

# MANPADs Threat to Commercial Aviation



Centre français sur les Etats-Unis à l'IFRI  
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***Congressional Research Service***

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# Outline

- Bottom Line
- Threat
- Mitigation Options
- Summary



# Bottom Line

## ■ Threat

- MANPADS are cheap, widely proliferated, easy to use and conceal, and potentially lethal to all classes of aircraft

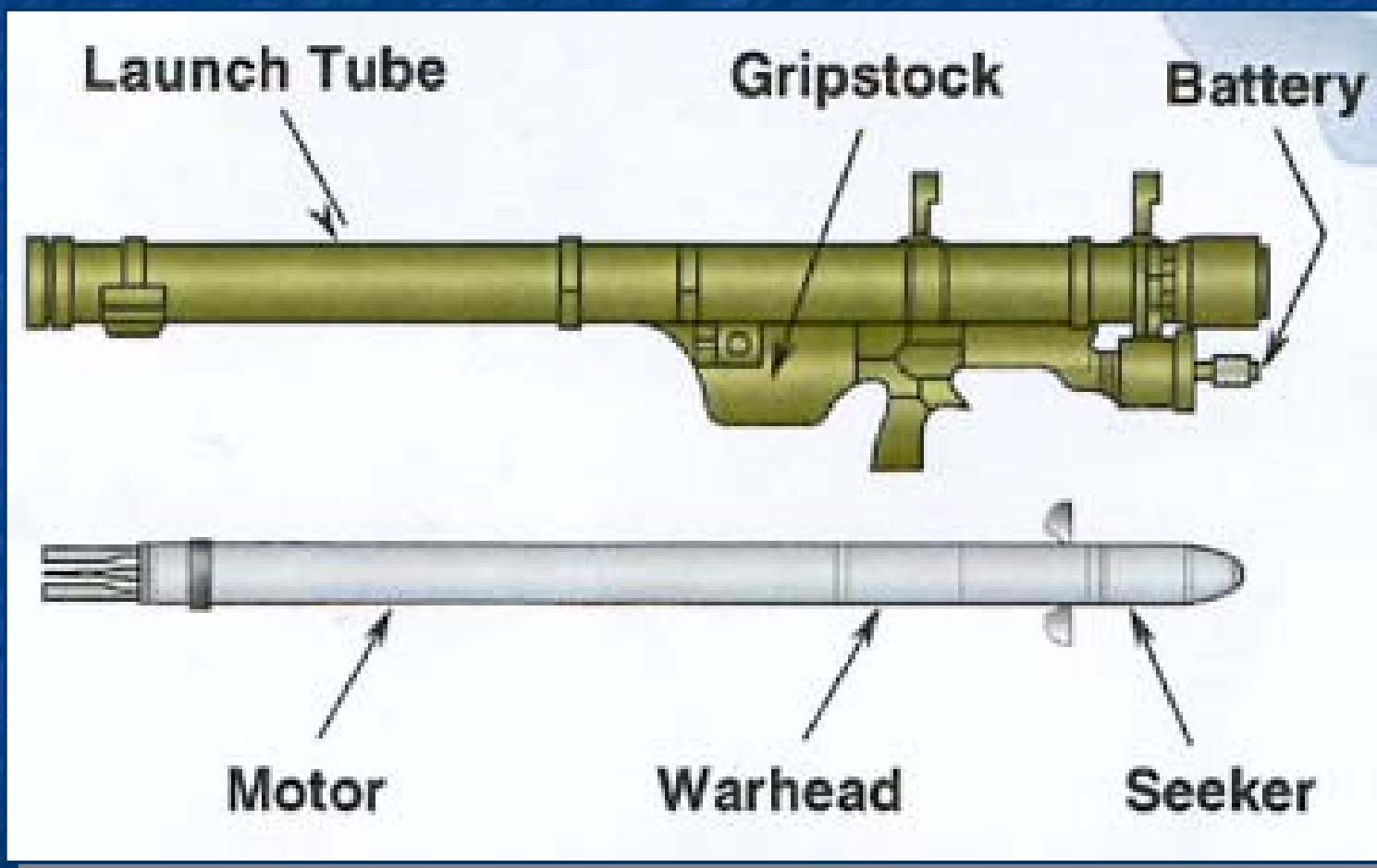
## ■ Mitigation Options

- No single-point solution
- Menu of options which are situationally driven

# Threat: Types/Capabilities

- Three Basic Types
  - Infrared (IR) – Stinger (US), SA-18 (Russia)
  - Command Line-of-Sight (CLOS) – Blowpipe, Javelin (UK)
  - Laser Beam Riders – RBS-70 (Sweden), Starstreak (UK)
  
