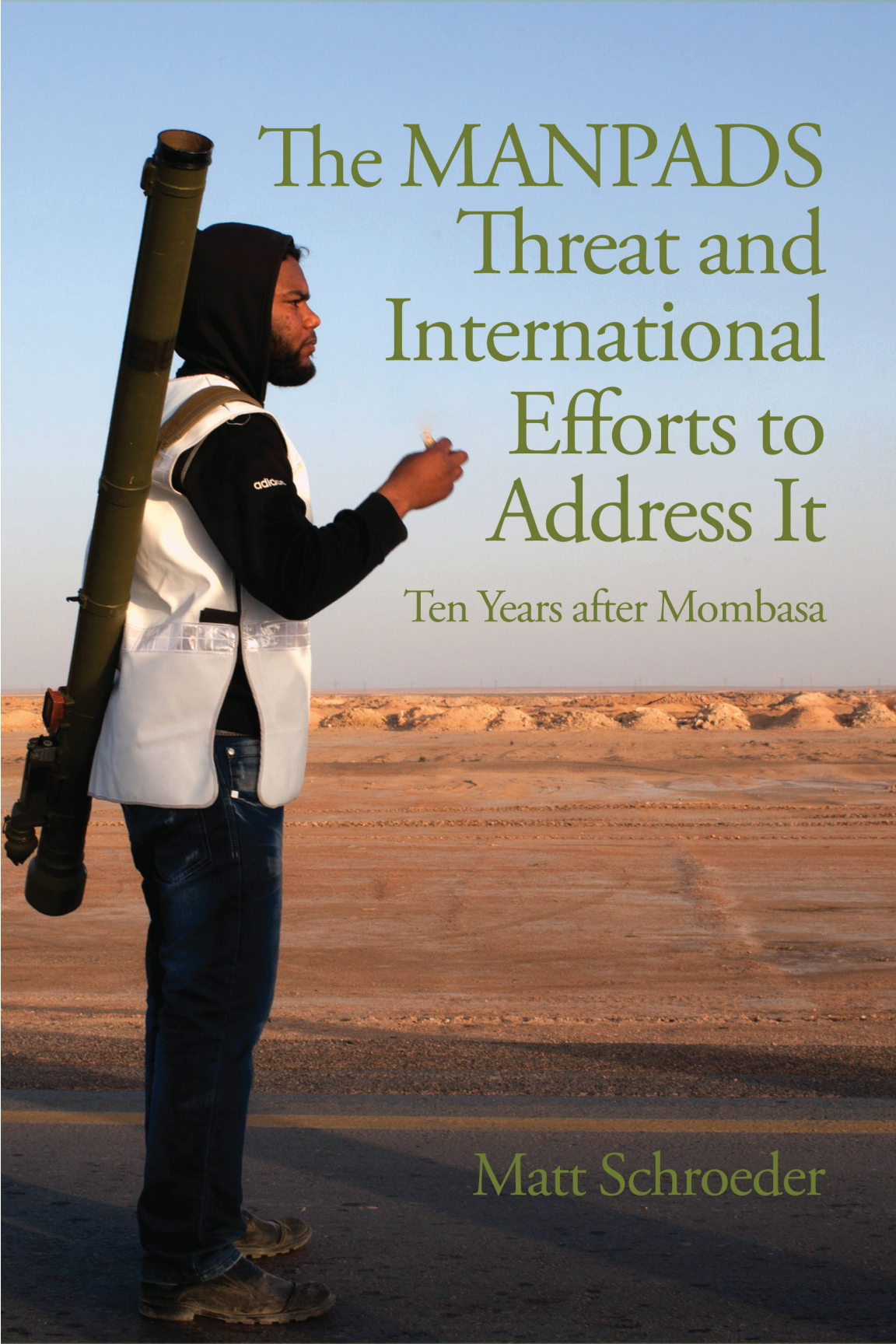
The MANPADS Threat and International Efforts to Address It
Ten Years after Mombasa
Matt Schroeder

The MANPADS Threat and International Efforts to Address It

Ten Years after Mombasa

Matt Schroeder

FAS
Federation of American Scientists

Published in the United States by the Federation of American Scientists

First published in August 2013

Federation of American Scientists
1725 DeSales Street, NW, Suite 600
Washington, D.C. 20036

Cover photo: A Libyan opposition fighter with a shoulder-fired missile at a checkpoint at the edge of Ajdabiya, Libya on March 3, 2011. © Tyler Hicks/The New York Times/Redux

Copy-edited by Tania Inowlocki
Design and layout by Gene Crofts
Printed by AGS Custom Graphics, Macedonia, Ohio

ISBN 978-1-938187-02-5

Contents

List of Abbreviations v
About the Author vii
About the Federation of American Scientists ix

Introduction 1

1 **Background** 3

Producers 3
Types and Technology 5
The Global Trade 6

2 **The Illicit Acquisition and Use of MANPADS since 2002** 9

Types of Illicitly Held MANPADS 10
Sources of Illicitly Held MANPADS 13
Use of Illicitly Held MANPADS 15

3 **Assessing Efforts to Counter the Illicit Proliferation and Use of MANPADS** 19

Transfer Controls 22
The Implementation of Transfer Controls 23
Obstacles to Implementing Transfer Controls 30
Physical Security and Stockpile Management, including Disposal 33
The Implementation of PSSM Provisions 34
Shortcomings in National PSSM Practices 39
Obstacles to Improving PSSM and Right-Sizing Stockpiles of MANPADS 42

Anti-Missile Systems for Commercial Aircraft 48
A DHS Evaluation of Anti-Missile Systems 48
Obstacles to Deploying Anti-Missile Systems on Commercial Airliners 49

4 **Stepping Up Security: A Look to the Future** 51

Securing Existing Inventories of MANPADS 51
Expanding the Use of On-Site Inspections 54
Increasing Transparency in the International Trade in MANPADS 56

Conclusion 61
Endnotes 63
Bibliography 71

List of Abbreviations

APEC	Asia-Pacific Economic Cooperation
CLOS	Command line-of-sight
CREWPADS	Crew-portable air defense system
DHS	United States Department of Homeland Security
DIRCM	Directed infrared countermeasure
EOD	Explosive ordnance disposal
ICAO	International Civil Aviation Organization
IR	Infrared
MANPADS	Man-portable air defense system
NAMSA	North Atlantic Treaty Organization Maintenance and Supply Agency
OAS	Organization of American States
OSCE	Organization for Security and Co-operation in Europe
PAL	Permissive Action Link
PSSM	Physical security and stockpile management
SIPRI	Stockholm International Peace Research Institute
UN Register	United Nations Register of Conventional Arms

About the Author

Matt Schroeder is the director of the Arms Sales Monitoring Project at the Federation of American Scientists in Washington, D.C., and a senior researcher at the Geneva-based Small Arms Survey. Since 2002, he has researched and written on the arms trade, arms export controls, and the illicit proliferation of small arms and light weapons. He is a co-author of the book *The Small Arms Trade* (Oxford: Oneworld Publications, 2007) and has published in *Arms Control Today*, *Defense News*, *Defense Technology International*, *Disarmament Forum*, *Jane's Intelligence Review*, and the *Small Arms Survey*, among other publications. He graduated summa cum laude from Wittenberg University with a bachelor's degree in history and received a master's degree in international security policy from Columbia University's School of International and Public Affairs.

About the Federation of American Scientists

Founded in 1945 by many of the scientists who built the first atomic bombs, the Federation of American Scientists (FAS) is devoted to the belief that scientists, engineers, and other technically trained people have the ethical obligation to ensure that the technological fruits of their intellect and labor are applied to the benefit of humankind.

The founding mission was to prevent nuclear war. While nuclear security remains a major objective of FAS today, the organization has expanded its critical work to other issues at the intersection of science and security.

FAS publications are produced to increase the understanding of policymakers, the public, and the media about urgent issues in science and security policy. Individual authors who may be FAS staff or acknowledged experts from outside the institution write these reports. These reports do not represent an FAS institutional position on policy issues. All statements of fact and expressions of opinion contained in this and other FAS reports are the sole responsibility of the author or authors.

For more information about FAS or its publications, please call (202) 546-3300, email fas@fas.org, or visit the website at www.fas.org.

Introduction

The morning of November 28th, 2002, began like any other in Kenya's bustling port city of Mombasa—home to more than 800,000 people and a popular destination for tourists. For the guests and employees of the beachfront Paradise Hotel in nearby Kikambala, the morning's tranquility came to an abrupt end when a sport utility vehicle laden with explosives crashed through the hotel's security gate and careened into the lobby. Seconds later, the car bomb exploded, reducing parts of the hotel to rubble. The owner of a neighboring hotel described the scene immediately after the explosion. "I can see bodies of local residents," he reported. "The whole hotel is burned totally, both wings, the lobby and everything, it's all burned" (Sawer, Arkell, and Harris, 2002).

Several minutes before the explosion at the Paradise Hotel, security staff at Mombasa's main airport watched a missile streak towards an Israeli airliner full of tourists as it was departing for Tel Aviv (Sawer, Arkell, and Harris, 2002). The passengers on flight 582 knew nothing of the chaos and carnage unfolding below them, or of the mortal threat to their own lives passing right outside their windows. Some heard a boom and felt the plane "rattle," but few, if any, knew the cause (Keyser, 2002). "It felt like something fell off the wing," recalled passenger Kerry Levy (Millar and Norton-Taylor, 2002). It was only hours later that the 261 people on board learned that two Soviet-designed SA-7 surface-to-air missiles had narrowly missed their aircraft. After the plane had landed, one of the passengers told a reporter that she was "[s]haky. Very shaky. And very grateful" (Gibson, 2002).

The passengers on flight 582 were not the only ones shaken by the attack. The near miss in Mombasa was a "wake-up call" for governments worldwide, many of which had failed to recognize that poorly secured and unsecured man-portable air defense systems (MANPADS) pose a special threat to commercial aviation—and thus to the global economy (Shenon, 2003).[1] Two weeks later, the U.S. government assembled an inter-agency task force charged with "develop[ing] an aggressive plan to assess and counter the MANPADS threat" (DHS, 2004). Their task was herculean. By 2002, arms producers in 20 countries had manufactured more than a million MANPADS missiles, at least half of which were still in existence (GAO, 2004, p. 10). These missiles were scattered in depots and stockpiles in more than 100 countries. While most were stored in secure government facilities, thousands of missiles were squirreled away in dilapidated depots, barracks, and other buildings where stockpile security was

minimal or non-existent. Compounding this problem was the steady stream of new MANPADS rolling off production lines, including in states with weak export controls and governmental links to terrorist organizations. The small coterie of U.S. officials on the newly created task force and their counterparts overseas faced a daunting challenge.

As demonstrated in this report, they rose to this challenge. Over the next few years, this group of like-minded states launched a series of diplomatic and political–military initiatives aimed at curbing the terrorist threat from MANPADS by securing and destroying surplus and poorly secured missiles, establishing detailed international standards for stockpile security and transfer controls on MANPADS, improving perimeter security at airports worldwide, developing anti-missile systems for commercial aircraft, and improving reporting and information sharing on the international trade and illicit activity involving MANPADS.

But are these efforts enough? A decade after the Mombasa attack, what has the international community accomplished, and where has it fallen short? What additional steps are required? This report attempts to answer these questions through an assessment of the MANPADS threat since 2002 and the international response to this threat.

