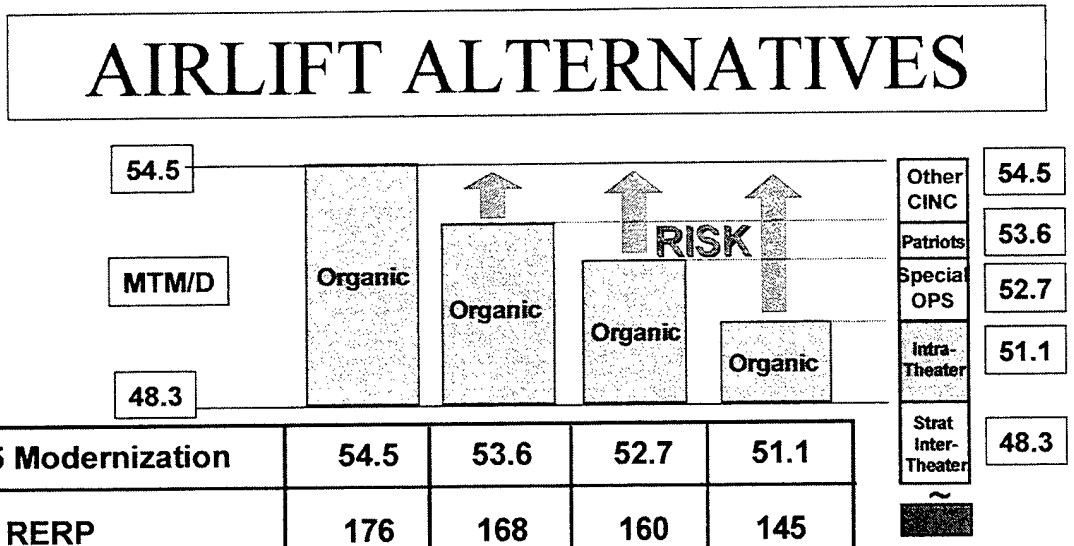


FIGURE 9. LEVELS OF MOBILIZATION MTM CAPABILITY

Figure-10 reflects airlift alternatives in the O&O AoA. Barring a large increase in the C-17 purchase, C-5 reliability must be addressed. From the O&O AoA, it would take 252 C-17s to replace all the C-5s.[114] The probable, most affordable solution appears to be a combination of more C-17s along with C-5 modernization.

The MRS-05 is still in review and not without controversy. The CINCs, JCS, and Services have agreed with MRS-05 requirements, but the Office of the Secretary of Defense has yet to approve it. In particular, the Pentagon's Program Analysis and Evaluation directorate has been determining whether such a requirement is affordable.[115]



C-5 Modernization	54.5	53.6	52.7	51.1
No RERP (C-5s at 65% MC)	176	168	160	145
RERP C-5Bs (C-5Bs at 80% MC)	170	162	154	140
RERP All C-5s (C-5s at 75% MC)	156	148	140	126

C-17s required to meet the various MTM/D levels using different C-5 options

FIGURE 10. ALTERNATIVE AIRLIFT SOLUTIONS

Some DOD officials "are attempting to take the requirement and change it into a funding study which it was never intended to be," a Pentagon official said of MRS-05. "When they saw that ton-mile per day requirement, they said it's unaffordable. Redo it." The Pentagon may also end up advising the acceptance of a higher level of risk. "In that case, there's no shortfall," the official said.[116] Air Force Secretary Whit Peters said recently, "We do not today have an executable plan to meet those growing needs," referring to strategic airlift.[117] This year, Congress created the National Defense Airlift Fund to take the financial pressure off Air Force acquisition accounts and allow the military to buy sufficient airlift. The FY01 Defense Appropriations Bill sets up the fund. Though 12 C-17s are funded under this new account, Congress merely shifted the money

from the Air Force to the new fund.[118] "Congress needs to fully fund the National Defense Airlift Fund," a Pentagon source said.[119]

Supporting airlift operations the magnitude of the Kosovo conflict could cause problems in the future, says the Air Force Chief of Staff:

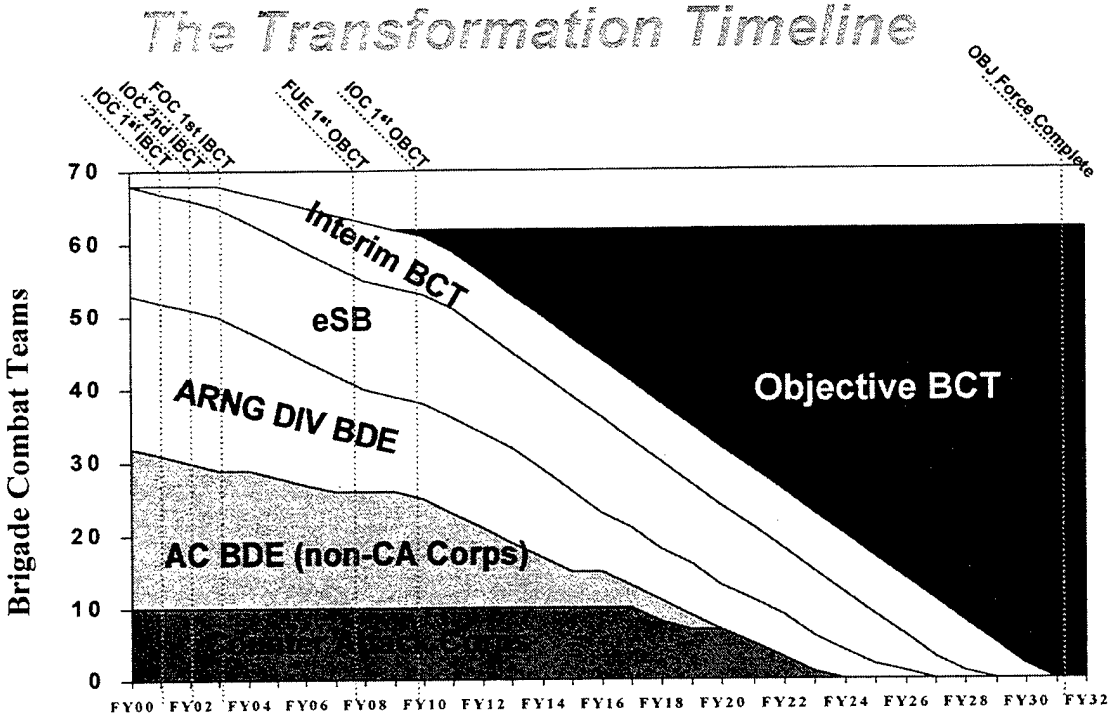
> From an airlift standpoint, on a day-to-day basis we have sufficient airlift. But where airlift becomes very, very important is in operations such as this last one and in MTWs. We are not a two MTW Air Force in a lot of areas. One of them is airlift. For planning purposes one of the reasons why we have 90 days between the two MRCs is to be able to swing the airlift from one theater to the other, because it's primarily a one-theater airlift force. I don't think we can afford to have a two MTW airlift force simultaneously. That would drive the numbers completely out of the reality realm. But we need to continue to modernize our airlift fleet and that's what we're working on very hard in our budgets.[120]

