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Routing

Flying the Unfriendly Skies
Defending against the Threat of Shoulder-Fired Missiles

by Charles V. Peña

Executive Summary

Shoulder-fired anti-aircraft missiles, or MANPADS (man-portable air defense systems), have proliferated throughout the world. They can be purchased on the military arms black market for as little as $5,000. More than two dozen terrorist groups, including Al Qaeda, are believed to possess such weapons. The FBI estimates that there have been 29 MANPADS attacks against civilian aircraft resulting in 550 deaths. At least 25 of the reported attacks have been attributed to nonstate actors.

Even though a U.S. airliner has not been attacked by a missile, the question well may be when, not if, such an attack will happen. Therefore, the federal government should act now to provide protection for civilian aircraft instead of waiting to respond to an attack. The need to act beforehand is particularly acute because, although the human death toll would likely be less than on September 11, 2001, the economic consequences of an attack could be enormous. According to one estimate, the total economic loss resulting from an attack could be as high as $70 billion.

After 9/11 the public could eventually be coaxed back into flying by assurances that the government and airlines were taking security precautions to prevent more hijackings. But if even a single airliner is shot down by a missile, public confidence will not be easily restored. The harsh reality is that ground security to defend against MANPADS is nearly impossible.

The U.S. government should take advantage of available technology currently used on military aircraft to protect the U.S. commercial aircraft fleet. The cost to outfit all 6,800 U.S. commercial aircraft with advanced laser-jamming infrared countermeasures against MANPADS is estimated at $11 billion plus $2.1 billion in recurring annual operating costs. In 2004 Citizens Against Government Waste documented a total of $22.9 billion in federal pork-barrel spending—more than twice what's needed to procure the countermeasures against shoulder-fired missile attacks. Canceling the Air Force's F-22, the Navy's F/A-19E/F, the Marine Corps' V-22, and the Navy's Virginia-class submarine would yield savings of $170 billion in future program costs. The president's proposed federal budget for fiscal year 2006 is $2.6 trillion. Certainly, the U.S. government can find needless spending equal to less than one-half of 1 percent of its budget to help fulfill its primary responsibility of providing for the common defense.

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Introduction

In November 2002 an Israeli Boeing 757 jet carrying 261 passengers was shot at by Soviet-made shoulder-fired anti-aircraft missiles, or MANPADS (man-portable air defense systems), in Mombassa, Kenya. A year later Iraqi insurgents hit a civilian DHL cargo plane with a shoulder-fired missile after it took off from Baghdad International Airport. In December 2003 at Baghdad International Airport, a C-17 Globemaster cargo aircraft was forced down by enemy fire, as was a C-5 Galaxy transport aircraft the following month. Although in those two cases U.S. military officials have not said what struck the aircraft,[1] presumably they were hit by MANPADS. In all of those incidents the aircraft were able to safely land and, fortunately, no one was seriously injured or killed.

Those four events raise the question of whether Al Qaeda might be able to use MANPADS to destroy a U.S. commercial passenger aircraft. The evidence from the Kenyan incident suggests that Al Qaeda (or a group connected to Al Qaeda) may have been linked to the failed attack.[2] Adding to the worry was the September 2003 arrest of an arms dealer who agreed to sell shoulder-fired anti-aircraft missiles to an FBI informant posing as a would-be terrorist. What is most troubling about that incident is, not whether the accused arms dealer, Helmant Lakhani—a 68-year old Briton of Indian descent—was an Al Qaeda ally or sympathizer,[3] but the relative ease with which MANPADS could apparently be bought and the fact that the seller was aware that the buyer wanted to shoot down U.S. passenger jetliners.[4]

In October 2003 the U.S. Department of Homeland Security announced a solicitation for proposals to counter the MANPADS threat; and in January 2004 BAE Systems, Northrop Grumman, and United Airlines were chosen to participate in a six-month Phase I counter-MANPADS study. In August 2004 BAE Systems and Northrop Grumman were selected to conduct a follow-on Phase II for 18 months to "continue with development, demonstration, and testing of counter-MANPADS devices on commercial aircraft, and complete engineering, manufacturing, installation, and operations and support planning documents."[5] In February 2004 Vice Admiral Lowell E. Jacoby, director of the Defense Intelligence Agency, said that "hijacking and *attacks with portable, shoulder-fired missiles against civilian aircraft* remain prominent concerns."[6]

Given the likely consequences of a MANPADS attack, possible defensive measures must be seriously considered and implemented as quickly as possible.

