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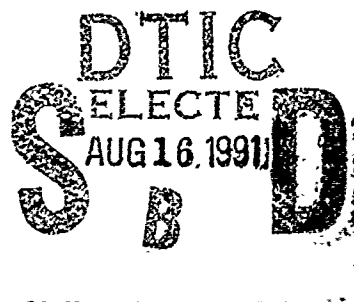
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A RAND NOTE

**The Civil Reserve Air Fleet: An Example
of the Use of Commercial Assets to Expand
Military Capabilities During Contingencies**

Mary Chenoweth

June 1990



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This Note documents the Civil Reserve Air Fleet (CRAF) as a case study on the use of commercial assets to augment military capabilities during contingencies or national emergencies. The CRAF illustrates some of the issues one might expect to find in a similar program using civil and commercial satellites. Both contend with the problem of providing an appropriate mix of incentives to participate, both must overcome or cope with design incompatibilities between commercial and military systems, and both must balance the need to maintain a high state of readiness and responsiveness with the need to maintain high participation levels. While solutions that work for CRAF may or may not be transferable to space-based systems, the CRAF does provide an example of how one defense program addressed these basic problems and continues to do so as industry's and the military's needs evolve.

A RAND NOTE

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**Prepared for the
United States Air Force**

RAND

PREFACE

This Note documents the Civil Reserve Air Fleet (CRAF) as a case study on issues one might expect to encounter in a military program using civil and commercial satellites. It supports a larger study entitled "Civil/Commercial Satellite Augmentation of DoD Space Assets," carried out under the Technology Applications Program in Project AIR FORCE. The Directorate of Space and SDI Programs of the Office of the Assistant Secretary of the Air Force for Acquisition, Plans and Policy (SAF/AQS) sponsored the research under Contract No. F49620-86-C-0008.

The Air Force asked RAND to help it assess means by which it could comply with DoD space policy established in 1987 which suggests the use of nonmilitary capabilities to expand existing DoD space systems for use during contingencies. It suggested that RAND determine whether it was appropriate for the DoD to assume a larger role in coordinating civil and commercial space systems in a Civil Reserve Air Fleet (CRAF)-like manner. This Note focuses only on common issues between the CRAF and a similar DoD program utilizing nonmilitary space systems. The suitability of CRAF as an analog for space systems and the Commercial SATCOM Interconnectivity (CSI) program will be addressed in a companion report.¹

This Note should be of interest to military planners concerned with planned military mobilization of civil and commercial assets during a national emergency or war.

¹The primary purpose of the CSI program is to provide emergency interconnectivity of the Public Switched Network (PSN). CSI is designed to facilitate the restoration of communications knocked out after a catastrophic event, such as a nuclear attack. CSI is a federally funded program which involves owners, users, and government agencies that play a role in regulating these assets. The major U.S. telecommunications companies, including COMSAT Corporation, are participants in CSI and have offices colocated with the Defense Communications Agency, the principal DoD representative. Corporate participation in the program, which is voluntary, is primarily motivated by industry's need to see its assets quickly brought back into service, although companies also receive modest financial compensation. The CSI is more than just a collection of owners and users—it includes its own infrastructure, to some extent. As a first phase, contracts have been let to build leased service, contractor-operated ground stations that would provide control of the surviving satellites. Operations at these sites would rely heavily on automation to reduce the requirement for skilled personnel. In the next phase, there are plans to develop small transportable ground stations to control surviving comsats. Future plans call for non-CONUS and international ground station sites. DoD is authorized to activate the CSI under the provisions of the Federal Communications Act of 1934, section 706.



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SUMMARY

This Note supports RAND research to assess means by which the U.S. Air Force could comply with DoD space policy established in 1987 calling for the use of nonmilitary satellites to expand DoD space system capabilities during a war or national emergency. One objective of the research was to determine if it was appropriate for the DoD to increase its role in the use of civil and commercial space systems in a program similar to the Civil Reserve Air Fleet (CRAF).

The CRAF presents a number of the same problems space systems do. Nonmilitary resources contribute inexpensive capability at a time of limited future growth in defense procurement programs, funding problems due to rising military system costs, and ever-increasing capability requirements. However, the use of nonmilitary space and airlift capabilities introduce a number of problems. Both contend with the problem of providing an appropriate mix of *incentives for participation*, both must overcome or cope with *design incompatibilities* between commercial and military systems, and both must balance the need to maintain a high state of *readiness and responsiveness* with the need to maintain high participation.

Incentives for participation. To encourage the voluntary participation of the airlines in the Civil Reserve Air Fleet, the Military Airlift Command (MAC) developed a combination of incentives for participation. The primary vehicle used to bring in and keep up participation are the MAC peacetime airlift contracts, amounting to \$600 million a year by one estimate. In return, the commercial capability represented by the airlines in this program provides the Air Force about 17 million ton miles per day of long-range international cargo airlift. Commercial aircraft contribute significantly to the minimum DoD goal of 66 million ton miles per day to be reached by the mid-1990s.

Other ways of making conditions more attractive to the airlines include the policy of staged activation of CRAF assets and added flexibility to MAC's contracting rules. Staged activation, implemented many years ago, stipulates that the number and type of aircraft called up will be proportional to the state of emergency. This avoids the problem of pulling assets away from regularly scheduled operations that are never used. New contracting rules allow airlines to pool their separate resources, such as aircraft and aircrew, to provide a complete package to MAC. These rules now open opportunities for small package carriers, which have eligible aircraft but too few aircrews, to team with another company with aircrews which may not be able to contribute aircraft.

Design Incompatibilities. Whereas commercial aircraft can provide the military with air services for contingency operations, they can also introduce problems of incompatibilities which must either be coped with or addressed.¹ Commercial aircraft were optimally designed for the market they serve, primarily passenger services. An important objective is to deliver their cargo in the most economically efficient manner, putting a premium on aerodynamic, lightweight designs. On the other hand, military aircraft designs emphasize performance over fuel economy. Their missions require delivery of bulky heavy equipment to potentially hostile locations, and the equipment must be loaded and unloaded as quickly as possible.

To increase CRAF cargo capability, MAC initiated and paid for the CRAF Enhancement Program designed to modify passenger aircraft with cargo convertible features, such as heavier floors, larger doors, and removable seats. The program was recently revised with more attractive terms in the hopes of drawing in greater airline participation.

There are also significant incompatibilities between military and commercial communications systems. Differences between communications equipment on commercial aircraft and at military ground control stations, and the lack of IFF (Identification Friend or Foe) equipment, are identified weaknesses in the system that are beginning to be addressed by the Air Force.

Assuring readiness and responsiveness. Finally, the use of voluntarily committed commercial resources, not optimally suited to military missions, raises the issue of how to ensure sufficient readiness and responsiveness of these assets. The Air Force must try to balance the need to maintain a high rate of participation against the need to enforce CRAF rules, and must balance the need to withhold information which might jeopardize national security while providing the airlines with sufficient planning data.

The information contained in this document was based on the most current publicly available literature, historical handbooks, a solicitation for CRAF peacetime air services, the 1988 edition of the MAC Regulation 55-8, phone interviews with MAC personnel, and material from MAC HQ received by RAND colleagues in a recent interview with MAC representatives, including the CRAF inventory summary sheet. Several drafts were reviewed by MAC.

¹Coping with problems introduced by incompatible systems is using them as is, whereas addressing the problem is defined as making modifications to reduce or resolve the problem.

ACKNOWLEDGMENTS

The author would like to express thanks to those individuals who contributed greatly to this work. Project sponsorship came from the Directorate of Space and SDI programs of the Office of the Assistant Secretary of the Air Force for Acquisition, Plans and Policy (SAF/AQS). The project monitor was then Lt Col Ted Mervosh, formerly assigned to SAF/AQS-P. Katherine Poehlmann, the Project Leader, provided guidance to the overall project and to this research.

A number of documents and data used in this research came directly from Headquarters, Military Airlift Command (HQ MAC). Several MAC representatives provided invaluable assistance, in particular Ronald B. Van Horn, Program Analyst, Chief of Capabilities, Office of the Assistant for Civil Air, DCS/Plans and Programs (MAC), who reviewed this document, Mr. Patrick Absher, formerly with the Office of the Assistant for Civil Air, DCS/Plans and Programs, Lt Col George Jenkins, Deputy Assistant for Civil Air, DCS/Plans and Programs, and Gail Kreitner in MAC's Office of Contract Airlift.

The Note reflects updated information on the CRAF provided by RAND colleagues Christopher Bowie and John Lund from their recent visit to MAC. Laura Zakaras, a communications analyst, provided excellent assistance in organizing the document's material. Finally, much credit belongs to Christopher Bowie, the document's technical reviewer and an airlift expert, who, through his careful and helpful review, greatly influenced the final product.

