OCCASIONAL
PAPER

Protecting Commercial Aviation Against the Shoulder-Fired Missile Threat

James Chow, James Chiesa, Paul Dreyer,
Mel Eisman, Theodore W. Karasik, Joel Kvitky,
Sherrill Lingel, David Ochmanek, Chad Shirley

RAND INFRASTRUCTURE, SAFETY, AND ENVIRONMENT

The research described in this report was supported through provisions for independent research and development in RAND's contracts for the operation of Department of Defense (DoD) federally funded research and development centers: RAND Project AIR FORCE (sponsored by the U.S. Air Force), the RAND Arroyo Center (sponsored by the U.S. Army), and the RAND National Defense Research Institute (sponsored by the Office of the Secretary of Defense, the Joint Staff, the unified commands, and the defense agencies). The research itself was conducted within RAND Infrastructure, Safety, and Environment (ISE), a unit of the RAND Corporation. The mission of ISE is to improve the development, operation, use, and protection of society's essential built and natural assets; and to enhance the related social assets of safety and security of individuals in transit and in their workplaces and communities.

Library of Congress Cataloging-in-Publication Data

Protecting commercial aviation against the shoulder-fired missile threat / James Chow ... [et al.].
p. cm.
"OP-106."
Includes bibliographical references.
ISBN 0-8330-3718-8 (pbk. : alk. paper)
1. Aeronautics, Commercial—Security measures. 2. Terrorism—Prevention. 3. Surface-to-air missiles.
I. Chow, James, 1966–

TL725.3.S44P76 2005
363.28'76—dc22

2004026555

Published 2005 by the RAND Corporation
1776 Main Street, P.O. Box 2138, Santa Monica, CA 90407-2138
1200 South Hayes Street, Arlington, VA 22202-5050
201 North Craig Street, Suite 202, Pittsburgh, PA 15213-1516
RAND URL: http://www.rand.org/
To order RAND documents or to obtain additional information, contact
Distribution Services: Telephone: (310) 451-7002;
Fax: (310) 451-6915; Email: order@rand.org

Summary

Air travel has become an integral part of modern life. Terrorists have long understood this and have made commercial aviation one of their prime targets. Al Qaeda and its affiliates have both the motive and the means to bring down U.S. commercial aircraft with shoulder-fired missiles, also known as man-portable air defense systems (MANPADS). No such attempt has yet been made against a U.S. carrier, but given the measures being taken to preclude 9/11-style attacks, the use of MANPADS will unavoidably become more attractive to terrorists.

What might be done to prevent such an attack? We concentrate here on the capabilities and costs of onboard technologies to divert or destroy an attacking missile. Given the significant costs involved with operating countermeasures based upon current technology, we believe a decision to install such systems aboard commercial airliners should be postponed until the technologies can be developed and shown to be more compatible in a commercial environment. This development effort should proceed as rapidly as possible. Concurrently, a development effort should begin immediately that focuses on understanding damage mechanisms and the likelihood of catastrophic damage to airliners from MANPADS and other forms of man-portable weapons. Findings from the two development programs should inform a decision on the number of aircraft that should be equipped with countermeasures (from none to all 6,800 U.S. jet-powered airliners) and the sequence in which aircraft are to be protected.

If it is determined that U.S. commercial airliners should be equipped with countermeasures upon completion of the development program, they should be employed as part of a broader set of initiatives aimed at striking and capturing terrorists abroad, impeding their acquisition of missiles, and preventing them and their weapons from entering the United States. Attention should also be paid to keeping MANPADS-equipped terrorists out of areas adjacent to airports and improving commercial airliners' ability to survive fire-induced MANPADS damage.

A multilayered approach is important because no single countermeasure technology can defeat all possible MANPADS attacks with high confidence. Nonetheless, substantial protection can be achieved. Laser jammers, for instance, will be commercially available for installation aboard airliners soon and should be able to divert single or possibly dual attacks by the relatively unsophisticated MANPADS accounting for most of those now in the hands of terrorists. Ground-based high-energy lasers (HELs) intended to destroy approaching missiles could counter MANPADS of any degree of sophistication, but they are not ready for deployment in the next few years and have significant operational challenges to overcome. Pyrophoric flares used reactively offer the promise of a cheaper alternative with better potential to handle

multiple attacks than laser-based systems, but their effectiveness at protecting large transport aircraft from any MANPADS attack is not well established, and they would be most likely ineffective against sophisticated future systems.