Consequences of a MANPADS Attack

Although the loss of life from a single MANPADS attack would be considerably less than that caused by the 9/11 attacks (perhaps several hundred killed rather than thousands), the terror spread by such an attack could be just as profound. Even an unsuccessful terrorist attack against a U.S. commercial aircraft would likely have a chilling effect on airline travel. The consequences of the September 11 hijackings serve as a useful baseline for estimating the potential effects of an attack with a shoulder-fired missile on a commercial airliner.

Even though the airline industry was facing significant challenges prior to 9/11, the sharpest decline in industry revenues in history—35 percent to 40 percent in the last quarter of 2001 due to corporate travel freezes and cancellation of leisure trips—is attributed to the terrorist attacks.[7] But the economic consequences rippled beyond the airline industry. According to a study by the Milken Institute, the U.S. economic output lost in the immediate aftermath of the attacks was $47 billion and the loss of stock market wealth (after the end of the first week of trading after the attack) was more than $1.7 trillion.[8] The immediate cost to the insurance industry was estimated at from $36 billion to $54 billion, the largest insured losses in history.[9] The economic losses associated with the attacks probably led to the loss of more than 145,000 jobs

in 34 states in 2001 and 2002.[10] Another Milken Institute study estimated that as many as 1.6 million jobs in U.S. metropolitan areas might eventually be lost because of 9/11.[11] Admittedly, it may be impossible to accurately measure the total costs of the September 11 attacks. But it is sobering that Robert Keleher, chief macroeconomist for the Joint Economic Committee, concluded that "terrorism's long-term costs may be more severe than suggested by many existing estimates."[12]

A MANPADS attack would have similar repercussions throughout the economy. A RAND Corporation study concluded that "demand for air travel could fall by 15–25 percent for months after a successful MANPADS attack on a commercial airliner in the United States. A weeklong systemwide shutdown of air travel could generate welfare losses of $3-4 billion, and when losses from reduced air traffic in the following months are added in, the result could exceed $15 billion."[13] The study estimated that if airlines were shut down for one month, the total loss could be more than $70 billion.

It is also worth noting an important difference between the 9/11 hijackings and a MANPADS attack. After September 11, the federal government was able to implement security measures designed to prevent future hijackings. Regardless of the efficacy of those measures, they provided some level of assurance to the general public that it was safe to fly. But if a shoulder-fired missile is used to attack a passenger aircraft (even if the attack is unsuccessful), it may be much more difficult to convince the public that it is safe to fly. Without active countermeasures, aircraft would still be defenseless against a MANPADS attack. And it would be nearly impossible to create a secure perimeter around a large enough area surrounding an airport to prevent a potential attack. Therefore, the effects of a MANPADS attack might actually be greater than those of 9/11. According to the Center for Strategic and International Studies, "Given the easy availability and number of MANPADS around the world, a future terrorist attack against commercial airliners may succeed sooner or later, potentially bringing the world economy to a standstill."[14]

The MANPADS Threat

MANPADS are relatively simple surface-to-air missiles that are used by single individuals. Once launched, the missile homes in on its target and the time to impact is five or six seconds. Typically, MANPADS are about five to six feet long and weigh about 35–40 pounds. The vast majority of current MANPADS use a passive infrared seeker[15] that locks onto the heat generated by the aircraft's engines to guide the missile to the target. But MANPADS can also be guided by sight or by laser beams. The former requires an operator to visually aim at the target and manually guide the missile. The latter requires the operator to continuously track the target by keeping a laser beam pointed at it.[16]

The shoulder-fired missiles used in the November 2002 attack in Kenya were Soviet-made SA-7s that use passive infrared guidance. The SA-7 has a speed of approximately 800 feet per second and a firing range of 11,000 to 13,700 feet and can hit targets up to an altitude of 4,900 to 7,500 feet.[17] More capable (greater speed, firing range, and engagement altitude) missiles include the SA-14, SA-16, and SA-18. The more advanced SA-18 may have been used in the attacks at Baghdad International Airport.[18]

The most commonly known U.S. MANPADS are the FIM-92A Stingers, which are highly capable systems[19] with at least 270 confirmed kills of military aircraft. During the 1980s the Central Intelligence Agency supplied 900 Stingers to the Afghan rebel mujahadeen groups fighting the Soviet occupation of Afghanistan.[20] In October 2001 Gen. Richard Myers, chairman of the Joint Chiefs of Staff, estimated that enemy Afghan forces had 200–300 Stinger missiles. In August 2002 a Pentagon spokesperson said that more than 5,500 shoulder-fired missiles had been captured in Afghanistan during Operation Enduring Freedom.[21]

Without active countermeasures, aircraft would be defenseless against a MANPADS attack.