The report is divided into four main sections. Section 1 provides background on MANPADS, including their roles, producers, types and technology, and international transfers (the global trade). Section 2 presents an overview of illicitly held MANPADS, with a particular focus on the post-Mombasa era. The third section reviews and assesses international governmental efforts to counter the MANPADS threat using, as a framework, the implementation of the four main international guidelines on MANPADS controls adopted by the Asia-Pacific Economic Cooperation forum, the Organization of American States, the Organization for Security and Co-operation in Europe, and the Wassenaar Arrangement. The fourth section offers recommendations for building upon and strengthening current counter-MANPADS efforts. The conclusion summarizes the findings of this study.

1

Background

Man-portable air defense systems are lightweight, portable surface-to-air missile systems intended primarily for use against low-flying aircraft. Definitions of MANPADS vary. Some definitions are limited to shoulder-fired missiles while others include both shoulder-fired systems and systems that are transported and operated by a small crew (crew-portable air defense systems, or CREWPADS).[2] Shoulder-fired systems usually consist of a missile in a launch tube, a trigger mechanism (gripstock), and a battery. Most shoulder-fired MANPADS are between five and six feet long (1.5–1.8 m) and usually weigh roughly 33 to 42 pounds (15–19 kg). CREWPADS usually consist of a missile in a launch tube and a launcher mounted on a pedestal. These systems tend to be significantly heavier than shoulder-fired systems, sometimes weighing more than 200 lbs (90 kg). In this report, the term "MANPADS" is used to refer to shoulder-fired systems as well as CREWPADS that are deployed in a dismounted configuration.

As explained by the U.S. Army, the first MANPADS were developed to protect "foot soldier[s] against attack by low flying, strafing planes and close-support aircraft" (Cagle, 1974, p. 1). While MANPADS are still used to protect dismounted infantry from low-altitude aircraft, the targets, roles, and platforms on which they are used have expanded. Today, MANPADS are also deployed at high-value military installations and civilian facilities. The models of missiles used with MANPADS—and sometimes the missiles themselves—are also mounted on helicopters, ships, and ground vehicles.

Technological improvements have expanded the list of targets against which MANPADS are effective. In addition to planes and helicopters, MANPADS fielded in recent years are marketed for use against unmanned aerial vehicles and cruise missiles. Some systems are also capable of engaging ground targets, providing the crew with some protection against hostile armored vehicles (Goodlad, 2011).[3] Their primary role remains air defense, however.

Producers

Development of the first MANPADS began in 1955 and culminated in the deployment of the U.S. FIM-43 "Redeye" in 1967 (Cagle, 1974, p. 6, 139). The Soviets launched their own program in 1960 and fielded their first system, the SA-7a (Strela-2), in 1968 (Fiszer and Gruszczynski, 2004). The number of producer states grew steadily over the next two decades, primarily as a result of

Image 1. Shoulder-fired SA-7 surface-to-air missile system. © U.S. Air Force

Image 2. Pedestal-mounted RBS-70 surface-to-air missile system. © LAC Christopher Dickson/Commonwealth of Australia

licensed and unauthorized production of U.S. and Soviet systems. Copies of the SA-7a and an improved version, the SA-7b (Strela-2M) started rolling off production lines in Warsaw Pact countries in the 1970s, followed by unauthorized (reverse-engineered) variants produced in China and Egypt a decade later. In the early 1980s, the United States authorized the manufacture of Stinger missiles by a European consortium consisting of Germany, Greece, the Netherlands, and Turkey (O'Halloran and Foss, 2011, p. 19). Switzerland entered into a separate coproduction agreement with the United States several years later (DOS, 2012, p. 266). Sweden and the UK unveiled their own indigenously produced man- and crew-portable systems in the mid-1970s (Saab, n.d.b). France and Japan were relative latecomers, deploying the Mistral and Type 91 MANPADS in the late 1980s and early 1990s, respectively (O'Halloran and Foss, 2011, pp. 14, 22). The number of producer states peaked in the mid-1990s, when producers in at least 19 countries[4] were manufacturing one or more types of MANPADS.

Since then, the number of countries in which MANPADS are produced has decreased significantly. Switzerland has not produced any Stinger missiles since 1997, and several manufacturers of first- and second-generation Soviet-designed SA-series missiles, including companies in Bulgaria, Romania, Serbia, and Slovakia, have reportedly ceased production. While it is unclear whether and to what extent these companies have retained the capacity to produce MANPADS, there is little reason for many of them to resume production given the technological obsolescence of the systems they produced, the costs of reassembling production lines, and the difficulty of sourcing key components.[5] Only a few countries have joined the group of producer states since the mid-1990s and only one new producer state—South Korea—has fielded its own indigenously developed system (the Chiron).[6]

Available data indicates that MANPADS are currently produced in the following countries:[7] China, France, Iran, Japan, North Korea, Pakistan, Poland, Russia, South Korea, Sweden, the UK, and the United States.[8] Among the most active developers of new systems is China, which has unveiled at least five new (or improved) MANPADS since 2000. New systems (or new missiles for existing systems) have also been developed in recent years by producers in France, Iran,[9] Pakistan, Russia, South Korea, Sweden, and the UK.

Types and Technology

MANPADS are usually categorized by their portability and configuration—i.e., shoulder-fired systems vs. crew-portable systems—and their guidance systems. The vast majority of MANPADS produced to date are shoulder-fired systems designed to lock onto the infrared (IR) energy emitted by the target aircraft and guide themselves to the aircraft. Improvements to later-generation missiles include the ability to detect both IR and ultraviolet energy, enabling them to more effectively distinguish the targeted aircraft from thermal countermeasures.

Laser-beam riding and command line-of-sight (CLOS) MANPADS differ from the IR-seeking systems in that the operator guides the missile to the target. As the name implies, laser beam-riding MANPADS "ride" a laser beam directed at the target by the operator. The Swedish RBS 70 and the British Starstreak are the only laser beam-riding MANPADS that are currently in production. The UK also developed two CLOS systems (the Blowpipe and the Javelin),[10] but neither is still being produced. Unique among MANPADS is China's QW-3, some versions of which reportedly have a semi-active laser guidance system.

Technological improvements have made successive generations of MANPADS faster, more maneuverable, more accurate, and more destructive.[11] This progression is illustrated by improvements to Russia's SA-series MANPADS. The first system fielded by the Soviets, the SA-7a, was only effective when fired from behind an aircraft and was often lured off course by background radiation and simple countermeasures. Its comparatively slow speed and contact fuse further limited its effectiveness against small, fast-moving targets such as fighter jets. In contrast, the latest generation of SA-series missile—the SA-24—can engage very small, high-speed targets such as cruise missiles from any angle, and its dual-channel seeker is reportedly resistant to thermal countermeasures. The SA-24 is also significantly faster than the SA-7a and has a larger warhead (O'Halloran and Foss, 2011, pp. 35–37).

The Global Trade

While data gaps preclude a definitive assessment of the international trade in MANPADS, publicly available information does reveal some of the contours of this trade, including the types and quantities of MANPADS exported in recent years, and the major importers and exporters. One of the most extensive publicly available sources of data on MANPADS transfers is the UN Register of Conventional Arms. While the data submitted to the UN Register is incomplete, it does include reports from most producers of MANPADS, including China, France,[12] Japan, Poland, Russia, South Korea, Sweden, the UK, and the United States.

As discussed in detail below, data submitted to the UN Register is not always a complete accounting of the reporting state's transfers in a given year. States are not required to report on transfers of missiles for MANPADS when they are exported separately from launchers or when they are intended for use with vehicle-mounted systems. Also missing is data on transfers between non-reporting states, which include two producers (Iran and North Korea), and several dozen states in Africa, Asia, the Middle East, and the Western Hemisphere, some of which are potential importers or re-exporters. Data compiled by the Stockholm International Peace Research Institute (SIPRI) captures some of these transfers, but it is likely that at least some MANPADS exports go unreported.

Data submitted to the UN Register and compiled by SIPRI indicates that Russia is the largest exporter of MANPADS in recent years. Russian transfers account for more than half of exported MANPADS declared in the UN Register since 2003. Documented exports of MANPADS by China are comparatively small, but licensed production of Chinese-designed systems appears to be significant. SIPRI estimates that Iran has produced up to 1,800 Chinese-designed MANPADS under license since 1996 and that Pakistan has produced more than 1,600 units of the QW-1 MANPADS since 1994 (SIPRI, n.d). Ukraine has reported transfers of several hundred SA-series MANPADS missiles and launchers to various countries, and the Swedish RBS-70 has been transferred to at least seven countries since 2003.[13]

Publicly available data suggests that many producer states have exported comparatively few systems. The UK has only authorized one export license for complete MANPADS since 2008,[14] and the only other transfer on record since 1995 was the sale of 96 Starstreak missiles to the same recipient (South Africa) in 2003 (SIPRI, n.d.). The same is true for several other current and former MANPADS producers, including Bulgaria, Germany, Pakistan, and Poland. Bulgaria's transfer of 549 gripstocks to the United States in 2005 appears to be anomalous. In January 2012, a Bulgarian official confirmed that "[t]he last export of a complete missile or launcher was [in] 2005." Bulgaria has exported components to Egypt since then but they were "very unsubstantial mechanical parts (springs, rings, rubber seals, covers, pins, etc.) for old type trigger mechanism[s]."[15]

Data on MANPADS transfers also sheds some light on the purposes for which MANPADS are imported. While most systems are intended for use in their traditional roles—i.e., short-range air defense—hundreds of MANPADS are imported for other purposes as well, including demilitarization, countermeasure development, and repair and maintenance. Many of the MANPADS exported from Ukraine were reportedly intended for use in developing countermeasures (Isby, 2007).[16] The 549 gripstocks exported by Bulgaria in 2005 were transferred to the United States for demilitarization.

The international trade in parts, components, and accessories for MANPADS is opaque. States are not required to report on transfers of parts to the UN Register or as part of the Organization for Security and Co-operation in Europe's reporting requirements on small arms and light weapons. In other data sources, including most national and regional reports and the United Nations Commodity Trade Statistics Database (COMTRADE), data on transfers of parts for MANPADS is aggregated with data on other items. Thus, public understanding of the international trade in MANPADS parts, accessories, and most components is extremely limited.

Data on export licenses for MANPADS and their components obtained from the British government provides a sense of licenses issued for components as compared to licenses for complete systems. Of the 46 licenses issued, only one was for complete systems (see Table 1).

Table 1. Export Licenses for MANPADS Issued by the UK Government, 2008–11

Number of MANPADS Export Licenses per Year				
MANPADS Type	**2008**	**2009**	**2010**	**2011**
Javelin (components only)	0	2	1	4
Starburst (components only)	2	0	0	0
Starstreak	8	5	8	16
Total	**10**	7	**9**	**20**

Note: One license was approved in 2010 for the export of 33 Starstreak missiles and 16 practice missiles. The end user was the South African Defence Force. All other exports were for components only.

Source: Data provided to the author by the UK government in April 2012

2

The Illicit Acquisition and Use of MANPADS since 2002

Despite global counter-MANPADS efforts, terrorists, insurgents, and other armed groups continue to acquire and use MANPADS. This section provides a brief overview of illicit MANPADS activity since 2002.

The analysis of illicit acquisition and use of MANPADS using open-source information is fraught with difficulties and imprecision. Most official reports are classified and information from publicly available sources is often vague, incomplete, and difficult to corroborate. Furthermore, sources of public information on illicit weapons, including the media, often lack the expertise to distinguish MANPADS from other types of weapons, resulting in erroneous reporting. Despite these limitations, photographs and reports on illicitly held MANPADS compiled from a broad array of sources provide some insight into the nature and extent of illicit MANPADS activity in recent years.

