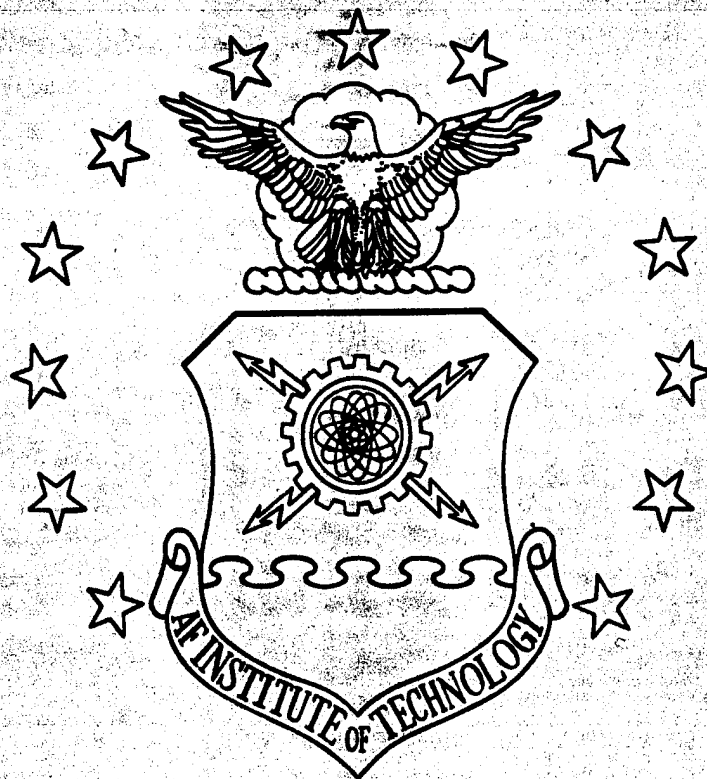




USAF CIVIL RESERVE AIR FLEET
AEROMEDICAL EVACUATION AIRLIFT CAPABILITY

GRADUATE RESEARCH PAPER

Donald R. Wilhite, Major, USAF

AFIT/GMO/LAL/96J-10

DEPARTMENT OF THE AIR FORCE
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GRADUATE RESEARCH PAPER

Presented to the Faculty of the Graduate School of
Logistics and Acquisition Management
Air Education and Training Command
In Partial Fulfillment of the
Requirements for the Degree of
Master of Air Mobility

Donald R. Wilhite, B.A., M.S.

Major, USAF

May 1996

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Donald R. Wilhite

Table of Contents

	Page
Acknowledgments.....	ii
List of Tables	iv
Abstract.....	v
I. Introduction	1
II. Historical Background.....	5
III. System Description	16
IV. Problem Statement.....	20
V. Discussion of the Main Problems	21
1) Lack of a Validated Requirement.....	21
2) Low B-767 Commitment.....	31
3) Low Capability of Present B-767/AESS Resources On-Hand.....	35
4) Other CRAF AE System Weaknesses.....	41
5) Summary of Discussion of the Main Problems	44
VI. Recommendations and Conclusions.....	45
1) Lack of a Validated Requirement.....	45
2) Low B-767 Commitment.....	47
3) Low Capability of Present B-767/AESS Resources On-Hand.....	56
4) Other CRAF AE System Weaknesses	61
VII. Summary	64
Bibliography	65
Vita.....	75

List of Tables

Table	Page
1. Airline Numbers of B-767s and Commitment to CRAF	32

Abstract

The Department of Defense, USAF, and Air Mobility Command (AMC) rely on the Civil Reserve Air Fleet (CRAF) to provide supplemental airlift in times of national emergency. AMC oversees the CRAF program which contains three segments: international, national, and aeromedical evacuation. The CRAF Aeromedical Evacuation (AE) program involves commercial B-767 aircraft, Aeromedical Evacuation Shipsets (AESS), a Casualty Transfer System, and a large number of support personnel and equipment.

Wartime planning in the early 1980s revealed a significant shortage of military airlift to accomplish the aeromedical evacuation mission. Consequently the CRAF AE program was initiated. Planning for Major Regional Conflict scenarios has currently set a requirement for 25 and 44 B-767 aircraft for CRAF Stages II and III, respectively. Unfortunately AMC has not been able to acquire full commitment to the CRAF AE program. In addition, the CRAF AE program has been beleaguered by a number of problems which have continually kept capability of the overall system low. This graduate research paper provides a comprehensive review of the AE shortfall issue from beginning to the present with recommendations and conclusions for the near future.

USAF CIVIL RESERVE AIR FLEET
AEROMEDICAL EVACUATION AIRLIFT CAPABILITY

I. Introduction

During peacetime, the Department of Defense (DOD) and USAF are properly equipped with organic military assets to handle strategic aeromedical evacuation airlift needs. However, planning for wartime and Major Regional Conflict (MRC) scenarios indicates a serious and potentially very large shortfall in military assets to accomplish strategic aeromedical evacuation (AE). Consequently Air Mobility Command (AMC) created the aeromedical evacuation segment of the Civil Reserve Air Fleet in order to use commercial aircraft to supplement military aircraft for AE in times of national crises or emergencies. This program has great promise--there is the potential to secure significant capability with tremendous cost-effectiveness. Unfortunately, though the program has great promise, it has never realized full capability. In fact, the Civil Reserve Air Fleet Aeromedical Evacuation (CRAF AE) program has been beleaguered by problems which have constantly kept capability low. The low capability of CRAF AE seriously jeopardizes our nation's ability to care for our critically wounded or ill soldiers during war or Major Regional Conflicts. The 1996 Air Mobility Master Plan states "the nation has an overriding moral responsibility to guarantee its armed forces the quickest, most humane casualty evacuation possible" (AMMP-96, 1995:5-28).

This graduate research paper examines the capability problems with USAF Civil Reserve Air Fleet Aeromedical Evacuation airlift. Air Mobility Command, one of the six major commands within the USAF and a component of U.S. Transportation Command (USTRANSCOM, or USTC), oversees the entire strategic aeromedical evacuation airlift system. In the 1996 Air Mobility Master Plan, AMC identified a shortfall in AE capacity:

Aeromedical Evacuation Capacity Shortfall

Deficiency:

- Shortfall in CRAF AE requirement, 19 on contract vs. 44 required
- Inefficient process to on/off load patients from B-767

Analysis:

- Fewer C-17s with a capability of only 12 - 36 litters does not replace retiring C-141s capability of 48 - 103 litters
- Only 19 B-767 aircraft committed under FY 95 CRAF contract
- 34 of 44 B-767 AE shipsets available
- Slow B-767 patient on/off loading impacts patient care and aircraft throughput.

Solutions:

- Pursue feasibility of equipping other AMC aircraft with AE capability, e.g. KC-10, KC-135, C-21
- Identify alternative commercial airframes and modify AE shipsets
- Improve incentives & priority for AE CRAF in future negotiations
- Evaluate current casualty transport system (CTS), jetway access for cost effective, deployable method to on/off load patients

Time Period: Today / Short / Mid

OPR: SGX / XPP / DOF
(AMMP-96, 1995:25)

The basic problem is that in times of war or defense-oriented national emergency, whether the USAF uses organic or commercial aircraft, there simply is not enough capability to meet the projections for strategic aeromedical evacuation requirements. AE capacity shortfall exists in organic airlift resources, in the CRAF supplement to organic airlift, and in the current ability to convert and use CRAF AE aircraft.

Projections for war or defense-oriented national emergency show large requirements for airlift sustainment missions in cargo and passenger movement. Consequently the USAF relies on the CRAF to supplement organic airlift to meet these needs. Beginning in 1986 the CRAF program provided not only cargo and passenger movement but also aeromedical evacuation. For MRCs the USAF is relying on the CRAF AE B-767 to meet nearly *all* strategic AE requirements. Unfortunately, though the Air Force has been working on the CRAF AE B-767 program for almost 10 years and has a fairly extensive set of equipment and resources on hand to convert B-767s from passenger to AE configuration, there are four consistent problems:

- 1) AMC is having difficulty determining a validated requirement for CRAF AE,
- 2) There has been constant under-commitment by the civilian airline companies of B-767 aircraft for AE (currently they have committed only 19 B-767s against a requirement for 25 or 44),
- 3) AMC has only partial capability to convert the 19 B-767s that are committed (currently AMC can convert only four of the 19 to meet full certification), and

- 4) There are continuing weaknesses in other aspects of the CRAF AE program and airlift system, such as in patient on/off loading.

The intent of this paper is simple: provide a comprehensive review of the AE shortfall issue from beginning to the present with recommendations and conclusions for the near future. This paper shall accomplish this by following the strategic decision-making tenets proposed by Charles Schwenk in his book, The Essence of Strategic Decision Making.

The paper will begin with historical background and a system description, then proceed to a problem statement, followed by a more in-depth discussion of the main problems, succeeded by recommendations and conclusions, then ending with a summary. Throughout this paper the intent will be to observe Schwenk's strongest recommendation for achieving a superior strategic decision: challenge assumptions and consider a full range of alternatives. To some extent this involves taking his "devil's advocate" approach.

This issue is complex and dynamic. Complexity is evident in the numerous elements involved, such as budget constraints, reduction in forces, changing doctrine, Major Regional Conflict (MRC) scenarios, casualty rates, theater beds, computer modeling, organic airlift assets, civil airlift assets, profit margins, and more. All of these elements interact and evolve in a dynamic environment. Consequently there is no one magical answer that will resolve the AE shortfall issue for all time. Instead, the result is time-phased solutions that change--today's answer is different tomorrow.

II. Historical Background

Aeromedical Evacuation began as early as 1870 when soldiers who had been wounded in the siege of Paris were airlifted out by balloon (Thomas, 1985:8). In 1912 two officers, Capt. George Gosman and Lt. Albert Rhoades, recommended that wounded soldiers who needed immediate surgery be transported by airplane from the battlefield to the hospital. Because airplane development was in its infancy at the time, their idea was resoundly rejected. (The Baltimore Sun ridiculed the idea: "The hazard of being severely wounded was sufficient without the additional hazard of transportation by airplane" (Davis, 1986:19).) The two young men were undaunted and, using their own funds, built the world's first ambulance plane. Unfortunately, during the airplane's trial run it ruptured an oil line and crashed. Nevertheless, the concept of using aircraft for aeromedical evacuation was born.

The first use of a U.S. airplane as an air ambulance occurred in 1918 in response to accidents while training pilots for World War I. A JN-4 Jenny biplane was converted into an air evacuation vehicle by removing the rear cockpit and fitting an Army stretcher into the space (Davis, 1986:20). However, aeromedical evacuation by the U.S. during WWI was never developed and its use was negligible.

The first large-scale use of aircraft for air evacuation occurred during WWII (Thomas, 1985:8). The War Department approved an air evacuation program on June 18, 1942, and charged the Army Air Force to develop and operate this service (Davis, 1986:20). In

WWII from 1942 to 1945, using C-46, C-47, and C-54 aircraft, over 1.3 million patients were transported by air evacuation; however, there was no standardized system in any theater. In 1947 the Military Air Transport Service (MATS) was formed and part of its initial mission statement directed that it was responsible for providing aeromedical airlift for the military services outside a battle zone. By 1949 the official policy of the Department of Defense was that all long-distance moves of military patients were to be by airlift (Thomas, 1985:8).

The Korean Conflict further reinforced the necessity of air evacuation and produced a stronger concept of operations. A restatement of the MATS mission in 1953 designated air evacuation a major function and no longer a corollary task to the delivery of personnel and cargo (Davis, 1986:21). The C-131A came on line in 1954 with an air evacuation role; it was the first fully pressurized twin-engine transport in the Air Force and could accommodate 27 litter patients or 40 ambulatory patients, or a combination of both. The arrival of the C-141 in 1966 revolutionized intercontinental air evacuation by incorporating high speed, long range, jet transport with patient movement.

