AIR WAR COLLEGE

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MISSILE DEFENSIVE SYSTEMS

AND

THE CIVIL RESERVE AIR FLEET

by

Glen R. Downing, Lt Col, USAF

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Biography

Lt Col Glen "Tron" Downing, USAF, is a graduate of the Air War College, Class of 2009. Previously, he served as the commander of the 32d Student Squadron, Squadron Officer College, Maxwell AFB, Alabama. He also completed tours at Scott AFB, Illinois; Pope AFB, North Carolina; Little Rock AFB, Arkansas; and Davis-Monthan AFB, Arizona.

Colonel Downing entered the Air Force as a distinguished graduate of the Reserve Officer Training Corps in 1990 following graduation from Iowa State University. He is a senior navigator with more than 1,700 hours in the C-130E, EC-130H, T-43 and T-37. He was a distinguished graduate of specialized undergraduate navigator training, C-130 initial qualification training and C-130 instructor qualification training. A graduate of the US Air Force Weapons School, he was qualified as an instructor electronic warfare officer in the EC-130 and instructor/flight examiner navigator in the C-130. He holds the Master of Military Arts and Sciences in Theater Operations from the Advanced Military Studies Program, School of Advanced Military Studies, US Army Command and General Staff College, Fort Leavenworth, Kansas, and is a graduate of the Army Command and General Staff Officer Course, Fort Leavenworth, Kansas. He also holds a Master of Science in Operations Management from the University of Arkansas, Fayetteville, Arkansas.

Introduction

Imagine yourself executing a tactical departure from Baghdad International Airport in your sleek 1979 Airbus 300. You and your crew are spiraling upward in a steep climb at 170 knots after a successful day of delivering US mail to troops. Passing through 8,000 feet, you hear a loud noise and the plane begins to shudder violently. Your engines are operating normally but you begin to notice the hydraulic pressure decreasing. As you glance out the window, your wing is on fire. Ten feet of the trailing edge of the left wing is gone or damaged by fire. Within a minute, you've lost all hydraulic pressure and your flight controls are inoperative. Your task, get the plane safely on the ground saving your crew and an invaluable asset.[1]

Figure 1 - MANPADS Damage to DHL Airbus A300, 22 November 2003[2]

This exact scenario played out in November 2003. A Belgian-flagged DHL aircraft, operated by a Belgian and British crew, safely returned to Baghdad International Airport after an

[1] David Hughes and Michael A. Dornheim, "DHL/EAT Crew Lands A300 With No Hydraulics After Being Hit By Missile," *Aviation Week & Space Technology*, 8 December 2003, http://www.aviationweek.com/aw/generic/story_generic.jsp?channel=awst&id=news/12083air.xml.

[2] Marek, "DHL A300 Airbus Demonstrates How Serious The Terrorist Threat Is," http://www.talkingproud.us/International051504.html.

attack by an Iraqi terrorist group firing a Man-Portable Air Defense System (MANPADS) rocket. This incident, and an attack on an Arkia Israeli Airlines Boeing 757 in Kenya a year earlier, heightened public awareness of the MANPADS threat. Congress responded by submitting multiple bills demanding commercial airliners be equipped with missile defensive systems. Time and the lack of subsequent incidents have lessened the urgency and attention devoted to this effort. This paper will show that US dependence on the civil reserve air fleet and contract aircraft, combined with a significant threat, demands equipping at least a portion of the US-flagged commercial airliner fleet with a missile defensive system.

The methodology is to investigate the US government's use of commercial aircraft and specifically, the civil reserve air fleet (CRAF), during contingency operations. I will present an overview of the CRAF, the number of aircraft participating, and strategic plans for use in a major theater war. Next, I'll discuss usage since 2001, examining current policies, delivery methodologies, and operating environment. Following, I'll examine future concepts of operation and potential enemy strategies to defeat those concepts.

Next is a careful examination of the terrorist threat to include proliferation of shoulder-fired weapons and a historical review of attacks on commercial aircraft. I will present possible information warfare effects on public confidence of a commercial airliner shoot-down. A description of friendly countermeasures follows.

Recommendations will focus on the required force structure of commercial aircraft equipped with missile defensive systems. The driving factors are cargo/passenger throughput and cost. Costs examined include unit cost, operating cost, and funding sources. Consideration of insurability and crew training is also necessary.

The civil reserve air fleet is both a program and a contract. As a program, the CRAF represents the number and capability of aircraft available for mobilization to augment the US military's organic airlift fleet. As a contract, CRAF represents contract guarantees for a "fixed buy" of projected DoD commercial business over the coming year and increased competitiveness for an "expansion buy" to fill the gap between fixed buy and actual needs.[3] Throughout the paper, the use of the term CRAF references mobilization or the program aspect. I will use commercial contract and commercial airlift to refer to the contractual aspects of the CRAF.

Civil Reserve Air Fleet Overview

The civil reserve air fleet is a critical component of the defense transportation system developed to supplement organic government resources in time of war or national emergency. Current studies show the US government will rely on the CRAF to move over 40% of the total air cargo requirement in a contingency operation. If the first Persian Gulf War is any indication, CRAF may also move over 85% of the total passenger requirement.[4]

The CRAF has three segments: international, national, and aeromedical. The international segment has both a long-range and short-range section. The long-range section provides extended intercontinental cargo and passenger airlift using predominantly civil wide-body aircraft. As of June 2008, there are 312 international long-range cargo and 582 international long-range passenger aircraft allocated to the CRAF.[5] The short-range section provides support in "near offshore operations."[6] US airlines commit 11 international short-range

[3] Congressional Budget Office, *Issues Regarding the Current and Future Use of the Civil Reserve Air Fleet*, (Washington DC: The Congress of the United States, 2007), 1.

[4] David Graham, Sustaining the Civil Reserve Air Fleet (CRAF) Program, staff study, 1 May 2003, 3,1.

[5] US Department of Transportation, "Civil Reserve Air Fleet (CRAF) Monthly Allocations," https://www.dot.gov/ost/oet/craf.

[6] Joint Publication (JP) 4-01, *Joint Doctrine for the Defense Transportation System*, 19 March 2003, III-3.

cargo and 245 short-range passenger aircraft to the CRAF.[7] The international segment performs missions the USAF would normally use C-5 and C-17 aircraft to perform.

The national segment helps the government respond to increased airlift requirements within the continental United States and Alaska. Transportation requirements from military bases to seaports of embarkation and response in support of the Department of Homeland Security are examples of missions accomplished by the national segment. Aircraft in this segment have at least 75 seats and are capable of carrying at least 32,000 lbs of cargo making them roughly equivalent to the capability of the USAF C-130.[8] Domestic air carriers are committed to provide 36 national-domestic aircraft and another four aircraft dedicated to Alaskan airlift.[9]

The last segment, aeromedical evacuation, transports patients and casualties. Fifty Boeing 767s operated by four major airlines have been specially modified to carry ambulatory and non-ambulatory patients as well as medical supplies and equipment.[10] Since the DoD no longer has dedicated aeromedical evacuation assets, this segment allows organic airlift assets to continue moving cargo rather than be diverted to this critical and high-profile mission.[11]

Though CRAF is a very flexible tool allowing for modular activation of portions of each segment, US Transportation Command plans account for a three-stage activation of assets. Stage I is a "committed expansion" and supports small, regional crises around the world. A "Defense Airlift Emergency" calls for the activation of Stage II in support of a major conflict such as the first Persian Gulf War and the more recent Operation IRAQI FREEDOM. Finally, "National

