Exhibit 12

CONCERNS ABOUT TERRORISTS WITH PGMS

Marvin B. Schaffer

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CONCERNS ABOUT TERRORISTS WITH PGMS[1]

Marvin B. Schaffer
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The principal concern about precision-guided munitions (PGMs) in the hands of terrorists is the possibility they will be used with modern shoulder-fired surface-to-air missiles (SAMs) to attack commercial passenger airliners, helicopters, and executive jets . There are a variety of existing SAM models with sufficient range and lethality which contribute to this concern. The possibility exists that hundreds of shoulder-fired SAMs are in the hands or at the disposal of terrorists. Countermeasures against what is currently in the field and on the open market are inadequate. In addition, SAMs of more advanced designs are being developed. Current countermeasure approaches, already insufficient, will be completely outclassed by advanced SAM designs.[2]

Terrorist SAMs originate from three sources: direct sales or arms grants from former Soviet and Warsaw Pact countries to third world armed forces that cooperate with terrorist groups; arms grants or sales from the United States to supported insurgents or counterinsurgents followed by pilferage and/or resale to terrorist groups; direct sales from arms-producing countries like Israel, France, Brazil, South Africa, and China either directly to terrorist groups or to forces linked to them. Table 1 identifies some SAMs of concern.

Table 1

CURRENT AND FUTURE SHOULDER-FIRED SAM THREATS

Infrared or Ultraviolet Passive Seekers

Deployed (Reticle Based IR or UV)	New (Quasi-imaging IR)	Future (FPA Imaging IR)
SA-7/14/16/18	Possible Russian Design	Possible Russian Design
Redeye	Mistral (French)	French
Stinger (Basic)	Stinger (POST/RMP)	U.S.
HN-5	Israeli	Israeli
Kieko SAM I		Japanese (Kieko SAM II)
Sakr Eye		

Command to Line of Sight Seekers

Deployed	New	Future
Blowpipe/Javelin	Starburst	Starstreak
RBS-70	RBS-90	

[1] For delivery at the LIC Technology Workshop, 24-28 Feb 1992, RAND, Santa Monica.

[2] A less likely threat exists from the potential use by terrorists of anti-tank guided missiles. Such weapons could be used effectively by terrorists, but unguided RPGs (rocket-propelled grenades) and command or contact-detonated land mines are more expedient and more likely. Hundreds of attacks have been made by terrorists with RPGs and land mines on a worldwide basis during the past 25 years.

Data on the availability of some of these weapons are provided in Table 2. Terrorists, in fact, have used such weapons periodically over the last decade at the rate of several per year. Details are provided in Figure 1 and Appendix A.

Table 2

TYPICAL SHOULDER-FIRED SAM EXPORTS

SAM Type	Number of Countries to Whom Sold	Number of Rds
Blowpipe / Javelin	15	36,500
Mistral	8	50,000 (planned)
RBS 70 / 90	10	-----
HN-5	6	-----
FIM-92 Stinger	8[a]	37,000 (by 1990)

[a] 8000 to FRG, Greece, Netherlands, Turkey
750 to Afghans
50-100 to UNITA (Angola)
30 to Chad
110 to Japan
Qatar and Sikh Militants have acquired; also Iran.