The Vietnam War placed heavy demands on the aeromedical evacuation system and produced two distinct systems in the Pacific theater to evacuate casualties: a tactical system within the combat zone and a strategic system for the remainder of the Pacific area. The aeromedical evacuation doctrine established during the Vietnam War has been the primary strategy over the last 30 years and, to a large extent, remains in effect today.

In the late 1970s a "Nifty Nugget" Exercise highlighted a serious shortfall in long-range strategic air evacuation capability in wartime. This produced a Joint Chiefs of Staff (JCS) tasking to consider expanding the CRAF program to include aeromedical evacuation. The Air Force, Military Airlift Command (MAC, now AMC), and the Army worked closely together through the early 1980s to develop the CRAF AE concept. By the mid-1980s the foundation had been set:

On November 17, 1985, CINCMAC (now CINCAMC) proposed to the Secretary of the Air Force that a segment of the CRAF be dedicated to aeromedical evacuation of casualties to and within CONUS. On March 12, 1986, the Office of Emergency Transportation within the Department of Transportation approved the inclusion of aeromedical evacuation in any future Memoranda of Understanding on the CRAF. On May 28, 1986, the Office of the Secretary of the Air Force, acting as the Department of Defense (DOD) single manager for airlift, approved the aeromedical evacuation segment of the CRAF. (Bouchard, 6 December 1994:1)

Thus the aeromedical evacuation segment of the Civil Reserve Air Fleet was born. From the "Nifty Nugget" Exercise in the late 1970s up to 1986, the JCS, the Air Force, the Army, and MAC studied and developed the concept of CRAF AE. They began by analyzing war plans and aircraft availability. This analysis revealed that as the scope of warfare increased the U.S. lacked sufficient strategic airlift to meet all of its needs, one of those being aeromedical evacuation. MAC, faced with the prospect of either buying more aircraft or, perhaps, expanding the CRAF, investigated the CRAF AE option. A July 1985 research study, The Use of the Civil Reserve Air Fleet in Evacuation of Battlefield Casualties--An Evaluation, conducted under a contract with the USAF School of

Aerospace Medicine, specifically examined using CRAF in an AE role and soundly confirmed the idea:

In an attempt to bring some relief to the strategic military aeromedical evacuation system, the suggestion has been made that aircraft belonging to the Civil Reserve Air Fleet (CRAF) could be used. The potential for utilization of the CRAF for medevac is excellent, due to the size and composition of the fleet. With 323 airplanes in the long-range international part of CRAF, all of the wartime troop deployment and medevac demands could be met, and the ability of the strategic airlift system to handle large and oversized cargo would thus be increased. (Thomas, 1985:i)

Following this report in late 1985, Boeing, at MAC's request, provided the Air Force with a study on the feasibility of converting B-767 aircraft to the AE role (Morrocco, 1986:55). Thus armed with years of analysis and study, in November 1985 General Duane Cassidy, CINCMAC, proposed to the Secretary of the Air Force to use CRAF for aeromedical evacuation. In March 1986 General Cassidy stated in congressional testimony that by forming a new CRAF segment devoted to AE "we can meet wartime aeromedical needs without procurement of additional aircraft" (Morrocco, 1986:55). With congressional support in place, in May 1986 the Secretary of the Air Force gave his stamp of approval.

The initial concept was simple and straightforward and still underlies the program today. The overall objective was threefold: 1) convert CRAF aircraft, 2) develop and produce conversion sets with 30-year life spans, and 3) perform aeromedical evacuation in time of national emergency or war. Likewise the payoff was threefold: 1) secure a dedicated strategic aeromedical evacuation fleet at a fraction of the cost of acquisition of airframes, 2) free the C-141 and other organic airlift to concentrate on transporting war

materiel, and 3) use the CRAF AE aircraft to transport medical personnel, supplies, and equipment back to the theater (Dow, 1 March 1995:3). The original CRAF AE plan included 85 B-767s and 30 MD-80s (North, 1986:37; Stanley, 1988:2). The B-767s were for strategic, intercontinental airlift to alleviate the workload on the C-141, and the MD-80s were for a CONUS redistribution network to alleviate the workload for C-9s and free that aircraft to assist C-130s in tactical, intratheater airlift (Famiglietti, 1986:3). In addition to the aircraft, the CRAF AE plan called for development of the necessary medical equipment to fit on board the planes. The Air Force Surgeon General Office (USAF/SG) at Brooks Air Force Base, Texas, was put in charge of providing the funding for the CRAF AE program and coordinating the medical requirements with specific equipment needs (North, 1986:37).

After conducting R&D during 1986, in June 1987 the USAF/SG released a Request for Proposal (RFP) for development of the onboard medical equipment. Four production options were proposed: 1) 34 B-767 aeromedical evacuation shipsets (AESS), 2) 60 B-767 AESS, 3) 33 MD-80 shipsets, or 4) 94 B-767 AESS. Operational requirements for these numbers came from HQ MAC (HSC/YAM, 14 July 1995:1). Each shipset would consist of three modules: a patient transport system (PTS) capable of supporting 111 or 87 litters, an aeromedical operations system (AOS), and a medical oxygen system (MOS).

After minor delays and extensions, a contract was awarded by the Surgeon General's Human Systems Center on August 2, 1988, to E-Systems, Inc., of Greenville, Texas, to

design and produce Production Option (PO) #1--34 Aeromedical Evacuation Shipsets. The initial plan was for E-Systems to have equipment ready for Initial Operational Test and Evaluation (IOT&E) by September 1989, then achieve Initial Operational Capability (IOC) by September 1990 with Full Operational Capability (FOC) by September 1991 (Stanley, 1988:3). Unfortunately the design and production process did not progress that rapidly. By 1990 E-Systems was just beginning the production process. The onset of the Gulf War in 1990-1991 prompted AMC to issue an immediate requirement for 10 shipsets for B-767 strategic aeromedical evacuation. E-Systems was not "sufficiently mature in production to meet operational needs in time," so an "undefinitized contract action (UCA)" was initiated for accelerated delivery of ten shipsets (HSC/YAM, 14 July 1995:1). Operation Desert Storm ended before E-Systems completed the production of these ten sets, but AMC used them for an accelerated Initial Operational Test & Evaluation in March 1991. AMC went on to accept the ten shipsets from the "undefinitized contract action" and pursue the 34 sets from the original contract; thus AMC was now going to obtain a total of 44 AEES.

Also during 1991 the MD-80 concept was running into a brick wall as it was hopelessly stalled due to Federal Aviation Administration (FAA) regulatory obstacles (HSC/YAM, 14 July 1995:2). The FAA would not allow liquid oxygen (LOX) on the passenger deck and the MD-80 cargo bay was not big enough to hold a LOX pallet. Consequently in 1991 the MD-80 portion of CRAF AE was canceled. Re-analysis indicated

that the CONUS redistribution could be satisfied with C-9s, C-130s, and mission extension of the B-767s (Nailling, 22 December 1995:1).

From 1991 to the present the CRAF AE program with B-767 aircraft and AESS equipment has progressed unevenly. The following are the major items that have occurred over the last five years and confront the program today.

First and foremost, the requirement for B-767s has changed from 85 total to 25 in CRAF Stage II and 44 in CRAF Stage III. (CRAF Stage II is a national security crisis short of a declared defense-oriented emergency. Stage II requirements are based upon worst case single MRC peak patient movement requirements (Jernigan, 3 November 1995:1). CRAF Stage III is a war or defense-oriented national emergency. Stage III requirements are based upon dual MRC patient movement requirements (Jernigan, 3 November 1995:1).) Though the requisite number of airframes has changed, a validated requirement has not been accurately determined and is a special interest item today. All decisions hinge on a validated requirement. In order to make sound decisions, commit funds wisely, and adapt aircraft and equipment appropriately, a validated requirement is absolutely necessary up front. It must be emphasized that for aeromedical evacuation precise calculation of a validated requirement is very difficult due to the span and complexity of the issue, assumptions made, scenarios posed, forecasts used, and numerous other variables. Nonetheless a detailed effort must be made to specify a probable range of aircraft required. Then this requirement must be regularly reviewed and updated.

Otherwise as long as the requirement remains tentative and uncertain it will be difficult to make good decisions.

Changes in the world political situation, downsizing of the entire U.S. military, and budget constraints have brought about significant changes in deployment of forces and doctrine. For example, no longer is there extensive pre-positioned medical facilities, personnel, and equipment. In addition, depending on scenarios, aircraft availability, and the need for force sustainment, when a conflict arises military planners anticipate cutting *back* the forward deployment of medical forces. In place of a heavy forward-deployed medical footprint there is a change in doctrine from one of moving *stable* patients to one of transporting *stabilized* patients receiving care in the air (Hoffman, 17 March 1995:3). This doctrinal change will impact CRAF AE airlift requirements by demanding more of the system.

Today the C-141 provides a significant amount of AE capability that is factored into calculation of the requirement for CRAF AE airlift. By 2006 all C-141s are to be retired from service. As the C-141 retires it is being replaced by the C-17. Regrettably the C-17 does not provide as much AE capability as the C-141. Thus over the next 10 years less organic capability will be available which will also impact the required number of CRAF AE aircraft.

The CRAF AE program never has achieved full commitment by the civilian airline companies. AMC has stated a requirement for 25/44 CRAF AE B-767s, yet currently only three airlines have committed 19 aircraft to the program. In addition, of these 19

only four are fully certified by the FAA. Unfortunately proposals to boost airline participation in the CRAF AE program have produced little to no results. Fortunately projects are underway to get the 19 aircraft committed to the program fully certified.

Increased commitment by the airlines is stalled on one account due to configuration problems in the main cabin and the cargo bays. The configuration problem has many ramifications: 1) all airlines are rethinking their commitments, 2) the number of litters per aircraft may have to be reduced, and 3) two complementary problems--AESS pin corrosion and Follow-On Test and Evaluation delay--cannot be resolved until the configuration problem is overcome.

Due to the interior configuration problems the requirement for 111 or 87 litters per aircraft is being reviewed. Current direction states 87 litters preferred, 84 minimum (Ledden, 16 October 1995:1). An extensive analysis of the different B-767 interior configurations is underway and may result in even lower litters per aircraft.

As for the AESS equipment, all 44 shipsets have been produced and are in storage, thus "Full Operational Capability" (FOC) was declared in July 1995 (Nailling, 1 September 1995: 2). But never have all 44 shipsets been fully available, ready-for-immediate-use. The AESS have been beset by numerous problems. As of February 1996 the status of the AESS is:

- only 19 shipsets are available with functional special electrical connectors;
- only 24 shipsets are available with no shelf-life problems;

- only 34 shipsets have all 111 litters per set available due to pin corrosion problems;
- and
- only 39 shipsets are available with functional Liquid Oxygen Sub-System (LOSS) units.

The Casualty Transfer System (CTS) is a continuing weakness in the overall system. The 1991 Initial Operational Test and Evaluation (IOT&E) identified the Casualty Transfer System--the ground support equipment used to transfer patients from ambulance buses to the aircraft and vice versa--as having "significant limitations" (Werner, November 1994:1). These limitations are: the CTS provides no electrical or oxygen support, the entire process is very time-consuming, and there are only six units in existence to supply worldwide coverage. This problem exists today largely unchanged from its status five years ago.

A Follow-On Operational Test and Evaluation (FOT&E) has never been conducted. In addition, no actual, operational aeromedical flight of the B-767 has ever been made. Thus the system is largely untried. With only one test flight of the system--that being the IOT&E five years ago conducted with numerous simulations and limitations--there could be a very rude awakening to the shortcomings of the system the first time it is used for real. With stabilized care being performed, and potentially lives hanging in the balance, that does not seem like the time to figure out system needs by trial-&-error. The IOT&E strongly recommended an eventual FOT&E. Unfortunately resolution of the FOT&E problem (and the pin corrosion problem) is dependent on resolution of the interior con-

figuration problem. The interior configuration must be established first in order to conduct the FOT&E.