[7] US DOT, "Monthly Allocations."
[8] JP 4-01, III-3.
[9] US DOT, "Monthly Allocations."
[10] Ibid.
[11] JP 4-01, III-4

Emergency" creates the necessity to activate Stage III of CRAF as our nation mobilizes for war.[12] Total aircraft committed to CRAF as of June, 2008 was 1,240 (See figure A-1).[13]

CRAF participants must meet other stringent criteria in order to participate. Air carriers must be US owned, FAR part 121 certified and operating US registered aircraft. A company must commit a minimum of 30 percent of its passenger fleet and 15 percent of its cargo fleet. Additionally, each operator provides four crews per aircraft. In return, participants received $379 million in contract guarantees in 2007 and an estimated $2.1 billion in additional business from the Department of Defense.[14] The opportunity for lucrative contract business has led to a remarkable level of volunteerism within the CRAF. Often this volunteerism has averted activation. In the Korean War, CRAF moved 67 percent of the passengers and 56 percent of the cargo.[15] Civil aircraft also moved over 11 million passengers and 1.3 million tons of cargo during the Vietnam conflict without activation of any stage of CRAF.[16]

Historical Usage

Although the CRAF is over 57 years old, formal activation has occurred only twice, the first time for Operation DESERT SHIELD/STORM and the second for Operation IRAQI FREEDOM. These activations generated favorable results for both the airlines and the DoD. During Operation DESERT SHIELD/STORM, the CRAF carried 25% of the cargo and 85% of

[12] Ibid.
[13] US DOT, "Monthly Allocations."
[14] Air Mobility Command (AMC), *U.S. Air Force Fact Sheet: Civil Reserve Air Fleet*, https://www.amc.af.mil/library/factsheets.
[15] Lt Col Donald M Schauber, Jr., *Impact of Foreign Ownership on the Civil Reserve Air Fleet*, Air War College, Maxwell Paper No. 42 (Maxwell Air Force Base, Alabama: Air University Press, April 2008), 4.
[16] Congressional Budget Office, *Moving U.S. Forces: Options for Strategic Mobility*, (Washington DC: The Congress of the United States, 1997), 85.

the passengers deploying to the Middle East following activation of the long-range portions of Stages I and II from August, 1990 to May, 1991.[17]

Military Airlift Command (MAC) used the CRAF on missions predominately from CONUS direct to Saudi Arabia and the Gulf States. This routing took best advantage of the capabilities of commercial wide-body aircraft and avoided complications associated with operating from commercial airfields in Europe. MAC provided tactical experts and intelligence personnel to brief commercial crews on operational and security concerns. Planners varied CRAF routing in order to avoid predictability; however, carriers requested crews only land in the area of operations (AOR) during daylight hours. This additional restriction posed no significant tactical risk since all airfields were beyond the reach of any real threat excluding SCUD missile attack.[18]

The greatest impact of the SCUD threat was psychological, but there were some operational impacts as well. Commercial aircraft are not compatible with military aircrew chemical defense gear. This makes it extremely difficult to protect a crew from chemical attack while airborne. Once on the ground, ground chemical defense equipment will provide protection, but DoD did not issue this equipment until late in the conflict and crews received inadequate training. These facts, combined with the media news barrage of the SCUD threat and the fact the commercial crew's military counterparts had full protection, led to declining morale and mission refusal.[19]

The operational impact of the SCUD was no different from military crews. During a SCUD alert, crews assessed the ability to stop all ground operations and immediately take-off to

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[17] James K. Matthews and Cora J. Holt, *So Many, So Much, So Far, So Fast: United States Transportation Command and Strategic Deployment for Operation Desert Shield/Desert Storm* (Washington, DC: Government Printing Office, 1996), 40-41, 260.

[18] Mary E. Chenowith, *The Civil Reserve Air Fleet and Operation Desert Shield/Desert Storm: Issues for the Future* (Santa Monica, CA: RAND, 1993), 17; Matthews and Holt, *So Many, So Much*, 48.

[19] Matthews and Holt, *So Many, So Much*, 49-50.

protect the aircraft from attack. If unable, they sought shelter, hoping their chemical defense suits were available. In at least one instance, a crew came under SCUD alert at Dhahran, Saudi Arabia, took off with too little fuel to depart the AOR and headed for Riyadh. While landing at Riyadh, they came under a subsequent SCUD alert. With no options left, they landed and immediately sought shelter.[20] Despite situations such as this, there were no personnel injuries or damage to aircraft during the entire period of activation during DESERT STORM.[21]

CRAF activation for Operation IRAQI FREEDOM was very short, lasting from February to June 2003. This fact disguises a significantly increased DoD reliance on commercial contract carriers in the period following 2003 and volunteerism based on a decreasing commercial market following the events of September 2001. When measured in terms of percentage of total revenue, DoD cargo business has tripled and passenger business doubled when compared to pre-IRAQI FREEDOM numbers.[22] Obviously, commercial aircraft are critical to US success in the AOR.

During the Army's initial deployment to Iraq, CRAF assets operated mainly into Kuwait City International Airport (KCIA) serving as both a military and commercial hub. The CRAF moved primarily passengers and some limited cargo. Disembarking passengers linked up with equipment moved by sealift to the Ash Shuaybah seaport or drawn from prepositioned stock at Camp Arifjan.[23]

The invasion of Iraq resulted in the capture of several airfields later converted to US military use. However, CRAF aircraft continued to operate primarily out of KCIA due to their inability to defend against chemical/biological and surface to air threats and the lack of ground

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[20] Ibid, 48-49.
[21] Ibid, 48.
[22] Congressional Budget Office, *Issues Regarding the Civil Reserve Air Fleet*, 5-6.
[23] COL Gregory Fontenot, LTC E.J. Degen, and LTC David Tohn, *On Point: The United States Army in Operation Iraqi Freedom*, (Fort Leavenworth KS: Combat Studies Institute Press, 2004), Chap 2.

security at many sites. Baghdad IAP began commercial operation in June 2004 with Balad AB following soon after. Today, contracted commercial airlift accounts for nearly 50% of all intratheater airlift.[24] Major operations still move through the KCIA hub, but several fields in Iraq are now open for commercial business. Many carriers are using their own infrastructure to accomplish military missions. One example is UPS. UPS operates from their hub in the United Arab Emirates and flies direct to commercial and military airports in Iraq. Final delivery is via UPS ground in country. This entire operation is largely outside the control of US Transportation Command, yet reflects the reliance of the military on commercial airlift support and the return to relative normalcy in Iraq.[25]

Future Use

The future battlefield will be non-linear and non-contiguous, just as Afghanistan and Iraq are today. Ground and air operations will occur simultaneously in multiple areas. Limited security and space will prevent the establishment of large logistical areas on the ground. Airlift assets will support multiple units flowing parallel to each other to multiple staging areas.[26]

Rapid force projection, or Global Strike, will grow in importance. The key enabler for both the deployment and sustainment of Global Strike assets is operational maneuver from strategic distances (OMFSD). OMFSD is the latest iteration of the direct delivery concept developed in the 1970s and a key driver of the C-17 acquisition.[27]

A couple challenges prevent the realization of these concepts. First, a current US Army heavy armored corps weighs approximately 1 million tons and relies on sealift to deploy. Much

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[24] Bruce Rolfsen, "Audit: 40% of cargo flights half-empty," *Air Force Times*, 11 September 2008, http://www.airforcetimes.com/news/2008/09/airforce_empty_planes_090908.