- General Capabilities
  - Portable, reliable, inexpensive, and fairly easy to use
  - Target detection range about 6 miles
  - Engagement range about 4 miles
  - Aircraft above 20,000 feet relatively safe
  - Take off and landing = most vulnerable to attack
  - Large engagement footprint = difficult to detect on the ground

# MANPAD Configuration



# Threat: Proliferation

- Estimates of Military Inventories – 350,000 to 500,000
- Non-State Actors – 5,000 to 150,000
  - 25 to 30 groups (IRA, FARC, Hezbollah, PKK)
  - Reported missiles
    - Stingers = **IR**
    - SA-7s = **IR**
    - SA-14/16/18s = **IR**
    - HN-5/QW-1 (China) = **IR**
    - Blowpipe = **CLOS**
- Reports of Missiles in Circulation
  - “5,592 missiles captured in Afghanistan as of December 2002”
  - “4,000 to 5,000 available to Iraqi insurgents”

# History of Use - Military Experience

- Vietnam
  - Low PK, but lots of shots
- Afghanistan
  - Turned the tide for Mujahadeen
- Post-Cold War
  - IR guided SAMs were the primary source of air combat losses in Operation Desert Storm
  - Since 1973, nearly half of all air losses in combat have been attributed to IR-guided SAMs, many of them SFM
  - Others estimate that SFMs caused 90% of worldwide combat aircraft losses from 1984-2001.

# History of Use - Civilian Attacks

- Most widely reported statistic - over the past 25 years:
  - 35 aircraft attacked
  - 24 shot down
  - Resulting in more than 500 fatalities
  - Majority of these attacks occurred in war zones
- First reported incident
  - 01/73 Rome, Italy *Black September* smuggles 14 SA-7's into Italy  
Caught as Israeli PM Meir's plane targeted
- CRS Research
  - Six incidents where large turbojet civilian aircraft attacked by shoulder-fired missiles