Open-source accounts of seizures of weapons caches, arms trafficking, weapons recovery programs, and terrorist attacks include documented[17] reports of illicit MANPADS activity[18] in more than 20 countries on five continents since 2002.[19] The extent and significance of this activity varies from country to country and ranges from the seizure of a single "corroded" SA-7 missile from a would-be arms trafficker in Nicaragua to the illicit stockpiling and use of dozens of MANPADS in Iraq (AP, 2005; Scarborough, 2005; Schroeder, 2008; Schroeder and King, 2012, p. 329). These accounts suggest that most illicit acquisition and use of MANPADS occurred in the Near East and Africa, with much of this activity occurring in four countries—Iraq, Libya, Somalia, and Syria. Most of the remaining reports are from current and former conflict zones in Central and South Asia. Documented illicit MANPADS activity in other regions of the world is largely limited to a few isolated incidents, such as the seizure by Thai authorities of ten MANPADS from North Korea in December 2009 and the recovery in southern France of two SA-7s from an arms cache reportedly linked to the Basque separatist group ETA (Schroeder, 2010; BBC News, 2004). U.S. law enforcement agencies have disrupted several plots to illicitly acquire or use MANPADS in the United States, but there is no evidence that any of the conspirators actually acquired—or had access to—a working MANPADS.[20]

Types of Illicitly Held MANPADS

Most of the missiles outside of government control appear to be first- and second-generation shoulder-fired, heat-seeking missiles, many of which are from former Warsaw Pact countries. An unclassified assessment by the U.S. State Department indicates that the Soviet-designed SA-7b is "the MANPADS most commonly held by terrorists groups" (DOS, 2011). This claim is supported by open-source accounts of illicit MANPADS since 2002. To date, nearly all of the loose MANPADS identified in Libya are SA-7s or foreign variants[21] (hereafter referred to as 'SA-7s'),[22] as are most illicitly held MANPADS documented in Iraq, Somalia, and most of the other countries identified above. While less plentiful than the SA-7, the Soviet-designed SA-14 and SA-16 MANPADS have also been found outside of government control in several countries, including in Iraq, Liberia, Sri Lanka, Syria, and Thailand.[23]

As noted above, SA-7s are primarily tail-chase systems that have smaller warheads, shorter effective engagement ranges, and less sophisticated seekers than later-generation MANPADS.[24] Furthermore, many are much older than their estimated shelf lives[25] and may no longer function, or function as intended. Improper storage—signs of which are evident in photographs of illicit SA-7s in Iraq and elsewhere—can hasten the deterioration of key components. However, the data also reveals that at least some illicitly held SA-7s are operational[26] and, as discussed below, capable of bringing down modern military helicopters and large fixed-wing aircraft, including airliners.

Third- and fourth-generation MANPADS have also been acquired and used by armed groups since 2002, but in smaller numbers. These systems include the Soviet-designed SA-18 and SA-24, the Chinese-designed QW-1, QW-1M, and FN-6, the Iranian Misagh-1 and Misagh-2, and the Pakistani Anza II.[27] As revealed in U.S. government reports on weapons seized from arms caches and other publicly available sources, armed groups in Iraq have acquired Misagh-1 and QW-1 MANPADS (see Image 3).[28] In Somalia, members of the terrorist group Al Shabaab have acquired several SA-18 MANPADS, one of which was used to shoot down a Belarusian cargo aircraft as it was departing from Mogadishu airport in 2007 (UNSC, 2007, p. 15; 2011, pp. 241, 243).

In January 2013, Yemeni and U.S. authorities intercepted a dhow carrying massive quantities of weapons, ammunition, and explosives near the coast of Yemen (see Image 4). Of the 20 MANPADS missiles found on the dhow, ten were for the Chinese QW-1M MANPADS, a third-generation system unveiled at the Zhuhai Air Show in 2002 (Sinodefence.com, 2009). Markings on the missile launch tubes suggest that most were manufactured in 2005 (Worth and Chivers, 2013).

Shortly after the seizure near Yemen, footage of Syrian rebels carrying complete Chinese FN-6 and Russian SA-24 MANPADS was posted online (Rebels Deir al-Zour, 2013; Special Forces Regiment 9, 2013; see Image 5). Both the

Image 3. SK-10 gripstock for the Chinese-designed QW-1 MANPADS found in an arms cache in Baghdad, January 2009. © Multi-National Force–Iraq

Image 4. MANPADS and other weapons seized off the coast of Yemen in January 2013. © Yemen's Defence Ministry Handout/Reuters

FN-6 and the SA-24 are notably more capable than the older systems that are more frequently encountered on the black market. Despite numerous (erroneous) reports of SA-24 MANPADS in Libya, no gripstocks for the SA-24 missile have been found, and officials from KBM—the manufacturer of the SA-24—have confirmed that only vehicle-mounted Strelets were exported to Libya (Pyadushkin, 2011; 2012). Illicit third-generation MANPADS have also been seized in Georgia.

Image 5. FN-6 MANPADS in Syria in 2013. © Rebels Deir al-Zour/YouTube

Image 6. Blowpipe missiles and other weapons uncovered in Uruzgan, Afghanistan, in 2012. © Special Operations Task Group/Commonwealth of Australia

Illicit activity involving MANPADS of U.S. and Western European origin appears to be minimal. Reports of illicit British- and U.S.-designed MANPADS are limited to a small number of missiles and components[29] found in arms caches in Afghanistan (Australian DOD, 2012; U.S. Army, 2011; see Image 6). Both systems were distributed to Afghan rebels in the 1980s,[30] and it is likely that the recovered weapons date back to this period. Few, if any, French, Japanese, South Korean, or Swedish MANPADS have been acquired or used by terrorists or armed groups since 2002.

Also notable is the apparent absence of illicit pedestal-mounted systems, including laser beam riders, some of which are 'unjammable' according to manufacturers (Saab, n.d.a). Available evidence indicates that the vast majority of illicit MANPADS are shoulder-fired, IR-seeking missiles. This finding is consistent with previous accounts of illicit acquisition and use of MANPADS by non-state armed groups[31] and is likely the result of a combination of factors, including smaller global inventories and comparatively limited global distribution of pedestal-mounted systems, higher unit prices, difficulty of use, and their comparatively large size. Furthermore, "fire and forget" IR seekers allow an operator to escape more quickly and avoid counter-fire than other systems, which require missiles to be guided all the way to the target. It is possible that some pedestal-mounted systems have been acquired by terrorists and insurgents in recent years, but probably only in limited quantities.

Sources of Illicitly Held MANPADS

While data gaps preclude a full accounting of the various sources of illicit MANPADS, a review of open-source information sheds some light on where and how terrorists and insurgents have acquired MANPADS in the post-Mombasa era. Among the most significant factors leading to the acquisition of illicit MANPADS in recent years has been regime collapse—i.e., the sudden loss of government control over MANPADS and other munitions during or after the deposal of the ruling regime. Prior to the fall of Saddam Hussein's regime in 2003, the Iraqi government had amassed hundreds of thousands of tons of weapons, which were dispersed among hundreds of stockpiles of varying sizes (Kay, 2003). These stockpiles contained several thousand SA-7, SA-14, and SA-16 MANPADS procured in the 1970s and 1980s. When the regime collapsed, many of the MANPADS were looted from unguarded stockpiles.[32] In 2004, the U.S. intelligence community estimated that 4,000 of Iraq's 5,000 MANPADS remained at large, prompting a three-fold increase in the global estimate of MANPADS outside of government control (Jehl and Sanger, 2004). Government-led collection programs and raids on illegal arms caches have reduced the number of illicit MANPADS in Iraq, but progress has been slow; Iraqi authorities reportedly seized arms caches containing multiple "Strela" missiles as recently as May 2012 (Al-Shorfa, 2012).

In 2011, a similar fate befell Libya's vast arsenal of SA-7 MANPADS, hundreds of which were seized by militias during the uprising against Muammar Qaddafi's regime. The U.S. government estimates that the Libyan government imported as many as 20,000 MANPADS missiles from Bulgaria, the former USSR, the former Yugoslavia, and other states over a 30-year period starting in the early 1970s.[33] As they seized territory from Qaddafi loyalists in 2011, anti-government militias removed the missiles along with other weapons from government depots. It is unclear how many MANPADS were taken by the militias, but photos of the weapons and emptied crates suggest that the total is at least several hundred missiles. Since then, participants in a multinational threat mitigation effort have accounted for and secured about 5,000 MANPADS and components (Shapiro, 2012). Unknown quantities were also destroyed during NATO bombing and were fired by militia members in combat. Whether and to what extent the looted MANPADS have been smuggled abroad is unclear.

The slow disintegration of Bashar al-Assad's regime in Syria has also resulted in the loss of government control of at least some of its MANPADS, although the full extent of these losses is not yet publicly known. Video footage of weapons seized by anti-government forces from a military installation near Aleppo shows multiple crates containing MANPADS, including at least two second-generation SA-16 missiles (Atareb Syriafree, 2012). Additional MANPADS of the types known to be in Syrian inventories are featured in other videos and photographs of the rebels, but it is not clear if these missiles were acquired domestically or from abroad.

Another prominent source of illicit MANPADS since 2002 is state sponsorship of armed groups. UN monitors have accused the government of Eritrea of transferring MANPADS to groups in Somalia in contravention of a long-standing UN arms embargo. These transfers include at least six third-generation SA-18s "delivered by Eritrea to [the Islamic Courts Union/Al] Shabaab," according to UN investigators (UNSC, 2007, p. 15). The Eritrean government has denied the accusations but at least two SA-18s seized from Al Shabaab were traced back to a consignment of missiles produced in Russia in 1995 and "shipped to Eritrea in the same year" (UNSC, 2008, pp. 24–25; 2011, p. 243).

Similarly, the U.S. government has accused Iran of providing MANPADS to armed groups operating in Iraq and Yemen. As noted above, U.S. forces have reportedly found several Iranian-produced Misagh-1 missiles and components in Iraq, including an expended missile found outside of Baghdad International Airport in 2004 (MNF-I, 2007). A more recent example is the above-mentioned arms shipment intercepted by U.S. and Yemeni forces in January 2013. The shipment contained ten QW-1M missiles, ten SA-7 missiles, and several gripstocks and battery units. According to government officials interviewed by *The New York Times*, the dhow that transported this cargo was spotted by the U.S. Navy after it was loaded at a port known to be controlled by the Iranian

military (Worth and Chivers, 2013).[34] Other sources of illicitly held MANPADS include private arms traffickers and other armed groups.