[25] Peter A. Buxbaum, "From Factory to Foxhole," *Military Logistics Forum*, 14 November 2008, http://www.mlf-kmi.com/military-logistics-forum/11-mlf-2008-volume-2-issue-5/63-from-factory-to-foxhole.html.

[26] Glen R. Downing, "The Mobility Air Forces, Unifying Culture for Contemporary Challenges," (Monograph, SAMS, 2005), 42.

[27] Ibid., 42-43.

of the equipment is air transportable by only the C-5. If every C-5 flew dedicated support to movement of the Corps and no sorties were lost, it would still take 66 days to move the unit contrasted with a sail time to Kuwait of less than 45 days. [28] Commercial airlift can do little to offset the demand since the CRAF lacks a robust outsize or oversize cargo capability. Sealift is not going out of business anytime soon.

Second, the quickest way to defeat rapid force projection is with anti-access tactics, specifically port denial. The most effective methods of port denial available to a weaker enemy are weapons of mass destruction and MANPADS. As demonstrated repeatedly through two CRAF activations, commercial assets lack the ability to cope with either effectively. This fact will continue to relegate the CRAF to passenger movement and resupply missions to rear areas until security is established.

Without major changes in equipment and training, future reception, staging, onward movement and integration (RSOI) will continue to look much like the current Iraqi operation. RSOI is the process used by land forces to receive forces in theater, match them to equip and units, move them forward toward the battle and integrate them into existing force structures. Commercial airlift will fly to a safe, secure hub where passengers and cargo will transition to other means of transportation for onward movement. Post conflict will enable eventual return to normalcy through small steps as seen from 2004 to the present in Iraq.

The US was incredibly fortunate in Operation IRAQI FREEDOM to have a commercial hub with a seaport of debarkation and prepositioned equipment. This factor greatly facilitated RSOI. Military operations at KCIA for 12 years prior to this deployment further enhanced security and the ability to conduct significant logistical improvements. A Naval War College study shows the lack of a suitable airfield for CRAF use will result in a combatant commander

[28] Lt Col James W. Herron, "Future Airlift Requirements," (Research Paper, Army War College, 2005), 5.

entering combat operations with half his planned equipment and less than half of the planned forces due to the requirement for military airlift to move troops and equipment from an intermediate hub to theater.[29] If the invasion of Afghanistan had been a conventional operation, it would have taken months to get the invasion force in place, affording the enemy a great amount of time to prepare.

The Man-Portable Air Defense System Threat

The Man-Portable Air Defense System is a growing threat to civil aviation. As an anti-access weapon, the MANPAD is readily available to both state and non-state actors, unlike weapons of mass destruction. As a terror weapon, it is the next logical step for non-state actors. Attacks against commercial aircraft, whether operating as part of CRAF or in the civil air transport system, are bound to have dramatic effects on public support for a conflict and confidence in the safety of the air transport system. As a result, defense against these threats is critical.

MANPADS are predominately shoulder-fired missiles manufactured in nearly 20 countries worldwide. These countries have produced over one million weapons to date. Approximately half these are in current arsenals. The large numbers is not a problem in itself, but control of these weapons is questionable in many nations of the world. There are estimates ranging from 5,000 to 150,000 missiles currently in terrorist hands.[30]

Terrorists have acquired these weapons through several means including the black market, theft, and even conventional arms sales. The United States gave Afghanistan over 1,000 Stinger missiles and training in their use during the 1980s in order to repel the Soviet invasion of

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[29] David D. Banholzer, "The Civil Reserve Air Fleet: A Vulnerable National Asset," (Research Paper, Naval War College, 2006), 17.

[30] Christopher Bolkom and Bartholomew Elias, *Homeland Security: Protecting Airliners from Terrorist Missiles* (Washington DC: Congressional Research Service, The Library of Congress, 2006), 3-4.

their country.[31] Coalition forces captured over 5,500 Afghani MANPADS of all makes by December 2002 with an unknown number still in circulation. Four to five thousand missiles of all makes and nationalities are available to insurgents in Iraq without further import of new weapons.[32]

Over two dozen non-state actors acquired MANPADS by 2001 (see figure A-2). It is unknown how many additional organizations have gained access to the weapons in the period since.[33] The weapons themselves weigh less than 40 pounds and are approximately 60 inches long, making it very easy to transport them from country to country. There are only a handful of countries without confirmed or suspected MANPADS.[34]

Figure 2 - MANPADS Attacks on Civil Aircraft[35]

MANPADS Attacks on Civil Aircraft			
Organization	Period Covered	Number of Attacks	Number of Deaths
TSA	1979-present	35	640
CIA	1977-1996	27	400
FBI	1970s-present	29	550
RAND	1975-1992	40	760
Janes	1996-2000	16	186

There are differing opinions on the number of MANPADS attacks on civil aircraft since the 1970s (see figure 2). The most widely accepted numbers are those produced by the Transportation Security Administration of 35 attacks resulting in 24 shoot downs and 640

[31] James Chow et al., *Protecting Commercial Aviation Against the Shoulder-Fired Missile Threat*, Occasional Paper 106 (Santa Monica CA: RAND, 2005), 4 and Alan J. Kuperman, "The Stinger Missile and U.S. Intervention in Afghanistan," *Political Science Quarterly* 114, no. 2 (Summer, 1999): 254.

[32] Christopher Bolkom, Bartholomew Elias, and Andrew Feickert, "MANPADS Threat to Commercial Aviation" (lecture, Centre francais sur les Etats-Unis a l'IFRI, 12 March 2004).

[33] Bolkom and Elias, *Homeland Security*, 4

[34] Bolkom, Elias and Feickert, "MANPADS Threat"

[35] Loren Thompson, "MANPADS: Scale & Nature of the Threat" (lecture, 12 November 2003).

deaths.[36] This statistic includes several aircraft types ranging from helicopters to multi-engine turbofans.[37]

The Congressional Reporting Service did further analysis of the available data and found only six attacks on large, commercial turbojets using MANPADS (see figure A-3). Two attacks resulted in catastrophic loss of the aircraft and all passengers. Three attacks resulted in substantial damage to aircraft, but no loss of life. One was a near miss.[38] Perhaps more importantly, all but one of the attacks occurred in a known hostile zone.

Public Reaction to Potential Attack

The American public became acutely aware of the MANPADS threat after the near miss on the Israeli 757 in Kenya following the 2001 attack on the World Trade Center. In response, Congress introduced two bills directed at countering the threat. The first, the Commercial Airline Missile Defense Act, called for the development and installation of a missile defense system on all US flagged commercial airliners. This bill died in committee.[39] The second, the Commercial Aviation MANPADS Defense Act, was a more comprehensive approach to counter proliferation and aircraft defense. This bill included international efforts to secure weapons and reduce their proliferation, intelligence sharing, airworthiness certification of defensive systems, and routine vulnerability assessments. This bill passed the house with a 423-0 vote. The senate did not consider the bill after two readings.[40]

The failure of these bills led Rep. Steve Israel to introduce the Civil Reserve Air Fleet Missile Defense Pilot Program Act of 2007. The intent of this act was to require the Department