Table 1
MANPADS Attacks on Civil Aircraft

Estimating Organization	Period Covered	Number of Attacks	Number of Deaths
TSA	1979–2003	35	640
CIA	1977–1996	27	400
FBI	1970s–2003	29	550
RAND	1975–1992	40	760
Jane's	1996–2000	16	186

Source: Loren B. Thompson, "MANPADS: Scale and Nature of the Threat," Lexington Institute, November 12, 2003.

An estimated 500,000 to 700,000 MANPADS have been produced worldwide[22] and are thought to be in the military inventories of at least 56 countries.[23] So containing their proliferation is a relatively moot point—especially since, according to the RAND Corporation, "SA-7s and other Russian made models can be purchased in arms bazaars in a number of Middle Eastern and Central Asian countries. In some of these markets, such systems are sold for as little as $5,000."[24]

The biggest concern about the MANPADS threat is that they are known to be in the possession of nonstate actors. According to a U.S. government estimate, there are 6,000 MANPADS outside the control of any government.[25] More than two dozen terrorist groups probably possess those weapons.[26] Al Qaeda is reported to have both first-generation SA-7s and second-generation Stinger missiles.[27] So the terrorist threat is not hypothetical. Moreover, MANPADS have been used to attack civil aircraft. Table 1 shows various estimates of the number of MANPADS attacks and the deaths attributed to those attacks. Table 2 shows the reported use of MANPADS by nonstate actors.

Al Qaeda is reported to have both first-generation SA-7s and second-generation Stinger missiles.

More Security?

One way to defend against the MANPADS threat would be to try to secure a perimeter around an airport to prevent a terrorist from firing a missile at an airliner. But there are two major problems with trying to provide wide-area security around an airport to prevent a MANPADS attack. First, the protected area would have to be quite large. For example, the RAND Corporation determined that the SA-7 MANPADS threat to Los Angeles International Airport would allow a terrorist to be anywhere within an 870-square-mile area[28] of the airport. Loren Thompson at the Lexington Institute estimates that protecting the approach and departure paths for a single runway "could require policing an area of 300 square miles."[29] Second, population density around major metropolitan airports would make those areas extraordinarily difficult to police. For example, based on the 2000 census, the City of Los Angeles had a population density of 7,873 persons per square mile and 2,850 housing units per square mile.[30]

If protecting Los Angeles International Airport requires securing an 870-square-mile area around the airport, that means a dedicated police effort in an area containing 6.8 million people and 2.5 million housing units. According to Thompson, "Protecting New York area airports alone could require policing more than 1,000 square miles containing 10,000,000 people."[31] It is not surprising, therefore, that the RAND Corporation concluded that "*completely* preventing an attack solely through the use of enhanced security perimeters would be impractical, considering the large urbanized areas involved, the cover