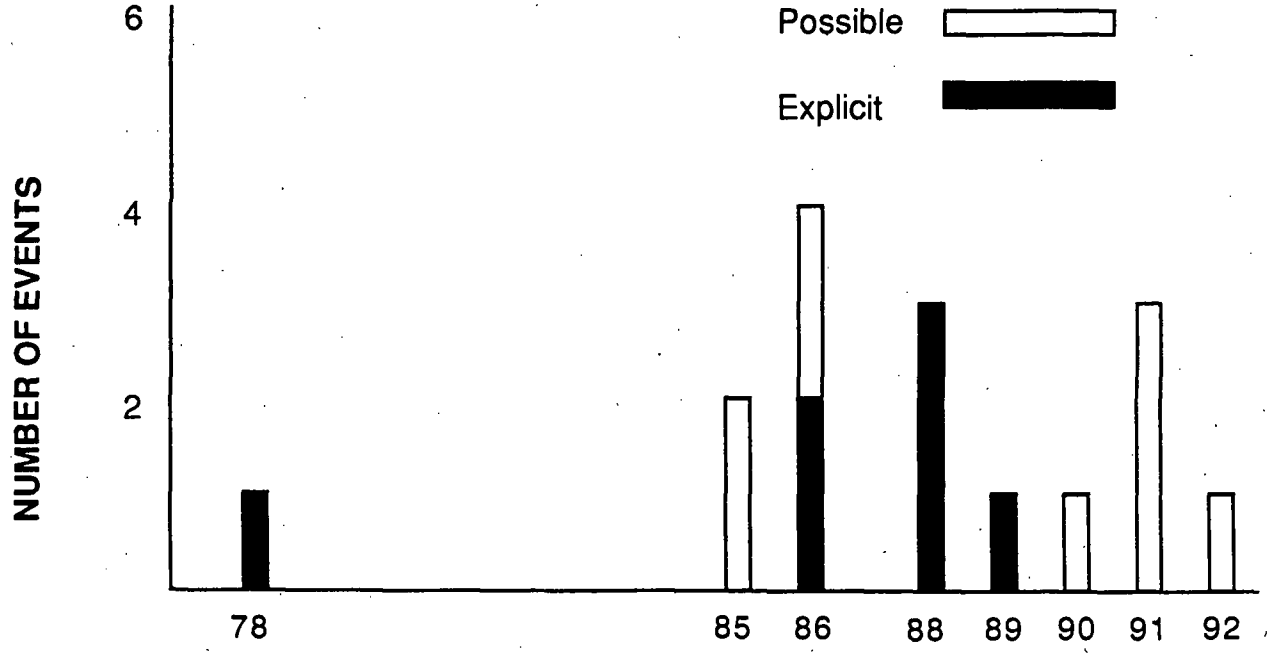

Fig. 1—YEAR OF OCCURRENCE

Infrared (IR) SAMs have been fielded in three distinct generations, and a fourth is being developed. The first generation uses uncooled PbS detectors and spinning reticles to amplitude-modulate (AM) the target signal. Some versions, such as Redeye, cool the detector elements with freon. Second-generation IR SAMs use a conical scan to frequency-modulate (FM) the signal. Most use liquid nitrogen to cool PbS or INSb detectors. Some use 2-color detection logic (ultraviolet/infrared or near-IR/mid-IR) to counter decoy flares while others use circuitry logic for that purpose. In Stinger, the ultraviolet (UV) is also a backup target detection mode. Third-generation IR SAMs use single or multiple detector elements for quasi-imaging. Some, such as the French Mistral, are in service; others, such as the rosette-scanning version of Stinger have been deployed in limited numbers. All have some form of flare rejection capability. Even more advanced (fourth-generation) SAMs are being developed. They will be full imaging focal-plane array (FPA) devices. The Japanese, French, Israelis, and possibly the Russians are within a few years of deploying missiles with such sensors.

Command-to-line-of-sight (CLOS) guided SAMs have also been fielded. Early versions (e.g., Blowpipe) employ magnified optics for target engagement coupled with radio controls to enable the gunner to guide the missile to the target. Later versions (Javelin) substitute television for the optical device, and still later versions (Starburst) substitute laser data links for the radio guidance. High-velocity laser beam-rider SAMs have also been fielded (RBS-70), and more sophisticated versions are under development (RBS-90 and Starstreak).

Shoulder-fired SAMs typically have detection ranges of about 10 km and engagement ranges of about 6 km. Therefore, aircraft flying at altitudes of roughly 20,000 feet and higher are relatively safe. It is at the approach and departure paths to and from airports where the danger lies. With steep departure and approach, airport perimeter danger zones can be narrowed, but the ability to gain useful leverage in this manner is limited. Thus, a terrorist lying off the runway edge some four miles away will still be within SAM range when the take-off angle averages 40°. For typical landing patterns, the danger zone will be about 50 mi long. Spiral approaches can shorten this considerably (as was done at Ton Son Nhut Airport in Saigon during the Vietnam War) but in most locations traffic density precludes this. Physical security in large hide areas can be provided at selected military and commercial bases for a few special occasions, but not routinely at the thousands of commercial airbases worldwide. If terrorist protection is to be provided routinely, other types of countermeasures will have to be relied on.