Comparing the Air Force budgets of the 1990s, the only category that saw an increase was 'airlift forces,' rising nearly 30% in constant '98 dollars (1999 vs. 1990).[121]

ARMY TRANSFORMATION

Army Transformation, announced October 1999, has as one of its goals major changes in deployment timelines. The Army will develop the capability to place a brigade on the ground anywhere in the world within 96 hours after liftoff, a division within 120 hours, and five divisions within 30 days.[122] An Army brigade equipped with M1 Abrams tanks can't deploy within 96 hours unless it is falling in on equipment already in place. An M1 does not fit on a C-130 cargo airplane-the Pentagon's most plentiful transporter. The C-17, the only other USAF cargo aircraft capable of landing on unimproved airfields, can only deliver one Abrams at a time and a C-5 can deliver only one-and not via direct delivery. Kosovo demonstrated that there are not nearly enough C-17s to meet all of the demands for airlift during a conflict. At the time the Army asked for C-17s to move tanks from Germany to Albania, the airlifters were engaged in delivering supplies to uprooted Kosovar refugees and supplies and support to USAF units, which actually were doing the fighting. The Army ended up waiting.[123]

From this experience, the Army has concluded that it must field a new combat vehicle that will perform like a tank but fit on a C-130. That has led the Army to acquire a new set of interim combat vehicles, each of which will weigh no more than 20 tons.[124] Four will fit into a C-17, greatly enhancing intratheater combat capability, and the C-5 will



The Legacy Force consists of all areas below the Interim BCT

FIGURE 11. ARMY TRANSFORMATION

carry five. The contract for the interim combat vehicle was announced November 2000.

It can be seen during Army transformation there will be three types of brigades: The legacy, interim, and objective forces. Figure-11 shows this will be a long-term process.[125] How much strategic airlift capability does the U.S. need to support this combination of Army brigades? In the year 2012, for example, will more airlift be required to support all three types of brigades than the airlift required to support a fully objective force? Will the Army itself evolve towards organic air mobility support? Will the Army drive the Air Force towards specialized theater air mobility support? It is undeniable that the timeframe for fielding the Objective Force correlates fairly well to the timeframe required to design and field a new air mobility aircraft.[126] Air Force Chief of Staff General Ryan, speaking recently of Army transformation said the new Army vision "that requires them to be more mobile and agile... is what the world needs for the future," but added this vision requires a degree of airlift that is unaffordable and unrealistic to expect.[127]

There will be pressure to use the C-17 in the intratheater role but with a final fleet size of only 135 this won't be possible. In the first 90 days of a major theater war the C-17

will be at best a direct delivery platform, but direct delivery has its limitations. In responding to the importance of direct delivery, General Kross said "It is overdone. We can deliver equipment to a forward concrete-capped runway in a continuous flow, and we can deliver equipment to a dirt airfield in one or two sorties but that's about it. Then dirt starts to behave like dirt and, consequently, C-17s cannot land there anymore."[128] The 1983 Master Airlift Plan called for the retirement of 180 C-130s to make way for the C-17 in the intratheater, but that was for a projected purchase of 220 C-17s.[129]

Congress has called for yet another detailed readiness report on the strategic airlift fleet. New legislation directs the Air Force to provide an analysis by March. Congress justified the report on the grounds that the pending DOD studies (MRS-05 and O&O AoA) do not take into account "fact-of-life changes in airlift requirements"-specifically the Army's "transformation" initiative. In the lawmakers' view, a transformed Army would be more or less a nullity if it were marooned by lack of airlift.[130]

ANALYSIS

Another tool to figure airlift requirements, in addition to the MTM/Day method AMC uses, is a cumulative cargo requirements projection.[131] Figure-12 chart projects required tons of war material for airlift over a specific timeline.[132] The chart is independent of distance and a specific number of airlift requirements per day.