The information above summarizes the recent events over the last five years in the CRAF AE program. CRAF AE is the culmination of a long history of aeromedical evacuation. AE has progressed from minor beginnings to a major consideration of our defense capability and doctrine. The CRAF AE program is a bona fide element of our national defense, but it is still developing and adjusting. Unfortunately in its 10 years of existence it has been beleaguered by problems which have continually kept capability low. As it stands today, the CRAF AE program is partially on-line and personnel are working hard to fully determine and meet AMC requirements.

III. System Description

Reviewing the historical background of the CRAF AE program sets the stage for the reader on the origins of the project and its current status. To further assist the reader in understanding the CRAF AE program, it is appropriate to define, or describe, the specifics of the CRAF AE system. The CRAF Aeromedical Evacuation system involves commercial B-767 aircraft, Aeromedical Evacuation Shipsets (AESS), a Casualty Transfer System, and a large number of support personnel and equipment.

The B-767/AESS portion of the CRAF AE system is multifaceted. To begin with, since these are commercial aircraft the entire system must be reviewed and approved by the FAA and attain an FAA Supplemental Type Certificate (STC). The FAA has approved operation of the B-767 for wartime (or national emergency) AE airlift but, due to emergency egress concerns, has not approved operation of the B-767 for peacetime AE airlift (Miller, 1993:1). The B-767 would be activated for CRAF AE only in national security crises Stage II or III. The B-767 provides only strategic AE airlift from major international airfields capable of receiving and operating wide-body aircraft. It is at these hubs that the B-767s will interact with the theater AE airlift system represented by C-130s, C-9s, helicopters, etc.

Upon CRAF Stage II or III activation and call-up, airline companies will convert B-767-200 or B-767-300 aircraft to a baseline configuration, i.e., they will remove nearly all seats and some internal structures, such as closets, lavatories, and galleys. The airlines

have 48 hours to complete the baseline configuration and deliver the first aircraft to E-Systems in Greenville, Texas. (The airlines are to deliver succeeding baselined aircraft every 12th hour thereafter.) When the aircraft arrives in Texas, E-Systems has 12 hours to install the AESS equipment.

The AESS consists of three modules: 1) the patient transport system (PTS), 2) the aeromedical operations system (AOS), and 3) the medical oxygen system (MOS). All of the systems fit into the B-767 without any permanent modification required on the aircraft. The PTS includes a single and double litter stanchion system. When combined with aircraft seating the system can accommodate 111 litters and 18 ambulatory patients or 87 litters and 52 ambulatory patients (ambulatory seating will vary depending on the version of B-767). The litter stanchion system fits into the airframe seat tracks; the single stanchions line the sides of the aircraft and the double stanchions run down the center. The AOS includes nurse work stations and the electrical power distribution system needed to provide power for medical equipment in the main cabin. The MOS consists of a liquid oxygen storage system and the oxygen distribution system necessary to provide therapeutic oxygen to the patients.

The AESS has been designated War Reserve Materiel (WRM) and as such is critical in nature. The contractor is responsible for maintaining the AESS in a constant state of operational readiness (Werner, November 1994:4)

If all goes as planned the first aircraft will be completely converted and available for service within 60 hours of call-up; succeeding aircraft should be available every 12th

hour thereafter. The reconfigured aircraft will likely proceed to a CONUS airfield to on-load medical personnel, supplies, and equipment, then proceed to a major airfield in the theater of operations, followed by return flight to the CONUS with patients. Patient on/off loading will occur via a Casualty Transfer System (CTS) or airfield jetway with the assistance of pre-positioned Aeromedical Staging Facility (ASF) personnel. Upon return to the CONUS the aircraft can land wherever patient support is most expedient, whether that might be military or civilian fields (which must be CTS or jetway capable) and whether they are located on the coast or farther inland. After offload the aircraft will be serviced for fuel, oxygen, maintenance, food, and any other requirements, then turn to another mission. The aircraft can backhaul to the theater medical personnel, supplies, and equipment. The duration of B-767 use will depend on when organic airlift, e.g., C-141s or C-17s, will be freed from their sustainment missions and be available for aeromedical missions.

The aircraft is operated by civilian pilots and flight attendants with military medical crews managing the patients. Operational control of the aircraft stays with the civilian airline company but mission control is with the Global Patient Movement Requirements Center (GPMRC), which works with the Tanker Airlift Control Center (TACC) on route structure. The major participants in the CRAF AE program are:

- AMC/SG: AMC Surgeon General; primary customer; provides inputs for requirements analysis and funding;

- AFMC/HSC: Air Force Materiel Command Human Systems Center; the System Program Office (SPO); manages modification of the systems;
- E-Systems, Inc.: authorized contractor; produces the AECS system; maintains FAA-approved Supplemental Type Certificate (STC); conducts required maintenance and inspections; installs and removes the AECS system;
- AMC/DOF: AMC office in charge of managing the entire Civil Reserve Air Fleet program;
- AMC/DOK: AMC office overseeing all contracts;
- AMC/XP: AMC office overseeing plans and requirements;
- AMC/TE: AMC office in charge of all test and evaluation plans;
- USTRANSCOM: single manager for all DOD transportation needs, specific offices greatly involved are SG and J5;
- airline companies: participate in CRAF and provide civilian aircraft and crews;
- Cadillac Corporation: producers of the Casualty Transfer System; and
- FAA: oversees and certifies all commercial airline operations.

IV. Problem Statement

The main problems with USAF CRAF Aeromedical Evacuation span four dimensions: 1) lack of a validated requirement, 2) low B-767 commitment, 3) low capability of present B-767/AESS resources on-hand, and 4) other CRAF AE system weaknesses, e.g., lack of a viable Casualty Transfer System.

V. Discussion of the Main Problems

1) Lack of a Validated Requirement

As USAF personnel try to generate the most advanced aeromedical evacuation system in the world the most frequently asked question is, "What is the requirement?" All decisions hinge on the requirement. Does AMC really need 44 B-767s and 44 shipsets capable of yielding 111 litters per set? Can AMC accomplish the CRAF Aeromedical Evacuation mission with lower resources? Or does AMC need greater resources? What organic resources does AMC need? The answer to all these questions is, "It depends."

Determination of a validated requirement for CRAF Aeromedical Evacuation depends on a large number of variables and a changing environment. To validate the requirement involves many independent, uncontrollable variables, such as MRC scenarios, battlefield actions and results, projected casualty rates, theater beds available, doctrine and forward-deployed medical footprint, stabilized versus stable patient care, litter versus ambulatory patients expected per aircraft, organic airlift availability and capability, CRAF airlift capability, shipset availability, airfield availability, flight times, ground times, maximum-on-ground (MOG) limitations, crew duty day limitations, and more. Furthermore many of these variables are changing and evolving. Obviously, determining the requirement is easier said than done. The analysis is complex, time-consuming, and difficult to accomplish. Nonetheless effort must be undertaken to determine a validated requirement because that, in turn, determines expenditure of resources which, in turn,

determines capability. Before AMC expends precious and constrained resources to pursue AE capability, AMC must have as definite a statement of requirement as possible.

A short review of the recent history of the stated requirements for CRAF AE airframes demonstrates how difficult it has been to validate a requirement.

From 1986 to 1991 AMC stated a CRAF AE requirement for 23 B-767s in Stage II and 85 B-767s and 30 MD-80s in Stage III (Stanley, 20 September, 1988:2). In early 1991 the MD-80 requirement was canceled. Also in 1991 the B-767 requirement was changed to 25 in Stage II and 44 in Stage III. The aircraft requirement was cut more than half--a significant reduction.

In March 1994 AMC/XPY, working in coordination with AMC/SGXP, conducted an "Analysis of AE CRAF Required Airframes." The analysis used SGXP inputs as a baseline along with many assumptions, e.g., worst case demand, worst case routing, six hour B-767 ground time, etc. The study examined 10-day increments of a nearly simultaneous double MRC. The summary of the analysis stipulated "33 airframes [B-767 only] are required to ensure enough airplanes are available for daily patient transportation..." (Schinelli, 1 March 1994:1).

By November 1994, XPY, now working in conjunction with SGXP, XOC, and XOX, had increased the maximum requirement to 37 airframes (Schinelli, 17 November 1994:1) Capt Schinelli in XPY specified "this is a 90% solution, meaning that there is variance in the answer depending on which assumptions are violated."

In January 1995 SGXP stated that using the most current assumptions and data "37 CRAF AE B-767 aircraft are required if also using retrograde C-141s; using CRAF AE only, 51 B-767s are required" (Bouchard, 5 January 1995:1).

In March 1995 Capt Greedan, USN, working in the SG office for USTRANSCOM (TCSG), stated in response to queries on CRAF aeromedical requirements:

Subject study you requested results on was conducted by AMC/SG in concert with AMC planners and operators. Although it appears that there may be some new numbers (slightly lower requirement) I am not sure whether AMC is ready to formally endorse them as the new requirement. Additional discussions need to be held between AMC med planners and ops planners. ... Will work with AMC/SG to provide you with latest numbers as soon as they are ready to stand up to them. As for now numbers remain as before Stage II - 25 Stage III - 44. (Greedan, 10 March 1995:1)

Following this communication, on March 23, 1995, TCSG distributed a memorandum restating an aeromedical requirement of 25 airframes (Stage II) and 44 airframes (Stage III). On May 22, 1995, USTRANSCOM/J5 (TCJ5) used the information from this memorandum to report CRAF AE requirements to the Joint Staff J4 office. However that same day a separate office in USTRANSCOM "input to the Joint Monthly Readiness Review ... aeromedical requirements of 31 airframes (Stage II) and 41 airframes (Stage III)," which were "... apparently the result of AMC analysis reflecting uncertainty of casualty assumptions" (Weber, 31 May 1995:1). The inconsistency between the two reports was the result of work-in-progress by TCSG reevaluating the CRAF AE requirement. By June 1995 TCSG and TCJ5 had resolved the inconsistency between the Joint Staff input and the Joint Monthly Readiness Review input--the agreed-upon requirement was 25 airframes Stage II and 44 airframes Stage III. TCSG went on to indicate "new

casualty numbers are being evaluated and analyzed; any changes to the CRAF requirement will not be made until all theater requirements are known" (Jernigan, 12 June 1995:1).

In November 1995 TCSG released a memorandum with revised CRAF AE requirements. They proposed 32 B-767 equivalents in Stage II and 41 B-767 equivalents in Stage III (Jernigan, 3 November 1995:1). The memorandum stipulated:

CRAF requirements as stated are based upon current unified command casualty estimates and, as estimates are modified, revisions may be necessary. An AE CRAF requirements review should occur at least annually. (Jernigan, 3 November 1995:1)

The memorandum was not formally endorsed by AMC or USTRANSCOM. Consequently at this time the CRAF Aeromedical Evacuation requirement remains 25 B-767s in Stage II and 44 B-767s in Stage III.

As you can see the calculation of a validated requirement is difficult and results have fluctuated broadly. It is interesting to note that--depending on the scenario and assumptions--at one time or another over the past five years the literature has shown requirements of 13, 16, 19, 23, 25, 26, 29, 31, 32, 33, 35, 37, 38, 41, 44, 51, 85, or 115 CRAF AE airframes.