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GLOSSARY

AFB	Air Force Base
AFLC	Air Force Logistics Command
ALTNT	Alternate
AQS	Acquisition
ARINC	Aeronautical Radio Inc.
AUTODIN	Automatic Digital Network
BOCCA	Bureau for the Coordination of Civil Aviation
CEP	CRAF Enhancement Program
CINCMAC	Commander-in-Chief, Military Airlift Command
CINCUSTRANSCOM	Commander-in-Chief, US Transportation Command
CONUS	Continental United States
CRAF	Civil Reserve Air Fleet
CSI	Commercial SATCOM Interconnectivity
DCS	Deputy Chief of Staff
DDN	Defense Data Network
DMS	Defense Military Services
DoC	Department of Commerce
DoD	Department of Defense
DoT	Department of Transportation
ESS	Electronic Switching System
FEMA	Federal Emergency Management Agency
FLOT	Forward Line of Own Troops
FOL	Forward Operating Location
GDSS	Global Decision Support System
IFF	Identification, Friend or Foe
JCS	Joint Chiefs of Staff
JV	Joint venture
LOGAIR	Air Force Logistics Airlift
MAC	Military Airlift Command
MACALT	MAC Alternate (headquarters)
MACR	Military Airlift Command Regulation

MAG	Military Airlift Group
MBI	Mobilization Base Index
MHS	Materials-Handling System
MoA	Memorandum of Agreement
MoU	Memorandum of Understanding
MPM/D	Million passenger miles per day
MTM/D	Million ton miles per day
NAF	Numbered Air Force
NAPCAP	NATO Allied Precommitted Civil Aircraft Program
NAVMTO	Navy Materiel Transportation Office
NAVSUPSYSCOM	Naval Supply Systems Command
OET	Office of Emergency Transportation
OSD	Office of the Secretary of Defense
PSN	Public Switched Network
QUICKTRANS	Navy Quick Transportation
RFP	Request for Proposal
SAF	Secretary of the Air Force
SATCOM	Satellite communications
SDI	Strategic Defense Initiative
TCJ3/4	Transportation Command Joint Staff of Operations and Logistics
USAFR	U.S. Air Force Reserve
USTRANSCOM	U.S. Transportation Command

I. INTRODUCTION

DoD space policy established in 1987 calls for the use of nonmilitary satellites as a means of increasing space capabilities during crises when defense requirements might exceed military capabilities. Unsure of the appropriate management structure that would best make these assets quickly available to DoD during a national emergency or war, the Air Force was interested in whether the Civil Reserve Air Fleet (CRAF), a similar program planning for the use of nonmilitary resources, might provide some insight. Nongovernment ownership of resources, technical differences between military and nonmilitary systems, and assured military access to commercial assets are just a few examples of issues shared by the CRAF and a program using nonmilitary space systems.

BACKGROUND

In the event of a war or national emergency, if the military need for airlift is greater than what U.S. Air Force transports can supply, commercial aircraft committed to the Civil Reserve Air Fleet could be mobilized to fly military missions. The CRAF is an Air Force program set up to use U.S. commercial aircraft under emergency conditions. Either the Commander in Chief of the Military Airlift Command (CINCMAC) responsible for all military air transportation or the Secretary of Defense would activate the CRAF if MAC could not supply the military with adequate airlift services from its aircraft resources. The Air Force could use CRAF aircraft to transport troops and equipment from CONUS to other theaters, maintain Air Force and Navy airlift services between domestic bases, and aurally evacuate individuals who need medical attention back to CONUS.¹

The military use of commercial aircraft during World War II and later the Korean War led to the creation of the CRAF. Both times the reason for using airliners instead of military transports was simple. the nation owned too few transports and badly needed additional aircraft to carry out its defensive missions. The military gained its first experience in working with the airlines in World War II when President Roosevelt directed the

¹In addition to these missions, MAC is also responsible for special operations aircraft, combat search and rescue, and weather reconnaissance aircraft. The specified command supports air sampling missions, and provides operational-support airlift, including helicopter support for SAC missile sites. It operates special forces aircraft and is the executive management agency for all federal search and rescue within the contiguous United States. See "Military Airlift Command," *Air Force Magazine*, May 1989, pp. 76-80.

Secretary of War on December 31, 1941 to take possession of any commercial aviation assets required by the war effort.² At that time MAC, then called the Air Corps Ferrying Command, could not meet the demand for airlift from government-owned airlifters. One of MAC's first missions was to ferry American-built lend-lease aircraft overseas to the United Kingdom.³ Commercial aircraft flew hundreds of missions and made significant contributions throughout World War II. Commercial transports flew military missions during the Berlin Crisis in 1948-49 when airlift was the only available means of delivering food and supplies to West Berlin.

One decade later, after receiving so much help from the civil aviation industry during the war effort, the Air Force needed it again. Between World War II and the beginning of the Korean War, military transport capability languished. During the same years the aviation industry grew rapidly. By June 1950, at the outbreak of the Korean War, there were just enough military airlift crews to provide a 2.5 hour-per-day utilization rate.⁴ The military's previous experience with the airlines, combined with the beginning of the Korean war in the early 1950s and equipped with insufficient airlift resources, led President Truman to consider establishing a more permanent partnership with the airlines.

In response to the delays and inefficiencies involved in transferring commercial aircraft from normal operations to military mission control, President Truman issued an executive order in December 1951, signed the next year by President Eisenhower. The directive called for a program to formalize agreements between DoD and the airlines for the use of their aircraft during military contingencies; it gave responsibility for developing the program to the Secretaries of Commerce and Defense. Their joint Memorandum of Understanding (MoU) signed in 1952 established the CRAF. With that agreement, the CRAF did away with DoD's ad hoc use of commercial aircraft and allowed for the first time systematic planning beforehand for their use under prescribed circumstances. The CRAF was activated for the first time on August 18, 1990 in support of Operation Desert Shield, which involved a massive airlift of troops and equipment to Saudi Arabia.⁵ Before the recent call-up, on a number of other occasions, the airlines have voluntarily offered their resources for military use.⁶

²Major General Donald D. Brown, "USAF Mobility Requirements," *Proceedings from the International Air Transportation Conference*, June 1-3, 1983, Montreal, Canada, AIAA-83-1588, p. 1.

³Dick J. Burkard, *Military Airlift Command: Historical Handbook 1941-1984*, MAC, United States Air Force, Scott AFB, IL, December 1984, p. 1.

⁴*Ibid.*

⁵Phone call to MAC, August 31, 1990.

⁶Commercial aircraft and crews participated in Operation Baby Lift during the Vietnam withdrawal in 1975 and in 1978 evacuated U.S. military dependents from Tehran

LOW COST TO THE AIR FORCE

The single most important advantage the CRAF offers the Air Force is its low hardware and maintenance cost. Expanded emergency airlift or airlift required during contingencies purchased from the commercial sector costs a fraction of what it would to meet airlift requirements with additional military organic transports. The airlines own and maintain their aircraft, operate them daily, employ aircrews and groundcrews, and have support facilities available to them wherever they fly in the world. In short, the military can use aircraft and key personnel during war that someone else has paid for, maintained, and trained during peacetime.⁷

The CRAF's low peacetime expense coupled with its ability to haul militarily useful payloads are probably the greatest advantages it offers the Air Force. Apart from some modification costs to incorporate cargo convertible features in wide-body commercial passenger aircraft (Sec. III), CRAF hardware costs to the Air Force are practically nonexistent. Comparing any military aircraft program against the CRAF is unfair in some respects because of the obvious cost advantage of the CRAF and important design differences and capability between military and commercial aircraft. Nevertheless, just by looking at the cost of several military airlifter programs, it is easy to see the compelling logic behind "buying" contingency airlift from the CRAF.

The program producing the largest airlifter, the C-5B Galaxy, in the MAC inventory is now nearing completion. It supplies MAC with 50 intertheater cargo aircraft, at a cost, estimated by one source, of about \$6.6 billion.⁸ Because it can carry items and loads that are either too large or too heavy to go into MAC's other strategic transports—the C-141 Starlifter or C-130 Hercules—the C-5B is a unique aircraft in the history of U.S. military aviation.⁹ The C-17 program, just beginning, serves another important need: it can directly deploy troops

just before the takeover of the American Embassy in Iran. For information on the Vietnam withdrawal, see Burkard, p. 12; for more information on the Tehran evacuation, see Col. Shirley M. Carpenter, USAFR, et al., "Aircrew Manning Constraints on the Civil Reserve Air Fleet (CRAF)," *Air Force Journal of Logistics*, Summer 1983, p. 14, also Burkard, p. 14.

⁷CRAF aircraft are not strictly free. MAC would pay for extra installation of equipment on aircraft considered essential for military missions, such as emergency voice transmitters, aeronautical charts, and in the future to include Identification Friend or Foe (IFF) equipment.

⁸For number of aircraft, see "Lockheed is in Talks with Fokker for Job After C-5B Project," *Wall Street Journal*, 15 January 1988, p. 22. For program cost see "Budget Cut Pressures US Industry," *Flight International*, 6 May 1989, pp. 20-21.

⁹The C-5 can carry main battle tanks, large missiles such as Minuteman, or mixes of aircraft and helicopters.

and equipment from a main operating base (MOB) in CONUS or elsewhere to a forward operating location (FOL) in Europe close to the FLOT and can either airdrop its cargo or offload on the ground. The program calls for the delivery of 210 aircraft by 1998-2000 at an estimated cost of \$37.7 billion.¹⁰ The cost could go higher—for just the first six airlifters, DoD requested \$3 billion.¹¹ While these military airlifters perform roles commercial aircraft cannot, one C-5B costs the taxpayer over \$100 million.

The private sector, on the other hand, offers inexpensive capability to meet contingencies, provided militarily useful aircraft can be brought into the program. The airlines are adding to and modernizing their already impressive inventories by ordering in record numbers new wide-body aircraft capable of long-range international flights. Backorders of undelivered aircraft have never been higher and nearly all major aircraft manufacturing companies are operating near capacity. Since strategic or long-range intertheater airlift is one of the MAC's main missions, these developments could directly benefit the military. Investments to upgrade and expand the airlines' own inventories run into the billions of dollars. In fact, one aerospace manufacturer estimates the market for new commercial aircraft to be worth \$450 billion between 1989 and 2005. Most of that will be for U.S. carriers—all at no charge to the taxpayer.¹²

The flurry of orders is due to the convergence of a number of phenomena, including:

- A rapidly growing air travel industry
- Replacement of aging aircraft fleets
- Decisions by some carriers to proceed with acquisition plans which had previously been put on hold due to deregulation
- Strengthened financial positions of the airlines
- Fear of stretched out delivery dates due to the high demand for new aircraft.¹³

According to Aerospace Industries Association of America, the number of passenger miles and cargo ton miles flown by U.S. carriers is up (Table 1).¹⁴ From 1980 to 1988, while U.S.

¹⁰Julian Moxon, "Pentagon Approves C-17s," *Flight International*, December 24-31, 1988, p. 5.

¹¹"Cassidy Links 66 MTM/D Airlift Capacity to Delivery of Last C-17," *Aerospace Daily*, March 1, 1989, pg. 330.

¹²"Airliner Makers Struggle with Growth," *Interavia*, June 1989, pp. 520-523.

¹³"Airframe Makers Exploit Boom by Adding Production Capacity," *Aviation Week and Space Technology*, May 29, 1989, pp. 95-98.