Table 2
Reported Nonstate Use of MANPADS: 1996–2001

Date	Nonstate Group	Missile Type	Killed/ Injured	Aircraft	Notes
23 Oct 00	Tamil Tigers (LTTE)	Stinger	4/0	Mi-24 Hind	Shot down near Trincomalee harbor, Sri Lanka.
04 Oct 00	Chechen rebels	Stinger	1/0	Su-24	Shot down near Urus-Martan, Chechen Republic.
04 Oct 00	Chechen rebels	Stinger	Unknown	Su-25	Shot down on reconnaissance mission.
10 Aug 00	LTTE	Unknown	0/0	Fighter jet	Aircraft fired at. No damage.
25–30 Aug 00	Chechen rebels	SA-7	0/0	Unreported	Helicopters fired on. All missiles miss.
07 May 00	Chechen rebels	Unknown	2/0	Su-24	Shot down in southern Chechnya.
31 Mar 00	LTTE	Unknown	40/0	An-26	Transport craft downed, possibly by MANPADS.
10 Nov 99	Revolutionary Armed Forces of Columbia (FARC)	Unreported	5/0	DC-3	FARC mistakenly downs civilian craft, press says.
04 Apr 99	Hezbollah	SA-7	0/0	F-16s	Two missiles fired on Israeli F-16s. Both miss.
06 Mar 99	Kurdistan Workers' Party (PKK)	Unknown	20/0	Puma helicopter	Helicopter shot down in southern Turkey.
02 Jan 99	United Front for the Total Independence of Angola (UNITA)	Unknown	14/0	C-130	UN plane shot down in central Angola.
26 Dec 98	UNITA	Unknown	9/0	C-130	UN-chartered plane shot down in central Angola.
15 Dec 98	UNITA	Unknown	10/0	An-12	An-12 struck by missile en route to Luanda.
10 Oct 98	Tutsi rebels	Possible SA-7	40/0	Boeing 727	Airplane struck over DR of Congo.
13 Aug 98	LTTE	Unknown	0/0	Kfir fighter/ surveillance aircraft	Missiles fired by rebels. No damage.
01 Dec 97	Kosovo Liberation Army (KLA)	Strela 2M	5/0	Yugoslav Air Transport	Serb reports KLA shot down craft near Pristina.
07 Oct 97	LTTE	Unknown	0/0	Mi-17 transports	Missiles reportedly fired from Tamil rebel boats.
10 Nov 97	LTTE	Unknown	2/2	Mi-17 transports and Mi-24 Hind	Missiles fired at helicopter convoy.
20 Aug 97	LTTE	Stinger (reported)	0/0	Kfir fighters	Miss over Puliyankulam.
18 May 97	PKK	SA-7	2/0	Super Cobra	Shot down during operations in Iraq.
May 97	PKK	SA-7	11/0	Cougar Transport	Shot down during operations in Iraq.
22 Jan 96	LTTE	Unknown	39/0	Mi-17	Unconfirmed MANPADS.
30 Apr 96	LTTE	Unknown	94/0	Unknown	Two air force transports downed.
Apr 96	Hezbollah	Unknown	0/0	UAV	Unconfirmed MANPADS.

Source: Thomas B. Hunter, "The Proliferation of MANPADS," *Jane's Intelligence Review*, November 28, 2002.

If counterproliferation to prevent terrorists from acquiring MANPADS and airport perimeter security to prevent terrorists from using MANPADS are not effective ways to defend against a possible terrorist attack, then active countermeasures may be the only way to defeat such an attack.

provided by urban structures, and the availability of multiple freeways for quick access to attack and getaway."[32]

Just as it is impossible to prevent the proliferation of MANPADS (because they have already proliferated) as a way to counter the threat, airport perimeter security is also an inadequate solution to a possible terrorist attack.

Technical Countermeasures

If counterproliferation to prevent terrorists from acquiring MANPADS and airport perimeter security to prevent terrorists from using MANPADS are not effective ways to defend against a possible terrorist attack, then active countermeasures may be the only way to defeat such an attack. There are three types of MANPADS countermeasures that are either deployed or under development: flares that could be mounted on and dispersed from aircraft, laser jammers that could be mounted on aircraft, and ground-based high-energy lasers (HELs) to defend airports. Flares and laser jammers are designed to confuse the infrared seeker of heat-seeking missiles. The HEL would destroy the missile regardless of its guidance system.

Flares

Flares can be dispersed from aircraft to create infrared signatures so large that the MANPADS' infrared seekers are fooled into thinking that the flares are its intended target instead of the aircraft. Such systems are currently deployed on a wide variety of military aircraft. Aircraft belonging to Israel's El Al airline are reportedly outfitted with countermeasure flares to defend against MANPADS.[33]

Flares are generally considered an effective countermeasure against first-generation MANPADS—such as the Soviet SA-7, which may be the most widely proliferated shoulder-fired missile system[34]—but would be less effective against second- and third-generation missiles with seekers that can discriminate between the thermal signatures of airplane engines and decoy flares. According to the RAND Corporation, "Advanced flares can counter this discriminant because they consist of an ensemble (cocktail) of flares, each peaking in a different waveband, such that the combined signature matches that of the aircraft."[35]

For commercial aircraft operating in civilian airspace over populated urban areas, the issue is less the effectiveness—especially if terrorist groups such as Al Qaeda are thought to possess first-generation MANPADS—than the operational consequences associated with using flares. As the RAND study pointed out, "Conventional flares could cause ground fires if released below 1,000 feet."[36] As a result, flares could not be deployed on a regular and indiscriminate basis because of the risk of causing fire damage to public and private property in the vicinity of the airport. Mitigating such consequences would require a nearly perfect missile warning system to minimize false alarms that would result in deploying flares to counter a perceived attack. So even though flares are available today and fairly effective against first-generation MANPADS (which are the most widely available), they may be an impractical solution for commercial aviation use.