Use of Illicitly Held MANPADS

As in previous decades, most MANPADS attacks since 2002 have occurred in conflict zones. While data limitations preclude a definitive assessment, open-source accounts of attacks in Iraq, Somalia, and Syria shed some light on this activity, including the types of MANPADS used and the fate of the targeted aircraft. During the 2003–11 war in Iraq, use of MANPADS by armed groups was widespread. While official data on the topic is classified, statements by military officials and data collected by private research organizations suggest that usage rates were high, at least in certain regions. In October 2007, a U.S. Defense Department spokesman told reporters that helicopters in the 1st Air Brigade alone came under fire from MANPADS roughly ten times per month (Baker, 2007b). Most of these missiles failed to find (or engage) their targets, as evidenced by the comparatively low number of U.S. aircraft shot down in Iraq.[35] When they did hit targeted helicopters, however, the damage was often catastrophic. In November 2003, for example, a U.S. Chinook helicopter was hit by an SA-7 missile while flying near Fallujah, killing and injuring 36 people on board (Gilmore, 2003). In May 2006, a British Lynx helicopter was hit by a MANPADS while flying over Basra. All five crew members were killed (UKMOD, 2006).[36]

In early 2007, Iraqi insurgents orchestrated three highly sophisticated ambushes of U.S. helicopters. The attacks, which brought down four helicopters and killed 21 people, not only underscore the lethality of MANPADS against helicopters but also the importance of the skill level and training of the operator. In all three ambushes, the attacks were very well planned and coordinated. During one of the ambushes, insurgents used multiple firing positions and a variety of weapons, including heavy machine guns, improvised explosive devices, and MANPADS, to shoot down two Apache helicopters (Knights, 2007). Rebel groups in Syria are also using MANPADS against helicopters. Amateur video of the conflict includes footage of several attacks, including the apparent destruction of a helicopter by an insurgent armed with a modern Chinese FN-6 (Military Council, 2013; see Image 7).

Fixed-wing aircraft have also been hit by MANPADS, but in most cases the crew has been able to land the damaged plane. Armed groups in Iraq and Somalia used MANPADS to bring down at least two military and two civilian transport and cargo planes from 2003 through 2007. The crews of the two military aircraft—a C-5 and a C-17—were able to land the planes (Schroeder, 2007). One of the civilian planes, an Airbus A300, was hit in the left wing shortly after taking off from Baghdad International Airport. The missile disabled the plane's hydraulics system and ignited a fire on the wing. Despite the loss of key flight

Image 7. Video of a Syrian rebel shooting down a helicopter with a Chinese FN-6 MANPADS. © Military Council, 2013/YouTube

controls, the crew managed to fly the plane back to the airport. While the crew was unharmed, damage to the plane was extensive. The other plane, an IL-76, crashed just outside of Mogadishu, killing all 11 passengers and crew members (UNSC, 2007, p. 15; Abdulle, 2007).

Documented MANPADS attacks in other regions have been rare. Israeli planes have reportedly been targeted by MANPADS but few, if any, aircraft have been lost in these attacks, even during the 2006 war with Hezbollah in Lebanon. Given the size and sophistication of Hezbollah's arsenal, this is noteworthy and suggests that even the best-armed groups often have difficulty acquiring large quantities of advanced MANPADS.[37] There have also been isolated reports of MANPADS attacks in other regions, including South America. With the exception of undated video footage of a MANPADS attack that reportedly occurred in Colombia (Noticias RCN, 2012), most of these reports are unverifiable and, in some cases, clearly erroneous.[38]

3

Assessing Efforts to Counter the Illicit Proliferation and Use of MANPADS

Since 2002, the international community has taken numerous steps to address the MANPADS threat. These efforts range from major multilateral negotiations involving dozens of states to minor regulatory changes by individual governments.

This section provides an overview of these efforts, including implementation of the Wassenaar Arrangement's Elements for Export Controls of Man-portable Air Defence Systems and three related guidelines: the Asia-Pacific Economic Cooperation (APEC) forum's Guidelines on Controls and Security of Man-Portable Air Defense Systems, the Organization for Security and Co-operation in Europe's (OSCE) Principles for Export Controls of Man-portable Air Defence Systems, and the Organization of American States' (OAS) Recommended Guidelines for Control and Security of Man-portable Air Defense Systems (hereafter referred to as "related guidelines"). While the guidelines vary in form and content, they share a common focus on improving transfer controls, strengthening stockpile security, and disposing of surplus MANPADS. This section also assesses efforts to develop anti-missile systems for civilian aircraft.

Attempts to control the acquisition and use of MANPADS are as old as the weapons themselves,[39] but their scope and scale increased dramatically after the Mombasa attack. To coordinate its response, the United States launched an inter-agency MANPADS task force comprised of representatives from 20 government agencies. The goal of the task force was to "address and develop ways to better manage vulnerabilities against a MANPADS attack" through (1) non-proliferation and threat reduction, (2) technical countermeasures, and (3) tactical operations (DHS, 2010, p. 5). Non-proliferation and threat reduction efforts are coordinated by the U.S. State Department and consist of improving export controls on MANPADS, securing and destroying surplus, obsolete, and poorly secured missiles, and improving physical security and stockpile management (PSSM) at storage facilities holding MANPADS. The U.S. Department of Homeland Security (DHS) took the lead in developing anti-missile systems for commercial aircraft (technical countermeasures); on tactical operations aimed at "identify[ing] and address[ing] vulnerabilities

to shoulder-fired missile attacks in areas surrounding civilian airports"; and with respect to preparing state and local governments to respond effectively to MANPADS threats (DHS, 2005, p. 7).

Several other states have contributed significantly to global counter-MANPADS efforts. Since 2002, the government of Australia has sponsored three UN General Assembly resolutions on preventing illicit transfers of MANPADS and has organized workshops on MANPADS and other small arms and light weapons (Australian DFAT, 2008). The Israeli government has engaged in several initiatives, including diplomatic efforts to prevent MANPADS transfers to states that support terrorists. It was also the first country to decide to equip its entire commercial fleet with anti-missile systems. Russia has led initiatives to improve information sharing and record-keeping among members of the Commonwealth of Independent States, remove MANPADS from insecure locations, and strengthen controls on MANPADS exports (Schroeder, Stohl, and Smith, 2007, p. 113). The UK has worked with governments to improve security at and around domestic and foreign airports and has assisted with stockpile security and surplus missile destruction programs (UKFCO, 2006, p. 23).[40]

Among the most notable multilateral accomplishments of the post-Mombasa era is the adoption of increasingly robust versions of the Wassenaar Arrangement's Elements for Export Controls of Man-Portable Air Defense Systems, versions of which were later adopted by several other multilateral institutions. First adopted in 2000, the Elements were substantially revised in 2003 and again in 2007 (WA, 2000; 2003; 2007). The latest version of the Elements calls on states to, among other things, adopt robust controls on the international transfer of MANPADS, criminalize violations of export control legislation relating to MANPADS, share information with other member states, and provide assistance to non-participating states.

By 2005, members of APEC, the OAS, and the OSCE had adopted the above-mentioned guidelines on MANPADS controls. These controls cover—to varying degrees—the entire life cycle of a MANPADS, i.e., from production to the disposal of excess stockpiles. The content and even the wording of the four agreements are often very similar, and some of the provisions are copied verbatim from the Elements.

Through the adoption of these agreements, the more than 100 members[41] of APEC, the OAS, the OSCE, and the Wassenaar Arrangement—which include most manufacturers and major exporters of MANPADS—have endorsed their provisions, many of which are more specific and robust than those in comparable agreements on small arms and light weapons. In addition, controls on stockpile security are elaborated in the OSCE's *Best Practice Guide on National Procedures for Stockpile Management and Security* (OSCE, 2003).

The Elements have also been endorsed by organizations with global

memberships. In 2004, the International Civil Aviation Organization (ICAO) adopted a resolution urging its member states to "apply the principles defined in the Elements for Export Controls of MANPADS" (ICAO, 2004). Similar endorsements have come from the UN General Assembly, which adopted resolutions on the "prevention of the illicit transfer and unauthorized access to and use of man-portable air defence systems" in 2004, 2005, and 2007. While the resolutions do not explicitly refer to the Elements, they do "welcom[e] the ongoing efforts" of international and regional forums (UNGA, 2004; 2005; 2007). The Group of Eight Industrialized Nations also lent its weight to the nascent global campaign in 2003 and 2004, adopting resolutions endorsing the Elements and calling on its members to "promote the application of the principles defined in these 'Elements' by a larger number of States" (G8, 2003; 2004).

In addition to adopting the Elements and the related guidelines, governments have pursued a broad array of initiatives aimed at reducing the illicit proliferation of MANPADS and the threat posed by systems that are already outside of government control. Below is a partial list of these efforts, several of which are discussed in more depth later in this section:

- assessing and securing government storage facilities containing MANPADS;
- disposing of surplus, obsolete, and illicit MANPADS;
- conducting MANPADS vulnerability assessments at airports;
- training border control officers to recognize MANPADS and key components;
- strengthening controls on the international transfer of MANPADS, components, and production technologies;
- retrieving MANPADS outside of government control through weapons collection programs and law enforcement operations;
- developing and, in some cases, installing anti-missile systems on civilian and military aircraft;
- hardening aircraft to minimize the damage from a MANPADS attack;
- preventing the illicit acquisition and transfer of MANPADS and dismantling arms trafficking networks through undercover operations and other law enforcement actions;
- sharing information on non-state entities that are illicitly seeking MANPADS and on governments that are unwilling or incapable of properly securing MANPADS; and
- increasing transparency in the international trade in MANPADS.

These efforts take many different forms and are implemented in various ways. Some are pursued by governments unilaterally through improvements to their own controls. Others are pursued bilaterally or multilaterally, either through existing institutions or ad hoc groups of like-minded governments. In November 2003, members of the Commonwealth of Independent States

agreed to a set of measures aimed at improving record-keeping and information sharing on MANPADS transfers and facilitating collaboration between national law enforcement agencies (Schroeder, Stohl, and Smith, 2007, p. 113). More recently, Australia, Canada, New Zealand, the UK, and the United States established a MANPADS Contact Group aimed at improving coordination of national counter-MANPADS efforts (DOS, 2011).

As part of the research for this study, the author solicited input on MANPADS controls and counter-MANPADS efforts from several dozen governments. A key component of this outreach was the drafting and distribution of a questionnaire on implementation of the Elements and the three related guidelines to members of APEC, the OAS, the OSCE, and the Wassenaar Arrangement. The questionnaire consisted of two sections: one on transfer controls and the other on stockpile security practices. The content, wording, and structure of the questionnaire closely corresponded with the relevant provisions in the Elements and the related guidelines.

Twenty-nine governments responded to the questionnaire. Interviews with government officials, research commissioned for this study, and other data sources yielded information on the policies of ten additional states in Africa, Asia, and Europe.[42] The author also conducted nearly 50 interviews with officials from multilateral institutions, representatives of the defense and airline industries, experts from donor states, and current and former members of UN monitoring groups.

Data and information collected through this research sheds new light on the nature and extent of global counter-MANPADS efforts pursued since 2002, and the barriers to implementing these efforts fully and effectively. Below is a summary of the findings.

Transfer Controls

As mentioned above, the Elements and the related guidelines contain numerous provisions aimed at establishing strong controls on international transfers of MANPADS. While the export controls in the Elements and related guidelines focus on issues that are similar to those addressed in other conventional arms control agreements, many of the provisions in the Elements are significantly more detailed, restrictive, and robust. This section briefly assesses these controls and their implementation through an analysis of responses to the questionnaire, interviews with government officials, and secondary sources. Given the dominant role of the major producer and exporter states—both in the global MANPADS trade and in multilateral efforts to control this trade—much of the country-specific analysis is devoted to their controls. The challenges associated with establishing, strengthening, and harmonizing key export controls are also assessed.[43]

The Implementation of Transfer Controls

Export Restrictions. The Elements and the related guidelines call on states to permit MANPADS exports "only to foreign governments or to agents specifically authorised to act on behalf of a government" (WA, 2007, para. 3.1).[44] The inclusion of this provision marks a significant departure from most similar agreements on small arms and light weapons controls and underscores the difference between MANPADS and other small arms and light weapons, both in terms of how they are used and by whom, and the level and rigor of controls that are politically and financially acceptable to governments.