Table 1

GROWTH IN PASSENGER AND CARGO
TRAFFIC FROM 1980 TO 1988

Type Service	1980	1988
Passenger	255	423
Cargo	7	11

^aPassenger service is measured in billions of revenue passenger miles. Cargo service is measured in billions of revenue cargo ton miles.

air carriers coped and finally adjusted to deregulation, they also flew over 65 percent more passenger miles and almost 65 percent more cargo ton miles. Recent attention on the structural fatigue of older jets is expected to produce tighter regulations, mandatory inspections, and a scheduled replacement of critical parts, thus increasing the cost of retaining aging aircraft in active inventories. According to one estimate, new regulations could force modifications on 1300 aircraft at a total cost of \$800 million.¹⁵ This may accelerate the rate to retire older aircraft for newer, bigger, more fuel efficient ones. Another event working in MAC's favor is the airlines' push to expand beyond the domestic air service market as they develop long-range international routes to maintain and expand their business. With stiffer competition on domestic routes, some airlines are pushing or expanding into the international market just to keep up their business volume. New buys are also possible because of the industry's renewed financial health. With the gradual strengthening of the financial position of most airlines, they can now afford to build up and modernize their fleets.

Air carriers commit not only their aircraft to the CRAF, but also their logistical support already in place at airports throughout the world. The Senior Lodger system, which becomes operational upon activation of Stage III, is expected to provide support services to CRAF and allied aircraft if the parent company cannot provide the necessary services at each Senior Lodger airport. Airlines may be flying aircraft on routes traveled at lower rates during peacetime and may not have sufficient ground support at particular airfields. A

¹⁴"Aerospace Facts and Figures 89/90," *Aviation Week and Space Technology*, 1989, pp. 84-85.

¹⁵The Airworthiness Assurance Task Force, a joint industry group, gave the estimate in "Economic Impact of Aging Aircraft Fixed Remains Unclear," *Aviation Week and Space Technology*, May 29, 1989, pp. 26-27.

Senior Lodger is a carrier which normally has the greatest support capability and/or largest number of aircraft flying in and out of an airport. The Senior Lodger can expect support from the host government within whose borders the airfields are located.

The Senior Lodger system provides for routine maintenance facilities, trained ground personnel and crews, and limited spare parts at Senior Lodger airports. The use of civil airports for services such as refueling, deicing, food, and so on, cuts down congestion at military air bases that would otherwise occur if commercial jets required these types of services from military facilities. As a result of the Senior Lodger system, greater airlift to a particular area is possible.

THE CRAF CONTRACT: WHO MAY PARTICIPATE

Airlines Must Meet Certain Conditions

Airline participation in the CRAF is voluntary. To participate in CRAF, a U.S. air carrier must meet certain criteria, agree to the conditions in the MAC/carrier MoU, and execute a standard MAC contract. Signing the MoU imposes no financial obligation to either party but states the conditions airlines must meet to join and lets the carriers know what MAC expects from them if activation occurs. To join the CRAF an air carrier must:

- Offer aircraft suitable for CRAF allocation
- Provide sufficient resources with each transport—such as air and ground crews, support personnel and support facilities—to allow up to 10 hours of use per day until it is “practical” for MAC to release them back to their normal operations¹⁷
- Operate in accordance with Federal Aviation Administration (FAA) regulations
- Maintain U.S. registry or control of the aircraft at all times.¹⁸

¹⁶Much of the information in this section was derived from MAC, *Airlift Service Procurement Request for Proposal*, International Air Transportation Services for Civil Reserve Air Fleet (CRAF)—Long Range International, 16 January 1988.

¹⁷ “[T]hose [aircraft] no longer needed will be released . . . for commercial operations as soon as practical.” See *Operations: Civil Reserve Air Fleet (CRAF)*, MAC Regulation 55-8, 28 June 1988, p. 17.

¹⁸Examples of failure to maintain control of the aircraft include (1) failure to retain U.S. registry, (2) leasing of aircraft to unapproved foreign carriers, (3) dry [without fuel] leasing of aircraft to U.S. airlines or aircraft operators not possessing a temporary or permanent certificate issued by the Department of Transportation, (4) removal of aircraft from active utilization (in storage, out of service or parked) and not flyable for reasons other than maintenance, repair or overhaul. See MAC *RFP* dated 16 January 1988, p. C-2.

- Provide and maintain a minimum of four qualified crews per CRAF aircraft *exclusive of Reserve or National Guard commitments* since these individuals would be called up for active duty by their respective service upon activation of the CRAF and be unavailable to fly CRAF missions; these employees should be excluded from consideration at the start
- Ensure that all cockpit aircrew are U.S. citizens and are eligible for security clearance levels of secret at the time of activation.¹⁹
(CINCUSTRANSCOM will authorize SECRET clearances upon activation of any stage.)
- Agree to a maximum response time after program activation.²⁰

When the program is activated—in August of this year, the CRAF was activated for the first time in history—the DoD agrees to pay for aircraft operating costs and would compensate the airlines for the use of the transport as well as incurred expenses, such as spare parts, petroleum-oil-lubricants (POL), and certain other costs.²¹

Suitable aircraft are those that can carry militarily useful payloads, such as troops or equipment. Criteria measuring military usefulness are defined. In particular, MAC determines usefulness in terms of the payload the aircraft can carry, structural lifetime, block speed, and range (See Table 2). Payload is the overall weight that can be carried a specified distance. Structural dimensions or fuselage volume will determine how many pallets of bulk cargo can be stowed aboard, what equipment can be carried in a combat-ready configuration, or how many troops can be airlifted. The importance of speed and range can not be overstated.

¹⁹MAC agreements state that the air carrier "...is responsible for obtaining a personnel security clearance of SECRET for all aircrew members performing duties on the flight deck in support of all flights operated under [the] contract." See the MAC RFP dated 16 January 1988, p. H-20.

²⁰RFP, p. C-2.

²¹On August 18, 1990, MAC activated thirty-eight CRAF aircraft capable of flying long-range international flights. Altogether, seventeen passenger and twenty-one cargo airliners were called up.

Table 2
MOBILIZATION VALUE COMPUTATION FACTORS

Payload	Unit of Measure
Payload	Aircraft load carrying capability at a specified range
Volume	Number of 463L pallets and containers (military standard pallets) carried on board cargo aircraft or passenger aircraft with lower cargo berths
Block speed	Block speed is computed using distance and average cruise speed plus 25 minutes for departure, arrival, and parking
Standard range	For example, 400, 1500, 3500 nm capability per aircraft

Allocation to the CRAF

Once MAC decides the aircraft offered are militarily acceptable and useful, it works with the Department of Transportation (DoT) to allocate those transports to the CRAF. The responsibility of overseeing civil transportation resources transferred from the DoC to the DoT when DoT was established in 1972. The Secretary of Transportation sets priorities for the use of the nation's commercial transportation assets, including commercial aircraft, during wartime or in a national emergency. Its Office of Emergency Transportation (OET) actually makes the allocation. During either type of crisis, the DoT would manage transportation resources to keep vital sectors of the economy functioning.²² To avoid both

²²In the event a crisis requires more airlift than what MAC and the entire CRAF can provide, procedures exist to pull in non-CRAF commercial aircraft to support military missions. In wartime, all commercial aircraft not in the CRAF would revert to the War Air Service Program within the Department of Transportation. WASP aircraft would maintain service on essential air routes in support of critical sectors of the domestic economy, such as the continued supply of essential materials to the industrial base. According to a Joint Chief of Staff publication, DoD may request "(d)uring periods of crisis, tension, or war..." the Department of Transportation to allocate from its authority available commercial transports to CRAF Stage III. See The Joint Chiefs of Staff, *Mobility System Policies, Procedures and Considerations*, JCS Publication 15, Washington, D.C., 15 September 1983, p. III-3.

the DoD and DoT depending on the same aircraft at the same time, DoT keeps track of all commercial aircraft, allocates to MAC those aircraft committed to the CRAF, and bases its own emergency plans on the remaining aircraft.

The advantage to clear lines of authorities within the government over the use of critical resources during war is clear: less time is lost in transferring them over to military operations. Prior arrangements for mission control of air carriers allows the most efficient use of these critical resources. As soon as war or a national emergency is declared, all aircraft would fall either under the authority of the DoT or DoD. Since both agencies agree to the allocation in peacetime, commercial operators know immediately who they would report to if hostilities occur.

DOCUMENT OUTLINE

The sections that follow discuss the issues posed by the military use of commercial aircraft during war or a national emergency. Section II sets out the problem of attracting sufficient participants into and keeping them in a voluntary program. The incentive of peacetime contracts proved to be the most effective, but the introduction of sensible rules within this framework has also increased participation. Section III discusses the problem of design incompatibilities. One of the greatest obstacles to the successful use of commercial aircraft for military purposes is their different construction and design. The CRAF Enhancement Program represents the Air Force's most ambitious attempt to deal with this problem. Section IV discusses the challenge of assuring CRAF responsiveness and readiness. Obviously, the use of civilian personnel and equipment poses particular problems for training, security, and readiness. Finally, Section V offers a summary of CRAF's efforts to address each of the major issues and suggests how these issues also pertain to the military use of commercial satellites.

II. INCENTIVES FOR PARTICIPATION

SHORTFALL IN STRATEGIC CARGO AIRLIFT

In the congressionally mandated Mobility Study of April 1981, the Department of Defense set a minimum strategic cargo airlift goal for MAC of 66 million-ton-miles per day (MTM/D) to be reached by the mid 1990s.¹ The Air Force's organic airlift can transport 30 million-ton-miles per day, which would meet 45 percent of the airlift goal.² According to these estimates, 36 MTM/D of the mobility goal is still unmet. CRAF's long-range international cargo aircraft has a current capacity of just over 17 MTM/D.³ (See the appendix for current CRAF inventory as of July 1, 1990.) Capability is not totally captured in the unit "million-ton-miles." For instance, it does not indicate ability to transport equipment in a combat-ready configuration, carry supplies all the way to the forward battle location, or airdrop its cargo. Nevertheless, this measure is used to roughly approximate airlift requirements.