Directed Infrared Countermeasures

Another way to fool MANPADS infrared seekers is with a directed infrared countermeasure, or DIRCM, that uses beams of light to emit signals that scramble the infrared seeker, causing the missile to miss its target. More than 3,000 DIRCM systems are deployed worldwide.[37] The Northrop Grumman Nemesis DIRCM system has been installed on more than 300 military aircraft, including U.S. Air Force C-17s and C-130s.[38]

The most advanced DIRCMs, which are currently being developed by Northrop Grumman in the United States and BAE Systems in the United Kingdom, use laser beams to jam an infrared seeker and would be effective against both first- and second-generation MANPADS. According to the RAND Corporation, "A single-turreted laser-based countermeasure system would have good effectiveness against single shots by the major-

ity of current MANPADS threat types."[39] Northrop Grumman's Large Aircraft Infrared Countermeasures (LAIRCM) system is a turret-mounted laser that is scheduled to be installed on 137 U.S. Air Force C-17 and C-130 transport aircraft and KC-135 and KC-10 tanker aircraft. The first LAIRCM-equipped C-17 was delivered in May 2003, and some are now being used on aircraft deployed in Iraq.[40] So while still relatively new, laser-jamming DIRCMs are deployed and operational and are a viable option for commercial aircraft application in the near term.

High-Energy Lasers

A longer-term possibility for MANPADS defense is a ground-based high-energy laser that could destroy the missile. The Northrop Grumman mobile tactical high-energy laser (MTHEL) under development for the U.S. Army has destroyed in flight five artillery projectiles and 28 short-range rockets, fired both singly and in salvos. The MTHEL has also successfully intercepted mortars fired singly and in salvos.[41]

Northrop Grumman has proposed a variant of MTHEL dubbed "Hornet" that would be a wholly contained system—missile warning, searching and tracking, pointing, and laser weapon—that would be able to fit in a trailer about the size of that of a typical eighteen-wheeler. Its deployment could be disguised and its location changed periodically to prevent terrorists from attacking the system. The advantage of a system such as Hornet is that it would provide defense for an airport, not just particular aircraft, so even aircraft without on-board countermeasures could be protected. Another advantage is that the lethality of an HEL against MANPADS is not a function of the seeker type, so a system like Hornet would be effective against all current and future MANPADS seeker technologies. One potential drawback is that lasers cannot operate under all weather conditions (e.g., rain or fog). However, "conditions that render the HEL inoperative will usually deny capability to MANPADS as well."[42]

An important issue with HEL is ensuring that the laser would not be a threat to aircraft if accidentally miscued. Reports of lasers being beamed into cockpits and distracting pilots during landing approaches (including at least one reported eye injury)[43] are evidence that this is not a trivial concern. Another concern is that the laser could directly damage the aircraft. According to the RAND Corporation, "Since the laser beam must be slewed rapidly to keep pointed on the missile, any chance illuminations [on aircraft] would last only milliseconds and would not cause damage."[44]

The biggest drawback of using HEL technology against MANPADS is that it is still very much a developmental system. Northrop Grumman is scheduled to deliver the first prototype of the MTHEL to the U.S. Army in 2007. The RAND Corporation estimates that actual production of a Hornet-like system is at least three years away—compared to flares or DIRCMs that are currently in production. So HEL is not an immediate answer to the MANPADS threat.

Table 3 summarizes the effectiveness of different countermeasures against different MANPADS threat types.

Cost Estimates

According to the Federal Aviation Administration, there were nearly 4,100 large passenger jet aircraft in the U.S. commercial aviation fleet in 2003 and almost 2,700 regional and commuter passenger aircraft (jet and propeller).[45] Robert DelBoca, Northrop Grumman's vice president of infrared countermeasure systems, told a congressional committee: "Our plan calls for equipping 300 aircraft, which fly internationally, with LAIRCM for approximately $2 million per plane. If the government decided to equip significantly more than 300 planes, the cost could drop to around $1 million per plane. For example, equipping approximately 3,000 aircraft of the U.S. domestic commercial aircraft fleet would cost approximately $3 billion and would require about six years to complete."[46]

Laser-jamming DIRCMs are deployed and operational and are a viable option for commercial aircraft application in the near term.

Table 3
Potential MANPADS Countermeasures

Threat Type	Proliferation	Countermeasures		
		Flares	Laser DIRCM	HEL
Older generation IR	Very wide	D	D	P
Current generation IR	Wide	P	D	P
Radio control	Limited	NE	NE	P
Laser beam rider	Limited	NE	NE	P
Future IR (imagers)	None	L	L	P

D = Demonstrated L = Limited NE = No Effectiveness P = Potential

Source: James Chow et al., "Protecting Commercial Aviation against the Shoulder-Fired Missile Threat," RAND Corporation, 2005, p. 23.