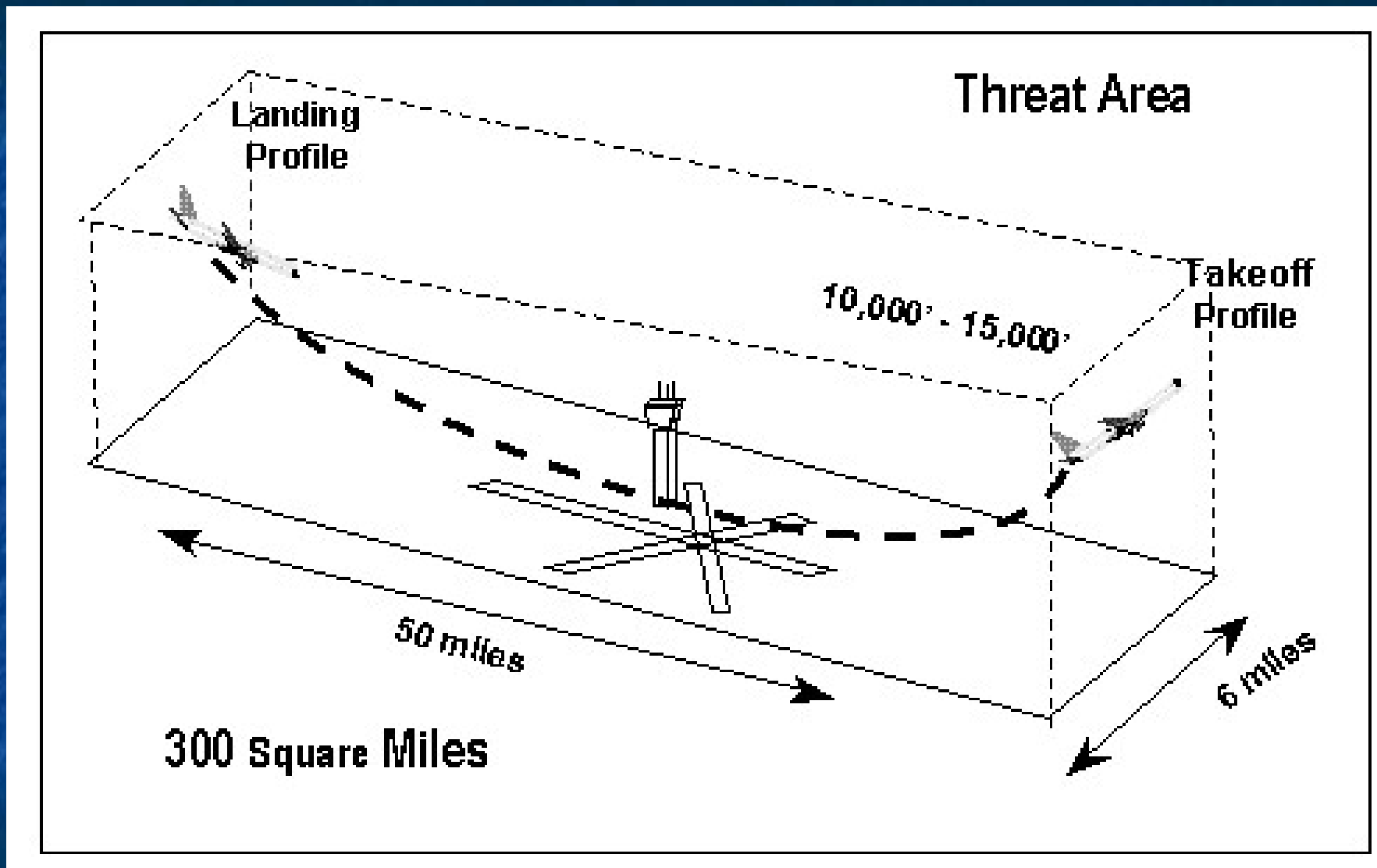


# Civilian Attacks

Date	Location	Aircraft	Operator	Outcome
8-Nov-1983	Angola	Boeing 737	Angolan Airlines (TAAG)	<b>Catastrophic:</b> 130 fatalities of 130 people on board
9-Feb-1984	Angola	Boeing 737	Angolan Airlines (TAAG)	<b>Hull Loss:</b> aircraft overran runway on landing after being struck by a missile at 8,000 ft during climbout. No fatalities with 130 on board.
21-Sep-1984	Afghanistan	DC-10	Ariana Afghan Airlines	<b>Substantial Damage:</b> Aircraft damaged by the missile, including damage to two hydraulic systems, landed safely. No fatalities.
10-Oct-1998	D.R. of Congo	Boeing 727	Congo Airlines	<b>Catastrophic:</b> 41 fatalities of 41
19-Nov-2002	Kenya	Boeing 767	Arkia Israeli Airlines	<b>Miss:</b> Two SA-7's fired during climbout, but missed. No fatalities.
22-Nov-2003	Baghdad	A300	DHL	SA-7 hit left engine. set the left wing on fire. Landed safety due to superb flying.



# Vulnerability of Civil Aircraft



# Vulnerability of Civil Aircraft



# Mitigation Option: Flight Procedures

- Limited Options, Significant Operational Constraints

OPTION	CONSIDERATIONS
Steep Climbouts, Spiral Descents	Aircraft performance Operational cost ATC and pilot workload Airspace congestion Passenger comfort Safety Won't eliminate threat close to airport
Varied Approach and Departure Paths	ATC and pilot workload Non-secure radio communications Published procedures Access to near real-time flight data

# Mitigation Option: Flight Procedures

OPTION	CONSIDERATIONS
Night Flights/No Lights	Schedule based on passenger demand Airport capacity and noise Safety requirements
Over Water Approaches and Departures	Limited applicability to airports near large bodies of water Already implemented for noise abatement at some airports Of limited benefit unless combined with maritime patrols to protect waters under flight paths

# Mitigation Option: Pilot Training

- Pilots already experience a wide variety of scenarios in the simulator
- Additional benefit of missile strikes scenarios needs to be assessed
- Evasive maneuvering is not advised

OPTION	CONSIDERATIONS
Specific Missile Strike Scenarios	Similarity to other in-flight emergencies Large number of possible post attack failure scenarios
Evasive Maneuvers Training	Missile detection capability Response time Aircraft performance Aircraft structural integrity Loss of control

# Mitigation Option: Aircraft Hardening

- Civil aviation survivability research has focused on internal bomb blasts
  - Program established in response to the Pan Am 103 bombing
  - Hardened cargo liners and containers
- Survivability characteristics of large transport aircraft from missile strikes is largely unknown
  - Service history: 24/35,  $P(k) = 69\%$ , but this represents a wide variety of aircraft types (props, helicopters, business jets, and large jets)
  - Five large jets have come under attack, two were destroyed
  - Military research and testing of limited applicability to the civilian domain



# Mitigation Option: Aircraft Hardening

- Options under consideration
  - Structural hardening
  - Isolating independent hydraulic and flight control systems
  - Improved fire suppression
  - Fuel tank inerting
  - Adaptive flight controls/Aircraft health monitoring
- Considerations:
  - Safety benefits
    - These options may protect aircraft against system failures as well
  - Long range mitigation strategy
    - May be applied to new type designs in the future
    - Replacement rate and introduction of new aircraft types is relatively low
    - Retrofitting is likely to be costly and may be technically infeasible or economically impractical
  - Hardening that increases aircraft weight may significantly increase operational costs