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[36] Thompson, "MANPADS" and Bolkom and Elias, *Homeland Security*, 7.
[37] Bolkom and Elias, *Homeland Security*, 8.
[38] Bolkom and Elias, *Homeland Security*, 8.
[39] GovTrack.us, "H.R. 580--108th Congress (2003): Commercial Airline Missile Defense Act," GovTrack.us (database of federal legislation) http://www.govtrack.us/congress/bill.xpd?bill=h108-580 (accessed Nov 11, 2008).
[40] GovTrack.us, "H.R. 580--108th Congress (2004): Commercial Aviation MANPADS Defense Act of 2004," GovTrack.us (database of federal legislation) http://www.govtrack.us/congress/bill.xpd?bill=h108-4056 (accessed Nov 11, 2008).

of Defense to determine the need and feasibility of equipping CRAF aircraft with missile defense systems. This bill is still in committee.[41]

Despite the defeat of the above bills, congress has provided extensive funding for counter-MANPADS efforts over the last five years under the umbrella of the National Intelligence Reform Act of 2004. The Department of Homeland Security received $173 million over three years to develop and test missile defense systems for commercial aircraft. Nearly $19 million had gone to DoD for ground-based defenses. The Department of State used $10 million for diplomatic efforts to curtail proliferations.[42]

These expenditures pale in comparison to the estimates of the loss of an aircraft to attack, from either MANPADS or other sources. RAND estimates the immediate cost of such an attack as $1 billion per aircraft, including hull loss and the death of passengers. Government reaction to the World Trade Center attacks resulted in a shutdown of the air traffic system. A similar shutdown may follow a MANPADS attack in the United States. A one-week shut down of the air traffic system in response to an attack may cost as much as $3.4 billion with long-term losses of over $15 billion. The total potential cost of a one month shut down is over $70 billion.[43]

Defeating the Threat

Defeating the MANPAD threat requires a multi-layered approach. RAND presents seven levels of protection. The first, "striking and capturing the terrorists" is the fundamental goal of the Long War.[44] Despite the expenditure of a great deal of treasure and manpower, only eight of the 26 non-state actors listed in figure A-2 are currently under direct offensive pressure from the

[41] GovTrack.us, "H.R. 2274--110th Congress (2007): Civil Reserve Air Fleet Missile Defense Pilot Program Act of 2007," GovTrack.us (database of federal legislation) http://www.govtrack.us/congress/bill.xpd?bill=h110-2274 (accessed Nov 11, 2008).
[42] Bolkom and Elias, *Homeland Security*, 22-23.
[43] James Chow et al., *Protecting Commercial Aviation*, 7-10.
[44] Ibid., 14.

US military. Pressure across all the non-state actors listed will require a great deal of international cooperation.

The second level is "preventing MANPADS acquisition by potential attackers."[45] This is a largely diplomatic effort requiring international cooperation, a counter proliferation effort climbing an uphill battle. As previously discussed, MANPADS exist in most countries in the world. A great number of non-state actors own and have demonstrated a propensity to use them. Therefore, this effort is akin to the marginally successful global landmine ban. Buyback programs, technology control, law enforcement and covert actions are examples of steps taken at this level.[46]

The third level of protection is "preventing MANPADS from being transported to location."[47] The international community has taken many notable steps here. The US DHS has greatly tightened the borders in improved monitoring of goods flowing in and out of the country. However, with a weapon as small as a shoulder-fired missile, total interdiction is extremely difficult. The weapons trade, narco-trafficking, and human trafficking are major funding streams for the very terrorists who would use MANPADS to attack commercial airliners and serve as indicators of the difficulty of preventing transportation.

The fourth level of protection is "preventing MANPADS from being fired."[48] This is usually a two-pronged effort. The first is to secure the airport and low-level flight path of the threatened aircraft. Based on the capabilities of even the most basic MANPADS, police must sanitize an area six miles wide and 50 miles long for every runway. This means an area greater

[45] Ibid.
[46] Ibid.
[47] Ibid.
[48] Ibid.

than 1000 sq miles with 10 million people to protect New York City's five major airports alone.[49]

The second prong of fire prevention is tactics. Commercial airlines currently fly spiral-down arrivals and spiral up departures at several Middle East airports.[50] These procedures keep the aircraft flight path within the airfield security perimeter. Since most MANPADS are infrared guided, or heat seeking, an additional benefit of these procedures are the reduced power settings required. Many other tactics are available to give the airliner some advantage over a potential threat but all, including the approaches and departures, require an increased level of training. This training includes simulator and actual aircraft use.

"Preventing a launched missile from striking the aircraft" is the fifth level of protection.[51] Missile defensive systems accomplish this task. Defensive systems are either ground-based or aircraft-based. DHS just completed testing two aircraft-based systems known as JETEYE and Guardian that provide this type of protection. Homeland Security is also investigating an unmanned aerial system (UAS) to defend the immediate vicinity of an airport. The DoD recently tested a ground-based system known as Vigilant Eagle.

JETEYE combines an airborne laser turret developed for the US Navy with an advanced missile detection and warning system. Guardian accomplishes the same using a directional infrared countermeasures system currently fielded by the US military. JETEYE permanently mounts to the aircraft where Guardian is a self-contained, pod-mounted system easily transferred from plane to plane. After a launch, the missile warning system detects and tracks the rocket.

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[49] Thompson, "MANPADS."

[50] Allan T. Duffin, "Landing in Baghdad," *Air & Space Magazine*, 1 November 2006, http://www.airspacemag.com/flight-today/landing_in_baghdad.html?c=y&page=1.

[51] James Chow et al., *Protecting Commercial Aviation*, 14.

The laser or infrared system then interferes with the guidance system on the rocket creating a miss.[52]

The DHS UAS, known as Project Chloe, pairs a high-altitude unmanned aerial vehicle with the Guardian pod. Flying at 50,000 to 65,000 feet, the UAS will detect and engage any missile launched within its scanning footprint. Commercial airliners will operate free from the threat underneath the UAS combat air patrol, if you will.[53]

Vigilant Eagle is a collection of tower-mounted missile detection and track systems, and an Active Electronically Scanned Array. The towers surround an airport and detect any launches in the vicinity. The electronic array emits a high-power microwave electromagnetic waveform interfering with the guidance system on the missile and causes a miss.[54]

Several efforts are underway to "minimize damage from a missile hit," the sixth level of protection.[55] Following lessons learned from recent major crashes, the aircraft industry began hardening aircraft in ways that have a second order effect of increasing survival after a missile hit. This first is onboard fuel tank inerting. These systems eliminate explosive fuel vapors in empty fuel tanks minimizing the secondary explosions after a hit. A similar system may have prevented the TWA flight 800 crash in 1996 and the Department of Defense uses it to increase the survivability of its cargo aircraft. [56]

Another improvement is propulsion-controlled aircraft. The DHL A300 attacked at Baghdad IAP in 2003 used throttle only control to return to the field and safely land. The crew

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[52] E. Richardson, "Counter MANPADS Program Completes Milestone," *Journal of Electronic Defense* 31, no. 8 (August 2008), 16 and Northrop Grumman, "Guardian," http://www.es.northropgrumman.com/countermanpads/index.html.

[53] G. Goodman, "DHS Demos Airliner Protection Concept," *Journal of Electronic Defense* 31, no. 10 (October 2008), 17.