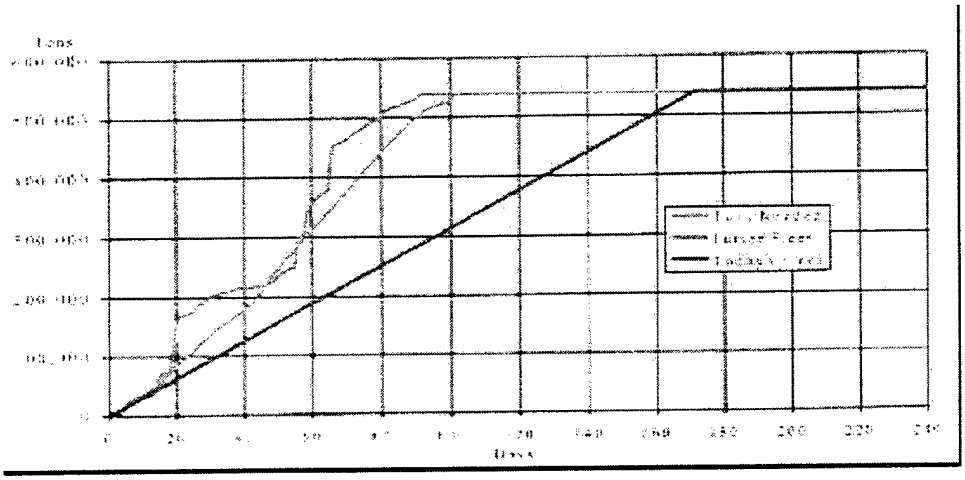


FIGURE 12. CARGO CLOSURE REQUIREMENT VS. CAPABILITY

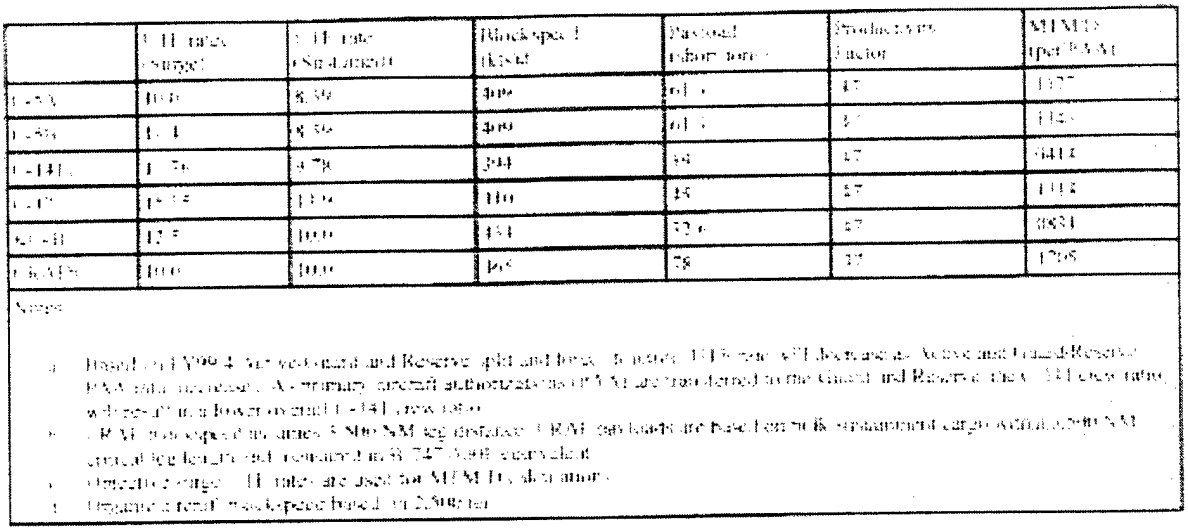


TABLE 6. SUMMARY OF STRATEGIC AIRLIFT PLANNING FACTORS

The jagged line in Figure-12 represents the warfighter's Time Phased Force Deployment Data (TPFDD) cargo "closure" or cumulative daily tons delivered to a theater. The middle line is the future fleet capability and bottom line today's capability (including full mobilization and CRAF activation). The gap between the TPFDD and capability is "risk."[133] The farther away the theater, the more MTMs required.

The initial buildup (first 14 days) of the cargo requirement plot is relatively shallow because the assets to facilitate airlift operations are being positioned in this phase. Once those assets are in place, lift requirements expand. From days 15 to 21, airlift assets are moving combat units into theater, specifically Air Force fighter wings, Marine expeditionary brigades and Army light divisions. At approximately 100,000 tons required in a 7-day period, this will require all organic airlift assets. For perspective, moving only one Army division requires 400 C-5 sorties and 1200 C-141 sorties.[134] Table-6, airlift planning factors from the Air Mobility Strategic Plan 2000, shows the payload capacities of the strategic fleet.[135] Twelve hundred C-141 sorties equates to about 500 C-17 sorties. Given 102 are available at 90% MC, this is over 5 roundtrips from the CONUS to move that one division.

From Figure-12, over the initial 90 days the tonnage is approximately 540,000. This equates to 6000 tons per day. Using notional distances of 8000 miles from CONUS (as a whole) to the two theaters (Persian Gulf and Korean Peninsula), this is 48 MTM/Day, close to the MRS BURU requirement.

Using the Persian Gulf scenario is alarming. From the start of Desert Shield to the beginning of the air war, the Coalition had over 160 days to accomplish the largest airlift of its kind in history. Figure-12 shows 160 days is where capability almost meets requirement. Given a future fleet with more capability, the TPFDD would have been met by the 100 day point, the end of November 1990 during Desert Shield. What would have

happened if the Iraqis initiated the war earlier, say day 20 of the timeline? One hundred forty days would have elapsed before airlift caught up with theater requirements. Looking at the diverging capability versus requirement lines from day 20 to 100, there are instances along the timeline where the shortfall exceeds 200,000 tons. That's 2800 M1 tanks, or 200,000-2000 pound bombs, or too much food or bullets still at CONUS bases waiting for airlift.[136] Using the airlift data from 7 August 1990 to 7 August 1991, the average MTM/Day was 12.1, and this put a strain on the system as well as the aircrews.

Aircrew ratio is a concern. During the Gulf War period, most of the reserve units were called up. The crew ratios at the time were almost double what they are today.[137] Notwithstanding those numbers, crew utilization was stretched to the limit. Post-mission crew rest was shortened. Due to the long flying times to the AOR and lack of staging bases, first pilot pools were set up in Europe. Basic crews were augmented with these first pilots to fly from Europe to the AOR and return in one crew duty day (which often exceeded the limit of 24 hours-it was waived). Maximum flying time was waived as noted earlier. Waiving the 90 day limit to 400 hours will be problematic if the airlift effort becomes protracted. With less crews today, there won't be the manning for these first pilot pools. This will constrain the concept of operations, ultimately stressing the aircrews even further.

What about attrition? It is a sensitive subject. Will C-17s be used in a hostile intratheater environment a la the C-130 in Vietnam? Between 1965 and 1972 the USAF lost 52 C-130s in Vietnam. This was an attrition rate of approximately 10.4 aircraft destroyed per 100,000 hours of flying time. During the civil war in Bosnia-Herzegovina C-130 and C-141 aircraft flying into Sarajevo routinely received battle damage from ground fire despite tactical measures to counter the surface threat. Operating in low threat environments on a routine basis, regardless of countermeasures, increases the risk of attrition.[138]

In his study "Responsive Projection of Decisive Combat Power II," retired Army General Carl Stiner, former U.S. Special Operations Command Commander, looks at the ramifications of the shrinking strategic airlift force. His study team included six Generals, including former MAC commander General Tom Ryan, and two colonels. A great deal of attention is being paid to MTWs, but forced-entry small-scale contingencies can be more demanding of airlift resources.[139] Historical precedents include:

- 1983 Urgent Fury (Grenada) Single airfield restricted rapid buildup of combat power.

- 1989 Just Cause (Panama) Forward based forces and infrastructure enabled simultaneous engagement of multiple targets
- 1991 Desert Shield (Kuwait) No notice deployments can occur requiring immediate response with sizable combat power
- 1994 Restore Democracy (Haiti) Capability to abort forces while airborne must be considered

Modeling operation Just Cause assuming the same conditions and objectives as in 1989, the strategic airlift solution that posed medium risk required 102 C-17s and with the added assumption of limited airfield availability (small austere airfields only-which precludes C-5 usage) required 181 C-17s. The study concludes:

- The U.S. cannot project adequate forces directly from the CONUS to combat configured to fight using the planned airlift force.
- Estimates are that over 200 C-17s would be required to execute Just Cause with the same risk and likelihood of success.
- The realities of today are that forced entry is the most likely as well as the most demanding small scale contingency (SSC) operation[140]

Another study recently released June 2000 from the General Accounting Office concluded an 8.6 MTM/Day strategic airlift shortfall. They took the MRS BURU shortfall of 5.2 MTM/Day (49.7-44.5) and factored in MC rates from the last three fiscal years for the fleet. The MC rate shortfall was calculated from the AMC standard wartime rate for each aircraft. This percent difference was then converted to an equivalent MTM/Day shortfall, arriving at a total deficit of 3.6 MTM/Day.[141] AMC disagreed with the methodology.