If Northrop Grumman's cost estimates are accurate, then outfitting the entire U.S. commercial aviation fleet would cost $6.8 billion. The RAND Corporation's cost estimate for installing laser DIRCM systems on 6,800 commercial aircraft was more conservative: $11.2 billion for procurement, $2.7 billion for annual operating and support costs, and $38.2 billion for total 10-year life cycle cost (LCC), which included various other costs.[47] The airline industry has estimated operating costs at $5 billion to $10 billion per year.[48] Using this wide range of cost estimates, the total 10-year LCC of equipping the entire U.S. commercial airline fleet could be as low as $33.8 billion and as high as $111.2 billion.

The potential cost of an HEL system to counter the MANPADS threat is difficult to estimate since the U.S. Army's MTHEL program has yet to produce a prototype. But it is possible to estimate potential upper and lower bounds. For example, the U.S. Army's tactical high-energy laser (THEL)—the basis for MTHEL and Northrop Grumman's Hornet system—went from an idea to an operational testbed system (that has successfully intercepted targets at the White Sands Missile Range in New Mexico) in four years at a cost of $275 million.[49] So we might expect that the first HEL systems to counter MANPADS might cost as much as several hundred million dollars each. At the other end of the cost spectrum, Northrop Grumman's Alvin Schnurr estimates the Hornet's cost "in the low tens of millions of dollars" per unit.[50] Although rather wide, a potential cost range for an HEL system might be $20 million to $200 million per unit, with $100 million as a "ballpark" unit cost estimate.

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According to the FAA, 140 hub airports in the United States account for 96.6 percent of all passenger enplanements (31 large-hub airports account for 69.6 percent, 37 medium-hub airports account for 19.3 percent, and 74 small-hub airports account for 7.7 percent). The remaining 3.4 percent of commercial passenger enplanements occur at 406 other airports (282 nonhub airports and 124 commercial service airports).[51]

For a ground-based HEL system such as Hornet, the RAND Corporation determined that "robust protection of a large airport such as Reagan National [Washington, D.C.] would require a minimum of three sites."[52] If we assume that a minimum of two sites are required for all other airports, Table 4 shows how much it might cost to protect U.S. commercial airports if a single Hornet costs $100 million.

If the requirement is to provide HEL protection for every airport in the United States, a mid-range estimate of the cost of procuring the requisite number of HELs is $112.7 billion. However, protecting only the 140 hub airports that account for nearly 97 percent of commercial airline passenger traffic would cost considerably less: $31.5 billion. If the

Table 4
Cost of HEL System to Protect U.S. Airports

	HEL per Airport	Total HEL	Total Cost ($ million)[a]
31 large-hub airports	3	93	9,300
37 medium-hub airports	2	74	7,400
74 small-hub airports	2	148	14,800
Subtotal, 96.6% of passengers		315	31,500
282 nonhub airports	2	564	56,400
Subtotal, 99.8% of passengers		879	87,900
124 other airports	2	248	24,800
Total, 100% of passengers		1,127	112,700

[a] Assumes that a single HEL costs $100 million. If the cost estimate range of uncertainty is $20 million to $200 million per HEL, then the total acquisition cost could be as low as $22.5 billion and as high as $225.4 billion.

HEL concept eventually proves to be an effective solution to the MANPADS problem, cost versus diminishing marginal returns will be an important consideration. And ultimately the per unit cost to deploy an HEL (as well as the recurring operating costs) will be a major factor. If the cost per HEL is only $20 million, then the total acquisition cost will be only $22.5 billion to protect all 546 commercial service airports in the United States.

Conclusion

The RAND Corporation concluded that a decision to invest $11 billion to install laser jammers on the entire U.S. commercial airline fleet should be put off: "Given the significant uncertainties in the cost of countermeasures and their effectiveness in reducing our overall vulnerability to catastrophic airliner damage, a decision to install should be postponed, and concurrent development efforts focused on reducing these uncertainties should proceed as rapidly as possible."[53] The RAND study listed these concerns:

- "Annual operating costs would be nearly 50 percent of what the federal government currently spends for all transportation security in the United States."
- "Well-financed terrorists will likely always be able to devise a MANPADS attack scenario that will defeat whatever countermeasures have been installed, although countermeasures can make such attacks considerably more difficult and less frequent."
- "Installing countermeasures to MANPADS attacks may simply divert terrorist efforts to less-protected opportunities for attack. To put it another way, how many avenues for terrorist attack are there, and can the United States afford to block them all?"[54]

The Air Line Pilots Association has also not been enthusiastic about MANPADS countermeasures because of cost concerns, particularly if the industry has to bear the costs:

> The airline industry is weathering the "perfect storm" of high fuel prices, terrorist threats, and a war-time environment, plus the rise of low-cost carriers, which are effectively setting fares for the "legacy" carriers. Established hub-

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and-spoke airlines are fighting for survival, despite the fact that passenger loads are now climbing again and are expected to equal or surpass pre–September 11 levels.