As reflected in responses to the questionnaire, most producers and exporters of MANPADS have embraced this provision, including governments that have supplied MANPADS to non-state groups in the past. The vast majority of respondents indicated that they permit transfers of MANPADS only to "foreign governments and agents specifically authorized to act on their behalf." Only two states responded "no" to this question.[45] One government indicated that, generally speaking, it did not permit any international transfers of MANPADS, including to governments. The second respondent represents a state that is not a producer or known exporter of MANPADS.

General Licenses. The Elements and related guidelines discourage the use of general licenses when exporting MANPADS, urging states to subject each MANPADS transfer to an "individual licensing decision" (WA, 2007, para. 3.2). Most states that responded to the questionnaire, including producers and recent exporters of MANPADS, indicated that they do not permit the use of general licenses for exports of MANPADS, and several noted that general licenses are not issued for any arms exports. Of the four governments that responded differently, two noted that the use of general licenses was limited to exports of spare parts and components. The third government indicated that MANPADS may be exported under general licenses for use by its own armed forces or those of allied governments deployed overseas, and for demonstration and repair "in situations where the risk assessment profile is low/negligible." The fourth government noted a similar exception for exports to the armed forces of European Union countries.

Non-Governmental Brokers. Recognizing the threat of diversion posed by unscreened or poorly vetted brokers,[46] members of APEC, the OAS, the OSCE, and the Wassenaar Arrangement agreed not to "make use of non-governmental brokers or brokering services when transferring MANPADS, unless specifically authorised to on behalf of the government" (WA, 2007, para. 3.3).

Most of the governments that responded to the questionnaire[47] indicated that they either prohibit the use of non-governmental brokers entirely or that they require non-governmental brokers to be licensed or otherwise specifically authorized by the government to engage in arms exports. Of the four remaining states, none are major exporters of MANPADS.[48]

Export Criteria. The Elements and related guidelines also call on member states to take into account several factors, or criteria, before authorizing the export of MANPADS. These criteria include the following:

- the potential for diversion or misuse in the recipient country;
- the recipient government's ability and willingness to protect against unauthorized retransfers, loss, theft, and diversion; and
- the adequacy and effectiveness of the physical security arrangements of the recipient government for the protection of military property, facilities, holdings, and inventories (WA, 2007, para. 3.7).

Most respondents indicated that they consider all three criteria before authorizing MANPADS exports,[49] and most reported that they consider the risk of diversion or misuse.[50] Whether such assessments lead to fewer problematic MANPADS transfers depends on how the criteria are assessed and whether—and to what extent—the resulting assessment affects the outcome of the authorization process.

Export officials assess the risk of diversion in a variety of ways. Procedures include screening individuals and companies affiliated with the proposed export against watch lists of suspicious or debarred parties; checking the authenticity of documentation submitted as part of the licensing request; conducting interagency reviews of proposed transfers;[51] reviewing intelligence on the recipient country; and, in some cases, conducting on-site inspections of storage facilities. Information gathered through these procedures is then used to assess the risk of diversion and unauthorized use (along with other export criteria). Since the risk of diversion is never zero and is usually one of several—sometimes competing—policy considerations, the decision whether to authorize the transfer is inherently subjective.

Most respondents provided little information on how they assess the risk of diversion, or how they weigh that risk against the perceived benefits of the proposed sale. Several European governments indicated that their assessments are based on the eight criteria in the relevant EU Common Position,[52] but they did not explain how they consider these criteria when reviewing potential exports of MANPADS.

Documentation published by the U.S. Defense Department provides some insight into how the U.S. government assesses the risk of diversion. For all MANPADS transfers, the U.S. Defense Department requires the submission of a detailed Country Team Assessment that includes an analysis of, among other things:

- the terrorism and proliferation record of the potential recipient;
- the potential recipient's track record in "maintaining security of national stockpiles of small arms," including any incidents of theft or other illicit transfers;

- whether the quantity of MANPADS is "reasonable in relation to the intended use, current on-hand inventories, and predictable usage rates";
- the quantity of MANPADS that will become excess as a result of the proposed sale and any plans for transferring, storing, or destroying the excess weapons; and
- interagency concurrence that includes the U.S. Department of State.

Also included in the assessment is an analysis of the perceived benefits of the sale, that is, how it would "contribute to U.S. security and foreign policy goals" (DSCA, n.d.c, sec. C.5.1.4).

How governments respond to the risks associated with MANPADS transfers—both generally and in specific cases—is revealed to some extent through their exports. Data on MANPADS exports since 2002 suggests that many producers have exported very few MANPADS in the last decade, in part because they are extremely selective regarding potential importers. As noted above, the UK has only issued one export license for complete MANPADS since 2008 (to South Africa), and publicly available data for 2002 to 2008 reveals only one additional transfer, which also went to South Africa. Similarly, new sales of Stinger MANPADS are unusual; the proposed sale of 600 Stinger missiles and 110 gripstocks to Finland would be the first new international sale of MANPADS from the United States in many years (DSCA, 2011). Some governments are less restrictive, authorizing exports more frequently and to a more diverse group of importing states.

Rather than deny requests for MANPADS outright, some exporting states only offer systems intended for mounting on light vehicles to countries where the risk of diversion is deemed comparatively high. On at least two occasions since 2002, the Russian government has sold vehicle-mounted Strelets systems instead of MANPADS to reduce the risk of diversion. As noted above, Russia sold Strelets launchers and SA-24 missiles to the Libyan government in 2004 (SIPRI, n.d.). According to Russian MANPADS manufacturer KBM, no MANPADS gripstocks were provided (Pyadushkin, 2011; 2012). A similar sale to Syria also appears to have been shaped by concerns about diversion. The threat posed by terrorists or insurgents armed with Strelets systems is a matter of ongoing debate, but the size and configuration of these and other vehicle-mounted systems makes them much more difficult to smuggle across borders and surreptitiously transport to attack sites than MANPADS.

To further reduce the risk of diversion, some exporters produce missiles for vehicle-mounted systems that are incompatible with MANPADS launchers. According to KBM officials interviewed by independent analyst Maxim Pyadushkin, the electronics in the SA-24 missiles sold to Libya are "modified to work only with the Streletz trigger mechanism" (Pyadushkin, 2012, p. 6). Similarly, U.S. Stinger missiles sold for use with the Avenger and other vehicle-mounted launchers are specifically modified so they cannot be attached to a gripstock and fired.[53]

Technical Performance and Launch Control Features. The Elements call on states that produce MANPADS to "implement technical performance and/or launch control features for newly designed MANPADS as such technologies become available to them." The provision notes that "[s]uch features should not adversely affect the operational effectiveness of MANPADS for the legal user" (WA, 2007, para. 3.4).[54] The terms "technical performance" and "launch control features" are not defined in the text. According to one official who participated in the 2003 revision of the Elements, the drafters did not identify specific technologies in part because they believed that the best technological approach would vary from system to system. The official noted: "We weren't going to tell states how to do it. We would give them the idea, but not tell them specifically how to implement it."[55] Options reportedly discussed during the negotiations of the revised Elements include fingerprint recognition and "hand-shaking" technology.[56]

The idea of preventing unauthorized use of MANPADS and other portable guided missiles through the installation of technical-use controls is not new. In the mid-1980s, members of the U.S. Congress concerned about the illicit proliferation of Stinger missiles pressed for the development and installation of a "Stinger System Safeguard," which is described in one Congressional report as "electronic circuit lockout technology" that provides the capability to "render the weapon inoperable without entry of a pre-determined code" (USHR, 1988, p. 239). According to a Congressional staff member who worked on the issue, the device would be incorporated into the missile's circuitry. Once the missile was activated, it would search for an enabling code. If the code was provided, the missile would function as intended for as long as the system was enabled, which could be days, weeks, or even years. After that time, a valid code would need to be re-entered for the system to work (Sherman, 2003, pp. 4–5; Schroeder, Stohl, and Smith, 2007, pp. 96–98). The technology would be similar in function to Permissive Action Links (PALs), which have been used with nuclear weapons for decades. The U.S. Congress funded a study on the feasibility of the technology, but there is little evidence that the study led to the development of such controls (U.S. Congress, 1987; Sherman, 2003, pp. 4–5).

The issue of equipping conventional weapons, including MANPADS, with technical-use controls has received sporadic media attention since then and was discussed in a 2007 report by the RAND Corporation. As noted by RAND, use of such controls with conventional weapons is still widely viewed as "a new concept" (Bonomo et al., 2007, p. 87). In discussing possible options, the RAND report focuses on PAL technology,[57] including variants that would enable a system for use in "a particular time window or geographic box and not fully capable in other periods or places" (Bonomo et al., 2007, pp. 88–90). Discussion of the device is primarily conceptual; the design, structure, and operation of specific devices for MANPADS are not addressed in detail.

Assessing implementation of this provision by producer states is difficult because many governments view the topic of technical-use controls as sensitive. Questionnaire responses and interviews with government officials reveal little evidence of widespread development and deployment of technical-use controls by producers of MANPADS, but data gaps preclude a definitive assessment. Only one government indicated that it had developed such controls, which were described as "protective systems for trigger mechanisms." The government provided no additional information about the mechanisms, citing "the classified nature of the requested information."[58] Interviews with industry and government officials reveal a growing interest in this technology among some producer states, one of which is reportedly requiring "industry to consider [this technology] in the development phase of next-generation equipment." Whether this interest will lead to widespread use of these controls is unclear.

Re-Export Restrictions. The Elements and related guidelines also instruct member states to "assure [themselves] of the recipient government's guarantees not to re-export MANPADS except with the prior consent of the exporting government" (WA, 2007, para. 3.8).

Nearly all of the governments that participated in this study indicated that they require importing states to seek their consent before re-exporting MANPADS. The remaining governments indicated that the issue of restrictions on re-exports of MANPADS did not apply to them because they do not export MANPADS. Some states include re-export restrictions in documentation for every sale while others typically include the restrictions in the overarching government-to-government agreements required before MANPADS may be transferred.[59] These restrictions are often included in (or with) end-user certificates, which several states indicated that they authenticate through their diplomatic missions abroad, unspecified intelligence channels, or with the assistance of other governments "with substantial intelligence-gathering capacities," such as the United States.[60]

Notification of Compromise, Unauthorized Use, Loss, and Theft. The Elements and related guidelines also urge exporting states to obtain guarantees from recipient governments "to inform promptly the exporting government of any instance of compromise, unauthorised use, loss, or theft of any MANPADS material" (WA, 2007, para. 3.8). Most—but not all—respondents indicated that they require importing governments to inform them of instances of theft, loss, and unauthorized use of imported MANPADS. The Russian government, for example, requires prompt notification of loss, theft, or diversion, and the serial numbers of the affected weapons (Pyadushkin, 2012, p. 6). The United States requires similar notification from importers of Stinger missiles. Language in U.S. Letters of Offer and Acceptance indicates that any such notification will be followed by an investigation (DSCA, n.d.a; n.d.b).

On-Site Inspections. The Wassenaar Arrangement Elements and the OSCE Principles for Export Controls of MANPADS call on governments to:

> ensure that the exporting State has the opportunity to confirm, when and as appropriate, fulfilment by the importing State of its end-use assurances with regard to MANPADS and their components (this may include on-site inspections of storage conditions and stockpile management or other measures, as agreed between the parties) (WA, 2007, para. 3.8).