Presently USTRANSCOM and AMC are still wrestling with trying to determine and state a validated requirement. "Validate" is defined as:

Execution procedure used by CINC components, supporting CINCs, and providing organizations to confirm to the supported CINC and USTRANSCOM that all the information records in a TPFDD not only are error-free for automation purposes but also accurately reflect the current status, attributes, and availability of units and requirements. Unit readiness, movement dates, passengers, and cargo

details should be confirmed with the unit before validation occurs (Joint Pub 5-03.1). (NDU, 1993:I-45)

TPFDD stands for time-phased force deployment data and is defined as:

The Joint Operation Planning and Execution System (JOPES) database portion of an operation plan; it contains time-phased force data, non-unit-related cargo and personnel data, and movement data for the operation plan, including the following:

- In-place units,
- Units to be deployed to support the operation plan with a priority indicating the desired sequence for their arrival at the port of debarkation,
- Routing of forces to be deployed,
- Movement data associated with deploying forces, and
- Estimates of non-unit-related cargo and personnel movements to be conducted concurrently with the deployment of forces (Joint Pub 5-03.1). (NDU, 1993:I-42)

Essentially today there are two main obstacles in determining a CRAF AE validated requirement: 1) lack of dual MRC time-phased force deployment data, and 2) inaccuracy in casualty estimation. In addition, changes in doctrine and strategy toward stabilized care in the air have a significant impact as well.

A major problem in the requirements determination process for CRAF AE is the lack of dual MRC Time-Phased Force Deployment Data (TPFDD). The DOD has single TPFDDs for single MRCs, but it has not constructed a dual TPFDD for a dual MRC. Consequently AMC can use the single MRC TPFDDs to derive a Stage II requirement but AMC has no dual MRC TPFDD to derive a Stage III requirement. Presently the best that can be done to derive a Stage III requirement is to sum the single MRC TPFDDs together. This process is frequently cited as inaccurate; TCSG has stated that the

"summed" single MRC s contributes to the overstatement of evacuee patient requirements (Jernigan, February 1996:14).

Two points should be noted about TPFDDs. First, though they are constructed in great detail, they are not flawless. Thus even though AMC has single MRC TPFDDs there is debate about the Stage II requirement, and even when AMC uses a dual MRC TPFDD there will be debate about the Stage III requirement. Second, TPFDDs are just one piece of the requirement puzzle. Other pieces of the puzzle, such as casualty estimation, are independent variables and can change significantly thereby effecting the overall results. The reader should recognize that just because AMC acquires a dual TPFDD does not mean the requirement problems are solved. Nonetheless acquiring and using a dual TPFDD will reduce the controversy surrounding the inaccuracy of the present calculation method, though it will not in and of itself guarantee an exact determination of the requirement.

A second problem in the requirements determination of CRAF AE involves casualty estimation. The Joint Staff J4 Medical Readiness Division recently distributed wartime medical requirements which concluded "planning and resourcing for casualty care for future conflicts is considerably higher than for WW II and subsequent conflicts" (Joint Staff J4, 9 February 1996:2). Though the J4 study shows a significant reduction in wounded-in-action (WIA) rates and disease, non-battle-injury (DNBI) rates progressing from WW II to Korea to Vietnam to Operation Desert Shield/Storm, they postulate WIA and DNBI rates for a future single MRC *as high or higher* than the rates incurred in WW

II, and WIA/DNBI rates for a future dual MRC *two to three times higher* than the rates in WW II.

There is considerable belief that such casualty estimation is too high. TCSG has explained how casualties are determined:

Determination of battle and nonbattle casualties at the Unified Command level relies upon the Medical Planning Module (MPM) within the Joint Operational Planning and Execution System (JOPES). Its primary role is as a gross casualty estimator and the output data helps determine the medical force structure required to support a contingency operation. (Jernigan, 11 July 1995:2)

The DOD Medical Readiness Strategic Plan 1995 - 2001 describes the MPM in more detail:

The JOPES MPM is the only approved, standardized system used by the Services, the Unified Commands, and the Joint Staff to predict wartime medical care requirements. ... The MPM is directly linked to the major operational plans Time Phased Force Deployment Data (TPFDD).

The TPFDD provides the most accurate data on the U.S. force Population At Risk (PAR). The MPM provides user defined data on the number and type of "critical" physician, and nurse specialty care requirements. It computes bed requirements, blood, evacuee, and other logistic lift requirements. The MPM is primarily used by the Unified and Service component commands to aid in developing the medical annex of their OPLANs. The Joint Staff employs the MPM during OPLAN review, special studies, and during the Chairman's Program Assessment. (DOD, 20 March 1995:16)

TCSG has stated that the MPM overestimates AE theater casualty evacuee requirements (Jernigan, February 1996:14). They explained in detail the shortcomings of the MPM:

The JOPES MPM has not been used for a hostility for which a statistical validation or comparison between MPM estimated casualties and actual casualties has been made. Contingency operations since MPM's initial use in the early 1970s have been small unit actions; units smaller than a division which are not easily applied to MPM's classical design structure of conventional European defensive

warfare against a first class opponent. Furthermore, MPM does not account for the degree of success or failure in an operation nor does it account for lulls in OPTEMPO. MPM logic concedes if combat intensity is high, operational units will experience high casualty rates. This is not true during successful offensive, defensive, counterattack and exploitation operations. Such was the case in Operations Desert Shield/Desert Storm (DS/DS). Another problem with MPM is it uniformly applies intensity rates across the Corps battlefield sector. It is both unlikely and improbable that a Corps maneuver unit has the ability to uniformly apply intensity across the width and depth of its Area of Operations (AO). (Jernigan, 13 July 1995:1)

The DOD Medical Readiness Strategic Plan 1995 - 2001 has also found fault with the MPM:

While the JOPES MPM is the existing tool for determining wartime health services requirements, more accurate and up-to-date casualty rates are needed to generate valid wartime health services requirements. Currently, there have been difficulties in obtaining needed rates, or agreeing on the comparability of rates from different sources, as the operational situations they are being applied to are ill defined, and the rate categories used cannot be linked more directly to medical records. (DOD, 20 March 1995:17)

This DOD plan highlighted additional shortcomings of the MPM:

The MPM is the only standardized tool used to determine wartime health services requirements. ... Major improvements are needed, including capabilities to accommodate multiple scenarios and force changes - and current, validated and integrated casualty rate figures. (DOD, 20 March 1995:3)

The present MPM system does not accommodate force changes within operational zones (OPZONES). (DOD, 20 March 1995:16)

The MPM ... is the primary computer tool used today by medical planners. It dates from the 1970s and has many limitations which hinder its effectiveness, such as the inability to project casualties from Nuclear, Biological, and Chemical (NBC) warfare. Replacing the MPM with a more modern planning tool is a top priority. (DOD, 20 March 1995:14)

It is important to note that MPM computations are limited to the echelon 3 (Combat Zone), echelon 4 (COMMZ), and echelon 5 (CONUS) wartime requirements. Echelons 1 and 2 are based on Service force structure requirements. ... The Services employ "Service specific" planning factors in the MPM to compute bed requirements in support of POM (Program Objective Memorandums) develop-

ment. The dissimilarities in Service rates, rate development techniques, rate application methods, and the lack of any DOD or Service specific NBC casualty rates have prompted serious questions throughout the planning and analysis communities. (DOD, 20 March 1995:16-17)

The lack of a dual TPFDD and the inaccuracies of the MPM are not the only variables that have significant impact on the requirements determination process; a third and final variable that also has an important effect on this process is changes in doctrine. Actually there is more to it than just changes in doctrine. Changes in the world situation and budget constraints have led to downsizing and streamlining, which have led to changes in doctrine and strategy. For the strategic aeromedical evacuation community, changes in doctrine mean there is a significant transition underway from stable patient care to stabilized care in the air:

Identification and quantification of the new requirement (stabilized versus stable patient) and establishing an enhanced AE critical care capability to supplant our reduced theater wartime medical footprint is at the very core of the challenge. The evolving fixed-wing AE doctrine, *transporting stabilized versus stable patients*, will impact medical force structure and increase AE lift requirements. (Howard, 1995:1)

Current doctrine and strategy is moving toward a reduced forward-deployed medical footprint, consequently battlefield casualties will no longer be "treated and returned to duty," instead they will be "evacuated and replaced" (Hoffman, 17 March 1995:3). This doctrine directly impacts strategic aeromedical evacuation capability. Gradually the DOD and USAF is shifting from the current system of providing stable care during AE transport to a more in-depth system of providing stabilized care during AE transport. Stabilized care will require inflight medical capability for critically injured or ill, high

dependency patients at peak casualty levels as they are transported to definitive care facilities (HSC/PKRH, 27 October 1995:1). It is anticipated that patients will move from the operating room to the aircraft; thus inflight patient care will require more room as well as advanced technological equipment and more in-depth personal attention (Woodruff, 31 March 1995:2).

A direct example of the impact of these changes in doctrine is the situation surrounding the C-17 AE capability. When the C-17 was in the developmental stage, the AE capability portion was designed to meet the specifications at the time which included a minimum of 16" spacing between litter tiers. Consequently the C-17 litter stanchions were designed as a 4-tier configuration with 16" spacing between litters. On June 20, 1988, HQ MAC/SGROV concurred with this specification in the Critical Design Review (Woodruff, 31 March 1995:1). On January 4, 1995, however, AMC/SG briefed the AMC/CC that new AE doctrine--stabilized patient care--required 18" minimum spacing between litters and was soon increasing to 21" minimum spacing (Woodruff, 31 March 1995:2). This, obviously, necessitated a redesign of the C-17 litter configuration. The cost to field this litter redesign is \$67 million (assuming a FY96 start) (Woodruff, 12 February 1996:1). It is interesting to note that the current status of the C-17 aeromedical evacuation capability brings the entire issue of the lack of a validated requirement full circle:

The Systems Program Office is working on interim and long-term corrections to AE deficiencies. However, the C-17 AE requirement must be determined before a long-term solution can be fielded. Procurement of additional litter stations by the SG before a C-17 AE requirement is firmly established could be premature. Acquisition of additional litters will begin at once when a firm C-17 requirement is

determined. Purchasing extra litter stations at \$50K each (\$450K for each ship-set) could be a costly mistake. (Woodruff, February 1996:1)

Quantitative analysis of CRAF AE to determine a validated requirement is difficult. It involves a myriad of variables in a constantly changing environment. Currently two obstacles stand out: lack of a dual MRC TPFDD and questionable casualty estimation. Changes in doctrine and strategy toward stabilized care are having a major impact also. Improvements in assessing and incorporating these three variables will go a long way to determining an accurate validated requirement.

2) Low B-767 Commitment

With a stated requirement for 25 B-767s in CRAF Stage II and 44 B-767s in CRAF Stage III yet only 19 aircraft committed, obviously there is a problem with low B-767 commitment. Furthermore, at no time has AMC *ever* had full commitment to the CRAF AE program. Low B-767 commitment is a chronic problem in the CRAF AE program.

Though commitment to CRAF AE is low, it is not due to a lack of airframes. As of January 1995 there were 187 B-767s in use among U.S. airline companies. Table 1 summarizes by airline the total number of B-767 aircraft, CRAF commitments, and percentage of fleet committed. As you can see, of the 187 B-767s, 24 were committed to the CRAF passenger segment and 19 were committed to the CRAF AE segment. The two airlines with no commitment to CRAF AE are American and United (though American does have the sole commitment to the passenger segment, and a large one at that). Only

10% of the entire U.S. B-767 fleet is committed to CRAF AE. AMC's Stage III requirement amounts to a 24% commitment.

TABLE 1
AIRLINE NUMBERS OF B-767S AND COMMITMENT TO CRAF

Airline	B-767s	CRAF Passenger Segment	CRAF AE Segment	CRAF Total	%age of fleet committed to CRAF
American	67	24	0	24	36
Delta	55	0	12	12	22
TWA	14	0	4	4	29
United	42	0	0	0	0
USAir	9	0	3	3	33
Totals	187	24	19	43	13 Pax/10 AE

(Information source: Aviation Daily, 4 January 1995: 13-14).