AMC officials said if they needed to surge for wartime deployment, shortfalls may be reduced by increasing maintenance and aircrew availability, temporarily delaying some periodic maintenance activities, accelerating aircraft through maintenance, using training aircraft, and flying aircraft that would normally be considered not mission capable.[142]

The report cited that despite long-standing spare part problems, the Air Force has not consistently provided all of the funds its forces said are required to buy spare parts. Since fiscal year 1991, the Air Force has fully funded what it identified as the total requirement for spare parts only twice-in fiscal years 1995 and 1999.[143] The GAO also found that cannibalization rates for the C-5, and to a lesser degree the KC-10, are higher than expected, further evidencing the lack of spare parts.[144]

CHANGING STRATEGY?

The nearly simultaneous two MTW scenario has been a constant for almost the last ten years. Now there are signs this strategy may change. Four national military strategies the National Defense University recommends for a new administration are:

- "Shape, respond, and prepare now," the current policy
- "Engage more selectively and accelerate transformation," reducing the future use of U.S. military force and, at the same time, trying to more aggressively prepare for emerging threats, such as terrorism or WMD
- "Engage more selectively and strengthen warfighting capability." Which would focus more on confronting near-term threats by addressing immediate shortfalls in the U.S. arsenal
- "Engage today to prevent conflict tomorrow," which would call for the heavy use of U.S. military force to be engaged and intervene in many places to ward off larger conflicts[145]

The Hart-Rudman Commission calls the two-war strategy is a relic of the Cold war era. This commission does however call for lighter, rapidly deployable forces to respond to smaller crisis such as Somalia.[146]

Michael O'Hanlon, a senior fellow at the Brookings Institution, calls for replacing the two-Desert Storm paradigm with a Desert Storm plus Desert Shield plus Bosnia model. He calls for a rapidly deployable force.[147]

These possibilities point more to increased airlift requirements with calls for rapidly deployable forces, transformation, or strengthening warfighting capability.

CONCLUSION

The strategic airlift force of the U.S. today is highly capable. It has been proven many times over that when called upon, the airlift force will get the job done. There are difficult challenges ahead for strategic airlift, however. There is a smaller crew force to meet a steady demand for airlift, let alone the worst-case scenario. The fleet is getting smaller. Less the C-17, the fleet is aging. The fleet must meet the requirements of avionics modernization to comply with GATM. Defensive measures are necessary for the fleet. The MC rate of the C-5 needs to be turned around. On the positive side, technical problems of the C-17 are being solved. The C-17 performed admirably during Kosovo.

Based on the latest studies and pending MRS-05/O&O AoA there is a strategic airlift shortage. Notwithstanding the optimistic factors of the MRS-05 as outlined in Figure-8, risk mitigation calls for an MTM capability as high as 54.5 to 67.0, well above today's capability. Figure-12 shows the risk today with the inability to meet TPFDD requirements. The C-141 retirement is outpacing C-17 accessions, along with aging symptoms periodically surfacing with the C-141. The C-5 reliability issue compounds the problem. A shrinking fleet total lessens flexibility. The CRAF is critical to meet MTM requirements, but has limitations in terms of employment restrictions, and an imbalance in long range international cargo aircraft contributors, one providing almost 50 percent. It is apparent based on all these factors that more C-17s are necessary. Only a major shift in the NSS/NMS in a neo-isolationist direction would translate into a reduced strategic airlift requirement.

As General Stiner's study points out, even a forced entry SSC may require airlift capability that exceeds today's level. This study shows a SSC on the order of JUST CAUSE would require a sizable increase in the planned C-17 fleet size to maintain the level of risk experienced in the actual operation.

Now Army transformation poses new questions which motivated Congress to legislate for a new airlift study. The lofty deployment timetable goals of Army transformation will require an as yet undefined by definitely large increase in strategic airlift capability. The current C-17 purchase timeline runs out in 2004. With the Army transformation completed by approximately 2030, the C-17 fleet will be well past its half-life of 20 years. It becomes apparent the time will be right for a robust follow-on capability to the C-17 in the form of a new airlift aircraft, much like the C-17 is today for the C-141.

With a new administration about to take office, possibilities for a new or modified NMS complicate matters further. Will the MRS-05 be valid six months from now? The next QDR will be crucial in defining strategic airlift requirements and desired capabilities. Another Nifty Nugget type exercise might be advisable after the NMS is defined.

Ultimately, the question of required airlift rests with the accepted level of risk. And risk translates into casualties. It remains to be seen what this level will be.

WORD COUNT = 12528

ENDNOTES

[1] John Cirafici, Airhead Operations: Where AMC Delivers (Maxwell AFB, AL.: Air University Press, 1995), 67.

[2] Joint Chiefs of Staff, Doctrine for Planning Joint Operations, Joint Pub 5-0 (Washington, D.C., U.S. Joint Chiefs of Staff, 29 July 1998), III-14.

[3] Joint Chiefs of Staff, Joint Tactics, Techniques and Procedures for Airlift Support to Joint Operations, Joint Pub 4-01.1 (Washington, D.C.: U.S. Joint Chiefs of Staff, 20 July 1996), II-1.

[4] Department of the Air Force, Air Force Basic Doctrine, Air Force Doctrine Document 1 (Washington, D.C.: U.S. Department of the Air Force, September 1997), 54-55.

[5] Department of the Air Force, Airlift Operations, Air Force Doctrine Document 2-6.1 (Washington, D.C.: U.S. Department of the Air Force, 13 November 1999), 1.

[6] Jay H. Smith, Anything, Anywhere, Anytime: An Illustrated History of the Military Airlift Command, 1941-1991 (Scott AFB, IL.: Military Airlift Command, May 1991), 36.

[7] Ibid., 41.

[8] Keith Hutcheson, Air Mobility: The Evolution of Global Reach (Vienna, VA.: Point One, 1999), 8.

[9] Ibid., 11.

[10] Ibid., 13.

[11] Ibid., 14.

[12] Ibid., 19.

[13] Ibid., 22.

[14] Ibid., 23.

[15] Ibid., 24.

[16] Ibid., 25.

[17] Joint Chiefs of Staff, Joint Tactics, Techniques and Procedures for Airlift Support to Joint Operations, II-1.

[18] Daniel Goure and Jeffrey M. Ranney, Averting the Defense Train Wreck in the New Millennium (Washington, D.C.: CSIS Press, 1999), 33.

[19] William S. Cohen, Annual Report to the President and the Congress (Washington, D.C.: Department of Defense, 2000), 200.

[20] David Fulghum and Robert Wall, "Aviation Modernization Battered in Budget Plan," Aviation Week & Space Technology (14 February 2000): 27-28.

[21] Charles T. Robertson, "Air Mobility Strategic Plan 2000," October 1999; available from <http://www.amc.af.mil/xp.html>; Internet; accessed 11 December 2000.

[22] Ibid.

[23] Ibid.

[24] Ibid.

[25] Charles T. Robertson, Jr., "USTRANSCOM's Key Challenges," Statement and briefing slides with scripted commentary, House Armed Services Committee, 26 October 1999.