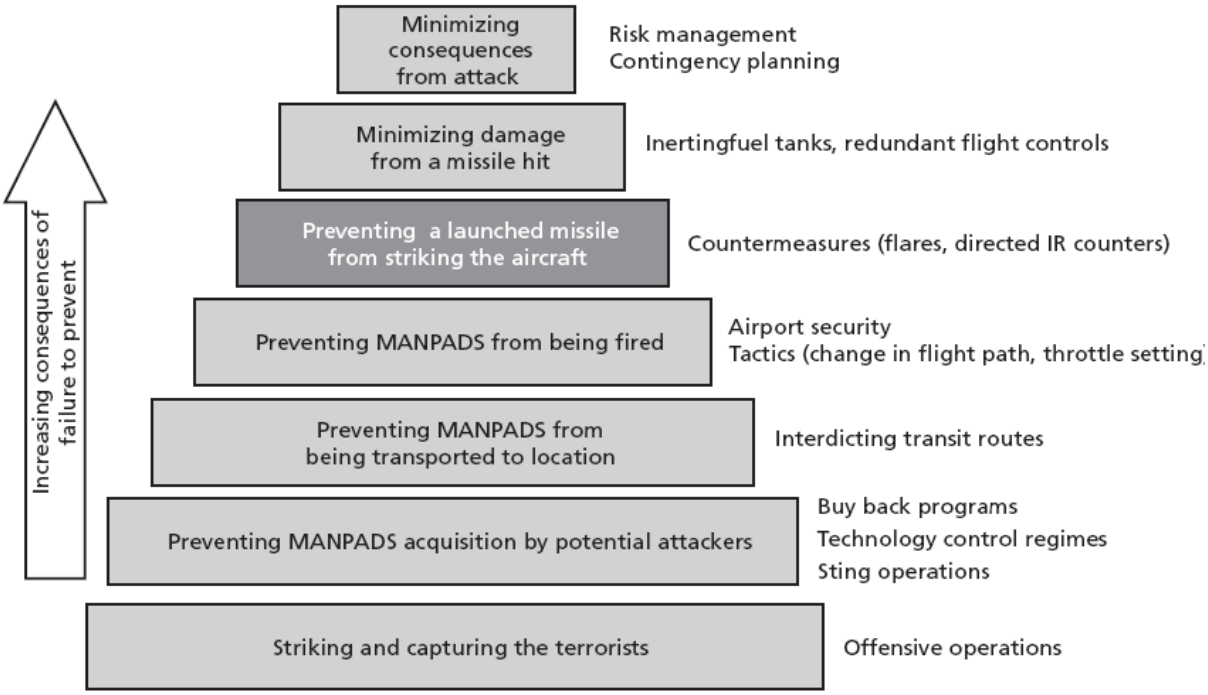
[54] Raytheon Corporation, *Vigilant Eagle Airport Protection System Product Data Sheet*, http://www.raytheon.com/capabilities/rtnwcm/groups/rms/documents/content/rtn_rms_ps_vigilanteagle_datas.pdf.

[55] James Chow et al., *Protecting Commercial Aviation*, 15.

[56] Federal Aviation Administration (FAA), *Fact Sheet: Fuel Tank Safety*, http://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=7318.

of a DC-10 used a similar technique to prevent a major aircraft disaster at Sioux City, Iowa in 1989. Since the major heat source on airliners is engines, engine loss is the most likely damage from a missile hit. Most aircraft have wing-mounted engines resulting in flight control loss as a secondary effect of the hit. Propulsion controlled aircraft technology will allow aircraft with wing damage, but operable engines, to safely land after the attack.

Figure 3 - Levels of MANPADS Protection[57]



The last layer of prevention is "minimizing consequences from attack."[58] The Federal Aviation Administration, International Civil Aviation Organization, and DoD all have strict accident response certification. All major airports are well equipped to handle a broad range of aircraft emergencies to include catastrophic crashes of wide-body aircraft. This is a major strength of the entire aviation system.

[57] Ibid.
[58] James Chow et al., *Protecting Commercial Aviation*, 14.

Recommendations

The layered approach is exactly the right answer for defeating the MANPADS threat. The best way to protect commercial aviation, and in fact any large aircraft, is to prevent attack in the first place. Unfortunately, this is not always possible. A proper amount of focus on defeating a launched missile is required.

Military aircraft routinely use flares for this purpose. Flares, however, present many problems, especially for commercial aircraft. Storage, assembly, and loading of the flares is a large logistical challenge. Commercial airports would have to build explosive storage areas and ground crews would have to learn to load the flares. All of this in the incredibly dense confines of an international airport where one incident with the highly flammable flares or explosives used to expel them from the aircraft could cause catastrophic damage to several aircraft. Additionally, the risk to the flying public from potential incidents with flares outweighs the risk presented by the threat on a daily basis.

The current trend in defending large military aircraft is laser protection similar to the JETEYE and Guardian systems discussed previously. These systems present the best and most effective answer for defending commercial aircraft. The Vigilant Eagle and Project Chloe systems hold great promise as well.

But what aircraft need protection? How many systems does the US need to purchase? There are four laser protection options ranging from equipping all US-flagged commercial airliners to none at all. The best choice depends on seven factors: unit costs, operating cost, funding, insurability, throughput penalties, crew training, and aircraft available to the US DoD through the CRAF.

Option 1 – Modify all US-flagged commercial airliners

There are 7,812 US-flagged commercial airliners currently in service. Of these, 3,972 are 90+ seat airliners, 1,008 are cargo, and 2,836 are regional aircraft of all propulsion types.[59] Equipping every one of them provides the greatest level of protection regardless of airfield or nation where the aircraft is operating. RAND estimates the total cost for fleet-wide modification at just over $11 billion. Unit cost is very close to the DHS target of $1 million per aircraft.[60] Operating costs, taking into account system maintenance and fuel penalties, are $300,000 per aircraft per year or $2.1 billion per year for the fleet.[61]

Funding for a project of this magnitude is a challenge. In an environment of $700 billion financial industry bailouts, one would think $11 billion is easy to come by. However, the entire DHS budget is approximately $36 billion. A third of the budget would go to funding one program. Annual operating costs under a requirement such as this will be borne by the TSA. The annual TSA budget is $4.4 billion. Half of every dollar spent on transportation security in the United States would be committed to this one program.[62] Over time, these costs will likely transfer to the airlines. As industry builds new airframes, defensive systems will be a part of the aircraft and the flyaway costs. Operating costs will become routine and consequently passed along to the customer, rather the US government under contract or the private citizen buying an airline ticket.

There should be little change in the insurability of commercial airliners under a fleet-wide modification. Every aircraft will look similar and federal regulation will likely force insurance companies to continue offering protection during routine air carrier operations.

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[59] Federal Aviation Administration, *FAA Aerospace Forecast: Fiscal Years 2008-2025* (Washington DC: Aviation Policy and Plans, 2008), 19.
[60] James Chow et al., *Protecting Commercial Aviation*, 24-25.
[61] Ibid., 26-27.
[62] Ibid., 29.

Insurability, however, has always been a factor in the eagerness of commercial air carriers to seek military contracts. It was one factor in the relatively slow speed at which commercial contract operations into Iraqi airfields began. Some means of aircraft protection may enhance the insurability of these air carriers and enable their ability to begin operations at hostile fields sooner.

The ability of the DoD to meet planned airlift throughput goals is unhampered by this solution. Though missile defensive systems will not give commercial aircraft access to every field in a hostile area, it may increase the number of fields or allow a hub closer to the fight.