U.S. airlines cannot afford the cost of installing and maintaining counter-MANPADS equipment on their fleets. If counter-MANPADS systems are to be installed on U.S. airliners, the federal government must bear the cost as part of the overall cost of ensuring national security.[55]

The ultimate responsibility of the federal government as set forth in the Constitution is to "provide for the common defense." In the post-9/11 context, that means, in large part, defending against terrorist attacks. To be sure, there are thousands of potential targets in the United States, and even with an unlimited budget it would be impossible to protect all of them from every conceivable attack. As the Irish Republican Army famously said in a statement after a failed attempt to kill British prime minister Margaret Thatcher in 1984: "Remember, we only have to be lucky once. You will have to be lucky always."[56] So a realistic approach to homeland security starts with understanding that a perfect defense against terrorism is not possible. It also means knowing that even if defenses are erected, the nature of terrorism is to morph and adapt, to flow around obstacles, and to find the path of least resistance. Therefore, a determined terrorist enemy will eventually find a way to exploit gaps in defenses and security—precisely what Al Qaeda did on 9/11.

The MANPADS threat to civilian commercial aircraft is known and predictable. The cost to execute an attack is relatively low. The consequences of such an attack could be immense, perhaps even greater than the costs of the September 11 attacks. It is impossible to predict with any degree of certainty whether Al Qaeda (or any other terrorist group) would use MANPADS against an airliner, although the FBI issued a warning about the threat in May 2002. We know that Al Qaeda and other terrorist groups possess SA-7 and Stinger missiles. We know such missiles have been used by nonstate actors to shoot down aircraft and kill passengers. We also know that airplanes have been objects of interest in previous Al Qaeda attacks.

Given those facts—and knowing that U.S. commercial aircraft are currently proverbial "sitting ducks" for the MANPADS threat—the U.S. government would be shirking its ultimate responsibility if it chose to do nothing to defend against the threat, especially when potential solutions are at hand.

Cost is certainly an important factor. The fiscal year 2006 budget request for the Department of Homeland Security is $41.1 billion.[57] The $11 billion cost estimate by the RAND Corporation to install laser-jamming DIRCMs on all U.S. commercial aircraft would be 27 percent of the DHS budget. RAND argues that "any decision about government-mandated countermeasures installation aboard commercial airliners should thus consider the overall budget available (or necessary) for homeland-security purposes."[58]

To be sure, DHS's $41.1 billion budget may not be large enough to support a new $11 billion project, but the focus should not be just on DHS. If the federal government's primary responsibility is to provide for the common defense, the costs must be viewed from a wider perspective. The Bush administration's FY06 budget request for the U.S. government is $2.6 trillion.[59] So the $11 billion estimated cost for aircraft-mounted MANPADS countermeasures is less than one-half of 1 percent of the total federal budget—a modest amount for the government to spend to fulfill its primary responsibility. Regardless of whether one approves of the size of the federal budget, it is hard to believe that we can't find $11 billion within that budget to protect ourselves from a serious threat. And defending against probable future terrorist attacks should be at or near the top of the government's priorities.

Can $11 billion be found to pay for the installation of MANPADS countermeasures

The $11 billion estimated cost for aircraft-mounted MANPADS countermeasures is less than one-half of 1 percent of the total federal budget—a modest amount for the government to spend to fulfill its primary responsibility.

on civilian aircraft? And can another $2.1 billion be found annually to pay for the operating costs of those countermeasures? The answer is, emphatically, yes.