[26] Charles T. Robertson, "Air Mobility Strategic Plan 2000," October 1999.

[27] Air Force Association, "Air Force Almanac 2000," Air Force Magazine (May 2000): 148-149.

[28] The author is a C-141C initial-cadre flight examiner pilot with extensive instructional training and operational experience with both the new avionics and defensive systems.

[29] Charles T. Robertson, "Air Mobility Strategic Plan 2000," October 1999.

[30] Air Force Association, "Air Force Almanac 2000," 148.

[31] Mark E. Raymond, "C-5 Brigade Airdrop Test," The Mobility Forum (July-August 2000): 29-30.

[32] Ken S. Brown, "AMC Outsize and Oversize Cargo Airlift Capability Analysis of Alternatives," Briefing Slides, Scott AFB, IL.: Air Mobility Command, November 2000.

[33] Katherine M. Peters, "The Right Stuff," Government Executive (December 1999): 32.

[34] Ken S. Brown, "AMC Outsize and Oversize Cargo Airlift Capability Analysis of Alternatives," November 2000.

[35] Robert T. Cossaboom and Dr. James K. Matthews, General Robert L. Rutherford: An Oral History (Scott AFB, IL.: USTRANSCOM, October 1996), 31.

[36] Walter Kross, "Air Mobility Symposium Address," Air Mobility Symposium (19-20 September 1997): 263.

[37] Thomas D. Pilsch, "The C-X Requirement: Perspective on Airlift," Airlift Operations Review (January 1981): 8.

[38] Ibid.

[39] Edgar Ulsamer, "New Defense Horizons: Changing Strategies for a Changing World," Air Force Magazine (February 1980): 61.

[40] Pilsch, 12.

[41] Ibid.

[42] Paul Jackson, Jane's All The World's Aircraft (Alexandria, VA.: Jane's Information Group, Inc., 1999), 579.

[43] Charles T. Robertson, "USTRANSCOMs Key Challenges," 26 October 1999.

[44] Robert Wall and David A. Fulghum, "C-17 Production Plan Takes New Twist," Aviation Week & Space technology (14 February 2000): 31.

[45] Frank Wolfe, "Boeing Seeks Funding Increase For C-17s," Defense Daily (17 October 2000):1 [database on-line]; available from UMI ProQuest Direct, Bell & Howell, UMI publication no. 50616591.

[46] Frank Wolfe, "Peters: Air Force Needs Funds For Sustainment of C-17 Line in Fy'02," Defense Daily (14 September 2000):1 [database on-line]; available from UMI ProQuest Direct, Bell & Howell, UMI publication no. 60311222.

[47] General Accounting Office, "Airlift Requirements: Commercial Freighters Can Help Meet Requirements At Greatly Reduced Costs," 11 July 1994; available from <http://www.fas.org/man/gao/gao94209.htm>; Internet; accessed 29 November 2000.

[48] General Accounting Office, "Military Airlift: Options Exist for Meeting Requirements While Acquiring Fewer C-17s," 19 February 1997; available from <http://www.fas.org/man/gao/ns97038.htm>; Internet; accessed 4 October 2000.

[49] General Accounting Office, "C-17 Aircraft: Cost and Performance Issues," 26 January 1995; available from <http://www.fas.org/man/gao9526.htm>; Internet; accessed 24 November 2000.

[50] Dr. John W. Leland and Dr. James K. Matthews, General Ronald R. Fogleman: An Oral History (Scott AFB, IL.: USTRANSCOM, March 1995), 45-46.

[51] Dr. John W. Leland and Dr. James K. Matthews, 46-47.

[52] Robert T. Cossaboom and Dr. James K. Matthews, General Walter Kross: An Oral History (Scott AFB, IL.: USTRANSCOM, October 1999): 65.

[53] Charles T. Robertson, "Air Mobility Strategic Plan 2000," October 1999.

[54] Robert M. Hunter <robert.m.hunter@boeing.com>, "C-17 Payload-Range Info," electronic mail message to Toben Rower <toben.rower@carlisle.army.mil>, 17 November 2000.

[55] Ibid.

[56] Department of the Army, Airdrop Support Operations in a Theater of Operations, Army Field Manual 10-500-1 (Washington, D.C.: U.S. Department of the Army, 19 June 1991), 1-1.

[57] Department of the Air Force, Airlift Operations, 18.

[58] Louis Arana-Barrados, "C-17s First Brigade Airdrop," 28 June 1995; available from <http://www.af.mil/mens/Jun1995/n19950628_680.html>; Internet: accessed 4 October 2000.

[59] Danita Hunter, "C-17s deliver a brigade in 30 minutes or less," 22 February 2000; available from <http://www.fas.org/man/dod-101/sys/ac/docs/n20000222_000257.htm>; Internet; accessed 24 November 2000.

[60] Charles Robertson, "USTRANSCOM's Key Challenges," 26 October 1999.

[61] Hutcheson, xiv.

[62] Charles T. Robertson, "Air Mobility Strategic Plan 2000," October 1999.

[63] Department of the Air Force, "KC-10A Extender Fact Sheet," no date; available from <http://www.af.mil/news/factsheets/KC_10A_Extender.html>; Internet; accessed 28 November 2000.

[64] Smith, 81.

[65] Hutcheson, 119.

[66] John Daly and Paul Needham, "Air Transportation: Elements of a Changing Environment and What it Means to the Civil Reserve Air Fleet," Defense Transportation Journal (December 1999): 7.

[67] Air Mobility Command, AMC HQ FORM 312, CIVIL RESERVE AIR FLEET (CRAF) CAPABILITY Summary (Scott AFB, IL.: U.S. Air Force Air Mobility Command, 1 October 2000).

[68] Ibid., 121.

[69] Air Mobility Command, AMC HQ FORM 312, CIVIL RESERVE AIR FLEET (CRAF) CAPABILITY Summary.

[70] Ibid.

[71] David L. Merrill, "The 'Miraculous' Requirements Study for FY 2005 (MRS-05)," Briefing slides, Scott AFB, IL., Air Mobility Command, November 2000.

[72] Ronald N. Priddy, A History of the Civil Reserve Air Fleet in Operations Desert Shield, Desert Storm and Desert Sortie (Cambridge, MA.: Volpe National Transportation Systems Center, 1993), 148-150.

[73] Daly and Needham, 6.

[74] Air Mobility Command, AMC HQ FORM 312, CIVIL RESERVE AIR FLEET (CRAF) CAPABILITY Summary.

[75] John Daly and Paul Needham, "Air Transportation: Elements of a Changing Environment and What it Means to the Civil Reserve Air Fleet," Defense Transportation Journal (February 2000): 9.

[76] Air Force Magazine, "Air Force Almanac 2000," 66-67.