According to General Duane H. Cassidy, former U.S. Transportation Command (USTRANSCOM) Commander-in-Chief, the DoD airlift goal would be reached by 1998 or 2000 with the completion of the 210-aircraft C-17 program.⁴ The current budget submission provides for 120 aircraft. However, if more than one scenario is assumed, then the airlift requirement would have to be adjusted from 66 MTM/D to between 75 and 125 MTM/D. The mobility target refers to cargo, not passenger capability.

¹*Emergency Airlift: Responsiveness of the Civil Reserve Air Fleet Can Be Improved*, Report to the Secretary of Defense, GAO/NSIAD-86-47, General Accounting Office, March 1986, pp. 8-9, and private correspondence with HQ MAC on September 15, 1989.

²Correspondence from MAC, May 10, 1990.

³Wide-body aircraft would provide 12.5 MTM/D and another 3.9 MTM/D would be supplied by narrow-body airliners. Figures are from HQ MAC as of September 1, 1989.

⁴A presidential order signed by President Reagan in April 1987 (activated on October 1, 1988) established the U.S. Transportation Command (USTRANSCOM). Co-located with HQ MAC at Scott Air Force Base in Illinois, this new unified command would monitor the peacetime operations of all defense transportation commands and would provide a single channel of communications between the Secretary of Defense and all three lift commands. MAC's operational and day-to-day responsibilities are unchanged, including those concerning the CRAF. See "United States Transportation Command," News Release No. 8825, September 27, 1988, p. 30. For number of aircraft, see "As Air Cargo Grows, Pentagon Tries Again to Revive CRAF," *Aerospace Daily*, January 25, 1989, p. 139.

By MAC estimates, CRAF's passenger capability could support a national emergency. The CRAF requirement for war and national emergency is 225 wide-body aircraft equivalents and is almost met with their current inventory of 201 wide-body equivalents.⁵ CRAF is expected to move 95 percent of all troops airlifted into a theater during war.⁶ Plans to review the ability to move these troops will include consideration of the space required by fully dressed soldiers with additional gear. According to recent figures, 252 long-range passenger jets in the CRAF would supply 147 million passenger miles per day (MPM/D).⁷ (See the appendix for complete CRAF inventory as of July 1, 1990.)

Participation of the Airlines

The CRAF captures approximately 60 percent of the currently available aircraft capable of long-range international travel *that MAC can use*, according to a CRAF operations analyst at MAC headquarters.⁸ In July 1990, of the 506 aircraft in the CRAF inventory, most were capable of long-range international flights and most of those were passenger transports (see Table 3).⁹ Cargo aircraft make up over a third of the CRAF transports able to fly intertheater airlift.¹⁰

Table 3

NUMBER AND CAPABILITY OF CRAF LONG-RANGE INTERNATIONAL AIRCRAFT AS OF JULY 1, 1990

Aircraft Type	No. of Aircraft	Capability	
		MPM/D	MTM/D
Passenger	252	147	—
Cargo	141	—	17
Total	393	147	17

⁵A wide-body equivalent is based on the capability of a B-747 [phone call to HQ MAC on September 15, 1989].

⁶*Airlift Services Management Report*, FY1987 First Quarter, Quarterly Airlift Management Report, MAC, p. 21.

⁷Monthly Civil Reserve Air Fleet (CRAF) Capability Summary, MAC HQ Form O-312, July 1, 1990.

⁸Correspondence from MAC, May 10, 1990.

⁹MAC measures capability in units of million passenger miles per day (MPM/D) for passenger aircraft and million ton miles per day (MTM/D) for cargo aircraft. The capability figures came from the *Monthly Civil Reserve Air Fleet (CRAF) Capability Summary*, September 1, 1989, HQ MAC.

¹⁰CRAF cargo aircraft come in three varieties: convertible, freighter, and combi-transports. Combi-aircraft carry both passengers and cargo at the same time (cargo stored in the aft section), whereas convertible carriers can be reconfigured overnight to transport either passengers or cargo. MAC gives the highest value to freighters, which carry only cargo.

The number of U.S. commercial aircraft flying is much higher than what is currently committed to the CRAF. Yet MAC claims to capture most of what they can use from that inventory. According to a census of worldwide airlines in 1989, there were about 3900 aircraft owned or operated by U.S. carriers.¹¹ Roughly 870 aircraft are of a similar type as aircraft committed to the CRAF, but not all of those are capable of strategic missions or able to meet MAC's other requirements for "military usefulness."

Long-range international aircraft, which make up most of the CRAF, must meet certain military payload criteria. For instance, aircraft used for strategic missions must have extended over-water capability, FAA approval to operate internationally, and four aircrews assigned to each plane. In addition to these requirements, cargo aircraft must have a rail and locking system whose dimensions are compatible with military pallets. Taken together, these criteria eliminate many aircraft from consideration. Out of more than 3900 U.S. commercial jet aircraft flying today, more than 700 are useful for strategic DoD airlift missions.¹² MAC's ability to bring in over 500 of those aircraft which are useful is largely due to the guaranteed business they offer CRAF participants.

CURRENT INCENTIVES FOR U.S. CARRIERS

Peacetime Contracts

The multi-year contracts between the carriers and MAC which outline the military's criteria for participation in the program also open the door to DoD's guaranteed peacetime airlift business. Because no direct compensation to the carriers for services rendered occurs until activation, MAC began the practice of offering a certain percentage of its peacetime airlift business to the airlines as an inducement for wider participation.

¹¹This number includes aircraft produced by Airbus, Boeing, Lockheed, and McDonnell-Douglas. Of these, about 1070 jetliners are of the same type found in the CRAF; when leased aircraft are excluded, this number drops to approximately 870 carriers. Bron Rek, "The World's Major Airlines," *Interavia*, October 1989, pp. 984-1045.

¹²The 700 useful aircraft estimate is given by MAC (May 10, 1990). Corroboration of this figure was beyond the scope of this study.

According to MAC estimates, MAC spends about \$600 million a year for airlift services provided by commercial airlines for the routine movement of troops and equipment.¹³ The military is the airlines' largest single customer. Most of MAC's peacetime flying time, and consequently CRAF peacetime contracts, are concerned with "channel missions" that provide regular service between military bases or other important locations. MAC has about 880 active channels operating in 87 nations it must routinely serve either with its own transports or CRAF aircraft.¹⁴ MAC's ability to capture the bulk of available commercial cargo capability in the program—it claims to have signed up over 70 percent of all available U.S. cargo aircraft—rests on the monetary value of those contracts and the flexible terms they now offer the airlines.¹⁵

The Air Force lets contracts preferentially to the airlines according to the military usefulness of the aircraft they commit to the CRAF. MAC determines the worth of each aircraft by assigning it Mobilization Value (MV) points, the measure of the value DoD places on an aircraft for meeting wartime requirements.¹⁶ It awards contracts on the basis of an overall "point" score, among other things, at a rate tied to the costs of operation. Rates are determined by pooling the operational costs of all air carriers participating in the CRAF and arriving at a "fair" price. MAC also bases its awards on such factors as whether the carriers agree to use uniform MAC negotiated rates and the extent to which the carrier successfully arranges "no work stoppage" agreements with its employees. Carriers can negotiate to receive bonus credits by placing firm orders for wide-body convertible or cargo aircraft.

Two kinds of contracts form the basis for CRAF contracts. Both involve commitment of aircraft and personnel to the CRAF but differ in what stage of activation they must commit aircraft to and whether peacetime airlift is involved. CRAF assets are called up in three stages that correspond to the severity of the crisis. Each type of contract is described below:

¹³ "Pentagon Pursues Additional Commitments from Airlines to Boost U.S. Airlift Capacity," *Aviation Week and Space Technology*, January 30, 1989, p. 24.

¹⁴ "Military Airlift Command," *Air Force Magazine*, May 1989, pp. 76-80.

¹⁵ Private correspondence with HQ MAC on September 15, 1989.

¹⁶ Mobilization value computations are based on aircraft payload, volume, block speed, configuration incentive (long-range aircraft only), and range (See Table 2). See MACR 55-8, 28 June 1988, p. 14.

- Commitment to the CRAF *without* fixed buy airlift business: Aircraft are committed to Stage III only, and are eligible for expansion business.
 - Stage III indefinite quantity, indefinite delivery contracts* are those in which carriers participate in peacetime DoD expansion business and agree to make aircraft available for Stage III activation of the CRAF.
- Commitment to the CRAF *with* peacetime airlift business: Resources must be committed to all three stages of the CRAF to qualify for the long-range international contracts, and to Stages II and III for short-range international, domestic, Alaskan, and aeromedical contracts:
 - Fixed buy contracts* cover regular, anticipated peacetime airlift business over three years' time and bind the air carriers to provide specific aircraft to their level of CRAF mobilization.
 - Delivery orders for expanded airlift services* fill any gaps left in the fixed buy contracts. Under provisions of the fixed buy contract, from time to time the government may order additional airlift services from that carrier, subject to the contractor's acceptance. If services cannot be procured here, MAC may also award expanded services to other carriers participating in CRAF but not in fixed buy contracts.

Staged Activation

MAC introduced staged mobilization of commercial air transportation assets in 1963 to increase program participation by addressing one of industry's concerns. Original CRAF procedures called for mobilization of all aircraft in the program for any declared crisis, whether minor or catastrophic, which caused reluctance among some carriers to join the CRAF. These carriers feared that if their committed aircraft were called into CRAF service but not used, their competitors would profit from assets unnecessarily pulled away from regularly scheduled flights. Staging also made economic sense for the government, which otherwise would have had to pay for the costs of activating unused aircraft. An MoU signed in 1963 by the Departments of Defense and Commerce outlined the concept for the three activation stages of CRAF.¹⁷ Another DoT-DoD MoU signed in 1981 established

¹⁷John Conrad Pathwick-Paszyc, "The Acquisition of Airlift Services from Commercial Sources: A Revised Method," Thesis from the Naval Postgraduate School, NTIS ADA 058 039, December 1979, p. 21.

procedures for incremental activation of even within these stages of call up.¹⁸ This agreement fine-tuned the activation of assets down to the level of individual aircraft, so that mobilization could be as equitable as possible.