Fleet modification demands fleet-wide aircrew training. Current designs call for an automated defensive system, so equipment operation training is minimal. However, airlines must continue to instruct aircraft defensive maneuvering. The challenge with teaching defensive maneuvering or tactical arrival and departure to a commercial crew is not their ability to learn and perform the maneuvers, but their ability to maintain any proficiency at those tasks. Military transport crews are only required to train once semi-annually creating a perennial problem with proficiency. Prior to actual deployment to a hostile area, military crews routinely perform intensive training in order to increase proficiency. The best solution for commercial airlines is defensive systems that have high enough probability decoying a missile that there is no requirement to maneuver in response to an attack.

The greatest benefit of this option to the DoD is an unlimited supply of CRAF and commercial contract aircraft. Air carriers will be able to use all their aircraft to meet CRAF goals or commercial contract requirements. There will be no need to manage their fleet by specific aircraft or tail number. This option gives the maximum flexibility to the entire system, but places the cost burden in the wrong place.

Option 2 – Modify all CRAF aircraft

The Federal Aviation Administration certainly admits a potential for MANPADS attacks in the United States exists, however, they also state "…there is no specific, credible information that terrorists have smuggled MANPADS into the United States…."[63] The lack of a credible threat and the passage of time since 2001 have led to congressional inaction concerning legislation requiring defensive systems on commercial aircraft. Only time will tell if any are reintroduced in the 111th Congress in 2009. Counter-MANPADS efforts focus predominately on non-proliferation. The U.S. State Department, the International Civil Aviation Organization (the United Nations' organization that governs international aviation), and the G8 have all taken specific actions against non-proliferation while only encouraging defensive systems.

The defense of U.S. commercial aircraft operating overseas is likely to remain a private corporate burden and appropriately so. Private enterprise puts these aircraft in harm's way; therefore, private enterprise must offset the expense associated with protection. The exception is the CRAF. The U.S. Government puts CRAF in harm's way. As a result, it is reasonable to expect the Department of Defense to share the expense associated with the risk.

The first challenge to modifying all CRAF aircraft is defining a CRAF aircraft. There are participation and activation goals; however, actual participation usually exceeds the activation goals significantly. Additionally, participation changes on a monthly basis. What does stay relatively constant is an overall participation of approximately 1,100 aircraft.

Equipping only 1,100 aircraft may drive the unit cost up, however start-up costs will drop due to a much smaller procurement number. Surprisingly, Northrop estimates unit costs of less

[63] International Federation of Air Line Pilots' Associations, "Man Portable Air Defense Systems (MANPADS)," IFALPA Security Bulletin, Safety Bulletin No. 03SAB008 (March 2003).

than $1 million after only 200 systems.[64] Operating costs may increase slightly over the $300,000 estimate due to the production of fewer spare parts.

Funding will likely transfer to the DoD under a CRAF only construct. Installation costs in the $1-2 billion range are easier for the DoD to absorb than any other federal agency. Modification will occur once an aircraft is committed to the CRAF, much like the government did with the reinforcement of floors to make passenger aircraft cargo capable or the aeromedical evacuation modification. The possibility of purchasing a limited number of future aircraft that are "CRAF capable" off the assembly line remains a possibility as well.

Defensive systems may enhance insurability, yet insurance remains a problem for the CRAF and commercial contracts. If commercial insurance providers cancel policies, as happened in Desert Storm, the FAA offers insurance protection under Title XIII of US Code. There are several issues associated with Title XIII insurance, these include the limits of coverage and when it is in force, among many others. For example, if a terrorist attacks an aircraft outside the designated hostile area, Title XIII likely will not cover the claim. Additionally, there are disagreements on the value of the aircraft itself. Government and industry insurance must reform to make the use of commercial aircraft in a hostile environment a reality.

Throughput will not change under this plan. There are enough aircraft over and above planning estimates to meet major theater war airlift goals. Air carriers may have to perform some tail number management to ensure the properly equipped aircraft are available, but the demand is minimal.

Training costs will decrease since airlines will not train every crew. Not training every crew increases the management burden and decreases crew flexibility. This is a particular problem since a large number of commercial crewmembers are also US Air Force Reserve or Air

[64] Richardson, "Counter MANPADS Program," 16.

National Guard crewmembers. During a time of high mobilization, the air carriers will lose a significant number of available crews. This option requires government funding for only the aircraft the government will put at risk, however not all CRAF aircraft will face the same threat.

Option 3 – Modify Long Range International segment only

The most vulnerable segment of the CRAF is the long range international and aeromedical evacuation segments. These aircraft operate primarily in international and hostile airspace, far removed from the protection of DHS. In June 2008, 944 aircraft were participants in this segment of the CRAF, however planning targets are limited to approximately 300 wide-body aircraft (see figures 4 and A-1). This option requires federal funding of defensive systems for 300 wide-body aircraft and air carrier funding for any additional CRAF participation above the planning targets.

The unit cost for 300 systems is likely the highest of the options presented. However, it is above the 200 systems Northrop says they need to meet the $1 million per system target. Operating costs will also increase.

DoD funding is the correct answer for 300 systems and is defensible under the current force structure models calling for CRAF to deliver nearly 40% of the cargo and nearly all of the passengers to a major theater war.[65] Profit incentive drives air carrier participation beyond 300 wide-body aircraft. Contract guarantees or fixed buys and favorable treatment for expansion buys are the primary incentives. Missile defensive systems should be a requirement for participation in these contracts. The air carrier will bear the cost of aircraft modification and operation. They will pass the additional expense back to the government in the negotiated contract price. As stated earlier, this is an over $2 billion per year business for commercial air

[65] Banholzer, "A Vulnerable National Asset," 9.

carriers. Replacing CRAF capability with organic military airlift would cost at least twice as much for the aircraft only, not even accounting for personnel or maintenance.

Figure 4 - CRAF Long Range International Planning Targets[66]

	Stage I	Stage II	Stage III	Total Required/Committed
Cargo	30	75	120	120/221
Passenger	30	87	136	161[67]/304
All numbers expressed in wide-body equivalents (capacity of one B-747-100).				

Insurability will continue to be a problem. One potential change is the insurance industry demanding defensive systems on CRAF participating aircraft, further reinforcing the government position. Overall insurance reform may be required in the end.

Properly managed there will be no throughput changes. A relatively small number of defensive system equipped aircraft does increase the scheduling challenge associated with any large deployment. The tail management challenge for air carriers increases as well. Similarly, crew management and training has the same concerns outlined in option 2.

Essentially voluntary compliance with a defensive system mandate for long-range international segment participation does run the risk of a reduction in participation. Federal funding of 300 wide-body equivalents ensures the minimum participation for national defense. It does not address the current reliance on commercial contract carriers. Contracts that allow recoupment of defensive systems expenditures and increased contract guarantees will help offset any industry uneasiness.

Option 4 – Maintain the status quo

Obviously, the cheapest option is maintaining the status quo. Failure to equip aircraft with a missile defensive system places constraints upon DoD use of commercial aircraft.

[66] All data derived from Graham, Sustaining the CRAF, 2-3.
[67] Includes additional requirement for aeromedical evacuation segment.

Insurability will continue to be a driving factor of where and when these aircraft may be used. Delays in securing airfields will drive inefficiencies in the overall airlift system and slow the rate of deployment or resupply.

In a time of true national emergency, the DoD will be unable to take advantage of one of our nation's greatest strengths, global mobility. As stated earlier, a hub and spoke system based upon an intermediate staging base well outside the hostile area means only half the required materiel and personnel will arrive in combat within planned time frames. Our major theater war plans will be at risk.