There are a number of factors that explain why the airline companies are reluctant to commit B-767s to the CRAF AE program. The principal reason for low CRAF AE commitment is that the B-767 airframe is "very profitable for carrying commercial passengers" (Heisel, 5 January 1995:1). "The B-767 is a very dependable money-maker for the airline industry; therefore unless adequate incentives/compensation is discovered, AMC cannot expect additional B-767s in the AE program" (Heisel, 3 October 1995:3). The airlines realize significant profits from the B-767 and are very hesitant to relinquish or jeopardize that, even though they are compensated for CRAF participation with shares of AMC's peacetime business. When a B-767 is committed to CRAF and activated for a crisis, an airline suffers in three ways: 1) that particular airframe is no longer bringing in profits, 2) the airline sacrifices profit margins by using less efficient airframes in place of

the B-767s, and 3) the airline sacrifices market share as other firms move in on their routes.

Another factor that dovetails with the profitability of the B-767 is the lack of significant incentives to encourage participation in CRAF AE. Airlines that participate in CRAF are rewarded with shares of AMC's peacetime airlift business and compensation for that work. Those that participate in CRAF AE are further rewarded with no Stage I requirement, double mobilization value points, which leads directly to greater government business, and guaranteed minimum daily compensation (Porter, 3 October 1995:10). Though these may appear to be strong additional incentives, they have not produced more commitments nor alleviated the chronic low commitment problem.

A third factor that explains low CRAF AE commitment is the airframe configuration problem. Though installing the AESS does not require any permanent modification on the aircraft, it does require baselining the interior of the airframe, i.e., removing nearly all seats and some closets, lavatories, and galleys. As the airline companies have reviewed these baselining requirements they have raised numerous objections regarding time involved, possible damage, leakage, or corrosion, warranty implications, and more (Heisel, 2 May 1995:1). Furthermore American Airlines refuses to commit B-767s because of safety concerns with the configuration of the LOSS unit in the forward cargo bay (Heisel, 21 July 1995:4; Reid, 20 October 1995:1). American has expressed willingness to commit airframes if the LOSS unit was moved to the rear of the aircraft (Heisel, 12 December 1995:1). Unfortunately this would be an extremely large and expensive modifi-

cation that AMC wants to avoid and believes is unnecessary, especially considering that the present LOSS configuration has been approved and certified by the FAA.

United Airlines is reluctant to commit B-767s due to one issue unrelated to any of the other airlines. They are concerned with the effect of AE missions on their Extended Twin Engine Operations (ETOPS) rating (Heisel, 21 July 1995:2-3). Because of past problems with mission aborts, United is currently on a provisional ETOPS rating with the FAA. United is concerned that AE mission aborts would count against their rating. The FAA has ruled that if a mission abort is due to an AE cause, it would not count against the airline (Heisel, 21 July 1995:3). Nevertheless the airline has reservations about taking that risk.

A fifth issue that has adversely impacted not only CRAF AE commitment but all CRAF participation involves insurance coverage. As explained by the General Accounting Office in a recent report investigating the Civil Reserve Air Fleet:

Normal commercial insurance policies generally exclude coverage for air carriers operating in war zones or during CRAF activation periods. Thus, commercial carriers flying during an activation must generally rely on supplemental insurance programs provided by the government. The Aviation War Risk Insurance Program, administered by the FAA under Chapter 443 of Title 49 of the U.S. Code, provides this indemnification. During the last activation, carriers experienced difficulties in obtaining this insurance coverage and were especially concerned about gaps in coverage. (GAO, 29 March 1996:8)

The GAO report goes on to state that the War Risk Insurance Program has been substantially modified to address many of the serious deficiencies. A new policy will have a rider covering war-risk and all-risk concerns, and it will dovetail with commercial policies to cover any gaps (Porter, 3 October 1995: 9). However concerns remain about in-

adequate funds available either from the FAA or DOD for damage reimbursements, and possibly long delays in receiving settlements.

The low B-767 commitment to CRAF AE can be summarized in five areas: 1) profitability of the airframe makes airlines hesitant to commit, 2) AMC offers insufficient incentives to overcome the profitability factor, 3) the baselining requirements have raised numerous objections by the airlines, 4) United Airlines is concerned about effects on its provisional ETOPS rating, and 5) adequate insurance coverage remains a concern for the airlines. Finally, as stated earlier, American and United are the only two airlines with B-767s that have made no commitment to the CRAF AE program. Extensive effort has been made to obtain their participation. American remains reluctant to commit due to money, configuration problems, safety concerns, and insurance; United continues to balk due to money, configuration problems, and ETOPS concerns (Holland, 23 May 1995:5).

3) Low Capability of Present B-767/AESS Resources On-Hand

The present B-767 and AESS resources are not operating at full capability. Currently there are 19 B-767 committed to the CRAF AE program but only four are fully certified. This is due to a significant problem with the configuration of the aircraft. This configuration problem is preventing the other 15 aircraft from meeting full FAA Supplemental Type Certificate compliance. It is also impacting the likelihood of additional airline companies to commit more aircraft to the program. An ancillary problem is the AESS resources--44 shipsets have been produced and are in storage but at no time have all 44 been ready for use. Over time one problem after another has prevented all 44 shipsets

from being fully available. For example, since 1991 there has been an outstanding pin corrosion problem that makes either 34 shipsets completely available at 111 liters per set or, after cannibalization, 44 sets available but at 85 liters per set. Likewise there has been similar capability-reducing problems with the electrical connectors, the storage environment and its effect on shelf-life items, the Liquid Oxygen Sub-Systems, and the Multiple Servicing Units. Let's review the AESS deficiencies one-by-one then return to the B-767 configuration problem

The first AESS shortcoming involves the special electrical cables to connect the palletized power system in the cargo bay with the main cabin. Since 1991 these cables have not been available; without them none of the shipsets would be functional on the aircraft. This was a case of mistaken responsibility. The contracts and system design specified that the airlines were to furnish these electrical cables, but the airlines were unaware that this was their responsibility (Heisel, 21 July 1995: 3). The Air Force recognized this problem in 1995 and contracted for the cables to be manufactured. In February 1996, 19 connectors were delivered with the remaining 25 expected this summer. Determination is in progress for who will be responsible for the connectors and where they will be stored.

A second AESS shortcoming involves storage and shelf-life problems. The current storage warehouse is not air-conditioned and becomes extremely hot in the summer. This has contributed to excessive deterioration of various AESS items ahead of their proposed shelf-life and, consequently, less than full readiness of the equipment (Pikula, 23 October

1995:1). The less than full readiness is in direct contradiction to the War Reserve Material status of the AESS that requires a constant state of readiness.

AMC/DOF was concerned that E-Systems, Inc., did not seem to act in a timely manner and give AMC adequate notice in order to program funds and complete replacement of expired items to avoid non-operational kits (Porter, 23 October 1995:1) AMC/DOKR asked the Staff Judge Advocate (AMC/JAQ) to review the contract with E-Systems, Inc., in light of the shelf-life premature expirations to determine if E-Systems had committed a breach of contract "both for failure to fulfill our requirements and failure to provide timely notification of adverse actions" (Pikula, 23 October 1995:1-2). AMC/JAQ determined that the contract was silent on the number of shipsets necessary to satisfy government requirements, consequently there was no "clear breach" and "no practical legal recourse available" (Doogan, 27 October 1995:2). JAQ recommended establishing a government minimum requirement for operational shipsets and amending the contract to reflect that.

The result of the situation is that month-by-month until mid 1996 as E-Systems, Inc., pulls AESS for inspections as part of their monthly management review a number of shipsets will be declared inoperative and in need of replacement items. Currently only 24 shipsets are available with no shelf-life problems. In addition, E-Systems has stated that if warehouse conditions remain the same, replacement for shelf life items will be an annual cost (Hajek, 14 November 1995:5). In contrast, if appropriate storage conditions are available, shelf-life replacement will be required approximately every three years. Fur-

thermore, E-Systems has stated that the excessive heat in the storage warehouse may void all of the AESS warranties.

A third AESS shortcoming centers on the stanchion litter arms locking pins. In 1995 inspection of the 10 shipsets produced by separate contract for the Gulf War detected a toxic corrosion on their locking pins which makes none of their litters available (Marshall, 12 May 1995:1-2). Resolution of this problem is dependent on resolution of the interior configuration problem. If the result of the interior configuration problem is to modify the aircraft to receive 84 litters or less, then the pin problem will be solved by cannibalizing good pins from the 34 complete sets. On the other hand, if the result of the interior configuration problem is to proceed with 111 litters per aircraft, then the Desert Storm shipsets must have their pins fixed at a cost of nearly \$500,000 and more months of delay.

A fourth AESS shortcoming involves the Liquid Oxygen Sub-System (LOSS). Each shipset contains one LOSS unit that provides therapeutic oxygen for patients in flight. Each LOSS unit consists of oxygen tanks mounted on a pallet which will be secured in the B-767 forward cargo bay. In late 1994 during a routine inspection three out of four LOSS units failed testing; this led to a full Preventive Maintenance Inspection (PMI) of all 44 units. Thirteen units failed the PMI (Heisel, 2 May 1995:1). Some of the failures were attributed to contamination and some were possibly due to excessive heat while in storage. Most of the units have been restored to service, but currently only 39 of the 44 are available for use.

Another weakness of the AESS equipment involves the Multiple Servicing Unit (MSU). Normal refilling of one LOSS unit can take up to six hours. The USAF wanted to reduce this time-consuming procedure so it improvised Multiple Servicing Units which are capable of filling half a LOSS unit in one hour. The goal was to use two MSUs at one time and fill one entire LOSS unit in one hour during actual operational servicing (HSC/YAM, 27 October 1995:3). However the MSUs have malfunctioned. E-Systems is not required to troubleshoot the problem nor maintain the MSUs since they are government-furnished property and are specifically excluded from the contract. Thus the Air Force must try to correct the problem. But the Air Force has discovered that the MSUs are no longer carried in USAF inventory and are therefore not supported by any Air Logistics Center. The problem is being worked but is still unresolved. It is not a show-stopper for CRAF AE airlift, however, since the LOSS units can still be filled using the original, time-consuming procedure requiring six hours per unit.

The AESS shortcomings have been numerous and persistent. Furthermore they are compounded by the B-767 configuration problem. Probably the biggest issue restraining B-767/AESS capability is the configuration problem.

Of the 19 aircraft committed to CRAF AE only four are fully certified. The reason for this involves the configuration of the aircraft, the FAA, and the STC--Supplemental Type Certificate. The initial design of the B-767 and AESS was fixed on a single baseline configuration for each version of the B-767 (the B-767-200 and B-767-300) to accommodate either 111 litters or 87 litters (Heisel, 21 July 1995:1). In addition, the initial

design was for an aircraft with a small forward cargo bay door. Thus the current STC is valid for only these four interior designs in conjunction with a small forward cargo door. Unfortunately, as B-767s roll off the assembly line different airline companies have slightly different configurations either in their interior arrangements or in the size of their forward cargo doors. Consequently not all B-767s meet the valid STC designs. Currently only the four aircraft from TWA meet the STC. The 12 aircraft from Delta and three from USAir have problems with center and rear lavatory and galley complexes, which create aisles that are too narrow to transport litters through, and wide forward cargo bay doors, which require adjustment of the location of the Liquid Oxygen Sub-System pallet (Fuston, 12 October 1995:2). Before these aircraft can be used for aeromedical evacuation they must attain Supplemental Type Certification, which requires new designs, a test flight, and FAA supervision and approval. Furthermore, the configurations that attain Supplemental Type Certification are the only configurations allowed. For example, currently the B-767 can be reconfigured with either 111 litters or 87 litters; no other arrangement, such as 90 litters, is allowed.