Each succeeding stage of activation corresponds to an increasingly worsening situation and is activated by a successively higher level of authority. Upon activation, crews would arrive with the fully fueled aircraft at the designated onloading site within a specified time. CRAF's three stages of activation are:

- *Stage I, "Committed Expansion,"* is an increase in current airlift requirements. Activated by the Commander-in-Chief, MAC (CINCMAC), the CRAF would help fill vacancies in the channel traffic caused by the deployment of organic MAC aircraft elsewhere and provide support for other military missions. Channel traffic is the routine airlift the Air Force conducts between important locations in its normal peacetime operations. Only those aircraft (mostly cargo) that can fly long-range international routes are committed to this stage. Aircraft, crew, and sufficient support resources are expected to be available for service within 24 hours of activation.
- *Stage II, "Defense Airlift Emergency,"* would be activated by the Secretary of Defense in emergencies falling short of full mobilization or a declaration of a national emergency. Both long-range and short-range international missions, as well as some domestic and Alaska missions are involved, but most emphasis is on long-range international aircraft. Aircraft and crew committed to this stage would report for duty within 24 hours of activation.
- *Stage III, "National Emergency,"* is the full mobilization of the CRAF. During wartime, in a defense-oriented national emergency, or in time of a non defense-oriented national emergency, the Secretary of Defense could activate Stage III.¹⁹ All aircraft in the CRAF are expected to be ready to fly missions within 48 hours of receiving their orders. More time is allowed since this stage

¹⁸A DoD-DoT MoU signed in 1981 established procedures for incremental activation. See *United States Air Force Fact Sheet. Military Airlift Command*, July 1986.

¹⁹This stage may also be called by the Director of the Federal Emergency Management Agency (FEMA) in a national security situation short of a declared defense-oriented national emergency. See The Joint Chiefs of Staff, *Mobility System Policies, Procedures and Considerations*, JCS Publication 15, Washington, D.C., 15 September 1983, p. III-3.

requires a significantly greater percentage of the airlines' assets compared to Stages I and II.²⁰ Senior Lodger stations may be activated after the decision is made to mobilize Stage III aircraft.²¹ Their activation orders would come from the HQ MAC CAT director.

Reimbursement rates during activation depend on which stage is mobilized. The same peacetime rates which were generated from data provided by all CRAF carriers on their respective operating costs would apply during activation of Stages I and II. Stage III rates are established by negotiation between the contractor and the government according to established procedures. Unless such negotiations take place and evidence is presented to the contrary, it is assumed that the rate of compensation for Stage III would be the same as that provided in the request for proposal (RFP) for peacetime airlift.²²

New Efforts to Increase Participation

Greater contract flexibility is one reason MAC recently boosted the number of cargo transports it brought into the CRAF.²³ They introduced the concept of joint ventures several years ago to help bring in the package delivery companies and other cargo airlines who were not able to meet MAC's requirement for four aircrews per aircraft from their own resources. Joint ventures allow airlines to contractually pool their aircrew assets to come up with a complete joint venture package. For instance, air crews from one airline can now be pooled together with a cargo aircraft supplied by another airline. Mobilization value would be given to the entire joint venture package and contracts let on that basis.²⁴

Finally, MAC and the air carriers have agreed to multiple-year peacetime airlift contracts. The airlines like the longer planning horizons to better integrate DoD business into their regularly scheduled traffic. Longer contracts required cooperation with Congress to pass legislation allowing multi-year agreements and to allocate the funding.

²⁰Major P. Lacombe, "CRAF—Our Partners in Airlift," *The MAC Flyer*, May 1984, pp. 16-17; also, GAO/NSIAD-86-47, p. 10, and *Airlift Services Management Report*, MAC, First Quarter, 1987, p. 22.

²¹MAC Regulations 55-8, pg 18.

²²MAC RFP, p. B-56, January 1988.

²³MAC says one of the main reasons for the increase is the introduction of new cargo aircraft into commercial inventories; nevertheless, the incentives discussed in this section are important to MAC's ability to draw in those aircraft. [Phone call to MAC on September 15, 1989.]

²⁴James Kitfield, "New Hopes and Hurdles for CRAF," *Military Forum*, September 1989, pp. 18-21.

ALLIED COMMERCIAL AIRCRAFT PARTICIPATION

The concept of expanding the military's capability during global contingencies through the use of commercial transports also includes transports operated by foreign carriers in allied countries. Agreements signed between MAC and the governments of nine NATO allies and South Korea promise foreign airlift assistance to the U.S. Air Force under certain conditions.²⁵ The NATO Allied Precommitted Civil Aircraft Program (NAPCAP) includes transports for use in contingencies involving the European theater. South Korea promises to make available some of its aircraft in the event of conflict involving the Republic of Korea. Detailed information on technical and operational agreements, aircraft type and capability, and the conditions in South Korea that would precipitate a mobilization of that country's aircraft for U.S. use is covered in classified agreements.

The foreign transports would be brought under MAC's mission control if, during wartime, the airlift requirement for the deployment of U.S. forces to a NATO or Korean theater outstrips both U.S. military and CRAF airlift capabilities. NATO commercial aircraft would only be used if a NATO theater is involved; South Korean commercial aircraft would be supplied only if the theater includes the Republic of Korea.

In NAPCAP, nations politically commit their aircraft to SACEUR's Rapid Reinforcement Plan. SACEUR allocates these aircraft to the Military Airlift Command for reinforcement purposes. With certain exceptions, the aircraft become available to MAC when SACEUR decides to reinforce NATO Europe. The exceptions are in the case of the U.K., Portugal, and Canada. Aircraft committed by these nations become available to MAC after they complete their own reinforcement efforts.²⁶

MAC transmits mission assignment to the appropriate agency in each country providing airlift support. The appropriate agency is designated in the agreements MAC has signed with each nation. NAPCAP aircraft are expected to respond similarly to CRAF aircraft under Stage III conditions. Within 48 hours of the airline's receipt of the NAPCAP activation message, the allied aircraft is expected to be at the designated onload site, fully fueled. Like the CRAF, mission control of flights for NATO (or South Korean) commercial

²⁵Under the terms of agreement, the governments of Belgium, Canada, Italy, Luxembourg, the Netherlands, Norway, Portugal, the United Kingdom, and West Germany would make available to the United States a number of commercial aircraft. As of July 1989, that number totaled 96 and included 24 cargo, 57 passenger, and 15 combi-transports. The discussion on the CRAF-like arrangements we have with our allies is based primarily on an October 12, 1988 phone call to MAC.

²⁶Correspondence from MAC, May 10, 1990.

aircraft would reside with HQ MAC, whereas operational control would remain with the foreign airline. Also, like the CRAF, aircraft foreign commercial transports would be tasked only on a mission-by-mission basis. Flights flown by NATO airliners would be reimbursed by the U.S. government at the rates negotiated by the NATO Tariffs Committee.

III. OVERCOMING DESIGN INCOMPATIBILITIES

Both military and commercial airlifters were designed for the particular markets they serve—markets with radically different operating environments and requirements. Whereas commercial passenger aircraft may be inadequate in some respects for transporting troops (such as narrow seating for soldiers in full-combat dress), the requirement differences are relatively minor compared to the problem of cargo aircraft incompatibilities. This section will examine the Air Force's efforts to close the gap between the capabilities of commercial and military cargo aircraft.

CARGO DESIGN DIFFERENCES

Whereas MAC aircraft were designed especially for military transport, most commercial aircraft are designed to move passengers. Commercial freighters that carry cargo exclusively are themselves derivatives of passenger aircraft, creating major configuration differences with their military counterparts. One of the most notable is that commercial transports do not have drive on/drive off capability. Nonetheless, by addressing those incompatibilities that can be changed—and many have been—MAC can stretch its own limited cargo assets.

Military cargo airlift usually falls into one of three categories: bulk, oversize, and outsize. Bulk cargo fits the usable dimensions of the 463L (88" x 108") standard military pallets. Oversize cargo consists of equipment and material too large to fit on standard military airfreight pallets. Such cargo must be carried on organic military transports like the C-130, C-141, or C-5, or wide-bodied CRAF cargo aircraft such as the cargo/convertible versions of the B-747 or DC-10. Outsize equipment refers to the largest and heaviest equipment in the military, such as main battle tanks and self-propelled guns, or equipment in a combat-ready configuration. Size and weight limitations prevent wide-body CRAF cargo aircraft from carrying outsize cargo. Outsize cargo is only carried aboard the C-5 military transport.

CRAF narrow-body cargo aircraft can transport only bulk cargo loaded on standard airfreight pallets. According to the estimate, about 70 percent of our cargo requirements during wartime would be of the bulk/oversize-cargo variety that most CRAF aircraft can handle.¹ Although commercial transports may not be able to carry the biggest guns and tanks, they serve a very useful role if they can haul most of what the military needs.

¹Major General Donald D. Brown, "USAF Mobility Requirements," *Proceedings from the International Air Transportation Conference*, June 1-3, 1983, AIAA-83-1588, p. 3.

Optimized for radically different operating environments, the design characteristics of the two types of cargo aircraft are understandably also quite different. The design of MAC transports reflects their requirement to load and unload their cargo as quickly as possible, under the most adverse conditions. Commercial cargo jets, derivatives of passenger designs, do not have the same time constraints imposed on them in their normal operations and this fact is reflected in their design.

Military transports all have a high-wing, high-tail design powered by four engines.² The high wing allows the fuselage to be suspended from the wing and provides a cargo compartment low to the ground with cargo doors in the nose or tail. This proximity to the ground gives it a drive on/drive off capability; wheeled vehicles and weapons systems can thus be quickly loaded and unloaded. The new C-17 will also be able to fly low and drop its cargo rather than landing to unload equipment and supplies, something none of the commercial jets can do.