Countermeasures against shoulder-fired SAMs can be divided into two categories: expedient and long-term. Expedient countermeasures[3] include emphasis on nighttime flights, minimum use of lights, infrared filters over the light sources that are used, unannounced flight schedules, physical security at the runway edges, and random use of flares during landing approaches and takeoff. Any or all of these would reduce the threat to a degree. Emphasis on nighttime operations would be helpful because effective use of SAMs requires initial target acquisition sensors such as forward-looking infrared (FLIR) or light

[3] Commercial pilots receive extensive training regarding emergency procedures if there is a catastrophic or sudden loss of power in one engine. Reintensified training in this area would also qualify as an expedient countermeasure to the use of terrorist SAMs.

amplification devices which are both expensive and difficult to maintain. Most current military air defenders with shoulder-fired weapons have only daytime capability, and it is unlikely that terrorists would excel in this area. Minimal use of lights in combination with infrared filters, where practical, make both the acquisition and tracking of aircraft that much more difficult. Physical security near the runways is another obvious countermeasure that can be taken. To lessen the physical security burden, steep departure and approach path flight profiles could be instituted, as noted earlier. This could be accomplished with nonlinear approach and departure path patterns at commercial airports, but that is far from an expedient countermeasure.

The random use of flares in the vicinity of landing fields would also have a marginally beneficial effect. El Al Airlines used this techique at Lod Airport periodically during the 1980s. Flares have an enhanced infrared output and a ballistic and aerodynamic design which allows them to be dispensed from aircraft. They are effective against first-generation and some second-generation IR SAMs. The Mistral SAM and later versions of Stinger (POST and RMP) employ a UV sensor to differentiate flares from aircraft; they are essentially impervious to conventional flare countermeasures. More advanced flare designs are being developed, but they appear to be at a disadvantage relative to sophisticated counter-countermeasures.

Taken as a set, expedient countermeasures could reduce but not eliminate the threat from terrorists with shoulder-fired SAMs. Some, such as routine physical security near runways, would be prohibitively expensive. Moreover, some of the expediencies would be objectionable to the flying public and probably unfeasible for routine commercial aviation. However, expedient countermeasures should definitely be considered during periods of suspected or imminent terrorist activity.

Longer term countermeasures of considerable effectiveness are possible, but they are also expensive and require development. Effective use of flares and jammers requires coupling to effective missile warning receiver sets. Several varieties are available to the military. Table 3 lists some models of current interest in the United States. Both active (radar) and passive (IR or UV) techniques are used. The principal issue with existing missile warning receiver technology is that the devices have excessively high false alarm rates.

Existing IR jammers use incoherent lamp sources (heated rods) and a mechanical method for modulation. The AN/ALQ-144A IR jammer represents the state of the art for protecting deployed helicopters (and presumably VIP fixed-wing aircraft). It performs well against first-generation SAMs, and offers some protection against the second and third generation. The AN/ALQ-144A has two weaknesses: it has a low jamming-to-signal (J/S) ratio in IR-band 4, and it has no logic for dealing with future imaging IR seekers. Laser jammers currently under development offer promise of redressing the J/S deficiency, but there is little indication that the imaging seeker threat is being addressed.

It is observed that infrared jammers and flares of the types currently in military service have essentially no potential against electro-optical seeker and laser beam rider SAMs. They are also thought to be of little value against future FPA seeker SAMs.

Table 3

TYPICAL U.S. MISSILE WARNING RECEIVER SETS

Item	Type	Status	Contractor
ALQ-156A	Pulse Doppler Radar	In Service	Lockheed Sanders
ALQ-199	Pulse Doppler Radar	In Service	Loral Electronics
ALQ-153(V)	Pulse Doppler Radar	Test	Westinghouse
ALQ-192	Pulse Doppler Radar	Developmental	Cartwright Electronics
AAR-47	Passive Ultraviolet	In Service	Loral I & I Systems
AAR-34	Passive Infrared	In Service	Cincinnati Electronics
AAR-44	Passive Infrared	In Service	Ciccinnati Electronics
AAR-FX	Passive Infrared	Developmental	Cincinnatti Electronics

Over and beyond jammers and flares to decoy and deceive infrared SAMs, there exists the possibility of physically hardening the structures and control systems of large commercial aircraft so that they better withstand attack by SAM warheads. Shoulder-fired SAMs generally contain only a few kg of high explosive. The most likely impact point on a large aircraft is on or near one of the engines. Assuming there is not a fuel explosion or major control impairment or structural damage to fuselage or wing, the problem becomes one of viable flight with the sudden loss of an engine. Takeoff and landing crash susceptibilities under such circumstances require detailed analyses peculiar to individual aircraft. Such studies are certainly warranted with the view of hardening the aircraft when feasible. Fuel explosion suppression technology should also be considered.