The guidelines adopted by APEC and the OAS do not contain this provision.

Questionnaire responses indicate that approaches to on-site inspections vary considerably from state to state, including among producing and exporting states. Some governments, including exporting states, indicated that they do not conduct such inspections. In contrast, the U.S. Defense Department conducts on-site inspections before Stinger MANPADS are shipped, when the weapons arrive, and annually thereafter (DSCA, n.d.d, sec. C8.4.1.2). During annual (post-shipment) inspections, U.S. officials conduct inventories by serial number of all exported Stinger missiles and gripstocks. The only exceptions are Stingers deployed during hostilities and those sent abroad for repair, which constitute roughly 8% of all exported Stingers in a given year, according to U.S. officials.[61] During these inspections, U.S. officials also inspect storage facilities to ensure they are in compliance with PSSM requirements, review records of inventories performed by depot personnel, and look for signs of unauthorized access. Additional on-site visits may be conducted when violations of U.S. law or regulations are suspected.

Some other respondents indicated that they also conduct—or reserve the right to conduct—on-site inspections. Data limitations prevent a comprehensive assessment of their practices,[62] but interviews and questionnaire responses suggest that such inspections are carried out less frequently than the annual checks performed by the United States. One exporting state indicated that it conducts pre-license and post-shipment checks "if necessary," but it did not provide any details on how these checks are conducted or under what circumstances. Another state specified that it reserves the right to conduct on-site checks but generally relies on the exporting company, which has regular access to the missiles, to "report to us any problem" that they encounter.[63]

A Bulgarian official indicated that pre-license and post-shipment checks of exported arms are conducted when "necessary and appropriate. Such checks are not conducted when exporting to trusted partners, such as the U.S. and EU states. Such checks are usually reserved for exports outside of the EU community." The official added that "if there are any doubts about the security of items proposed for transfer, an export license is not issued."[64]

The Russian government also reserves the right to conduct on-site inspections, which it occasionally exercises. According to Pyadushkin, provisions regarding on-site inspections are included in bilateral agreements with importing states and in delivery contracts. An example is the protocol with Syria on MANPADS

and Strelets signed in 2006. Under this protocol, Syria is required to provide Russian inspectors with access to weapons storage sites and all necessary documentation. The inspection teams generally consist of up to five individuals and are financed by the Russian government. Requests for inspections are to be made at least 15 days in advance. The protocol also requires Syria to (1) provide information on the availability, use, and decommissioning of MANPADS to Russia on an annual basis, (2) seek written permission from Russia before decommissioning MANPADS, and (3) urgently inform the Russian government of theft, loss, or diversion of MANPADS, and provide the serial numbers of the missing weapons (Pyadushkin, 2012, p. 6).

In an interview with the author, a Russian government official provided further clarification. "As [of] today," commented the official, "only a few inspections have been conducted. They were all post-shipment inspections." The official added that "[t]he most important thing for us is to have the possibility to conduct such inspections." He concluded by noting that his government does not conduct surprise inspections, which he described as "technically impossible."[65]

Effective Measures for Disposal. The Elements and related guidelines also urge exporting governments to "satisfy [themselves] of the recipient government's willingness and ability" to "[a]dopt prudent stockpile management practices that include effective and secure disposal or destruction of MANPADS stocks that are or become excess to national requirements" (WA, 2007, para. 3.9).[66]

To assess implementation of this provision, respondents were asked whether they *require* importing states to dispose of excess MANPADS.[67] Nearly all respondents indicated that they do not require disposal of excess MANPADS. In follow-up interviews, one official explained why his government does not impose such requirements on importing states. "One's understanding of what is 'surplus' is very subjective. We try not to impose subjective criteria on importing states."[68]

Only one respondent indicated that any authorization to export MANPADS would "require the importing state to dispose of or destroy MANPADS stocks in excess of national requirements." In follow-up interviews, another government indicated that it has a "new for old" rule for exports of small arms and light weapons, including MANPADS. The rule applies to exports for "third countries," i.e., countries other than members of the EU, NATO, Australia, Japan, New Zealand, and Switzerland. Sales contracts with end users in third countries include a provision that requires importers to destroy existing weapons that are replaced by newly imported weapons. The recipient must also agree to destroy the imported weapons when they are removed from use.

Some states also take into account existing MANPADS stockpiles when considering exports of new MANPADS. For example, the U.S. Defense Department requires a thorough accounting of any missiles that would be rendered excess by the proposed transfer of Stingers. This accounting typically includes

information on likely recipients of the excess MANPADS, how the excess MANPADS would be stored, and any plans for their destruction. In cases where surplus MANPADS are identified, the U.S. military works closely with the State Department and the importing government to dispose of them.[69]

Obstacles to Implementing Transfer Controls

The challenges associated with implementing robust, harmonized controls on international arms transfers range from institutional amnesia to divergent worldviews.[70] This section provides a brief assessment of these challenges as they apply to MANPADS, and specifically how they apply to the implementation of key provisions in the Elements and related guidelines.

First, the Elements and related guidelines are not legally binding and the institutions through which they were negotiated do not have enforcement mechanisms or the power to proscribe arms sales. As stated in the Wassenaar Arrangement's Initial Elements, "[t]he decision to transfer or deny transfer of any item will be the sole responsibility of each Participating State" (WA, 2011, p. 9). Regular meetings, reports on arms transfers, and notifications of denials of proposed transfers provide opportunities for states to scrutinize each other's arms transfers and call attention to activities that are inconsistent with the Elements, but the Wassenaar Arrangement Secretariat does not enforce its implementation. Moreover, since much of the information on transfers exchanged in these forums is treated as confidential, there is little or no public scrutiny; enforcement rests with member states.

Whether the Elements should have been pursued as a legally binding agreement with robust enforcement mechanisms is debatable, however. Legally binding documents are often more cumbersome and time-consuming for member states to ratify since they are subject to parliamentary debates, inter-agency review, and other bureaucratic and administrative procedures. Furthermore, ratification of a legally binding agreement does not necessarily result in more robust implementation. In the words of one OSCE official, "a country's attitude and culture are more a determinant [of implementation] than the status of the document."[71] Given the initial reluctance of some key states to support the Elements and related guidelines, and the diverse cultural, political, and strategic perspectives of the dozens of states that have agreed to them, attempts to include an enforcement mechanism would likely have imperiled negotiations or alienated key states. Such a mechanism may also have led to the softening of the language used in the guidelines or the exclusion of key provisions.

Nonetheless, research conducted for this study suggests that many of the provisions in the Elements and related guidelines have been widely adopted. Most states, including producers and exporters of MANPADS, indicated that they require importing states to seek their consent before re-exporting MANPADS, prohibit the use of general licenses for most MANPADS exports, and limit MANPADS transfers to governments and their authorized agents. Most states

also reported that they either regulate or prohibit the use of non-governmental brokers, and that they criminalize serious violations of national laws and regulations that apply to MANPADS.

Implementation of other key provisions is far from complete, however. Few states conduct regular on-site inspections of exported MANPADS or require importers to dispose of excess missiles. Publicly available evidence also suggests that few, if any, MANPADS are equipped with technical-use controls.

Interviews with government officials shed some light on the reasons why more states have not adopted these controls. Budgetary and institutional limitations are often cited as barriers. Export control authorities in some states lack funding for even basic supplies and amenities, such as fuel for border patrol vehicles or lodging for members of delegations attending international conferences. In addition, many states do not have extensive embassy networks, making on-site inspections difficult.[72] Expecting these states to establish an end-use monitoring program on par with the U.S. program is often viewed as unrealistic. The costs—or perceived costs—of these controls are a common concern for wealthier states as well. The recent European economic crisis has led to budget cuts of up to 30% in some government departments, according to one former UK government official. In some affected countries, "even the [purchase of a plane ticket] requires approval by someone at the three-star level."[73] These cuts are likely to make governments even more reluctant to adopt control measures considered costly or burdensome. Similarly, disposal of surplus MANPADS requires infrastructure and funding that some importing states lack (or may object to providing), and that are not readily available to many exporting states.

Administrative inertia and institutional amnesia also hinder implementation of the Elements and related guidelines. "Domestic regulatory processes can move at a glacial pace even when there isn't any opposition [to the agreement within a particular] government," observed one official. These delays can keep governments from fully implementing international agreements.[74] Even after agreements are adopted, staff turnover and fading interest can hinder implementation: "People and institutions simply forget about lots of agreements and initiatives. Unless there is a reminder or a dedicated point of contact, states will actually forget [about their obligations]."[75]

The wording of provisions on on-site inspections and technical-use controls reflects—and, to some extent, facilitates—reluctance to adopt these controls. In the Elements and the OSCE Principles, the wording of these provisions is more ambiguous than the wording of many other provisions.[76] Whereas member states "will" permit MANPADS exports only after the presentation of an official end-user certificate, they "may" include on-site inspections as a means of confirming fulfillment of end-use assurances. Thus, states can often legitimately claim that they have implemented the Elements and related guidelines without conducting on-site inspections.

Similarly, the provision on technical performance and launch control features contains wording that relieves states of the obligation to actively pursue implementation. The provision was an "aspirational feature of the Elements," according to one of the negotiators.[77] This view of technical-use controls is reflected in the wording of the provision, which calls for their development for "newly designed MANPADS as such technologies become available to them," and only if they do not "adversely affect the operational effectiveness of MANPADS for the legal user."[78]

Technical-use controls present an additional set of challenges. Military and government officials have expressed concerns about the impact of such controls on the functionality of the weapon,[79] the technological challenge and costs of developing and installing them, and the logistical challenges of preventing unauthorized access to the systems (Bonomo et al., 2007, p. 97).[80] Whether and to what extent these concerns reflect actual barriers to expanding the use of technical-use controls is difficult to assess given the lack of detailed information on the topic in the public domain. However, the concerns themselves may preclude the development of such controls by some producers, regardless of the merits of these concerns.

Other key provisions, including export criteria, are widely adopted but are implemented in different, often divergent, ways. This lack of harmonization is clearly illustrated by member states' assessments of—and responses to—the risk of diversion and misuse. As noted above, the Elements and related guidelines call on states to "take into account" the "[p]otential for diversion or misuse" in the recipient country but do not specify how to assess the risk of diversion or misuse, what is an acceptable level of risk, or how any perceived risk should be weighed vis-à-vis other national interests when deciding whether to authorize the sale. States are given significant latitude to determine how best to identify and assess risks and how to respond to them.

This ambiguity leads to transfers that other member states view as inconsistent with the spirit, if not the letter, of the Elements and related guidelines. Recent examples include the sale by Russia of advanced SA-24 missiles to Venezuela, which the United States opposed because of concerns about diversion to armed groups in neighboring Colombia (Forero, 2010), and the sale of Chinese FN-6 MANPADS to Sudan (SIPRI, n.d.), which was under EU and U.S. arms embargoes at the time of the sale. This inconsistency strains relations between member states and erodes the perceived effectiveness of the agreements.