Some commercial cargo aircraft, because their designs are often derivative of their passenger counterparts, take longer to load and generally cannot carry heavy equipment or weapons systems in a combat-ready configuration. Commercial carriers have a low-wing design with the belly of the cargo compartment sitting much higher off the ground than a military aircraft. Both drive on/drive off capability and cargo drops are out of the question with these aircraft. Loading times are longer for designs that handle material from a side-door. For side-door loading, pallets have to be moved 90 degrees once onboard to be secured—and require more time for handling at each terminus.

The differences between military and commercial pallet sizes create further complications. Some commercial aircraft can handle military pallets because their rail and locking systems are set up to accept pallets of differing sizes from various customers. The dimensions used in the civil aviation industry measure either 88 or 96 inches by 125 inches.³ The military uses a different standard pallet size—88 inches by 108 inches—and unless modifications are made to the regular nonadjustable military rail and locking system, commercial pallets cannot be used on military transports.⁴ This, in effect, precludes the use of commercial pallets. Although military pallets can be used in commercial aircraft, their use can result in wasted space since military pallets are smaller.⁵

²Major Kent N. Gourdin, "A Joint Venture: The Civil-Military Airplane," *Defense Transportation Journal*, April 1986, pp. 18-19.

³Paul D. Tuck, "A Uniform National Air-Cargo System: Do We Need It?" *Air University Review*, Vol. 33, No. 5, July-August 1982, p. 59.

⁴Gourdin, p. 21.

⁵Tuck, p. 60.

Even the loaders that place pallets onboard are incompatible. The military depends on the 463L Materials-Handling System (MHS).⁶ Designed for loading military cargo aircraft with fuselages located close to the ground, a MHS loader raises a pallet to a maximum height of 13 feet. Unfortunately, the main deck of a wide-body commercial airliner is 16 to 18 feet from the ground. To solve this problem, MAC purchased wide-body elevators. These elevators are used during MAC's normal peacetime business with civil carriers and would be deployed to bases CRAF aircraft are likely to service when required.

CRAF ENHANCEMENT PROGRAM

MAC's greatest recruiting concern is to bring available cargo aircraft into CRAF; a secondary approach is to influence incorporation of cargo convertible features on passenger aircraft. Converting an aircraft's configuration from passenger to cargo is more complex than just stripping out the seats and installing a rail, roller, and lock system. They do not have large enough doors in the right places or floors capable of handling the high weight densities required by military equipment. Regulations to force industry to conform to certain military requirements when they construct new aircraft are strongly resisted by the carriers; therefore, the Air Force is reluctant to take this approach. Instead, the Air Force started a program in the mid 1970s called the CRAF Enhancement Program (CEP). The CEP, a part of the National Defense Features Program (NDFP), was designed to offer incentives to incorporate cargo convertible features on existing and new commercial passenger aircraft.

In the CEP, the government offered compensation to air carriers if they modified their in-service passenger aircraft with:

- Reinforced floors or strengthened main deck and deck-mountings to permit transport of armored vehicles
- Rails and rollers to accept pallets
- Side cargo doors
- Capability for quick removal of seats

MAC originally wanted to incorporate these features on aircraft at the manufacturing site. Modifying in-service aircraft is more expensive because of ferrying costs, compensation for

⁶Tuck, p. 59.

lost business during modification, and the fact that the aircraft is completely assembled and less amenable to structural changes. When faced with indifference from airlines with new aircraft on order, they widened the program to include aircraft already delivered and flying.

Program participants were compensated for the direct and indirect costs of modifications, such as the flight to and from the modification site, compensation for the time the aircraft is out of service, and additional annual fees for the 12- or 16-year duration of a CEP contract to cover:

- Extra fuel consumption due to heavier weight
- Extra landing fees due to added weight
- Increased tire wear
- Increased maintenance costs

The entire program cost an estimated \$635 million.⁷ Per aircraft conversion costs amount to \$32 million or about one-sixth the cost of owning and operating a B-747 for the same time period, according to Air Force estimates. MAC estimated the program would cost less to modify commercial jets than it would to buy the extra capability with military transports. Even though the program did not pull in the 60 or so hoped-for participants, MAC still deemed it cost-effective.⁸

The first CRAF modification contract of \$17.4 million went to United Airlines in August 1980 for its purchase of a McDonnell Douglas DC-10 convertible aircraft rather than a standard passenger model. Pan Am offered the most aircraft. In 1983 the Air Force signed a contract with Pan American World Airways to convert a B-747 passenger aircraft to CRAF cargo-convertible standards with options to modify an additional 18 aircraft. MAC exercised their options and converted all 19 aircraft. The destruction of a Pan Am jet flying over Lockerbie, Scotland on December 21, 1988—now blamed on terrorist bombing—reduced the number of CRAF modified aircraft by one.⁹

The Air Force's estimate that over 60 aircraft would finally participate in the CEP turned out to be overly optimistic.¹⁰ The air carriers did not respond warmly to the program

⁷CRAF, Defense Marketing Services *Market Intelligence Report*, Military Aircraft, DMS Inc. 1988.

⁸Clifton F. Berry Jr., "The Civil Reserve Air Fleet—National Airlift Asset," *Air Force Magazine*, February 1980, p. 59.

⁹"Bomb destroyed Pan Am 747," *Flight International*, 7 January 1989, p. 2.

¹⁰Berry, p. 59.

because the economic incentives were not attractive enough. Originally, only new passenger aircraft still under production were considered for the program. Added to this, the carriers were offered a one-time lump sum to cover all modification costs as well as additional costs that came with increased structural weight forcing decreased payloads. The airlines resisted on the grounds of uncertain future fuel costs that might be greater than the government's projection.

REVISION OF THE CRAF ENHANCEMENT PROGRAM

The policy directive on national airlift signed in June 1987, which replaced the former national airlift policy dating back to 1960, called for the Departments of Defense and Transportation to develop a program jointly to increase participation in the CRAF and incorporate defense features in commercial aircraft, including cargo capability.¹¹ As one response to the directive, the Air Force asked for and received congressional funding for a revised CRAF Enhancement Program designed to be more attractive to commercial carriers.

The revised program addresses the drawbacks of the previous program from both the military and the airlines' perspective. One of the chief complaints from the airlines is the cost of heavier weight that cuts into an aircraft's long-range capability on formerly profitable routes and decreases resale values. The Air Force is considering a relaxation of DoD's own cargo-carrying requirements and extensive use of lightweight composite materials in cargo decking to avoid payload/range liabilities.¹² The use of lighter-weight composite materials in cargo decking would cost more, but would directly address the range restriction problem troubling many carriers. MAC will, at least initially, make its new modifications on aircraft still in production rather than in-service.

The Air Force would like greater flexibility in the laws governing CRAF agreements with the airlines. In the former CEP contract, MAC wanted to provide equipment for long-range overwater operations and military cargo handling for 20 UPS B-757PFs but could not because the current law limits the CEP to cargo-conconvertible passenger aircraft. In fact, all-cargo and passenger-cargo combination (combi) aircraft are excluded from the CEP, something MAC wants to see changed.¹³ Funding limits CEP participation to a few aircraft

¹¹The White House, *National Airlift Policy*, National Security Decision Directive Number 280, Washington, D.C., June 24, 1987.

¹²One drawback of this, from the military perspective, is that an aircraft using these materials may have reduced cargo capability compared with a modified plane using heavier materials. On the other hand, if range limitations can be minimized, some airlines may be more likely to join.

¹³"AF Wants Two CRAF Planes Per Year, Reports Missed Opportunities," *Aerospace Daily*, March 17, 1989, p. 429.

per year even though the number of aircraft the airlines are willing to enroll is greater than that, says MAC.¹⁴ Evergreen Airlines contracted with MAC in the fall of 1988 to modify two of their aircraft with cargo-convertible features even though neither the Air Force nor the airline intend to use them in the passenger configuration. The airline must store and maintain the passenger equipment, which it will probably never use. In another event, the Air Force says it would have liked to pay Federal Express to buy more DC-10s—for CRAF commitment—rather than the B-727s they recently ordered. Federal Express reportedly was willing to accommodate MAC if the government paid for part of the additional cost, but current law bars MAC from this type of deal.¹⁵

INCOMPATIBILITY IN COMMUNICATIONS

Military and civil communications differ in both their technical characteristics and equipment. In the past, neither military bases nor commercial aircraft had compatible communications equipment at military offload installations or onboard the CRAF aircraft. This has prevented adequate communications between crew members and their operations centers at the military offload sites and between the CRAF cockpit crew and military ground stations. CRAF participants must maintain operational control of their aircraft and should be able to communicate with their crews at each terminus. In 1986, most military bases did not have data communications systems linked to the commercial data service used by CRAF carriers that would allow the airlines to talk to their personnel.¹⁶ Data communications systems are now being installed at military bases. Under the old CRAF enhancement legislation, DoD was authorized to add only cargo convertible features. DoD sought to modify CRAF enhancement legislation to allow other defense-feature additions such as communications and IFF.

MAC is installing secure communications capabilities with the airlines. The Air Force has given priority to the installation of secure communications at the carrier operations centers and on the aircraft themselves. To facilitate MAC's ability to send classified information directly to the airlines, it recently installed secure voice and data communications equipment at the operations centers. MAC would also like to install secure communications devices in CRAF aircraft to enhance their air-to-ground communications

¹⁴ "New Hopes and Hurdles for CRAF," *Military Forum*, September 1989, pp. 18-21.

¹⁵ *Ibid.*

¹⁶ "Civil Reserve—GAO Expresses Doubts," *Flight International*, Vol. 129, No. 409, 3 May 1986, p. 12.

with base personnel. The problem is currently being studied to determine system requirements.

The Air Force is studying the possibility of adding military Identification, Friend or Foe (IFF) equipment to CRAF transports to protect them from being mistaken as unfriendly aircraft. Without this technology, DoD radars may not be able to distinguish between commercial aircraft and foreign military threat aircraft operating in a hostile environment.¹⁷ Before installing military communications, navigation, and NATO IFF equipment in CRAF aircraft, their performance must be tested and NATO interoperability standards adopted. When MAC wins the funding for IFF equipment for its own transports, it plans to add them also to CRAF aircraft.¹⁸

¹⁷ "AF Wants Two CRAF Planes Per Year, Reports Missed Opportunities," *Aerospace Daily*, March 17, 1989, p. 429.