In summary, we conclude that the shoulder-fired SAM terrorist threat against commercial and VIP aircraft is real. There are hundreds of SAMs in several varieties available to terrorists, and indeed experience in the last decade indicates several successful attacks per year. Expedient countermeasures against shoulder-fired SAMs reduce but do not eliminate the threat. A worldwide effort to tighten controls on SAM exports would fall in the same category. Longer term countermeasures have relatively good potential against today's threat, but they are expensive and of decreasing utility with the passage of time.

There is probably no single magic bullet to negate the terrorist PGM threat. Taken collectively, a variety of expedient and long term countermeasures together with arms control of the SAM export market could reduce the threat substantially.

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Appendix A

LIST OF TERRORIST INCIDENTS INVOLVING PGMS AGAINST AIRCRAFT

Date: Sept 8, 1978, Washington Post
The Rhodesian government confirmed yesterday that a heat-seeking missile was responsible for the crash Sunday of an Air Rhodesia passenger plane in which 38 of the 56 persons aboard were killed. Ten of the survivors were later slain by guerrillas.

Date: Apr 4, 1985 (Greece)
Black September credited for rocket attack against Jordanian airplane as it prepared to take off. The rocket failed to explode.

Date: Dec 9, 1985, Christian Science Monitor
Nicaraguan president Daniel Ortega charges that U.S. has been supplying Nicarguan rebels with surface-to-air missiles; refuses to answer questions concerning U.S. allegations that Cubans were among 14 killed when Contras shot down Sandinista helicopter.

Date: Feb 5, 1986 (Lebanon)
UN helicopter shot down by Sunni Muslim faction extremists. No detail of weapon given.

Date: Feb 10, 1986 (Angola)
UNITA downed U.S. transport plane with ground-to-air missile.

Date: Jun 4, 1986 (Guatemala)
FAR credited for downing EXXON helicopter. No detail of weapon used.

Date: Aug 18, 1988, New York Times
Sudan News Agency reports that Sudan Airways plane with 60 people aboard was shot down by Sudanese rebels using SAM-7 antiaircraft missiles; reports reaching Cairo from Khartoum indicate there are no survivors; attack comes after rebel forces in south, who are known as Sudan Peoples Liberation Army, threatened to shoot down all planes flying over areas they control in southern provinces.

Date: Apr 11, 1988 (Afghanistan)
SAM missiles used by Afghan guerrillas to shoot down Soviet airliner.

Date: Dec 8, 1988 (Western Sahara)
2 DC-7 planes shot down by Polisario guerrillas using heat seeking missiles.

Date: Dec 21, 1989 (Sudan)
Cessna (Doctors Without Borders) plane shot down by SAM missile.

Date: Jul 24, 1991, New York Times
Salvadorian military commanders say that their aircraft patrols have become limited since leftist guerrillas acquired surface-to-air missiles; since last November, guerrillas have used missiles, Soviet-built SA-14's, to bring down one helicopter and two fixed-wing aircraft.

Date: Jan 24, 1992, New York Times
Peruvian rebels claim responsibility for downing of two American helicopters this month in coca-producing region; three Americans aboard helicopter were killed; Shining Path guerrillas say they used surface-to-air missiles to down helicopter on January 12.

APPENDIX B

THE THREAT OF PGMS IN THE HANDS OF TERRORISTS

MB Schaffer

February 1992

OVERVIEW

- Significant Threat Posed by Terrorists with Shoulder-fired Infrared, Electro-optical and Laser Beam Rider SAMs to:
  - Commercial and VIP Fixed-Wing Aircraft In Landing and Takeoff Patterns
  - Commercial and VIP Helicopters During Entire Flight Profile.
- Threat Posed by Terrorists with Portable Ground-Target PGMs Less Significant -- But Only Because Unguided RPGs and Land Mines More Expedient.
- Expedient Countermeasures Can be Taken to Reduce but Not Eliminate the Shoulder-fired SAM Threat. Advanced IR SAMs, EO SAMs, and Laser Beam Rider SAMs are Robust to Current Military Countermeasures.
- Longer Term Countermeasures Involve the Use of Modulated Lasers in Conjunction with Sophisticated Missile Warning Receivers. Techniques for Reducing the Physical Vulnerability of Commercial Aircraft Warrant Study.
- Stronger Worldwide Arms Control Measures Would Also Reduce the Threat.