[77] Walter S. Hogle, Jr., 1998 Air Mobility Master Plan (Scott AFB, IL.: Air Mobility Command, 24 October 1997), 3-10.

[78] Charles T. Robertson, "Air Mobility Strategic Plan 2000," October 1999.

[79] Ibid.

[80] John G. O'Hara, "Strategic Mobility: We Have A Long Way To Go!," Defense Transportation Journal (August 1981): 27.

[81] Ibid., 28.

[82] Daly and Needham, 9.

[83] Pilsch, 8.

[84] Charles E. Miller, Airlift Doctrine (Maxwell AFB, AL.: Air University Press, 1988), 371.

[85] Smith, 175.

[86] Ibid.

[87] Ibid., 178.

[88] Peter Grier, "The Ton-Mile Gap," Air Force Magazine (November 1992): 30.

[89] Ibid.

[90] Ibid., 30-31.

[91] Ibid., 31.

[92] Ibid., 31.

[93] Randall L. Long, The USAF C-17 Fleet: A Strategic Airlift Shortfall? (Maxwell AFB, AL.: Air Command and Staff College, March 1997), 7.

[94] David L. Merrill, "The "Miraculous" Requirements Study for FY 2005 (MRS-05)," November 2000.

[95] Les Aspin, Report of the Bottom-Up Review (Washington, D.C.: Department of Defense, October 1993), 19-20.

[96] Dan Allsup, "The Air Mobility Master Plan," Air Force Magazine (February 1994): 55.

[97] Sandy Detering, "Mobility Requirements Study Bottom-Up Review Update," Point paper, Scott AFB, IL.: Air Mobility Command, 6 July 1995.

[98] Ibid.

[99] Ibid.

[100] William S. Cohen, Report of the Quadrennial Defense Review (Washington, D.C.: Department of Defense, May 1997), 34.

[101] Ibid.

[102] David L. Merrill, "MRS-05 Executive Summary," Scott AFB, IL.: AMC/XPY, 3 November 2000.

[103] William S. Cohen, Annual Report to the President and Congress, 200.

[104] Roger G. Thompson, Defense Transportation, Podium paper presented to the National Defense Transportation Association Luncheon at Charleston AFB, S.C., (Scott AFB, IL.: USTRANSCOM, 19 May 1999), 4.

[105] David L. Merrill, "Mobility Requirements Study for FY2005 (MRS-05)," background paper, Scott AFB, IL.: AMC/XPY, 8 November 2000.

[106] Ibid.

[107] Ibid.

[108] David L. Merrill, "The "Miraculous" Requirements Study for FY2005 (MRS-05)," briefing slides, Scott AFB, IL.: Air Mobility Command, November 2000.

[109] Frank Wolfe, "Zinni: Strategic Mobility Centcom's Greatest Need," Defense Daily (1 March 2000): 1 [database on-line]; available from UMI ProQuest Direct, Bell & Howell, UMI publication no. 50616591.

[110] Ibid.

[111] David L. Merrill, "The "Miraculous" Requirements Study for FY2005 (MRS-05)," November 2000.

[112] Ibid.

[113] Ibid.

[114] Ken S. Brown, "AMC Outsize and Oversize Cargo Airlift Capacity Analysis of Alternatives," November 2000.

[115] Frank Wolfe, "Mobility Plan Insufficient To Meet Military Strategy, Draft Study Says," Defense Daily (24 October 2000): 1 [database on-line]; available from UMI ProQuest Direct, Bell & Howell, UMI publication no. 62878097.

[116] Ibid.

[117] Peter Grier, "A Heads-Up From Whit Peters," Air Force Mmagazine (November 2000): 30.

[118] Frank Wolfe, "Peters: Current C-17 Procurement Plan Not Sufficient," Defense Daily (27 October 2000):1 [database on-line]; available from UMI ProQuest Direct, Bell & Howell, UMI publication no. 62974578.

[119] Frank Wolfe, "Mobility Study Recommends Higher Tonnage Requirement " Defense Daily (13 October 2000): 1 [database on-line]; available from UMI ProQuest Direct, Bell & Howell, UMI publication no. 62493359.

[120] Michael Dorsey, "Airlift future a question of balance," 25 August 1999; available from <http://www.fas.org/man/dod-101/sys/as/docs/n19990825_991586.htm>;Internet; accessed 14 December 2000.

[121] Robert Dudney, "Air Force Programs at the Core," Air Force Magazine (June 1997): 23.

[122] James R. Oman, A Case Study of the Army's Transformation Strategy (Carlisle Barracks, PA.: U.S. Army War College, 20 September 2000), 3.

[123] Richard Newman, "The Army Ponders Its Future," Air Force Magazine, (November 2000), 36.

[124] Ibid., 36.

[125] Department of the Army, "Army Transformation," briefing slides, Washington, D.C., U.S. Army DCSOPS, October 2000.

[126] Charles Robertson, "USTRANSCOM's Key Challenges," 26 October 1999.

[127] John Tripac, "The Needs of the Force," Air Force Magazine (September 2000): 42.

[128] Robert T. Cossaboom and Dr. James K. Matthews, General Walter Kross: An Oral History (Scott AFB, IL.: USTRANSCOM, October 1999), 63.

[129] Smith, 175-176.

[130] Paul Mann, "Congress Probes Airlift Deficit," Aviation Week & Space Technology (23 October 2000): 56.

[131] Long, 8.

[132] Hogle, Jr., 2-30.

[133] Ibid.

[134] Long, 9.

[135] Charles T. Robertson, "Air Mobility Strategic Plan 2000," October 2000.

[136] Long, 19-20.

[137] The author was stationed at Norton AFB at the time of Desert Shield/Storm. There were approximately 50 C-141s assigned to Norton at the time. There were 4 active duty and 3 reserve squadrons at Norton with close to 500 pilots assigned to those squadrons. That's a crew ratio of about 5.0!

[138] Long, 24-26.

[139] Carl W. Stiner, "Response Projection of Decisive Combat Power II: Just Cause-A Case Study," briefing slides, 5 August 1999.

[140] Ibid.

[141] General Accounting Office, Air Transport Capability Falls Short of Requirements (Washington, D.C.: U.S. General Accounting Office, June 2000), 10-12.

[142] Ibid., 11.

[143] Ibid., 14.

[144] Ibid., 42.

[145] Robert Wall, "U.S. Strategy Alternatives Emerge," Aviation Week & Space Technology (13 November 2000): 32-33.

[146] Andrea Stone, "Panel Labels Two-War Strategy Outdated," USA Today (19 April 2000): 9.

[147] Michael E. O'Hanlon, "Rethinking Two War Strategies," Joint Force Quarterly (Spring 2000): 11-14.

BIBLIOGRAPHY

Air Force Association. "1980 Air Force Almanac." Air Force Magazine. (May 1980): 160-162.