An addendum to this problem involves the baselining of the aircraft. As the airline companies have reviewed the steps of baselining they have reconsidered the removal of the lavatory and galley complexes. The airline companies have protested that removal of these internal structures creates five major concerns:

- 1) it requires extra time and money, and may void the warranties with Boeing;

- 2) if corrosion is discovered during removal, it must be corrected prior to the AESS being installed;
- 3) it may effect their ability to meet the required 48 hour call-up response time (in fact some airlines estimate baselining could take more than seven days);
- 4) damage may occur during removal and reinstallation; and
- 5) after removal and reinstallation of these items, leakage and corrosion is more likely. (Heisel, 2 May 1995:1)

The configuration problem poses a large obstacle for AMC with no quick and easy solution. AMC and E-Systems must resolve the interior layout, wide forward cargo door, and STC issues to the satisfaction of both the airlines and the FAA. It is very probable that the problem will not be resolved until 1997.

4) Other CRAF AE System Weaknesses

Finally, two problems separate from the B-767 and AESS yet part of the overall system need to be addressed. These other CRAF AE system weaknesses are the Casualty Transfer System and the Follow-On Test and Evaluation (FOT&E).

Casualty Transfer System. The CTS is a separate piece of equipment in the B-767/AESS system and is used for ground operations at military installations or civilian fields that lack passenger jetways. In all cases passenger jetways are the easiest means to on/off load litters or ambulatory patients with the B-767. However jetways are not always available, especially at military airfields. Consequently a separate transfer system is required. The Casualty Transfer System is the equipment used to transfer patients to-and-

from ground ambulance buses and the aircraft. The 1991 IOT&E identified significant limitations in on/off loading patients using the CTS (Holland, 1994:1; Werner, 6 December 1994:1).

The CTS is made of plywood and canvas. It consists of a five-pallet train assembled into a stable platform and locked into position on a 40 or 60 K-loader. The K-loader then performs as an elevator between ground level and the airplane door. The CTS has six litter stanchions, three per side; each stanchion holds four litters, thus the CTS can hold 24 litters total. Each litter position has an IV holder. There is a ramp at the airplane end of the CTS to compensate for difference in height between the K-loader and the airplane door sill. The canvas serves as a cover at either end of the CTS to minimize the effects of weather.

As noted, the IOT&E identified significant limitations with the CTS. The system has no electrical or oxygen capability nor medical supplies to sustain patient needs during transfer operations (Bouchard, 1994:2). The system is slow and requires extended ground times; it may take twice as long or more to on/off load as the C-141. This impacts airfield maximum-on-ground (MOG), crew duty day limitations, and B-767 availability. Furthermore, only six CTSs exist; all are located on the east coast, none are situated on the west coast. AMC personnel estimate a need for 25-30 systems for a dual MRC scenario (GAO, 29 March 1996:6). Finally, at the October 6, 1995, 3-Digit AE CRAF meeting, it was reported that "the CTS is insufficient to meet patient movement demands" (Nailling, 6 October 1995:2).

Follow-On Test and Evaluation (FOT&E). The normal process of new system design includes testing and evaluation to ascertain performance and possible refinements. The B-767/AESS system has conformed to part of this process. Fortunately, an Initial Operational Test and Evaluation (IOT&E) was conducted in 1991. It identified some deficiencies in the system, suggested improvements, and recommended a Follow-On Test and Evaluation (FOT&E). Unfortunately, no Follow-On Test and Evaluation (FOT&E) has ever been conducted, nor has the system ever been used on an actual AE operational mission (Holland, 1994:1). Thus the operational capability of the B-767-AESS system is, to some extent, unverified. Furthermore, the FOT&E cannot be conducted until the configuration problems and STC amendments have been resolved. Moreover since B-767s are very profitable and operate on a tight schedule, and since an FOT&E is an extensive operation involving military, E-Systems, FAA, and civilian personnel, to schedule an FOT&E requires significant advance notice. The overall result is that final verification of the B-767/AESS system is on indefinite hold.

In March 1991, with the Gulf War looming in the background, AMC/TE conducted an accelerated IOT&E of the B-767/AESS system. This test cited a number of areas for review, refinement, and eventual follow-on testing. Three findings stand-out: the configuration problem, the electrical connectors (or hookup kit), and the Casualty Transfer System (CTS). In addition, AE equipment tested during the IOT&E was somewhat limited (Werner, November 1994: 2). AMC/SG pointed out that one substantial piece of

equipment that was not tested was the Liquid Oxygen Sub-System (LOSS), and they indicated it was very important that the LOSS unit be tested (Halama, 1994:4)

The final IOT&E suggestion was to conduct an FOT&E to determine if the AESS could be used under the original concept of operations. The FOT&E will ensure our B-767 CONOPS plans are operational and functional, and will lead to permanent FAA approval of the AESS (Werner, 6 December 1994:1). An FOT&E will resolve key deficiencies and perform a critical evaluation that was not completed during initial testing in 1991 (Halama, 1995:1). A long list of FOT&E operational effectiveness and suitability objectives have been identified; two of the more notable objectives are to evaluate the LOSS during inflight operations and to evaluate the CTS during ground operations.

Summary of Discussion of the Main Problems

CRAF AE has four main problems. The dominant problem is lack of a validated requirement. Until a sound, solid requirement is established, it is difficult to select and proceed in one direction over another, make decisions, commit funds, and adapt equipment. To proceed without a validated requirement is to put the cart before the horse. AMC needs to ascertain a validated requirement and then go forward to achieve that capability. After settling on the requirement, the Air Force can give full attention to resolving the remaining significant problems: low B-767 commitment, low B-767/AESS capability, and other CRAF AE system weaknesses.

VI. Recommendations and Conclusions

Over time a number of recommendations and conclusions have surfaced to resolve the four main problems of the CRAF AE program. This chapter will highlight the more prominent proposals. In addition, this chapter will try to observe Charles Schwenk's strongest recommendation for achieving a superior strategic decision: challenge assumptions and consider a full range of alternatives.

1) Lack of a Validated Requirement

The two greatest steps that can be taken at this time to improve determination of the validated requirement are: 1) construction and use of a dual TPFDD, and 2) development and use of a different casualty estimator than the JOPES Medical Planning Module (MPM). In addition, more consideration of the impact of changes in doctrine and strategy toward stabilized care in the air is necessary also. Fortunately all three measures are progressing forward.

As of February 1996, TCJ5 had begun the arduous process to construct a dual MRC TPFDD. They have completed the initial stages of setup and coordination. An overall outline and schedule for the project is complete. Appropriate agencies have been contacted. Working groups have met and will continue to meet. TCJ5 estimates that a dual MRC TPFDD should be complete by early to mid 1997.

As for a replacement for the MPM, the Joint Staff is developing the Medical Planning Execution System (MEPES) (DOD, 20 March 1995:3). This system is considered a sig-

nificant improvement over the MPM. MEPES will not only accommodate OPZONE force changes but also generate and calculate non-unit medical supply, blood, and AE crew and equipment requirements, detailed medical personnel requirements by specialty, and sustainment requirement changes based on 10 day time periods (DOD, 20 March 1995:16). Specific objectives for the MEPES are:

Establish planning factors for 2nd through 5th echelon medical facilities based on Time, Task, Treater clinical database. Validate all MEPES planning factors annually.

Develop a mechanism to assess requirements and capabilities for combatant commanders, Services and the Joint Staff.

Develop a methodology appropriate for each Service to ensure a match of casualty rate development and application across the full range of operational situations. (DOD, 20 March 1995:3)

Another planning tool that is being developed and will assist in the requirements determination process, as well as elsewhere, is the Wartime Medical (WAR-MED) Planning system. WAR-MED is a USAF project that is in the initial stages of development, including some prototype evaluation. It is intended to be a tool that will assist in deliberate and crisis planning and in formulating realistic training requirements. It will provide USAF medical planners with computer modeling and auditable databases. WAR-MED will perform iterative analysis of integrated wartime medical systems in order to determine manpower and resource allocations, and examine complex wartime medical plans and operations (HSC/YAM, 2 March 1996:1). WAR-MED will provide the USAF Surgeon General with the first auditable tool to evaluate the USAF wartime medical system using operationally significant measures of effectiveness (HSC/YAM, 2 March 1996:1).

The final point regarding the lack of a validated requirement involves the changes in doctrine and strategy from stable patient care to stabilized care in the air. The stabilized care strategy is gradually being implemented and must be factored into all future planning. Stabilized patient care will have a profound impact on force structure and airlift requirements. The current C-17 AE capability modification is evidence of the impact of these changes.

2) Low B-767 Commitment

The low B-767 commitment problem revolves around five issues: 1) airframe profitability, 2) lack of sufficient incentives, 3) configuration problems, 4) United Airlines' ETOPS rating, and 5) adequate insurance coverage. AMC is working on various alternatives to overcome this chronic low commitment problem.

Basically there are two options AMC can pursue to try to overcome the profitability of the B-767 issue. One option is to examine, devise, and offer the type of incentives that will lure the airlines to participate in the program. The second option is to simply wait it out and see how the total airline aircraft situation changes over time, possibly leading the airlines to eventually reconsider and commit B-767s based on changed circumstances.

With regard to better incentives, AMC has taken the step of asking the airlines what they consider to be appropriate incentives. AMC/DOF personnel have met with various airline representatives, most recently in March 1995 with American and United Airlines and the Fall 95 Mobility Representative (MOBREP) Conference, to discuss and determine what steps can be taken to increase B-767 commitment (Heisel, 3 October 1995:1;

Reid, 20 October 1995:1). At the Fall 95 MOBREP Conference many carrier representatives suggested several ideas for monetary incentives:

- Submission of cost data--currently the cost data AMC uses to compute the AE rate is solely based on data supplied by Delta Airlines
 - A new AE rate based on more data might benefit carriers
- Double MVPs for DC-10s as an alternate AE aircraft; same as the B-767 AE MVP rate
- Relook the 60/40 rule to either 50/50 or eliminate it
 - 60/40 rule requires an air carrier receive no more than 40 percent of the company's business is derived from government sources
- City Pair connection--tie City Pair eligibility to AE participation (i.e., if you have B-767s in your fleet)
- Market share guarantee--After CRAF activation, the government guarantees a return to their previous market share
- Substitution Cost--could we ensure that if a carrier substitutes another aircraft for B-767s, AMC would reimburse them for additional costs for operating the substitute. (Heisel, 3 October 1995:2)

AMC is considering incentives such as increasing Mobility Value Points, or offering premium rates for AE commitments, alternative contracting, substitution requirements, and Aeromedical Evacuation Shipset (AESS) compatibility issues (Reid, 20 October 1995:2). In addition, a recent General Accounting Office report cited additional incentives or requirements that AMC is considering to aid participation in all segments of the CRAF program:

- allowing carriers to bid for contracts to transport small packages if they commit more than the minimum number of aircraft required;
- allowing carriers to use military bases for commercial operations if they meet or increase the minimum number of aircraft committed; and
- working with other federal agencies, such as the Federal Emergency Management Agency or the Departments of Transportation and State, to require that carriers wishing to do business with those agencies be enrolled in the CRAF program. (GAO, 29 March 1996:4)

AMC could use one or all of these suggestions to specifically assist the CRAF AE program. In addition, AMC might also consider using a Marketing Scheme or Public Relations effort to create incentive for CRAF AE participation. At the Fall 95 MOBREP Conference carrier representatives suggested AMC "pitch the idea of AE participation to the Airline Transportation Association" (Heisel, 3 October 1995:2). In this way air carrier CEOs could be targeted to explain the AE shortfall and how they could help. Likewise a Public Relations effort might spur commitment to CRAF AE. This idea was first expressed by MAC/XPW in 1988:

RECOMMENDATION. Publicize the creation of the CRAF Aeromedical Segment to the maximum extent possible.