Other Alternatives

The Vigilant Eagle concept affords some interesting alternatives. According to the FAA, 35 airports manage 72 percent of the air traffic in the United States. Leveraging the necessity to protect 35 airports rather than 6,800 aircraft, Raytheon estimates system procurement costs 6 times less than the airborne systems. They estimate total lifecycle costs over 20 years of less than $2 billion dollars.[68]

A portable version of Vigilant Eagle offers similar protection to forward air bases. This is a very cost effective alternative to even the 300 wide-body option. The greatest weakness in the portable systems is defending the sensor towers. Adequately securing these towers will demand either increased patrolling or a decreased defensive footprint placing all the towers within the secure perimeter of the airfield.

DHS' Project Chloe offers potentially the best of all the air or ground-based solutions. It is capabilities based since a UAS can serve the dual purpose of intelligence, surveillance, and reconnaissance (ISR) while protecting a well-defined geographic area from MANPADS attacks.

[68] Raytheon, *Vigilant Eagle Fact Sheet.*

One UAS operating above 60K feet can defend an area the size of Los Angeles County. [69] The concept was 100 percent effective in live fire testing using a manned vehicle operating at 50K feet.[70] Though UAVs are expensive, the dual-use nature of Project Chloe combined with ready mobility makes this a promising solution for deployed military operations. All aircraft, civilian or military, US or foreign, benefit from the protective umbrella. The ISR capability augments an under resourced and overly taxed ISR system currently operating in Iraq and Afghanistan.

Within the United States, Chloe is likely more expensive and provides less coverage than the Vigilant Eagle system. Working much like our current Operation NOBLE EAGLE combat air patrols, one cannot patrol all of North America at once. Chloe systems will operate randomly or in areas where DHS suspects a direct threat. The ISR capability will enhance border and highway security. Nearly 100 percent of the cost will be borne by the already under resourced DHS. With a flyaway cost of nearly $75 million per UAV capable of operating at the altitudes required, DHS may not have the resources to purchase an adequate number of these systems to defend a large part of the United States. Additionally, UAVs require ground personnel in sensor operators, pilots, and maintenance to operate.

Both alternative solutions suffer from not considering the threat to CRAF operations during a contingency. Most airfields used by the military lie in the interior or southern parts of the United States and are outside the coverage proposed for these systems. A hybrid system of defensive system equipped aircraft and the alternative solutions is the only way to guarantee full protection for the CRAF mission within the United States.

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[69] Allison Barrie, "Eye in the Sky: New Flying Laser Will Stop Heat-Seeking Missiles," *Fox News*, 22 May 2008, http://www.foxnews.com/story/0,2933,357322,00.html (accessed 17 December 2008).

[70] Goodman, "DHS Demos Airliner Protection Concept," 17.

Conclusion

One of the United States greatest military advantages is rapid global mobility. No nation in the world can match our ability to project power. The cornerstone of the power-projection capability is military airlift. Military airlift is responsive, flexible, and uniquely capable of operating in a hostile environment. However, current planning for major theater war demands commercial aircraft, specifically CRAF, augmentation for nearly 40 percent of our cargo movement needs and nearly 100 percent of our passenger movements. We will continue to rely upon the CRAF and commercial contracts indefinitely.

Though MANPADS are widely proliferated, evidence shows the threat to routine commercial airliner operations is low. There has never been a MANPAD attack in the United States on any aircraft, civil or military. DHS has a multi-layered protection system in place that works. Likewise, 35 MANPADS attacks and 640 deaths globally pale in comparison to the 1,223 fatal airliner hull-loss accidents and over 32,000 deaths globally in the same period. On average, 42 civil airliners and over 1,100 passengers are lost every year.[71] These numbers do not prevent travelers from filling airliners every day. Estimates of the fiscal losses due to a MANPADS attack on commercial aviation are valid only for an attack on American soil. However, there is a very real threat to CRAF and commercial aircraft operating in a hostile environment supporting military operations.

Given the continued reliance on commercial aircraft for military support and the very real threat involved with military operations, the CRAF requires missile defensive systems. Option 3 provides the most responsible solution placing the fiscal burden in the appropriate places. The DoD must immediately equip 300 wide-body equivalent aircraft with defensive systems.

[71] Flight Safety Foundation, Aviation Safety Network, "Fatal Airliner Hull-Loss Accidents," http://aviation-safety.net/statistics/period/stats.php?cat=A1 (accessed 11 December 2008).

Furthermore, US Transportation Command and the US Department of Transportation must modify existing contracts to allow higher rates in order to recoup the cost of CRAF participating air carriers voluntarily equipping aircraft in the long-range international segment beyond the 300 aircraft goal.

The optimal CRAF solution includes the DoD taking over and further developing Project Chloe for use in a contingency environment. Chloe is easily deployable, capabilities based, and defends all aircraft under its umbrella. Project Chloe offers the greatest promise of all the options discussed.

The best solution for United States commercial air traffic operations is vigilant eagle. For only a fraction of the cost, DHS can provide protection to the majority of air traffic operations in the US with this system. It is automatic, unmanned and reliable.

Positive action now is necessary to prevent replaying the scenario experienced by the DHL A300 crew described at the beginning of this paper. Without visionary and creative defensive solutions, one man walking around in the desert with an inexpensive, easy to procure rocket system can unhinge our entire rapid global mobility system. Defend the CRAF now.

Appendix

Figure A- 1 - CRAF Monthly Allocations - June 2008[72]

June

OFFICE OF INTELLIGENCE, SECURITY, AND EMERGENCY RESPONSE

Enclosure 1

CIVIL RESERVE AIR FLEET (CRAF) MONTHLY ALLOCATIONS

INTERNATIONAL LONG-RANGE PASSENGER (ILP)

ILP Se	AAL	AMT	COA	DAL	HAL	NAO	NWA	OAE	RYN	UAL	USA	WOA	TOTAL
A-300 Series													0
A-330 Series							28				9		37
DC-10-30								8				2	10
B-747-200							2						2
B-747-400							16			30			46
B-757	118		41			5	10	2	3	29	5		213
B-767-	11		10						1				22
B-767-	55		10	26		5				23			119
B-767-400				21									21
B-777-	47			8						52			107
L1011 Series													0
MD-11												5	5
OTAL	231	0	61	55	0	10	56	10	4	134	14	7	582

INTERNATIONAL SHORT-RANGE PASSENGER (ISP)

ISP Se	AAL	ASA	AMT	BSK	CCP	COA	DAL	GWY	HAL	JBU	NWA	RYN	SCX	SWG	SWI	UAL	TOTA
A-300	30																30
A-320-200										30							30
B-727-200/B					0												0
B-737 Series	24			7									4				35
B-757-200							73										73
B-757-300											16						16
B-767-300 Series									11								11
MD-80	50																50
TOTAL	80	24	0	7	0	0	73	0	11	30	16	0	4	0	0	0	245

INTERNATIONAL SHORT-RANGE CARGO (ISC)

ISC Se	ABX	DHL	EIA	LYC	NAC	XNA	TOTAL
A-300-B4F	6						6
B-727-100F							0
B-727-200F	3						3
B-737-200					1		1
B767-2	0						0
DC-8-6	0						0
DC-9-33F							0
L-100-30				1			1
TOTAL	0	9	0	1	1	0	11

INTERNATIONAL LONG-RANGE CARGO (ILC)