# Mitigation Option: Airport Security

- Threat assessments
  - Examine airport layout, flight paths to identify specific vulnerabilities
    - Large U.S. airports
    - Selected foreign airports
      - Bangkok, Thailand – APEC Summit in October 2003
      - Athens, Greece – 2004 Olympics



# Mitigation Option: Airport Security

- Deploying security forces – increased patrols
  - Coast Guard and National Guard
  - Federal and local law enforcement
  - “Neighborhood Watch” type programs
  - Considerations:
    - Other Homeland Security concerns
    - Very large areas to protect
      - Hundreds of square miles around every airport
- Surveillance technology
  - Forward looking infrared – aerial patrols
  - Ground radar
  - Cameras and remote sensors



# Mitigation Option: Flares

- Pyrotechnic decoys
- Considerations
  - Mature technology
  - Relatively cheap
  - Omni directional
  - Can be used preemptively
  - Safety
  - More difficult to spoof latest generation seekers
  - Pyrophoric flares in development that are safer and more effective vs discriminating two-color missile threats



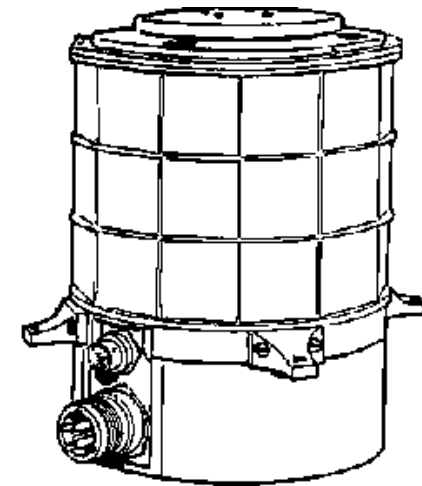
# Mitigation Option: Directed IR Countermeasures (DIRCM)

- **Directed laser, “blinds” IR-guided missile**
- **Considerations**
  - Very powerful jammer
  - Effective against all classes of IR-guided threats
  - Relatively expensive: \$1 - 3 million per aircraft / 6,000 aircraft
  - Just being fielded in the military
  - Can't be used pre-emptively
  - Effective missile approach warning system (MAWs) is crucial
  - No effect on CLOS or Laser beam riding MANPADs



# Mitigation Option: IR Countermeasures (IRCM)

- Lamp- or lantern-based heat source “blinds” IR-guided missile
- **Considerations**
  - Fielded on numerous helicopters and some fixed wing aircraft
  - Omni-directional, continuous operation
  - Weaker J/S than DIRCM
  - Placement relative to engine important
  - No effect on CLOS or laser beam riding MANPADs



TRANSMITTER ASSEMBLY  
T-1360A(V)/ALQ-144A(V)  
(01-323-4999)

# Mitigation Option: Airport Active Defense

- Airport-based flares, IRCMs, active defenses, escort aircraft (or aerostat?) equipped with DIRCM (E-DIRCM)
- Considerations
  - Protects all aircraft, not just U.S. carriers
  - Limited footprint
  - Fratricide (HUMRAAM)
  - Technological maturity (THEL)
  - J/S ratio over large area (lamp based IRCMs)
  - Airspace control (E-DIRCM)



# Mitigation Option: "Camouflage"

- **Reduce the aircraft's EO/IR reflectivity and emissivity**
  - Suppress engine IR signature (duct turning, shrouds, thermal barriers)
  - Use neutral, flat paints and/or low-IR paint



- **Considerations**

- Entirely passive
- Synergy potential: can be used in conjunction with IRCMs and other options
- Reducing engine's IR signature may reduce performance (USA helos: -80% IR, -2% thrust. USAF turbofans: -80% IR, +75% drag count)
- Aircraft integration (weight, balance, actuation system)
- Paint may have weight and maintenance benefits
- Some paint schemes may raise safety concerns

# Mitigation Option: Tamper-proofing MANPADs

- Incorporate Permissive Action Links (PALs) in design of new MANPADs
  - Microchip-based, cryptographical “trigger locks”
- Considerations
  - Cultural impediments
  - May raise costs for U.S. weapons
  - May threaten legitimate exports unless multi-lateral
  - Retrofitting proliferated missiles a challenge