APPLICATION. Publicity will concentrate on the humanitarian nature of the segment and the strong civil-military partnership of the CRAF. It will be important to mention carriers' participation by name. Should USAF/SAM (School of Aerospace Medicine) sponsor a cooperative program, it can be highlighted as another positive example of mutual cooperation between the Air Force and the civil airline industry. (Durham, 23 May 1988:4)

As a suggestion, Public Service Announcements (PSA) could be used as a form of incentives. For example, the U.S. Olympic Committee has a very successful program acquiring corporate sponsors. Part of that program is an advertising incentive recognizing "Official Sponsors of the 1996 Olympics." AMC might try a similar program using an advertising program to recognize "Airlines of the Civil Reserve Air Fleet Aeromedical Evacuation Program." This advertising program could take others forms as well, for example, using PSAs to simply inform the public of the AE airlift need and thank the airlines that have committed for their participation.

The second option in trying to overcome the profitability of the B-767 airframe is simply a wait-and-see approach that may lead to more commitment. This notion has been summarized by AMC/DOF:

- Present level of orders and leases of B-767s by major carriers may allow them to make more commitments, possibly in two years, as they receive these aircraft in their inventories

- Boeing has orders for 670 B-767-300s worldwide and major U.S. carriers alone account for 126 of the 670 (118 have extended range capability we require)

- Newer aircraft (i.e., B-777 and A-340) could eventually replace the B-767 as the carriers' biggest money maker, thus making the AE commitment of B-767 aircraft less of a financial risk for the carriers

- Charter carriers will procure B-767s in the future and likely commit to CRAF, i.e., American Air Trans in 2 - 3 years. (Reid, 20 October 1995:1)

Moving on to the baselining and configuration problems, AMC has a study underway by E-Systems, Inc., to examine and correct these obstacles to CRAF AE participation.

"A more flexible kit to accommodate different B-767 configurations would allow the kits to be installed quicker, at less cost, and require less equipment removal--encouraging airlines to commit aircraft" (Heisel, 3 October 1995:2). This particular study will be covered in more detail later in this paper. The essential point here is that AMC is progressing forward on these issues to remove them as barriers to airline commitment in the CRAF AE program.

In addition, AMC may want to reconsider its position on American Airlines' (AAL) offer to participate in CRAF AE if the LOSS unit was moved to a rear cargo bay. Granted there is extra expense to design and accomplish this modification, but recognize that AAL has committed 24 aircraft to the CRAF Passenger Segment, and if six or more

of them were committed to CRAF AE it would satisfy the STAGE II (25) requirement, and if all 24 of them were committed to CRAF AE it would leave AMC just one short of the Stage III (44) requirement. The low B-767 commitment problem would be solved. Furthermore, this could be done without adversely effecting the CRAF Passenger Segment. The current CRAF Passenger Segment has 161 aircraft committed with a requirement for 136 wide-body equivalents (GAO, 29 March 1996:3-4). If AAL was to commit its 24 B-767s to CRAF AE, the CRAF Passenger Segment would still meet its requirement.

As for the final two issues in the low B-767 commitment problem, AMC has made some progress on at least one of them. It seems there is little that can be done to convince or persuade United Airlines that the CRAF AE mission will not adversely impact their provisional ETOPS rating. The FAA has stated that CRAF AE would not have a negative impact, but the airline continues to raise the issue as a problem. In regard to the adequacy of insurance coverage, DOD and AMC have already taken many positive steps to alleviate this problem, and the remaining concern of the airlines about inadequate funds available for reimbursements and possibly long delays in receiving settlements has also been addressed. According to DOD officials, to resolve this problem, DOD has proposed legislation allowing the Secretary of Defense to tap unobligated funds from any source to promptly pay carrier liability claims (GAO, 29 March 1996:5).

That completes a review of the five issues--one-by-one--surrounding low B-767 commitment and the steps taken by AMC to rectify each item. There remains one action

by AMC on this problem that needs to be covered, however. AMC has taken one giant step to rectify the overall problem of low commitment. AMC is reconsidering the B-767 as the sole CRAF AE airframe.

Currently a study is underway examining the feasibility of adapting DC-10 aircraft for the CRAF AE mission. Since the Aeromedical Evacuation Shipsets (AESS) only fit the B-767 airframe, this study is also examining adapting some of the AESS for use on the DC-10. Along with this, study and changes are underway to improve and expand the AE capability on the C-17. Furthermore, another study is in progress examining the potential to reinstall AE capability on the KC-135.

The DC-10/AESS study should be complete later this year. Discussions with various AMC/DOF and AMC/SG personnel indicate that there is a strong possibility that the DC-10 study will be completed but not pursued. In some ways this is probably for the better. It was thought in 1986 when the B-767 CRAF AE program was initiated that the system would come on-line fairly quickly and easily with few problems. Ten years later AMC has achieved only partial capability and a number of problems exist and are being worked. Considering the difficulties the USAF and AMC has had getting the CRAF AE B-767 program on-line, it is probably a smart decision to resolve the present problems with this system before taking on any new ones with another system. As an example of future problems with a DC-10 CRAF AE system, preliminary indications from the DC-10 study show:

...the airlines intend to begin moving DC-10 into cargo service in the future which will make them unsuitable for AESS installation. When the aircraft are moved to cargo service, many of the systems required by the FAA are removed such as the

passenger emergency oxygen system, emergency exit lighting systems, life rafts, passenger lavatories, etc. ... One problem that has already arisen is that some or all of the DC-10s may not have an active fire suppression system in the cargo bay like the B-767 does. This could require the development of an active fire suppression pallet which would have to have a control mounted in the cockpit. In the past, airlines have been extremely reluctant to modify the cockpit area. (HSC/YAM, 27 October 1995:9-10)

Another item to consider regarding the DC-10 is that it could turn out to be like the B-767 in that there could still be a low commitment problem. Prior to beginning the DC-10 study AMC personnel did contact airlines to see if there was enough interest to justify funding and proceeding with the study. Though enough interest was expressed to justify conducting the study, no airlines have made any commitments to DC-10 CRAF AE. Consequently there is no guarantee that acquiring DC-10 CRAF AE capability will resolve the low commitment of AE airframes problem. Furthermore DC-10 CRAF AE may aggravate problems with the AESS. The AESS system has been beleaguered by problems since its inception. To modify some shipsets for DC-10 use could lead to additional storage and handling problems.

The DC-10 proposal has numerous flaws. All things considered it might be a wiser course of action to spend the money being considered for the DC-10 modification on modifying the B-767 to carry the LOSS unit in a rear cargo bay in order to accommodate American Airlines. Following the latter option would not only appease AAL and reduce or eliminate the low commitment problem, but it would also make the CRAF AE B-767/AESS system more flexible.

Proposals to improve and expand the AE capability on the C-17 and possibly reinstall partial AE capability on the KC-135 have a great deal of merit. Both of these proposals give the USAF more organic AE capability and flexibility for MRC scenarios as well as for peacetime contingencies. In addition these proposals capitalize on the concept of core competency. The core competency for strategic aeromedical evacuation airlift rests with AMC, not commercial airliners.

Considering that the C-17 is the replacement for the C-141, and the C-141 currently is the backbone of organic strategic AE capability, it is logical that the C-17 should be modified for as much AE capability as possible. In addition, the need for AE capability could easily be used to justify buying more C-17s or buying stretch C-17s in the future. With regard to the KC-135, though its primary mission will always be as a tanker platform to "pass gas," to acquire a secondary role for partial AE transport gives the USAF extra capability and flexibility at any time. In addition, the KC-135 originally had an AE capability which was eventually removed. Logic here may lead one to conclude that if it was a good idea once, it might be a good idea again.

Furthermore, to resolve the low B-767 commitment problem other proposals for military aircraft that may have merit are to consider setting aside a number of C-141s as dedicated AE aircraft or consider using the C-130 in a strategic AE airlift role. Over the next few years as the C-17s come on line and C-141s retire it may be possible to dedicate a number, for example 10, of C-141s to perform strictly AE missions (Lorraine, 25 November 1995:3). Of course the logistics and maintenance tail for the aircraft would have

to be maintained so this proposal would have a short life span. As for the C-130, currently this aircraft is the primary *theater* AE airlifter. If C-130s were to acquire an air refueling capability (some already have) it would extend their range and make it possible for them to perform some limited strategic AE airlift. This idea has the added benefit of minimizing patient transport onto and off of aircraft. It also has the benefit of giving the C-130 added capability--air refueling--that can be used for *any* mission, not just aeromedical evacuation. In these days of reduced budgets, downsizing, and the need for greater air mobility to respond to contingencies on short notice, expanding the capability of the C-130 makes sense. Altogether expanding the AE role on the C-17, KC-135, C-141, even the C-130 gives the USAF more capability through flexibility.

This final point--**capability through flexibility**--is probably the most important of all when it comes to resolving the low B-767 commitment problem. Given that AMC cannot say as an absolute that 44 CRAF AE B-767 airframes will be sufficient for strategic aeromedical evacuation airlift, and given that the state of the requirement is continually changing, what AMC should pursue is to obtain as much AE capability as can reasonably be afforded in as many different ways as can reasonably be achieved--**capability through flexibility**. Thus to pursue strategic AE airlift with B-767s, C-17s, KC-135s, dedicated C-141s, and air refuelable C-130s seems a wise course of action. Since AMC has already achieved extensive development of the B-767/AESS system, AMC should pursue the participation of as many B-767s as possible. In addition, if the need arises for more than 44 CRAF airframes, AMC should have the ability to generate more AESS on short no-

tice. Furthermore, this concept recognizes a blend of military organic AE airlift, which has core competency in aeromedical evacuation, and commercial AE airlift which are extremely cost-effective. Finally, this concept does not focus on one airframe to provide strategic AE airlift, but encompasses five airframes, which gives decision-makers more capability to respond to uncertain situations that have potentially high demands.

3) Low Capability of Present B-767/AESS Resources On-Hand

The low capability problems of the present B-767/AESS resources on hand need to be resolved once and for all. The AESS has been designated War Reserve Materiel, as such it is critical in nature and supposed to be in a constant state of readiness. AMC needs to get the entire system fully on-line, ready for immediate use.

Resolution of the five problems with the AESS--electrical connectors, storage and shelf-life, pin corrosion, LOSS units, and MSUs--is moving forward. Progress is being made in almost every item.

As stated earlier, 19 electrical connectors have been delivered to the USAF and the remaining 25 are due this summer. The only other concern in this issue is who will be responsible for the connectors and where will they be stored. A plan that is being worked is to store the connectors with the AESS and have E-Systems take responsibility for them. Though this problem is well in-hand now, it highlights a very serious point. Going five years without having the proper equipment on hand to install the AESS in the B-767--in effect, having a completely dysfunctional system and not even being aware of it--highlights the need for better planning and management of the AESS system.

The storage and shelf-life problems are well on their way to being resolved, also. The Human Systems Center (HSC)/System Program Office (SPO) at Brooks AFB, TX, identified four options to rectify the excessive heat problem in the storage warehouse:

- a) Remain in the General Services Administration (GSA) warehouse, but air condition it,
- b) Seek warehouse space near Greenville,
- c) Build a warehouse at Brooks AFB, or
- d) Seek warehouse space at Kelly AFB. (Pease, 8 November 1995:2)

Late 1995 HSC/SPO made their decision and recommended air conditioning the current GSA facility at a cost of \$400,000 up front with no rent charges for two years then reduced rent charges the following years (Nailling, 8 December 1995:1). Final details are being worked to write and fund a contract and the air conditioning system should be installed prior to the beginning of summer. As for the shelf-life problems, AMC will simply have to suffer through a few months of decreased operational status. In the meantime lessons have been learned and a better tracking system is being organized in order to stay ahead of any future shelf-life deficiencies. Once again, better planning and management of the system is called for.