_____. "1986 Air Force Almanac." Air Force Magazine. (May 1986): 189-191.

_____. "1990 Air Force Almanac." Air Force Magazine. (May 1990): 48-50, 149-153.

_____. "1995 Air Force Almanac." Air Force Magazine. (May 1995): 51-54.

_____. "1999 Air Force Almanac." Air Force Magazine. (May 1999): 63-66.

_____. "2000 Air Force Almanac." Air Force Magazine. (May 2000): 65-68, 145-149.

Allsup, Dan. "The Air Mobility Master Plan." Air Force Magazine (February 1994): 54-58.

Anonymous. "National Defense Transportation Association 2000 Almanac." Defense Transportation Journal (April 2000): 28-30.

Arana-Barradas, Louis. "C-17s First Brigade Airdrop." 28 June 1995. Available from <http://www.af.mil/mens/Jun1995/n19950628_680.html>. Internet. Accessed 4 October 2000.

Aspin, Les. Report of the Bottom-Up Review. Washington, D.C.: Department of Defense, October 1993.

Association of the United States Army (AUSA). Strategic Mobility & Responsive Power Projection. Arlington, VA: AUSA, December 1999.

Berry, Clifton. "The Civil Reserve Air Fleet- National Airlift Asset." Air Force magazine (February Force Magazine (February 1980): 60-61.1980): 54-59.

Boeing Company. "C-17 Globemaster III." no date. Available from <http://www.boeing.com/defense-space/military/c17/c17.htm>. Internet. Accessed 10 November 2000.

Browne, Ken S. "AMC Outsize and Oversize Cargo Airlift Capacity Analysis of Alternatives." Briefing slides. Scott AFB, IL., Air Mobility Command, November 2000.

Cirafici, John. Airhead Operations: Where AMC Delivers. Maxwell AFB, AL.: Air University Press, 1995.

Cohen, William S. Annual Report to the President and the Congress. Washington, D.C.: Department of Defense, 2000.

_____. Report of the Quadrennial Defense Review. Washington, D.C.: Department of Defense, May 1997.

Cossaboom, Robert T. and Matthews, Dr. James K. General Robert L. Rutherford: An Oral History. Scott AFB, IL.: USTRANSCOM, October, 1996.

_____. General Walter Kross: An Oral History. Scott AFB, IL.: USTRANSCOM, October 1999.

Daly, John and Needham, Paul. "Air Transportation: Elements of a Changing Environment and What it Means to the Civil reserve Air Fleet." Defense Transportation Journal (December 1999): 6-11.

_____. "Air Transportation: Elements of a Changing Environment and What it Means to the Civil Reserve Air Fleet." Defense Transportation Journal (February 2000): 6-9.

Department of the Air Force. "C-5 Galaxy Fact Sheet." No date. Available from <http://www.af.mil/news/factsheets/C_5_Galaxy.html>. Internet. Accessed 28 November 2000.

_____. "C-17 Globemaster III Fact Sheet." no date. Available from <http://www.af.mil/news/factsheets/C_17_Globemaster_III.html>. Internet. Accessed 24 November 2000.

_____. "C-141B Starlifter Fact Sheet." No date. Available from <http://www.af.mil/news/factsheets/C_141B_Starlifter.html>. Internet. Accessed 28 November 2000.

_____. "KC-10A Extender Fact Sheet." No date. Available from <http://www.af.mil/news/factsheets/KC_10A_Extender.html>. Internet. Accessed 28 November 2000.

Department of the Army. "Army Transformation." Briefing slides. Washington, D.C. U.S. Army DCSOPS. October 2000.

Detering, Sandy. "Mobility Requirements Study Bottom-Up Review Update." Point paper. Scott AFB, IL.: Air Mobility Command, 6 July 1995.

Dorsey, Michael. "Airlift future a question of balance." 25 August 1999. Available from <http://www.fas.org/man/dod-1101/sys/ac/docs/n19990825_991586.htm>. Internet. Accessed 14 December 2000.

Dudney, Robert. "Air Force Programs at the Core." Air Force Magazine (June 1997): 22-26.

Federation of American Scientists. "Airlift Cargo Aircraft." No date. Available from <http://www.fas.org/man/dod-101/sys/ac/lift_comp.htm>; Internet. Accessed 28 November 2000.

Fulghum, David and Wall, Robert. "Aviation Modernization Battered in Budget Plan." Aviation Week & Space Technology (14 February 2000): 27-30.

Goure, David and Ranney, Jeffrey M. Averting the Defense Train Wreck in the New Millennium. Washington, D.C.: CSIS Press, 1999.

Grier, Peter. "A Head's Up From Whit Peters." Air Force Magazine (November 1992): 30-33.

_____. "The Ton-Mile Gap." Air Force Magazine (November 2000): 30-32.

Hannah, Steven R. and Ronsick, Eugene J. Airland Battle Combat Airdrop Doctrine and Requirement. Maxwell AFB, AL.: Air War College, 11 April 1988.

Hogle Jr., Walter S. 1998 Air Mobility Master Plan. Scott AFB, IL.: Air Mobility Command, 24 October 1997.

Hunter, Danita. "C-17 Delivers A Brigade in 30 Minutes or Less." 22 February 2000. Available from <http://www.fas.org/man/dod-101/sys/ac/docs/n20000222_000257.htm>. Internet. Accessed 24 November 2000.

Hunter, Robert M. <robert.m.hunter@boeing.com>. "C-17 Payload-Range Info." Electronic mail message to Toben Rower < toben.rower@carlisle.army.mil>. 17 November 2000.

Hutcheson, Keith. Air Mobility The Evolution of Global Reach. Vienna, VA.: Point One, 1999.

Huxsoll, Dave. "C-17 Proves Its Worth in Allied Force." 2 July 1999. Available from <http://www.fas.org/man/dod-101/ops/docs99/n19990702_991295.htm>. Internet. Accessed 24 November 2000.

Jackson, Paul. Jane's All the World's Aircraft. Alexandria, VA.: Jane's Information Group, Inc., 1999.

Kross, Walter. "Air Mobility Symposium Address." Air Mobility Symposium (19-20 September 1997): 259-264.

_____. "Posture Statement." Defense Transportation Journal (June 1997): 10-12.

Leland, Dr. John W. and Matthews, Dr. James K. General Ronald R. Fogleman: An Oral History. Scott AFB, IL.: USTRANSCOM, March 1995.

Leland, John W. "Air Mobility In Operation Desert Shield/Storm." Air Mobility Symposium (19-20 September 1997): 143-168.

Long, Randall L. The USAF C-17 Fleet: A Strategic Airlift Shortfall? Maxwell AFB, AL.: Air Command and Staff College, March 1997.

Mann, Paul. "Congress Probes Airlift Deficit." Aviation Week & Space Technology (23 October 2000):56.