ILC Se	ABX	APW	ATN	CKS	DAL	DHL	EIA	FDX	GCO	GTI	MUA	NWA	PAC	SOO	TDX	UPS	WOA	TOTAL
DC-8-62 CB			1															1
DC-8-6	0	2																2
DC-8-70F Series			10			8					3							21
DC-10-10C/F								13										13
DC-10-30F		4							7									11
B-747-100F				6			4									2		12
B-747-200F				12			9			13		13	1	15	0	3		66
B-747-300F										1				1				2
B-747-400F										11			6					17
B-767-	16	1																17
B-767-300																		0
B-767-400ER																4		4
L-1011-200F																		0
MD-10/11F-CF								127	4							9	6	146
OTAL	16	7	11	18	0	8	13	140	11	25	3	13	7	16	0	18	6	312

NATIONAL- DOMESTIC (DOM)

DOM	FFT	MEP	SWA	TRS	TOTAL
A-319-	3				3
A-320-200					0
B-737-300					0
B-737-700				3	3
B-757-200		29			29
MD-80 Series	1				1
TOTAL	3	1	29	3	36

NATIONAL-ALASKA (AAC)

AAC S	LYC	NAC	TOTAL
DC-6 Series		2	2
L-100-	2		2
TOTAL	2	2	4

AEROMEDICAL (AERO)

AERO Segmen	AAL	DAL	UAL	USA	TOTAL
B-767-200ER				6	6
B-767-300DR			4		4
B-767-300ER		32	8		40
TOTAL	0	32	12	6	50

CARRIER LEGEND

AAL - AMERICAN AIRLINES	COA - CONTINENTAL	JBU- JET BLUE	SCX - SUN COUNTRY AIRLINES
ABX - ABX AIR	DAL - DELTA AIRLINES	LYC - LYNDEN AIR CARGO	SOO - SOUTHERN AIR
APW - ARROW AIR	DHL - DHL AIRWAYS	MEP- MIDWEST AIRLINES	SWA - SOUTHWEST
ASA - ALASKA AIRLINES	EIA - EVERGREEN	MUA-MURRAY AIR	SWI - SUNWORLD INTERNATIONAL
ATN - AIR TRANSPORT INTL	FDX - FEDERAL EXPRESS	NAC - NORTHERN AIR CARCO	TDX - TRADEWINDS AIRLINES
BSK - MIAMI AIR INT'L.	FFT - FRONTIER AIRLINES	NAO - NORTH AMERICAN AIRLI	UAL - UNITED AIRLINES
CCP - CHAMPION AIR**	GCO - GEMINI AIR CARGO	NWA- NORTHWEST	UPS - UNITED PARCEL
CKS - KALITTA AIR	GTI - ATLAS AIR	OAE-OMNI AIR INTERNATIONAL	USA - U.S. AIRWAYS
CKS - KALITTA AIR	GWY - USA 3000 AIRLINES	PAC - POLAR AIR CARGO	WOA - WORLD
	HAL - HAWAIIAN AIRLINES	RYN - RYAN INTNL AIRLINES	XNA - EXPRESS.NET

NEW CARRIER in BOLD **= CARRIER DROPPED OUT

U.S. DOT, Office of the Secretary of Transportation

SUMMARY

	Past Mo. April	Change	Current Mo. June
ILP	582		582
ILC	316	-4	312
ISP	240	5	245
ISC	11		11
DOM	36		36
ACC	4		4
AERO	50		50
TOTA	1239	1	1240

[72] US DOT, "Monthly Allocations."

Figure A- 2 - Non-State Groups with Shoulder Fired SAMS, 1996-2001[73]

Group	Location	Missile Type
Armed Islamic Group (GIA)	Algeria	Stinger (c)
Chechen rebels	Checnya, Russia	SA-7 (c), Stinger (c), Blowpipe (r)
Democratic Republic of the Congo (DRC) rebel forces	Democratic Republic of the Congo	SA-16 (r)
Harkat ul-Ansar (HUA)	Kashmir	SA-7 (c)
Hizbullah	Lebanon	SA-7 (c),QW-1 (r), Stinger (r)
Hizbul Mujahedin (HM)	Kashmir	Stinger (r)
Hutu militiamen	Rwanda	Unspecified type (r)
Jamaat e Islami	Afghanistan	SA-7 (c), SA-14 (c)
Jumbish-i-Milli	Afghanistan	SA-7 (c)
Khmer Rouge	Thailand/Cambodia	Unspecified type (r)
Kosovo Liberation Army (KLA)	Kosovo	SA-7 (r)
Kurdistan Workers Party (PKK)	Turkey	SA-7 (c), Stinger (c)
Liberation Tigers of Tamil Eeelam	Sri Lanka	SA-7 (r), SA-14 (r), Stinger (c), HN-5 (c)
Oromo Liberation Front (OLF)	Ethiopia	Unspecified type (r)
Palestinian Authority (PA)	Palestinian autonomous areas and Lebanon	SA-7 (r), Stinger (r)
Popular Front for the Liberation of Palestine-General Command (PFLP-GC)	Palestinian autonomous areas and Lebanon	Unspecified type (r)
Provisional Irish Republican Army (PIRA)	Northern Ireland	SA-7 (c)
Revolutionary Armed Forces of Colombia (FARC)	Colombia	SA-7 (r), SA-4 (r), SA-16 (r), Redeye (r), Stinger (r)
Rwanda Patriotic Front (RPF)	Rwanda	SA-7 (r), SA-16 (r)
Somali National Alliance (SNA)	Somalia	Unspecified types (r)
Al Qaeda/Taliban	Afghanistan	SA-series (c), Stinger (c), Blowpipe (c)
National Liberation Army (ELN)	Colombia	Stinger (r), Unspecified types (r)
National Liberation Army (UCK)	Macedonia	SA-18 (c)
National Union for the Total Independence of Angola (UNITA)	Angola	SA-7 (c), SA-14 (r), SA-16 (r), Stinger (c)
United State Wa Army	Myanmar	SA-7 (c), HN-5N (c)
United Somali Congress - Somali Salvation Alliance (USC-SSA)	Somalia	Unspecified types (r)

Note: (c) is possession confirmed through intelligence sources or actual events; (r) is reported but not confirmed.

[73] Bolkom and Elias, *Homeland Security* 5.

Figure A- 3 - MANPAD Attacks Against Large Civilian Turbojet Aircraft (1978-Present)[74]

Date	Location	Aircraft	Operator	Outcome
8-Nov-1983	Angola	Boeing 737	Angolan Airlines (TAAG)	Catastrophic:130 fatalities of 130 people on board
9-Feb-1984	Angola	Boeing 737	Angolan Airlines (TAAG)	Hull Loss: aircraft overran runway on landing after being struck by a missile at 8,000 ft during climb out. No fatalities with 130 on board.
21-Sep-1984	Afghanistan	DC-10	Ariana Afghan Airlines	Substantial Damage: Aircraft was damaged by the missile, including damage to two hydraulic systems, but landed without further damage. No fatalities.
10-Oct-1998	Democratic Republic of Congo	Boeing 727	Congo Airlines	Catastrophic: 41 fatalities of 41 people on board.
28-Nov-2002	Kenya	Boeing 757	Arkia Israeli Airlines	Miss: Two SA-7's were fired at the aircraft during climb out, but missed. No fatalities.
22-Nov-2004	Iraq	Airbus A300	DHL Cargo	Hull Loss: Aircraft wing struck by missile departing Baghdad. Aircraft suffered a complete loss of hydraulic power and departed the runway during an emergency landing.

[74] Bolkom and Elias, *Homeland Security*, 9.

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