The pin corrosion problem is on hold until the interior configuration issue is decided. As stated earlier, if the interior configuration redesign results in 84 liters or less, the pin corrosion problem disappears as cannibalization of extra pins from good shipsets will replace the corroded pins from the impaired shipsets. On the other hand, if the interior configuration study results in installation of more than 84 liters per shipset, then some work must be done to correct or replace the corroded pins. E-Systems has recommended

replacing the equipment and, since there is no warranty on the shipsets bought under the UCA for the Gulf War, their proposed price is over \$477,000 (Ledden, 12 May 1995:1). Obviously AMC will wait and see whether it needs the pins before spending that much money to replace them.

The 13 LOSS unit inspection failures are almost completely resolved. One-by-one the units are being repaired and returned to service with all units back on-line by early 1996 (Hajek, 14 November 1995:3). Of the 13 units, only one was not covered by warranty and, thus, cost the USAF extra money. Still, for well over one year the AESS equipment experienced reduced capability. This larger, more serious cost of a period of time with decreased system capability is more significant than the amount of money involved. This problem in conjunction with the others is indicative of the frustrating, aggravating types of problems that have emerged one after another in the CRAF AE B-767/AESS program. AMC is continually finding itself reacting to problems rather than being in a proactive position. This would lead one to suggest that AMC incorporate better management of the system in order to stay ahead of problems rather than behind them.

The Multiple Servicing Unit problem is a final example of the frustrating, aggravating types of problems that the AESS equipment has faced. Though deficiencies of the MSU have not reduced overall system capability, they highlight once again the difficulty in managing the system and keeping it on-line in the best manner possible. The current situation for the MSU is:

E-Systems recommended that the current MSU be replaced. They offered to research a replacement on their own time, suggesting they could build a smaller less expensive unit. E-Systems will propose a replacement under the ECP proposal

process on the CLS contract. DOKR, DPRO, and SGXC concurred on allowing E-Systems to pursue the plan. (Nailling, 8 December 1995:2)

The AESS problems demonstrate clearly the need for better planning and management of the equipment in order to be more proactive than reactive. Fortunately, AMC has recognized this as well:

During the development of the CRAF AESS, AMC (then MAC) made the decision to conduct sustainment with their own organic resources. This decision was based upon the belief that the AESS was designed for long term storage and would be relatively easy to maintain. However, the AESS has proven to be more difficult to sustain than originally envisioned and requires sustainment engineering support. In May, 1994 AMC sent the program office a letter requesting that they be relieved of sustainment by AFMC. (HSC/YAM, 27 October 1995:4)

Initially AFMC and HSC contacted personnel at the San Antonio Air Logistics Center (SA-ALC) to determine if they would be willing to take on sustainment of the AESS. SA-ALC declined the proposal citing the need for increased manpower authorizations to conduct the program, yet it was in the midst of manpower cuts. In addition, since then SA-ALC has been designated for closure. The Oklahoma City Air Logistics Center was contacted as well but they expressed disinterest (HSC/YAM, 27 October 1995:4). Eventually HSC System Program Office (SPO) discovered that the AESS could not be sustained at an ALC since they are not FAA repair stations for Liquid Oxygen Subsystems (Nailling, 1 September 1995:1). Consequently HSC/SPO began researching the possibility of assuming sustainment. On October 4, 1995, HSC conducted an AESS "New Start Review" (Hajek, 4 October 1995:1) At about the same time HSC formed an Integrated Product Team (IPT) to fully research the issue and draft a proposal to AMC. By December 14, 1995, HSC was ready to commit to CRAF AESS sustainment:

My staff has thoroughly investigated the task of managing the CRAF AESS sustainment effort and has briefed me on the projected annual costs and manpower requirements. Further, the Integrated Product Team (IPT) has recommended that sustainment responsibility be assumed by HSC. I have tentatively agreed that we could accept sustainment contingent upon receipt of adequate funding for the sustainment effort from AMC. (Long , 14 December 1995:1)

With HSC/SPO taking over responsibility for sustainment of the AESS equipment hopefully there will be fewer problems and greater capability with the system.

Moving on to consideration of the B-767 configuration problem, the process to fix this issue is contained in the AESS maintenance contract:

- E-Systems will identify the problem to the contracting officer, as they already have
- AMC will request E-Systems submit an estimated time and cost proposal to fix the problem
 - This has been accomplished, and DOK is awaiting a formal reply from E-Systems
 - The initial feedback was that it will take 5 months to alter the kits
 - This will include parts to be manufactured and the required FAA Supplemental Type Certification
- If the formal proposal is satisfactory to AMC, E-Systems will proceed with the modification once funding is available. (Heisel, 2 May 1995:1-2)

Thus E-Systems, in coordination with the Human Systems Center and AMC, is currently examining all the issues and attempting to determine solutions. To assist in this study, AMC/DOK, in conjunction with AMC/SG, submitted a change in litter requirement to E-Systems:

- a. The minimum litter requirement is 84, but 87 litter positions are preferred.
 - b. Patients need to be moved down both aisles.
- Other than the above, HQ AMC/SG desires that E-Systems remove as little as possible from carriers' existing configuration(s). (Ledden, 16 October 1995:1)

Thus E-Systems is trying to come up with a forward cargo door redesign for the LOSS pallet along with an interior redesign that accommodates 84 minimum, 87 preferred litter positions and requires minimal, if any, lavatory/galley removals by the airlines. Both the wide forward cargo door and the interior lavatory/galley/litter redesign require STC amendments. To attain these amendments will require not only the redesign drawings but also actual flight of at least one aircraft. The estimated completion date for this analysis, test flight, and FAA STC amendments is uncertain and remains at least one year away.

Hopefully the analysis underway by E-Systems, AMC, and HSC will resolve this layout and cargo door problem not only for the 15 aircraft presently committed to CRAF AE that do not comply with the current Supplemental Type Certification, but also for any other B-767-200 or B-767-300 aircraft that might be considered for the program. It makes sense to try to resolve this problem once and for all rather than to have to reopen the issue and redo the study as more B-767s are committed to the program.

4) Other CRAF AE System Weaknesses

Resolution of the Casualty Transfer System weaknesses is also moving forward. Three major steps have been taken. One, in the last half of 1995, AMC/DOKR placed advertisements in Commerce Business Daily seeking equipment improvements or suggestions. DOKR received two responses, one verbal and one written, that were reviewed by the 3-Digit AE CRAF members (Nailling, 19 January 1996:2). Two, in December 1995, Cadillac Corp., producers of the CTS, visited AMC/SG to discuss needs and inves-

tigate alternatives (Nailling, 2 January 1996:2). Three, and most significant of all, in early February 1996, AMC/SG contacted HSC to discuss HSC assuming responsibility for procuring the CTS or its replacement (Nailling, 31 January 1996:2). HSC responded that they will assume responsibility for procuring the CTS or replacement (Nailling, 6 February 1996:2).

HSC/YA is planning to issue a competitive contract for production of a new system and has drafted a Statement of Objectives (SOO). They anticipate the following CTS solution:

... modular construction, lightweight, quick and easy off/on loading, stored at designated locations, adjustable at top to accommodate different aircraft (B767/DC10) entry door heights and at bottom for ambulances/ground, low maintenance aspects--and minimize production costs. (Roclevitch, 7 February 1996:1)

HSC/YA will conduct the procurement, but they are still looking to AMC to provide the funding.

Meanwhile as plans for a new system move ahead, AMC is still faced with insufficient equipment on-hand. Acquisition of a new CTS should occur quickly and alleviate this problem soon. For the present AMC can try to rely on jetway-equipped airfields to assist in patient movement and thereby overcome CTS deficiencies.

Finally, in regard to the FOT&E problem, unfortunately AMC has no choice but to simply wait until the B-767 configuration study is completed before it can conduct the test flight. However, as a suggestion, since scheduling an FOT&E is very difficult and involved, AMC/DOF and AMC/SG, in coordination with all other appropriate agencies,

might consider making tentative arrangements for an FOT&E at various points in the future in anticipation of completion of the configuration study. In this manner, instead of waiting for the configuration study to be completed *then* making arrangements for an FOT&E, which could further prolong accomplishment of the test flight for another year, tentative scheduling and arrangements could be set up now so that the FOT&E could follow on the heels of completion of the study more quickly. For example, tentative scheduling and arrangements could be made with the airlines, FAA, and all others for June 1997, September 1997, and December 1997. These tentative arrangements could be made with the stipulation that three or four months prior to a scheduled date, determination will be made as to whether that date will be a "go" or not. If the study is complete and all other arrangements can be solidified in time, then the decision is "go" and the FOT&E can be completed. If the determination is "no go at this time," then all parties can fall back on the next scheduled date. This suggestion might help shorten the delay between completing the B-767 configuration study and conducting the FOT&E.

VII. Summary

The concept for CRAF Aeromedical Evacuation began in the late 1970s and a firm decision to go forward with the program occurred in 1986. Since then in over 10 years AMC has achieved limited CRAF AE capability.

Five years after the firm decision to go forward the Gulf War came along out of the blue and AMC was not ready for CRAF Aeromedical Evacuation. AMC scrambled to put together a system (fortunately it was not needed). Five years later AMC is still not ready. If AMC would need large-scale CRAF Aeromedical Evacuation today, AMC would be scrambling again.

Over the next 10 years the situation will become even more acute. C-141s will gradually fade away and their replacements, C-17s, will provide less AE capability. CRAF Aeromedical Evacuation needs to achieve full capability. To achieve full capability CRAF AE needs to establish and regularly update a validated requirement, aggressively pursue and acquire complete B-767 commitment, and ultimately secure all aspects of the system, from AESS to CTS, fully on-line.

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He attended Undergraduate Navigator Training and received his wings upon graduation on 30 August 1983 as a Distinguished Graduate. His first assignment was at Rhein-Main AB, Germany, as an AWADS C-130E Navigator. His second assignment was at Mather AFB as a T-43 Instructor Navigator and T-45 Simulator Curriculum Manager. His third assignment was at Dover AFB where he performed duty as a C-5 Special Operations Low Level II Navigator, Airlift Control Squadron, Squadron Operations Officer, and Deputy Wing Executive Officer. In addition, while stationed at Dover he earned a Master of Science degree in Public Administration from Wilmington College. In February 1995 he entered the first class in the Advanced Study of Air Mobility sponsored by the Air Mobility Warfare Center in conjunction with the Air Force Institute of Technology School of Logistics and Acquisition Management. His follow-on assignment in June 1996 is to U.S. Transportation Command in J3/J4, Operations/Logistics.

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13. ABSTRACT (Maximum 200 words) The Department of Defense, USAF, and Air Mobility Command (AMC) rely on the Civil Reserve Air Fleet (CRAF) to provide supplemental airlift in times of national emergency. AMC oversees the CRAF program which contains three segments: international, national, and aeromedical evacuation. The CRAF Aeromedical Evacuation (AE) program involves commercial B-767 aircraft, Aeromedical Evacuation Shipsets (AESS), a Casualty Transfer System, and a large number of support personnel and equipment. Wartime planning in the early 1980's revealed a significant shortage of military airlift to accomplish the aeromedical evacuation mission. Consequently the CRAF AE program was initiated. Planning for Major Regional Conflict scenarios has currently set a requirement for 25 and 44 B-767 aircraft for CRAF Stages II and III, respectively. Unfortunately AMC has not been able to acquire full commitment to the CRAF AE program. In addition, the CRAF AE program has been beleaguered by a number of problems which have continually kept capability of the overall system low. This graduate research paper provides a comprehensive review of the AE shortfall issue from beginning to the present with recommendations and conclusions for the near future.				
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