OUTLINE

- Nature of the Threat
- Relevant PGMs -- What is Available to the Terrorist
- Historical Experience
- Expedient Countermeasures
- Long-Term Countermeasures
- Summary

NATURE OF SHOULDER-FIRED SAM THREAT

- Liklihood that hundreds of shoulder-fired SAMs in hands of or at disposal of terrorists* on world-wide basis.

- Terrorist SAMs originate from three sources:

  - Direct sales or grants from former Soviet / WP countries.
  - Arms grants or sales to US-supported insurgents or counterinsurgents followed by switched allegiances, pilferage or resale.
  - Direct sales from arms-producing countries; e.g., UK, France, Israel, Brazil, S. Africa, China, with loose arms-export controls or as policy.

- Targets are commercial or VIP airliners or helicopters. The purpose is to intimidate governments or commercial entities by the production of mass terror.

* Any regular or irregular military force willing to attack civilian elements for gain, political or otherwise.

SHOULDER-FIRED SAMS

INFRARED or ULTRAVIOLET PASSIVE SEEKERS

DEPLOYED (Reticle based)	NEW (Quasi-imaging)	FUTURE (FPA Imaging)
SA-7 / -14 / -16 / -18	Possible Russian Design	Possible Russian Design
Redeye	Mistral (French)	French
Stinger (Basic)	Stinger (POST/RMP)	U.S.
HN-5	Israeli	Israeli
Kieko SAM I		Japanese (Kieko SAM II)
Sakr Eye		

COMMAND TO LINE OF SIGHT SEEKERS

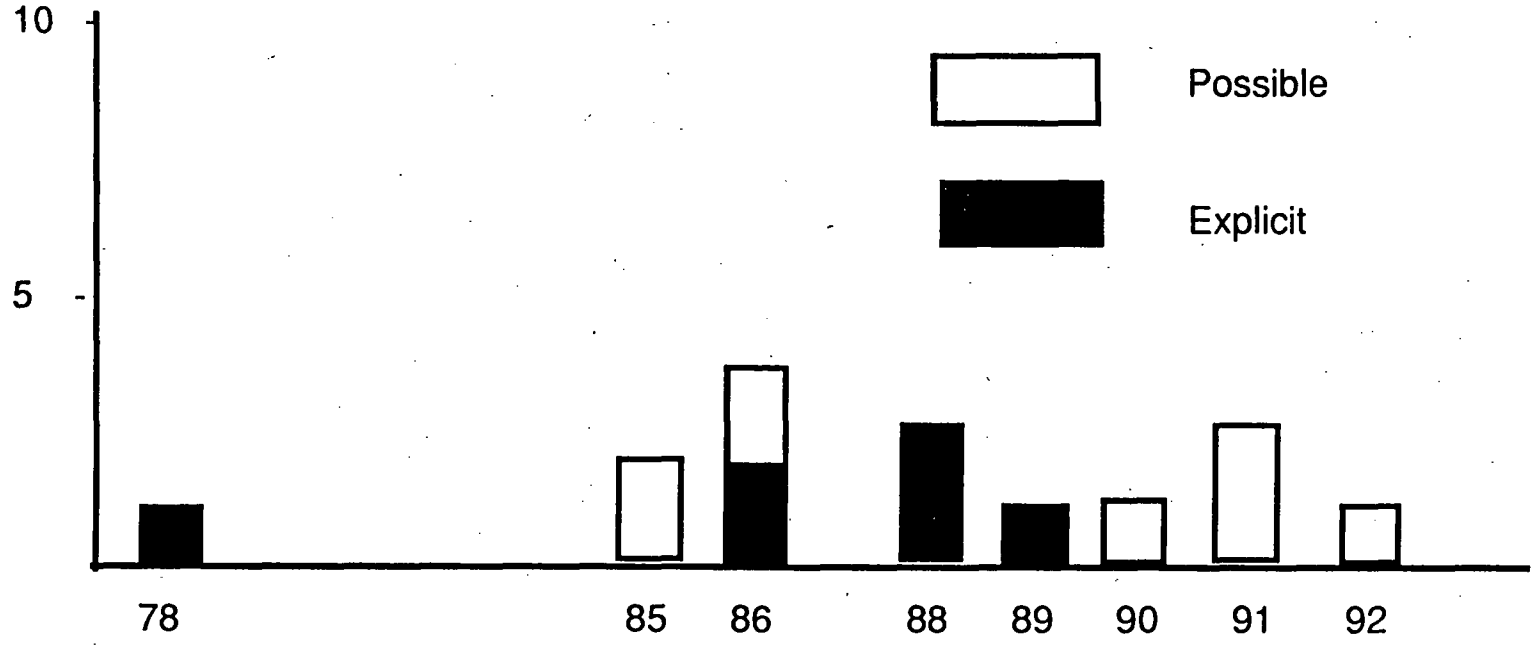
DEPLOYED	NEW	FUTURE
Blowpipe / Javelin	Starburst	Starstreak
RBS-70	RBS-90	