Harmonizing implementation of export criteria is extremely difficult, however. Assessing risk—particularly in relation to other national interests—is inherently subjective, and attempting to reduce this subjectivity through greater precision and specificity in the text of the agreements is problematic. "The risk of diversion and misuse are judgment calls," observed one official. "There are no binary yes/no answers."[81] Attempting to standardize risk assessments by enumerating very specific factors would raise difficult definitional issues (such as what

constitutes "misuse") and would still fail to adequately address many real-world scenarios encountered by licensing officers. Furthermore, greater specificity could be counter-productive. Discrete lists of specific rules can be used to justify transfers that are not expressly prohibited but are problematic nonetheless.[82]

Physical Security and Stockpile Management, including Disposal

Recognizing the danger posed by surplus and poorly secured MANPADS, the Elements and related guidelines contain provisions aimed at securing and right-sizing national inventories. Of particular relevance is the provision calling on each exporting state to "satisfy itself" that potential recipients possess the "willingness and ability to implement effective measures for secure storage, handling, transportation, use of MANPADS material, and disposal or destruction of excess stocks" (WA, 2007, para. 3.9). The APEC and OAS guidelines also urge member states to apply the same practices to their own inventories of MANPADS. These practices include the following:

- obtaining written verification of receipt of MANPADS shipments;
- conducting an inventory by serial number of the initial shipments of all transferred firing mechanisms and missiles, if physically possible, and maintaining written records of inventories;
- conducting a physical inventory of all MANPADS subject to transfer, at least once a month;
- accounting by serial number for MANPADS components expended or damaged during peacetime;
- storing, where the design of MANPADS permits, missiles and firing mechanisms in locations sufficiently separate so that a penetration of the security at one site will not place the second site at risk;
- ensuring continuous (24-hour) surveillance of MANPADS;
- establishing safeguards under which entry to MANPADS storage sites requires the presence of at least two authorized persons;
- transporting MANPADS in a manner that provides for the highest standards and practices for safeguarding sensitive munitions in transit, and, when possible, transporting MANPADS missiles and firing mechanisms in separate containers;
- where applicable, bringing together and assembling the principal components of MANPADS only in the event of hostilities or imminent hostilities; for firing as part of regularly scheduled training, or for lot testing, for which only those rounds intended to be fired are to be withdrawn from storage and assembled; when systems are deployed as part of the point defenses of high-priority installations or sites; and in any other circumstances that might be agreed between the receiving and transferring governments;

- limiting access to MANPADS-related hardware and any related classified information to military and civilian personnel of the recipient government who have the proper security clearance and who have an established need to know the information to perform their duties;
- limiting released information to that necessary to the performance of assigned responsibilities and ensuring, where possible, that the information be released orally and visually only; and
- adopting prudent stockpile management procedures that include effective and secure disposal or destruction of MANPADS stockpiles that are, or become, excess to national requirements.[83]

The Implementation of the PSSM Provisions

Assessing national implementation of these provisions—and PSSM more generally—is often difficult because many states view data on PSSM practices as sensitive and therefore do not make it available to the public. Even when such information is released, assessing how effectively and consistently stockpile security controls are implemented is usually not possible. The resulting data gaps preclude a comprehensive assessment of national PSSM as applied to MANPADS. Nonetheless, data collected for this report does provide some insight into how governments secure their MANPADS.

As mentioned above, questionnaires on implementation of the Elements and the related guidelines were distributed to members of APEC, the OAS, the OSCE, and the Wassenaar Arrangement. Part of the questionnaire focused on stockpile security, and specifically on the implementation of the above-mentioned list of PSSM practices. Twenty-three governments responded to this section of the questionnaire, and information on the practices of additional states was obtained through interviews, commissioned research, and other data sources. Of the 23 governments that responded to the questionnaire, 17 stated that they currently have MANPADS in their national inventories.[84]

Nearly all of the respondents indicated that they provide written verification of receipt of imported MANPADS and that missiles and launchers are transported separately. Nearly all respondents[85] also indicated that they conduct an inventory by serial number of all shipments of imported missiles and firing mechanisms. Information collected during the initial inventory varies and includes the type, serial number, date of manufacture, and lot numbers of imported MANPADS. One respondent noted that records on MANPADS are kept for at least 20 years after the missiles are withdrawn from service. Other practices adopted by nearly all respondents include:

- storing missiles and launchers separately;
- accounting for damaged or expended MANPADS by serial number;
- requiring the presence of at least two authorized persons when entering storage sites;

- limiting access to MANPADS to personnel with proper security clearances and an established need to know; and
- ensuring 24-hour surveillance of MANPADS.[86]

The responses provide insight into the various ways in which the relevant provisions are implemented. States provide surveillance via cameras, armed guards, and/or electronic systems (such as "intruder detection systems," "alarm systems," and "movement detectors"), with several states indicating that they use a combination of armed guards and electronic systems. Notably, one government indicated that it had "insufficient capacities [for] ensuring security in accordance with international requirements." Specifically, it mentioned a shortage of "modern monitoring systems," including "intrude[r] detection and alarm systems."

While all respondents indicated that they conduct regular inventories of MANPADS holdings, several do not conduct them monthly, as recommended by the Elements and the related guidelines. One of these states indicated that it conducted inventories on a quarterly basis, two reported doing so every six months, one specified that it did so "more than once a year," and four states noted that their inventories were conducted annually.[87]

Responses to the questionnaire—and information from other sources—also shed light on how states handle surplus MANPADS. About half of the respondents indicated that they either require the destruction of surplus MANPADS or that they typically destroy surplus ammunition, even though such disposal is not a "national obligation." Disposal through destruction takes several forms. Some of the weapons are disposed of locally while others are transported to a third country for destruction. In recent years, Bulgaria has both imported and exported surplus MANPADS. In 2005, it exported 549 MANPADS gripstocks to the United States for demilitarization. Several years later, the company EXPAL imported SA-18 MANPADS into Bulgaria from Slovenia for the same purpose.[88]

States dispose of surplus and obsolete MANPADS in a variety of ways. While most are destroyed, hundreds of surplus MANPADS have been exported for use as air defense weapons and in the development of anti-missile systems (Isby, 2007). Other states use obsolete MANPADS for air defense drills (Gyurosi, 2010) and in training explosive ordnance disposal (EOD) personnel.

The legitimate demand for surplus and obsolete MANPADS is significantly smaller than the global supply, however, and therefore destruction is the only viable option for many governments. Recognizing that some states lack the technical and financial resources to dispose of their excess MANPADS safely and expeditiously, the Wassenaar Arrangement's Elements and the OSCE Principles urge their members to "assist recipient governments not capable of executing prudent control over MANPADS to dispose of excess stockpiles, including buying back previously exported weapons" (WA, 2007, para. 3.10; OSCE, 2008, para. 3.8).

The international community has made significant progress since 2002 in reducing the global inventory of surplus, obsolete, and poorly secured MANPADS. Through bilateral and multilateral assistance programs, governments have cooperated with other governments to destroy more than 33,000 MANPADS in more than 30 countries. The vast majority of these MANPADS were destroyed with financial and technical assistance from the U.S. State Department's Office of Weapons Removal and Abatement. U.S.-funded projects are conducted bilaterally with host governments and under the auspices of multilateral institutions, such as NATO and the OSCE. Other states that have assisted with surplus MANPADS disposal include Australia, Belgium, Canada, France, Germany, Italy, the Netherlands, and the UK.

While data limitations prevent a full accounting of all surplus missiles destroyed in the last decade, summaries of destruction assistance programs reveal the extent of global efforts aimed at right-sizing MANPADS inventories. Table 2 provides a partial accounting of these efforts.

These efforts have significantly reduced the number and size of surplus stockpiles of MANPADS worldwide, including in countries with unsecured or poorly secured MANPADS. In 2003, the U.S. State Department identified at least 17 countries "whose security over their MANPADS stockpiles raised concerns" (GAO, 2004, p. 12). The U.S. Government Accountability Office identified five of these countries by name: Bosnia and Herzegovina, Cambodia, Liberia, Nicaragua, and Serbia (GAO, 2004, p. 12). Since then, the U.S. government has partnered with the governments of all five countries to destroy surplus stockpiles and improve stockpile security (DOS, 2004, p. 3; 2011). The governments of

Table 2. International Assistance for Destruction of Surplus and Obsolete MANPADS, 2003–12

Country	Year	Type	Quantity Destroyed[a]
Afghanistan	2005–11[b]	MANPADS	>100
Belarus	2005-2008	SA-7	29
Bolivia	2005	HN-5	Various estimates
Bosnia	2003–04	MANPADS	5,964
Bulgaria	2011	MANPADS	1,000
Burundi[c]	2007–08	SA-7	312
Cambodia	2004	MANPADS	233
Chad[c]	2006–11	SA-7, Redeye	13

Table 2. *Continued*

Country	Year	Type	Quantity Destroyed[a]
Croatia	2009–11[d]	SA-7	1,000
Cyprus	2009	MANPADS	425
Democratic Republic of the Congo[c]	2007–09	SA-7, SA-16	12
Ecuador	2010	MANPADS	42
Greece	2007	Redeye	573
Hungary	2005–06	SA-7	1,540
Kazakhstan	2008	MANPADS	300
Liberia	2003	MANPADS	45
Libya	2011–12	Mainly SA-7	5,000[e]
Mauritania	2012	MANPADS	141
Montenegro	2008[d]	MANPADS	1,500
Nicaragua	2004	SA series	1,000
Republic of the Congo[c]	2008	SA-7, SA-16	80
Republic of Macedonia	2007	MANPADS	156
São Tomé and Príncipe	2004	SA-7	54
Serbia	2008–11	SA-7	3,764[f]
Somalia[c]	2007	SA-7	2
South Sudan[c]	2006–11	SA-7, HN-5, unspecified	66
Tajikistan	2006	SA-7	40
Ukraine	2007	SA series	1,012

[a] The figures in the "quantity destroyed" column include missiles, missile tubes, gripstocks, and/or complete systems; batteries and other parts are excluded. The data sources often do not indicate whether the quantities specified are complete systems or key components (i.e., missiles, launch tubes, or gripstocks).

[b] As of early 2011.

[c] Data for these states reflects only weapons destroyed by the Mines Advisory Group, as obtained from the group by James Bevan on 9 February 2012.

[d] U.S. government fiscal year.

[e] This figure includes missiles and components that were destroyed or secured.

[f] This figure reflects only items destroyed with U.S. assistance from 2008 to 2011. Available data sources indicate that the Serbian government has destroyed several thousand additional MANPADS.

Sources: Data compiled from various governmental and non-governmental sources

Bosnia, Cambodia, and Liberia destroyed their entire national inventories of MANPADS,[89] and Nicaragua and Serbia have reduced their holdings by at least 1,000 and 9,000 MANPADS, respectively (Likins and Fisk, 2005; Gobinet, 2011, p. 106). In 2006, then U.S. Assistant Secretary of State John Hillen estimated that the 18,500 systems in 17 countries destroyed with U.S. assistance as of early 2006 was "probably about half of what we estimate might be the population of possible MANPADS out there that are unsecured, and therefore, potentially available to someone" (USHR, 2006).

It is too soon to tell whether and to what extent these efforts will lead to permanent "right-sizing" of national MANPADS inventories. Data on recent procurement does suggest that many countries previously in possession of large stockpiles of MANPADS have either refrained from importing any MANPADS or have only imported small quantities of modern systems. The governments of Albania and Bosnia, for example, have eliminated all of their MANPADS and there is no evidence that either government has acquired new systems. In 2006, the Czech Republic destroyed 424 MANPADS gripstocks and, a year later, agreed to destroy 1,400 missiles and 234 additional gripstocks.. The Czech government also reportedly indicated that it would destroy 2,000 of the remaining SA-7 missiles in their inventories once they reached the end of their shelf lives (Zdobinsky, 2007a). The government replaced the SA-7s with a smaller number of modern, pedestal-mounted RBS 70 systems from Sweden (Zdobinsky, 2007b). Similarly, Hungary has reduced its once vast arsenal of SA-7 and SA-16 MANPADS to fewer than 50 SA-16 gripstocks (UNGA, 2013, p. 10).