¹⁸ Communications with HQ MAC, September 15, 1989.

IV. ASSURING READINESS AND RESPONSIVENESS

MAC must balance the need to provide sufficient incentives to keep up voluntary participation in the CRAF with the need to maintain sufficiently high standards to ensure adequate readiness and responsiveness when CRAF is activated. Readiness is defined here as the ability to fly military payloads as outlined in the CRAF contracts with DoD; responsiveness refers to the ability to respond within the time required by each stage's activation. Without the assurance of readiness and responsiveness, the value of a commercial contribution to a war or emergency effort would be seriously undermined. On the other hand, if participation is decreased as a result of stiffer enforcement of requirements, the military could also lose.

Key issues for ensuring readiness and responsiveness in the CRAF are:

- Centralizing management during peacetime and centralizing mission control during activation
- Providing adequate information to the airlines without jeopardizing national security
- Providing adequate CRAF training with the military
- Providing sufficient support at the Senior Lodger stations

CENTRALIZED PEACETIME AND CRISIS MANAGEMENT

Centralized management is one of CRAF's hallmarks. It brings all resource planning together into one organization during peacetime and provides for the efficient call-up of commercial assets and mission control during activation. Moreover, MAC works with the Secretary of Transportation to make sure all government agencies know which civil aviation resources each agency can depend on for its own emergency plans. Authority to activate the CRAF and manage commercial aircraft afterwards is already determined. From the airline's perspective, they would centralize operational control of their aircraft by vesting their operations center with control of communications and assignments from MAC to their respective aircraft. Both the Air Force and CRAF operators have a streamlined chain of command that would automatically go into effect once the decision to mobilize is made. This should decrease inefficiencies resulting from uncertainty and lack of central leadership.

DoD airlift requirements—which MAC uses to develop its own airlift strategy and operations plans—are based on the anticipated needs of all the services in the event of war or a national emergency. Each year the JCS draws up contingency plans based on their estimate of possible global scenarios and policy objectives. These plans form the basis for global airlift requirements for MAC and the CRAF in particular. With these contingency plans, the Office of the Secretary of Defense (OSD) identifies airlift requirements and peacetime airlift services required by the services and sends the information on to CINCMAC. In this way, MAC determines how much of the needed airlift will be met with its organic fleet and how much by the CRAF.

The Department of Transportation, one of the original CRAF MoU signatories, is involved indirectly with the CRAF during peacetime and activation. It oversees commercial aircraft regulations through the Federal Aviation Agency (FAA) and allocates those jetliners MAC requests to the CRAF by type and tail number during war or crisis. DoT receives copies of the CRAF activation messages that go to the airlines.

Authority for CRAF activation comes from CINCMAC or the Secretary of Defense, depending on the severity of the crisis and how many CRAF aircraft are required. In the event of an emergency, the MAC Crisis Action Team (CAT)—a group of airlift specialists who are called up on short notice—would be formed to oversee mission control of both organic transports and CRAF aircraft. If, in evaluating the situation, MAC CAT projects an estimated shortfall in organic military airlift capability, it would determine the number and types of commercial aircraft needed from the CRAF to carry out DoD's airlift requirements and recommend to CINCMAC whether CRAF should be activated, and if so, which stage.

Activation messages—which signal the beginning of mission control over the aircraft committed to that stage—would be sent by MAC to the airline operations centers to mobilize their particular CRAF aircraft. CINCMAC is authorized to activate Stage I. If it is determined that Stage II or III should be activated, authorization to activate the CRAF must be given by the Secretary of Defense, and the HQ MAC CAT will send the message. Orders for CRAF activation would be sent down from the respective higher office to the Directorate of the Transportation Command Joint Staff of Operations and Logistics (TCJ3/4), CINCTransCOM. MAC would then receive its orders from TCJ3/4. In all cases, once airlift begins, MAC would take over and directly manage the entire airlift fleet through its crisis action team, MAC CAT.

Both the operational control of CRAF aircraft and all communications between MAC and the carrier would be handled by the same office within each of the CRAF airlines. As soon as they are requested, the airlines would establish an around-the-clock operations center to remain in continual contact with MAC and with their own aircraft. The airlines would also send liaison and communications supervisor personnel who understand the carriers' overall operations and management to HQ MAC and HQ MAC ALT.¹ These personnel assist MAC while the operations center is functional and can act as company representatives if communication with the operations center is lost.

MAC obviously benefits from having such a well-defined and highly streamlined chain of command for the use of CRAF resources. If coordination of CRAF resources between the Air Force and another agency within DoD—or even within another part of the government—were required at the outbreak of any crisis, CRAF's responsiveness would almost certainly be degraded. Moreover, the immediate setup of a single communications channel between MAC CAT and each airline's operations center reduces confusion that might otherwise occur if more than one channel were open—or worse, if none were open.

MISSION PLANNING VS. NATIONAL SECURITY

An obstacle to achieving readiness and responsiveness is that the Air Force must withhold detailed planning activities from the airlines to protect national security. The airlines agree to supply sufficient support for their aircraft to keep them flying 10 hours per day until MAC releases them back to their normal operations. For the carriers to meet this requirement, they need to know what kind of workload to expect—for example, volume of cargo, expected utilization rate, routes flown, and the like. With this information, they can better stock and position replacement parts and provide crews.² If, because of insufficient planning data, the carriers cannot adequately carry out their responsibilities, their responsiveness will clearly suffer. On the other hand, the Air Force must withhold information that could compromise national security. The challenge to MAC is how to most effectively balance both needs.

The Air Force gives some general planning guidelines when it assigns aircraft to one of five mission categories. These categories, along with the number of aircraft assigned to each, as well as to each stage of activation, are shown in Table 4. The mission categories, and the criteria for aircraft assigned to them, are described below.³

¹*Operations: Civil Reserve Air Fleet (CRAF)*, MAC Regulation 55-8, 28 June 1988, p. 15.

²"GAO Wanted Changes in the Civil Reserve Air Fleet," *Air Force Times*, May 19, 1986, p. 23.

³Discussion on mission categories is based on MAC Regulation 55-8 and *Airlift Services Management Report*, and Tuck, pp. 58-67.

Table 4

NUMBER OF AIRCRAFT BY MISSION TYPE AND STAGE

Mission Type	I	II	III
Domestic		44	44
Alaskan		4	4
Short-range international		23	34
Long-range international			
Passenger	18	77	252
Cargo	22	39	141
Aeromedical			31
Total CRAF	40	187	506

- *Long-range international.* The largest need for CRAF aircraft is for long-range international or strategic airlift. Commercial aircraft would support MAC C-141s and C-5s in intertheater cargo and passenger movement (as well as C-17s when they are deployed). Aircraft in this category must be capable of extended overwater operations and have a standard range of 3500 nautical miles. MAC can, at their discretion, relax the range requirement to 2350 nautical miles to include aircraft capable of flying cargo the distance between San Francisco and Hawaii. Long range international passenger and cargo aircraft include Boeing 747s and 707s, DC-8s, and DC-10s.
- *Short-range international.* This mission supports short-range airlift or short-haul operations from the continental U.S. to relatively close offshore locations or between particular Pacific islands. Short-range destinations include the Caribbean, Greenland, and Iceland. These CRAF aircraft must be capable of overwater operations and have a productive range of 1500 nautical miles. Airliners used for these missions would be medium-range cargo or passenger-convertible aircraft, such as the B-727 and B-737.
- *Domestic.* The domestic CRAF supports LOGAIR and QUICKTRANS peacetime and wartime cargo airlift requirements. The Air Force Logistics Command (AFLC) oversees the Logistics Airlift (LOGAIR) service, which shuttles high-value supply items between Air Force bases. Analogously, the Naval Supply Systems Command (NAVSUPSYSCOM) is responsible for the

Navy Quick Transportation (QUICKTRANS). Together LOGAIR and QUICKTRANS represent the air pipeline service between military bases in CONUS. Once activated, mission command and control of these aircraft would be transferred to the AFLC and the NAVSUPSYSCOM. CRAF aircraft allocated to this segment are cargo or convertible cargo models that have a range of 400 nautical miles.

- *Alaskan.* The Alaskan mission provides airlift support for the Alaskan Air Command (AAC) and Distant Early Warning (DEW) radar site for the Aerospace Defense Command. Once activated, mission command and control for these aircraft is the responsibility of the AAC. Aircraft must be available in Alaska and capable of flying a range of 400 nautical miles, performing missions in severe Alaskan flying conditions, and coping with short runways and a lack of extensive ground support.⁴
- *Aeromedical evacuation.* Aeromedical evacuation aircraft are now identified in the CRAF capability summary produced by MAC. This is a new mission for the CRAF. The aircraft assigned to this category support MAC in carrying out its aeromedical evacuation responsibilities to help ease the shortfall in cargo capability for the European theater. CRAF aircraft assigned to this mission would augment the C-141s currently responsible for aeromedical evacuation and release 12 MAC C-9As for redeployment elsewhere. CRAF aircraft would be modified to incorporate litter support equipment and other medical equipment onboard. Twenty-eight B-767s currently committed to this mission would be used for intertheater movement and three MD-82s for CONUS patient redistribution.⁵

In response to a GAO study published in 1986, MAC now releases notional or order-of-magnitude workload data to CRAF airlines that helps them plan better, without being so specific as to endanger national security. MAC says they are in contact with the airlines on a daily basis and often use secure communications.

Just as the airlines require greater planning data for the CRAF aircraft to be more responsive to MAC, the Senior Lodgers also require more information to prepare better for activation. Senior Lodger responsibilities are assumed by commercial air carriers with

⁴Tuck, pp. 58-67.