TYPICAL SHOULDER-FIRED SAM EXPORTS

- Blowpipe/Javelin Sold to 15 Countries -- 36,500 rds.
- 6000 Mistrals Ordered by 8 Countries -- Plan 50,000.
- RBS 70/90 Sold to 10 Countries; HN-5 to 6 Countries.
- 37,000 FIM-92 Stingers Produced by 1990.
  - -- 8,000 to FRG, Greece, Netherlands, Turkey
  - -- 750 to Afghans
  - -- 50-100 to UNITA (Angola)
  - -- 30 to Chad
  - -- 110 to Japan
  - -- Qatar and Sikh Militants have acquired; also Iran.

HISTORICAL EXPERIENCE

(PGM SAMs as Terrorist Weapon)



- SA-7 Reported 8 Times; SA-14 Three Times; Stinger Once; Blowpipe Once
- Rhodesian Guerr, UNITA (Angola), Sudan Guerr, Afghans, Polisario (Morocco) Black Sept, Sunni Muslems, FAR, Shining Path, El Salvador Guerr, Contras

REPRESENTATIVE ANTITANK GUIDED MISSILES

Suitable for Export

ITEM	COUNTRY	GUIDANCE	RANGE (km)	WEIGHT (kg)
Dragon	US	Wire, CLOS	1.0	14
TOW	US	Wire, CLOS	3.8	25
AAWS-M (Javelin)	US	IR, F & F	2.0	20
HOT	Fr/FRG	Wire, IR	4.0	20
Milan	Fr/FRG	Wire, IR	2.0	6.4
Cobra 2000	FRG	Wire, CLOS	2.0	10
Mamba	FRG	Wire, CLOS	2.0	11
Swingfire	UK	Wire, CLOS	4.0	25
Bantum	Swed	Wire, CLOS	2.0	7.6
Sagger AT-3	USSR	Wire, CLOS	2.3	15

EXPEDIENT COUNTERMEASURES

- Emphasize Nighttime Flights; Minimize Use of Lights; Filter IR
  - Not Appropriate for Many Commercial Operations
- Physical Security Emphasizing Takeoff and Landing Paths
  - Not Feasible for Worldwide Commercial Operations
- Steep Departure and Approach Paths
  - In Limit, Cuts Departure Danger Zone to About 4 Mi from Runway
  - Approach Path Danger Zone Approx 50 Miles or More
- Dispense Flares Randomly
  - Objectionable for Routine Commercial Operations
  - Only Effective Against 1st-Generation IR SAMs.

LONG TERM COUNTERMEASURES

- Missile Warning Receiver Plus Flares
  - Only Effective Against 1st Generation IR SAMs
- Missile Warning Receiver Plus IR Lamp Jammer
  - Not Effective Against EO or 3rd Generation or Later IR SAMs
- Missile Warning Receiver Plus Existing Developmental Laser Jammers
  - Not Effective Against Future SAMs with FPA Seekers
- Missile Warning Receiver Plus More Sophisticated Laser Jammer
- Reduce Physical Vulnerability of Commercial and VIP Aircraft

SUMMARY

- Shoulder-Fired Terrorist SAM Threat Against Commercial and VIP Aircraft Real.
  - Hundreds of SAMs in Several Varieties Available to Terrorists
  - Experience in Last Decade Several Attacks per Year, Many Successful
- Expedient Countermeasures Against Shoulder-fired SAMs Reduce But Do Not Eliminate Threat. Stronger Worldwide Arms Control Same Effect.
- Long Term Countermeasures Expensive, and of Decreasing Utility Against Later Generation SAMs.
- ATGMs Also a Threat to Civilian Ground Vehicles But Their Use Considered Unlikely Because of Proliferation of Effective RPGs and Land Mines.
- Probably No Magic Bullet. Exploit All Mutually Supportive Countermeasures.