According to Citizens Against Government Waste, in 2004 congressional appropriators stuck 10,656 projects in 13 appropriations bills for a total of $22.9 billion in pork-barrel spending,[60] more than twice what's needed to procure the countermeasures cited in the RAND report. The biggest government pork-barrel spender, according to CAGW, was the Department of Defense ($11.5 billion)[61] followed by combined Transportation and Treasury projects ($4.4 billion).[62] CAGW also made 592 recommendations that, if enacted, would trim the FY05 budget by $217 billion and save $1.65 trillion over the next five years. Some recommended cuts include canceling the international space station program ($9.3 billion savings over five years), eliminating community development block grants ($24.5 billion savings over five years), reducing the federal gas tax and eliminating highway trust funds ($62 billion savings over five years), and eliminating the Natural Resource Conservation Service ($12.9 billion savings over five years).[63]

The Defense Department will spend nearly $500 billion in 2005, including the funds for military operations in Iraq and Afghanistan. Eleven billion dollars for MANPADS countermeasures would be about 2 percent of the Pentagon's spending. As is the case with the total federal budget, money saved in the Defense Department's budget could be used to pay for MANPADS countermeasures. According to a Business Executives for National Security study, "By adopting modern business practices, the Department of Defense could realize savings conservatively estimated at $15 billion to $30 billion."[64]

The Defense Department is also buying exorbitantly expensive new weapon systems that are not needed in a strategic environment in which the United States no longer faces a serious conventional military challenger or global hegemonic threat. Such weapons are not needed for hunting down and destroying the Al Qaeda terrorist threat. The Air Force's F/A-22 Raptor was originally designed for air superiority over Soviet tactical fighters that were never built, and the U.S. Air Force does not have a current or prospective adversary that can seriously challenge it for air superiority. The Navy's F/A-18E/F Super Hornet is another unneeded tactical fighter. The Marine Corps' V-22 Osprey's tilt-rotor technology is still unproven and inherently more dangerous than helicopters that can perform the same missions at a fraction of the cost. The Navy's Virginia-class submarine was designed to counter a Soviet nuclear submarine threat that no longer exists.

Canceling the F-22 Raptor, F/A-18E/F Super Hornet, V-22 Osprey, and Virginia- class attack submarines would save a total of $12.2 billion in procurement and RDT&E (research, development, testing, and evaluation) costs in the Defense Department's FY05 budget and a total of $170 billion in future program costs—more than enough to protect airports if the promise of HEL against MANPADS is realized and if cost can be kept relatively low. But it is still too early to know if HEL is a viable and cost-effective option.

There has not yet been a terrorist missile attack against a U.S. commercial airliner. But as the RAND Corporation concluded, "As measures are taken to preclude 9/11-style attacks (e.g., improvement in screening at airports, deployment of air marshals on aircraft, strengthening of cockpit doors), attacking aircraft with MANPADS will unavoidably become more attractive to terrorists."[65] We may be living on borrowed time.

The federal government can ill afford to continue to study the problem and delay a decision to protect civilian aircraft until the cost of MANPADS countermeasures comes down, especially when there are available solutions to the problem. The money necessary to deploy MANPADS countermeasures can come from canceling unneeded federal spending programs. True, countermeasures will not create a perfect defense against MANPADS (there is no such thing as a perfect defense), and they will not prevent terrorists from using

The federal government can ill afford to delay a decision to protect civilian aircraft until the cost of MANPADS countermeasures comes down.

Countermeasures may deter terrorists from using shoulder-fired missiles against aircraft.

other means to attack aircraft or other targets. But countermeasures will raise the cost of attack and lower the likelihood of success and thus may deter terrorists from using shoulder-fired missiles against aircraft.

Notes

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4. "Feds Tell How the Weapons Sting Was Played," *CNN.com*, August 14, 2003, http://edition.cnn.com/2003/LAW/08/13/arms.sting.details/.

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11. Ross Devol et al., *The Impact of September 11 on U.S. Metropolitan Areas*, Milken Institute Research Report, January 2002, p. 1.

12. Joint Economic Committee, U.S. Congress, "The Economic Costs of Terrorism," May 2002, p. 11, http://www.house.gov/jec/terrorism/costs.pdf.

13. James Chow et al. "Protecting Commercial Aviation against the Shoulder-Fired Missile Threat," RAND Corporation Occasional Paper, 2005, p. 9.

14. Center for Strategic and International Studies (CSIS), *Transnational Threats Update* 2, no. 4 (January 2004): 1.

15. Passive guidance means that the seeker does not emit any signals to detect a heat source; infrared MANPADS are "fire and forget" weapons because the operator is not involved in guiding the weapon to the target.

16. See Christopher Bolkcom, Bartholomew Elias, and Andrew Feickert, "Homeland Security: Protecting Airliners from Terrorist Missiles," Congressional Research Service Report for Congress, Order Code RL31741, updated November 3, 2002, pp. 1–3, for more detailed explanations of the various guidance technologies.

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