⁵*Airlift Services Management Report.*

support by the host government in which the airfield is located. The success of the Senior Lodger program depends on the respective carrier, with the government's support to respond to the ground servicing needs of the CRAF and allied aircraft transiting through commercial airfields.⁶ The Senior Lodgers agree to provide or acquire services—all reimbursable by the U.S. government—such as ground support, fuel or POL, assistance in flight operations, traffic services, communications, supplies, maintenance, and accommodations for the crews.⁷ DoD requires the Senior Lodger to provide data on on-site characteristics and assets for each of the airports it is assigned.⁸ The Air Force doesn't expect Senior Lodgers to stockpile POL or additional parts, but does give them responsibility to do all they can to secure required services from the private sector once their station is activated. After CRAF airlift begins and all civil sources have been exhausted, the Senior Lodger is expected to report any deficiencies to MAC.

To be responsive, it seems that some advance planning by the Senior Lodgers is a good idea, in addition to providing the government an inventory of resources. According to the 1986 GAO study, Senior Lodger officials indicated they were not sure what MAC's service requirements would be in terms of the volume, rate, and type of traffic they could expect to transit through their respective airports. Without this information, Senior Lodgers can make only limited plans for contingencies.

The study advised the Air Force to address the problem of potentially unprepared Senior Lodger stations in two ways: provide more planning data to the designated carriers, and expand host nation agreements. Host nation agreements cover a foreign government's promise to provide services for airports within its borders or, in the case of U.S. carrier Senior Lodgers, help it acquire additional supplies that it cannot locate or procure itself, such as POL supplies. MAC says it now gives more detailed workload data to CRAF airlines and, in response to the GAO report, is attempting to improve its host nation agreements with foreign countries to reduce reliance on commercial operators in Europe and the Pacific.⁹

⁶GAO/NSIAD-86-47.

⁷GAO/NSIAD-86-47, p. 11.

⁸MAC Regulation 55-8, p. 18.

⁹"GAO Wanted Changes in the Civil Reserve Air Fleet," *Air Force Times*, May 19, 1986, p. 23.

SECURITY CLEARANCES

CRAF personnel expected to handle classified instructions or information must be U.S. nationals and hold a secret security clearance. Chief among these are the cockpit crewmembers who receive classified information about their mission at the onload site. Another group is the Senior Lodger personnel responsible for handling secret material at the airfield.

Many crews, however, do not currently hold such clearances. According to a 1983 study on the potential aircrew manning constraints on the Civil Reserve Air Fleet, almost 40 percent of all CRAF pilots were not sure they had security clearances.¹⁰ It is unclear how personnel could hold clearances and not be aware of them; therefore, on the surface this number appears alarming. The airlines attribute the low number of security clearances to several factors: frequent rotation by crewmembers among CRAF and non-CRAF committed aircraft, administrative cost burden, and investigative processing time.¹¹

MAC, however, does not seem particularly concerned about this problem. The government, acknowledging the real burden and cost of record-keeping for the airlines, has provided a simple solution: once the decision to activate the CRAF is made, USCINCTRANS would grant clearance approval to any CRAF eligible crewmember.

TRAINING

The extent of "training with the military" that most carriers receive is working with the DoD through peacetime contracts. Payloads which must be picked up at and delivered to military air bases offer regular opportunities for the carriers and MAC to work together before a crisis occurs. While this daily working relationship brings some problems to light to be resolved (such as incompatible loading equipment), without formal exercises it is not certain how well the CRAF would respond to a real crisis. The recent activation of CRAF Stage I should provide the Air Force critical data on this question.

MAC's ability to conduct CRAF exercises is, of course, constrained by funding limitations and the impracticality of pulling commercial aircraft from their regularly scheduled—and profitable—flights. The same applies to NAPCAP transports, aircraft in the European counterpart to the CRAF, and South Korean commercial airliners. However, the Air Force conducts simulated airlift exercises, mainly to keep MAC personnel familiar with

¹⁰Col. Shirley M. Carpenter, USAFR, et al., "Aircrew Manning Constraints on the Civil Reserve Air Fleet (CRAF)," *Air Force Journal of Logistics*, summer 1983, p. 15.

¹¹GAO/NSIAD-86-47, p. 37.

CRAF procedures.¹² In the fall of 1989, the Air Force planned to conduct a military readiness exercise along the same lines as the Nifty Nugget exercise in 1978.¹³ Although the use of CRAF aircraft was not planned, personnel from the CRAF airlines operations centers were expected to be stationed at Scott Air Force Base to participate in activities at the MAC airlift mission control center.¹⁴

For a number of CRAF airlines, the only training with the military they have is through the execution of peacetime contracts. Many, however, were involved in the recent call-up of aircraft and to date have flown several hundred missions for the Air Force.¹⁵ Clearly, there is now a unique opportunity to analyze CRAF airline readiness and responsiveness under real conditions. It must be remembered that only a small percentage of the CRAF is committed to Stage I. It would not be surprising to expect that problems encountered during Stage I conditions would be worse for Stages II and III. The Air Force can expect to learn much from the activation. For allied aircraft, the problem of training is more difficult. It is unclear whether there are plans to test procedures for the activation of allied aircraft involving only personnel. Since there are more organizations and personnel involved with the use of allied aircraft, such procedural exercises might be highly beneficial.

¹² "GAO Wanted Changes in the Civil Reserve Air Fleet," *Air Force Times*, May 19, 1986, p. 23.

¹³ "Pentagon Pursues Additional Commitments from Airlines to Boost U.S. Airlift Capacity," *Aviation Week and Space Technology*, January 30, 1989, p. 24.

¹⁴ Phone call with MAC on September 15, 1989.

¹⁵ Private correspondence with MAC, August 31, 1990.

V. CONCLUDING OBSERVATIONS

The Civil Reserve Air Fleet (CRAF) presents an array of potentially similar issues with a program utilizing space systems. Nonmilitary resources contribute relatively inexpensive capability that might not otherwise be met because of limited future growth in defense procurement, funding problems due to rising military system costs, and competing military goals. The use of nonmilitary space and airlift capabilities introduce similar problems. Both contend with the problem of providing an appropriate mix of *incentives for participation*, both must try to *overcome design incompatibilities* between commercial and military systems, and both must balance the need to *ensure readiness and responsiveness* with the need to keep participation high.

Incentives for participation. The CRAF addresses the problem of providing appropriate incentives for participation by offering its fixed-buy peacetime airlift business only to those airlines participating in the CRAF. The DoD is the single largest paying customer of the commercial airlines. The result is that 60 percent of the long-range international U.S. commercial aircraft that can carry military payloads to locations of interest to the Air Force are voluntarily committed to the CRAF. Of course, other factors contribute to this high rate of participation, such as the principle of staged activation and MAC's creative thinking when it comes to contracts. Staged activation of CRAF aircraft avoids unnecessary financial loss to the airlines through incremental allocation of resources. Also, MAC has increased its flexibility by allowing airlines to cooperate with each other in providing a complete aircraft, crew, and support package.

Overcoming design incompatibilities. The significant design incompatibilities between commercial and military aircraft make only certain commercial transports useful for DoD missions. The military's greatest wartime airlift need is the intertheater movement of equipment and troops. Aircraft, particularly cargo aircraft, capable of long-range international travel, is in shortest supply. Commercial cargo aircraft, because their fuselage sits high off the ground, are limited in the roles they can perform and present unique loading problems. Nevertheless, the contribution of wide-body cargo aircraft is so important that several programs have been instituted to convert them to military use. The most important one, called the CRAF Enhancement Program (CEP), incorporates cargo convertibility features into passenger aircraft. MAC pays for the costs. The revised CEP will try to address some of the problems which discouraged airline participation in the initial program.

Ensuring readiness and responsiveness. Finally, MAC must ensure readiness and responsiveness of resources it does not control. MAC's objectives range from centralized mission control to better planning, installing compatible communications equipment, and improving training exercises. Centralized management of all airlift assets within DoD, including CRAF aircraft, streamlines mission control and eliminates the confusion of competing authorities. To maintain CRAF readiness and responsiveness, MAC must provide the airlines with enough information to help them prepare for mobilization, while withholding any detailed planning data that might jeopardize national security. Recently, MAC has been releasing more information to commercial carriers than in the past. MAC is also implementing improvements in communications. Commercial communications equipment installed at military bases will allow the CRAF crews to communicate with their operations center. MAC secure communications devices and IFF equipment are also planned for CRAF aircraft in the future. As for training, MAC has relied almost exclusively on peacetime airlift contracts to provide the airlines with experience in military transport. In current exercises, however, airline personnel are joining MAC at mission control headquarters to observe and participate in airlift training exercises. In the future, such exercises might involve some commercial aircraft. The activation of Stage I should also serve to highlight whether the current approach to training is adequate.

The three issues summarized above are basic to any voluntary program in which nonmilitary resources—such as satellites and their support infrastructure—are used. Particular solutions that work for CRAF may or may not be transferable to space-based systems. Some important differences make space-based systems in some ways more complicated, such as multinational or non-DoD government ownership of certain satellite systems, their tasking procedures, plans, if they exist, for their transfer to military missions, and so on. Nevertheless, the CRAF does provide an example of how one defense program addressed these basic problems and continues to as industry and the military's needs evolve.

APPENDIX

Available CRAF assets are tracked on a monthly basis by the DoD through MAC Form 312 listing each vehicle according to carrier, type of aircraft and mission, and aircraft tail number. Current CRAF inventory and capability figures used in this document were taken from the Monthly Civil Reserve Air Fleet (CRAF) Capability Summary for July 1, 1990, shown on the next page. The number of aircraft committed to the CRAF are listed in the summary sheet according to aircraft and mission type, activation stage, and owner. CRAF mission categories are referred to as "segments." Three joint ventures—in which several airlines pool their separate resources, such as the aircraft and crew—are represented as numbered "J.V."s.

MONTHLY CIVIL RESERVE AIR FLEET (CRAF) CAPABILITY SUMMARY															SOURCE		HQ MACX/PW		1 July 1990	
DOMESTIC SEGMENT															SHORT-RANGE INTERNATIONAL SEGMENT		ALOP		CAPABILITY	
ALASKAN SEGMENT															LONG-RANGE INTERNATIONAL SEGMENT		TYPE		CAPABILITY	
AEROMEDICAL SEGMENT (STAGE III ONLY)															TOTAL		TOTAL		TOTAL	
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