McQuillan, Bill. "C-17 Passes new Dual-Row Airdrop Capability Tests." January 1999. Available from <http://www.afmc.wpafb.af.mil>. Internet. Accessed 4 October 2000.

Merrill, David L. "MRS-05 Executive Summary." Scott AFB, IL.: Air Mobility Command, 3 November 2000.

_____. "Mobility Requirements Study for FY2005 (MRS-05)." Background paper. Scott AFB, IL.: AMC/XPY, 8 November 2000.

_____. "The "Miraculous" Requirements Study for FY 2005 (MRS-05)." Briefing slides. Scott AFB, IL., Air Mobility Command, November 2000.

Miller, Charles E. Airlift Doctrine. Maxwell AFB, AL.: Air University Press, 1988.

Newman, Richard. "The Army Ponders Its Future." Air Force Magazine (November 2000): 34-38.

O'Hanlon, Michael E. "Rethinking Two War Strategies." Joint Force Quarterly (Spring 2000): 11-17.

O'Hara, John G. "Strategic Mobility: We Have a Long Way To Go!." Defense Transportation Journal (August 1981): 27-30.

Oman, James R. A Case Study of the Army's Transformation Strategy. Carlisle Barracks, PA.: U.S. Army War College, 20 September 2000.

Peters, Katherine M. "The Right Stuff." Government Executive (December 11999): 28-34.

Peters, Whitten and Ryan, Michael E. U.S. Air Force Posture Statement 2000. Washington, D.C.: Department of the Air Force, 2000.

Pilsch, Thomas D. "The C-X Requirement: Perspectives on Airlift." Airlift Operations Review (January 1981): 8-17.

Priddy, Ronald N. A History of the Civil Reserve Air Fleet In Operation Desert Shield, Desert Storm, and Desert Sortie. Cambridge, MA.: Volpe National Transportation Systems Center, 1993.

Raymond, Mark E. "C-5 Brigade Airdrop Test." The Mobility Forum (July-August 2000): 28-31.

Robertson, Charles T. "Air Mobility Strategic Plan 2000." October 1999. Available from <http://www.amc.af.mil/xp.html>. Internet. Accessed 11 December 2000.

_____. "USTRANSCOM's Key Challenges." Statement and briefing slides with scripted commentary. House Armed Services Committee, 26 October 1999.

_____. 1999 Annual Command Report. Scott AFB, IL: USTRANSCOM, 2000.

Smith, Jay H. Anything, Anywhere, Anytime: An Illustrated History of the Military Airlift Command, 1941-1991. Scott AFB, IL.: Military Airlift Command, May 1991.

Stiner, Carl W. "Responsive Projection of Decisive Combat Power III: Just Cause – A case Study." Briefing slides. 5 August 1999.

Stone, Andrea. "Panel Labels Two-War Strategy Outdated." USA Today (19 April 2000): 9.

The Secretary of Defense. Annual Report of the Department of Defense Reserve Forces Policy Board for Fiscal Year 1986. Washington, D.C.: U.S. Department of Defense, 10 February 1987.

_____. Annual Report of the Department of Defense Reserve Forces Policy Board for Fiscal Year 1990. Washington, D.C.: U.S. Department of Defense, 2 March 1991.

_____. Annual Report of the Department of Defense Reserve Forces Policy Board for Fiscal Year 1995. Washington, D.C.: U.S. Department of Defense, 17 April 1996.

_____. Annual Report of the Department of Defense Reserve Forces Policy Board for Fiscal Year 1999. Washington, D.C.: U.S. Department of Defense, March 2000.

Thompson, Roger G. Defense Transportation. Podium paper presented to the National Defense Transportation Association Luncheon at Charleston AFB, S.C. Scott AFB, IL.: USTRANSCOM, 19 May 1999.

Tripac, John. "A Clamor for Airlift." Air Force Magazine (December 2000): 24-30.

_____. "The Need's of the Force." Air Force Magazine (December 2000): 40-45.

U.S. Air Force. AMC HQ FORM 312, CIVIL RESERVE AIR FLEET (CRAF) CAPABILITY Summary. Scott AFB, IL.: U.S. Air Force Air Mobility Command, 11 October 2000.

U.S. Air Force Material Command. "Strategic Public Affairs Plan for the Air Force's C-17 Globemaster III." 1994. Available from <http://www.fas.org/mad/dod-101/sys/ac/docs/1211KJ1.htm>. Internet. Accessed 10 November 2000.

U.S. Army War College. "Army Transformation." Briefing slides available on Army War College intranet 'P' drive. Carlisle Barracks, PA. No date.

U.S. Congressional Budget Office. "Moving U.S. Forces: Options for Strategic Mobility." February 1997. Available from <http://www.fas.org/man/congress/1997/cbo_mobility.htm>. Internet. Accessed 25 November 2000.

U.S. Congressional Research Service Issue Brief. "C-17Cargo Aircraft Program." 6 December 1996. Available from <http://www.fas.org/man/crs/93-041.htm>. Internet. Accessed 24 November 2000.

U.S. Department of the Air Force. Air Force Basic Doctrine. Air Force Doctrine Document 1. Washington, D.C.: U.S. Department of the Air Force, September 1997.

_____. Airlift Operations. Air Force Doctrine Document 2-6.1. Washington, D.C.: U.S. Department of the Air Force, 13 November 1999.

U.S. Department of the Army. Airdrop Support Operations In A Theater of Operations. Army Field Manual 10-500-1. Washington, D.C.: U.S. Department of the Army, 19 June 1991.

U.S. General Accounting Office. "Airlift Requirements: Commercial Freighters Can Help Meet Requirements at Greatly Reduced Costs." 11 July 1994. Available from <http://www.fas.org/man/gao/gao94209.htm>. Internet. Accessed 29 November 2000.

_____. Air Transport Capability Falls Short of Requirements. Washington, D.C.: U.S. General Accounting Office, June 2000.

_____. "C-17 Aircraft: Cost and Performance Issues." 26 January 1995. Available from <http://www.fas.org/man/gao/gao9256.htm>. Internet. Accessed 24 November 2000.

_____. "C-17 Aircraft: RM&A Evaluation Less Demanding Than Initially Planned." June 2000. Available from <http://www.fas.org/man/gao/ns96126.htm>. Internet. Accessed 3 December 2000.

_____. "Military Airlift: Options Exist for meeting Requirements While Acquiring Fewer C-17s." 19 February 1997. Available from <http://www.fas.org/man/gao/ns97038.htm>. Internet. Accessed 4 October 2000.

U.S. Joint Chiefs of Staff. Doctrine for Planning Joint Operations. Joint Pub 5-0. Washington, D.C.: U.S. Joint Chiefs of Staff, 13 April 1995.

_____. Joint Tactics, Techniques and Procedures for Airlift Support to Joint Operations. Joint Pub 4-01.1. Washington, D.C.: U.S. Joint Chiefs of Staff, 20 July 1996.