# Mitigation Option: Arms Control

- Coordinated international attempts to limit proliferation
  - Multilateral and unilateral export controls
  - Sting operations
  - MANPADs “Buy Back Programs”
- Considerations
  - “An ounce of prevention is worth a pound of cure”
  - Large number of MANPADS already proliferated
  - Can focus on biggest threats (e.g. CLOS, dual mode seekers)
  - No multi-lateral arms control treaty -- no international consensus
  - Informal arrangements a start, but often lack “teeth”
  - Effect of “buy back” questionable in light of well funded terrorists

# Summary

## ■ Threat

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## ■ Mitigation Options

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# Back Ups



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# Capabilities/Characteristics

- Engagement times: 3 to 10 seconds
- Altitudes up to ~15,000 ft
- Ranges: out to ~5 miles
- Cost: \$5,000-\$80,000
- Guidance
  - Infra Red (IR)
  - Command Line of Sight (Laser, RF)
- High “surprise quotient”
- Potentially lethal to all classes of aircraft

# Select Producers/SFMs

## China

- HN-5
- HN-5A
- HN-5B
- Vanguard
- QW-2
- FN-6

## Bulgaria

- SA-7B
- SA-14
- SA-16

## Egypt

- Sakr Eye

## France

- Mistral

## Japan

- Keiko

## Pakistan

- Anza I
- Anza II

## Romania

- SA-7B

## Russia

- SA-7A
- SA-7B
- SA-14
- SA-16
- SA-18

## Serbia

- SA-7B
- Strela-2M/A

## Sweden

- RBS-70

## Ukraine

- SA-18

## United Kingdom

- Blowpipe
- Javelin
- Starstreak

## United States

- Redeye
- Stinger
- Stinger RMP
- Stinger Block 1

**up to  
700,000  
produced  
world wide**

# Proliferation



- 27 militia groups and terrorist groups estimated to have SFMs
- SFM have attractive attributes: cheap, easy to conceal, easy to use, effective

# Proliferation

- No multi-lateral arms control treaty
  - Wassenaar Agreement attempts to provide transparency
  - Country-by-country export controls
- State sponsors of terrorism
  - Direct transfer to terrorists
- Diversion of legitimate export
  - Hundreds of *Stingers* and *Blowpipes* given to Afghan rebels in the 1980s unaccounted for

# Proliferation

- Black Markets/Poor Control and Accountability
  - Former Soviet Union
  - Yemen
  - Iraq
  
- Arms Dealers
  - Virgin Islands: 10/30/02 FBI arrests 2 Pakistanis and 1 U.S. citizen trying to trade drugs for *Stingers*
  - Hong Kong: 11/06/02 three men with links to *Al Qaeda* tried to buy *Stingers* from FBI agents
  - NYC: 8/12/03 FBI arrests dealer trying to sell Russian SFMs
  - Saudi Arabia: 8/03 intercept of truckload of SFMs in Jeddah

# Civil Aircraft Engagements

## Estimates Vary

**FBI estimates airliners hit at least 29 times causing <550 deaths**

**RAND: as many as 40 civil aircraft were shot down between 1975 and 1992; causing up to 760 deaths**

**CIA (1997 Report)**

- 27 incidents
- > 400 casualties



**Source: BAE Systems**

Sources: Thom Shanker. "Ideal Terror Weapons: Portable Deadly, Plentiful Missiles." *New York Times*. November 29, 2002. p.32.. Marvin B. Shaffer. *Concerns about Terrorists with Manportable SAMs*. RAND. Santa Monica, CA. October 1993. p.3.. GlobalSecurity.org



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# Threat: History of Military Use

**Arab-Israeli Wars**      Egypt damaged or shot down 36 Israeli aircraft with SA-7s; Syria shot down 11 aircraft

**Vietnam**      SA-7s credited with shooting down or damaging 204 U.S. and S. Vietnamese aircraft

**Soviet Union/  
Afghanistan**      Mujahadin downed 269 Soviet aircraft using 340 shoulder-fired SAMs

**1991 Gulf War**      12 of 29 Coalition aircraft lost due to MANPADs

**Iraq (OIF)**      ??



# Select Reports of Terrorist Use/Attempted Use

- 01/73 Rome, Italy
  - *Black September* smuggles 14 SA-7's into Italy
  - Caught minutes before Israeli PM Meir's plane lands
- 05/02 Prince Sultan AB, Saudi Arabia
  - Sudanese terrorist attempts to fire two SA-7s at U.S. aircraft
- 11/28/02 Mombassa, Kenya
  - Two SA-7s fired at an Israeli airliner on take off
- 09/06/03 Baghdad, Iraq
  - Two SFMs fired at C-141 aircraft on take off
- 11/23/03
  - DHL A300B4-200 freighter hit by SA-7