We estimate that it would cost about $11 billion to install a single laser jammer on each of the 6,800 commercial aircraft in the U.S. fleet. The operating costs of fleetwide countermeasures will depend on the reliability of the system. Extrapolating from early reliability data from the systems currently deployed on large military aircraft, the operating and support (O&S) costs for a commercial variant were assessed to be $2.1 billion per year for the entire commercial fleet. The full ten-year life-cycle costs (LCCs) for developing, installing, operating, and supporting laser-jammer countermeasures are estimated to be $40 billion. If reliability goals recommended by the Department of Homeland Security (DHS) can be achieved, the ten-year LCCs are estimated to be $25 billion.

When would such an investment be worth it? That is not a question answerable solely through quantitative analysis, but some light can be shed by four avenues of inquiry. First, what would be the likely economic costs of a successful attack? If we take into account the value of a lost aircraft and a conventional economic valuation of loss of life, the *direct* cost would approach $1 billion for every aircraft downed. The indirect economic damage from an attack would be far greater. These costs result from the loss of consumer welfare through preemption of a favored travel mode or reluctance to use it, as well as operating losses suffered by airlines subsequent to an attack. These amounts will depend primarily upon two factors: the length of any possible systemwide shutdowns in air travel and any kind of longer-lasting public reluctance to fly. Both factors are difficult to predict, but if air travel were shut down for a week (it was shut down for three days after 9/11), the economic loss would amount to roughly $3 billion during the shutdown itself. Extrapolating from the long-term effects of the 9/11 shutdown, losses over the following months might tally an additional $12 billion, for a total economic impact of more than $15 billion.

A second avenue of inquiry can help place the cost of MANPADS countermeasures in context. To what extent must homeland-security and other counterterrorism resources be expanded or diverted to fund this one effort to help respond to a single threat? The $2.1 billion annual O&S cost, should it be borne by the government, amounts to only about 6 percent of the annual DHS budget. The fraction is much smaller if the costs of operations in Iraq and Afghanistan are included in the base. However, the $2.1 billion is a substantial fraction of total current federal expenditures on transportation security.

Third, it must be recognized that loss of life and economic impact would not be the only costs of a MANPADS attack. The perceived inability of the U.S. government to prevent attacks on its citizens on its own soil would set back U.S. efforts to counter terrorist groups globally and could weaken U.S. influence across a range of other interests abroad. Such an attack would also cause unquantifiable losses of security among the U.S. populace.

Fourth, and lastly, while countermeasures have been demonstrated to be an effective resource in protecting our military aircraft, the circumstances of protecting commercial airliners from terrorists are sufficiently different that we should ask ourselves the following questions: Upon deployment of countermeasures, how easy do we think it will be for terrorists to adapt and find vulnerabilities to airliners through the use of weapons that are not affected by countermeasures? Would defenses against these weapons be possible, or would they require a similar level of funding to protect against?

A decision as to whether to proceed with a MANPADS countermeasure program must thus balance a variety of considerations. On the plus side:

- New countermeasure technology with capability against a variety of attack situations will be available in the near term, with the potential to avert the loss of hundreds or even thousands of lives and tens of billions of dollars.
- Funding such a system would require a reallocation or expansion of federal homeland-security resources of perhaps 5 percent—and a much smaller proportion of total federal counterterrorism resources.

On the minus side:

- Annual operating costs would represent 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?

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. The current DHS research, development, test, and evaluation (RDT&E) activities are a prudent step both toward reducing significant cost uncertainties involved and minimizing the delay of program implementation once a go-ahead decision is reached.

To summarize, any federal policy to protect against MANPADS should not be restricted to countermeasures development, but should involve multiple layers, with emphasis on the following areas:

1. Rapidly understanding and finding ways to reduce the O&S cost component of countermeasures in a commercial-airline setting. In addition, decisionmakers should be thinking about how specific countermeasure systems would work best in conjunction with other protection efforts and technologies. Understanding the weaknesses of countermeasures should help focus these efforts, and vice versa.
2. Focusing a concurrent technology development effort on understanding damage mechanisms and the likelihood of catastrophic damage to airliners from MANPADS and other forms of man-portable weapons such as rocket-propelled grenades (RPGs), mortars, and small-arms fire. This will serve three purposes: clarifying the damage caused by single or

multiple MANPADS hits on airliners, informing choices regarding the implementation of mitigating measures such as inerting fuel tanks and missile countermeasure systems, and assessing the seriousness of other forms of attack against airliners.

3. Working with international governments to slow down the proliferation of MANPADS technologies, in particular those against which countermeasures are less effective.
4. Putting together concepts of operation that integrate countermeasures into the overall aviation safety, security, and law enforcement system. These can help local law enforcement establish the size and location of airport security perimeters and define ways in which information from the onboard countermeasure system sensors can be used to help find, track, and apprehend MANPADS operators. Lastly, they would help provide an understanding of the costs from false alarms to air-traffic operations and local law enforcement.