Parallel efforts to improve physical security and stockpile management practices have helped strengthen controls over MANPADS in the national inventories of these and other states. The largest provider of PSSM assistance for storage facilities holding MANPADS is the United States. Since 2001, the Small Arms Light Weapons Branch of the U.S. Defense Threat Reduction Agency's On-site Inspection Directorate has conducted PSSM assessments and seminars in at least 67 countries, many of which have MANPADS in their national inventories. As of 2011, the agency had conducted assessments of storage facilities holding more than 27,000 MANPADS (Marek, 2011, pp. 8, 15). These assessments frequently lead to the provision of assistance from the U.S. State Department for improvements to storage facilities or the destruction of surplus MANPADS.[90]

Several other states have provided similar assistance, including Australia, Germany, Switzerland, and the UK. This assistance ranges from rebuilding depots to hosting workshops on best practices for PSSM. Also worth noting are the numerous projects that assist with general improvements to PSSM practices, which are often coordinated by the EU, NATO, the OSCE, and the UN Development Programme.

Shortcomings in National PSSM Practices

Despite these efforts, there are still thousands of surplus, obsolete, and poorly secured MANPADS in depots worldwide. Publicly available estimates indicate that individual national inventories of surplus and poorly secured MANPADS range from a few dozen missiles to more than 10,000. In many cases, these stockpiles consist primarily of aging first-generation MANPADS of dubious military utility. The risks posed by these stockpiles depend on many different factors, including the quantity, type, and serviceability of the MANPADS; their distribution; the rigor of PSSM applied to storage facilities; and national and regional political stability. The latter is of particular concern in countries with very large stockpiles of MANPADS, as illustrated by the sudden loss of government control over thousands of MANPADS in Iraq and Libya.

The conflict in Syria could result in a similar dispersion of the government's large stockpiles of MANPADS. Like Libya, the Syrian government has reportedly acquired thousands of MANPADS, some of which have been looted from overrun military installations. Jane's Information Group estimates that the government has imported more than 15,000 SA-7 and SA-14 MANPADS since the 1970s, which is consistent with statements by U.S. officials (SIPRI, n.d.; O'Halloran and Foss, 2011, p. 572).[91] There are also unconfirmed reports that Syria's inventories include third-generation SA-18 MANPADS and possibly more sophisticated SA-24 MANPADS (SIPRI, n.d.; O'Halloran and Foss, 2011). As noted above, videos of rebel activity posted on the Internet include footage of SA-16-pattern missiles acquired from the regime (Binnie, 2012; Marrouch, 2012; Atareb Syriafree, 2012); however, as of early 2013, the full extent of this looting was unclear. Should Syria go the way of Libya and Iraq, the international community could be confronted with the loss of government control over thousands of additional MANPADS, some of which are significantly more sophisticated than most of the MANPADS looted from depots in Libya.

The threat of theft, loss, and diversion of MANPADS is not limited to large stockpiles. PSSM practices continue to be weak or non-existent in countries with small stockpiles of MANPADS, particularly in the least developed countries. Research conducted for this study reveals the extent of these problems in Africa. "Although their circumstances differ greatly," observes James Bevan of Conflict Armament Research, "a majority of African states experience severe problems in relation to the management and security of weapons and ammunition" (Bevan, 2012, p. 6). These problems are poignantly illustrated by a weapons storage facility in West Africa inspected by Bevan in 2010. The facility itself was a barracks, not a purpose-built depot. The roof consisted of "an unprotected sheet of corrugated metal, which could easily be prised open." The door of the building was "flimsy" and was secured with a single padlock. Also contrary to international best practices, the facility had no perimeter fence and no external lighting (Bevan, 2012, p. 7; see Images 8 and 9).

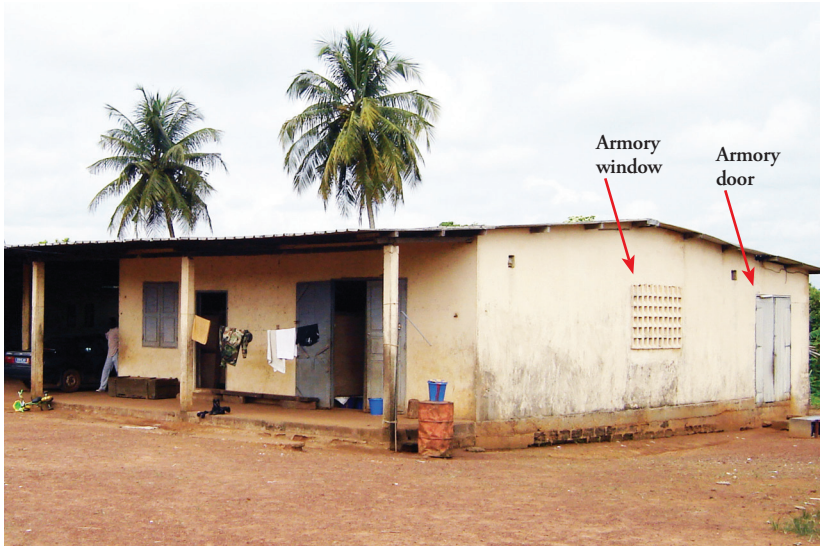

Image 8. Depot in an undisclosed West African country. © Conflict Armament Research Ltd., 2012

Image 9. Poorly secured SA-7 launch tube and battery found in a West African depot. © Conflict Armament Research Ltd., 2012

Inside the facility, Bevan found piles of arms, ammunition, and explosives accumulated over several decades, including two SA-7b launch tubes with batteries. The missiles had been taken out of their original containers and were lying unsecured on a table.

After reviewing documents in the facility, Bevan concluded that "there has been no comprehensive inventory" of its contents. Armoury personnel had compiled lists of frequently used weapons, including assault rifles, but "[g]renades, landmines, military explosives, rocket launchers and MANPADS […] have not been inventoried and are mixed with other items." The presence of non-military items, such as mattresses and bags of rice, suggests that the staff were using the armory as a storage space for personal effects, which, in turn, resulted in "relatively free access to weapons and ammunition (possibly including unsupervised entry)" (Bevan, 2012, p. 7). According to Bevan, no steps were taken to strengthen controls at the depot or to move the missiles to a more secure facility.[92]

These observations are echoed by other researchers and EOD experts who have first-hand experience in countries in Africa. In one East African country, physical security and stockpile management outside of the main urban center "barely exists." According to one former UN monitoring group member, weapons, including MANPADS, are stored in huts, abandoned school buildings, and corrugated steel shacks. More secure depots are being constructed in the capital, but improving PSSM of weapons deployed elsewhere, including at the border, "is not a high priority."[93] In Côte d'Ivoire, many storage sites are "no more than converted barracks and civilian buildings." In that country, researchers have identified at least one MANPADS—the current whereabouts of which are unclear, according to Bevan—along with two MANPADS launch tubes and batteries.[94]

In other African countries, PSSM deficiencies include missing and damaged fencing, a lack of exterior lighting, poor or non-existent record-keeping, and staff with little training or expertise. At one site, EOD experts found MANPADS and other sensitive munitions (such as anti-personnel mines) that depot personnel did not know were in their facility.[95] Some of these problems were subsequently addressed through foreign aid programs, but they nonetheless point to broader, systemic problems with PSSM that, as Bevan notes, are prevalent in many African countries.

While often less acute in other regions, problems with PSSM are not unique to Africa. Interviews with government officials and EOD experts, responses to the above-mentioned questionnaire, and other sources reveal several recent examples of PSSM deficiencies at storage facilities—including facilities that contain MANPADS—in Central Asia, Europe, the Near East, and South America.[96] In one Near Eastern country, EOD experts found a depot containing SA-7 MANPADS with "horrible" fencing, sub-standard lighting, and a lack of communications equipment. They also found MANPADS that were stored in 1940s-era magazines while newer, NATO-standard magazines were used for

storage of small arms ammunition. The experts repaired the fences and provided low-cost walkie-talkies for the depot personnel, but it is not clear whether the other problems were corrected.[97]

Obstacles to Improving PSSM and Right-Sizing Stockpiles of MANPADS

Right-sizing MANPADS stockpiles and establishing and maintaining proper physical security and stockpile management practices at storage facilities holding MANPADS are complex, multi-faceted processes that are influenced—and sometimes undermined—by a broad array of diplomatic, political, budgetary, logistical, and organizational factors. Below is a brief overview of these factors and how they affect national and international efforts to secure stockpiles and destroy surplus missiles.

Challenges Confronting National Authorities. The barriers to establishing effective PSSM are often daunting, particularly in the least developed countries. Among the biggest challenges are resource shortages. "Most African states face severe budgetary constraints in relation to the funding of their armed forces," observes Bevan, who notes that the effect of these constraints is often exacerbated by other political–military dysfunction, including the marginalization of national armed forces, disparities in the distribution of resources between core units and installations and those considered peripheral, and the prioritization of other concerns. These constraints often lead to a lack of investment in storage facilities and inadequate training of facility personnel, which lead to further problems with PSSM.[98]

At depots where personnel are poorly paid and receive little training, they often have little or no knowledge of the weapons and ammunition in their care or how to track, maintain, and secure them (Bevan, 2012, p. 10).[99] EOD experts recounted several examples of incomplete or non-existent record-keeping and other signs of incompetence at weapons depots in Africa and elsewhere, including at depots containing MANPADS. As noted above, experts visiting a depot in Central Africa found weapons and ammunition—including MANPADS and anti-personnel mines—of which the staff was unaware. To illustrate the incompetence of the depot staff, one expert noted that the MANPADS were later transported to the disposal site in the back of a pick-up truck with fuzed anti-tank mines.[100]

Low wages can also lead to varying degrees of corruption, which also undermines stockpile security. Such corruption can be obvious, as in the case of the diversion and illicit sale of weapons by staff, but it can also be subtle. As Bevan observes, low wages "often blur the distinction between military and private goods. For example, barracks become homes to families and staff may rent secure military storage area—including weapon and ammunition depots—to house commercial goods" (Bevan, 2012, p. 10). An example is the West African

depot where Bevan found poorly secured SA-7 missiles. As noted above, the depot was also used to store various civilian goods, including food and bedding (see Image 10). Even when there is no malicious intent, such misuse of storage facilities is both indicative of problems with PSSM (such as inadequate controls on access to storage facilities) and a potential contributor to them.

These examples also point to another key problem at many depots—the absence of proper oversight by senior-level officials. Proper, consistent, and sustained implementation of PSSM practices requires a functional chain of command, which, in turn, requires strong senior-level leadership. PSSM practitioners identify the cultivation of middle- and senior-level management as a constant challenge. "Many of the skills required to be a good manager and leader are not easily taught," observes veteran EOD project manager Steve Priestley. Failure to teach these skills affects the entire PSSM management structure since "[t]he willingness of junior staff members to do their jobs properly is a reflection of the example set by their co-workers and those who manage them" (King, 2011, p. 57).

Political instability and civil unrest also affect the ability of national authorities to account for and control MANPADS stockpiles. The civil war in Côte d'Ivoire led to the dispersal of that country's weapons inventory into small stockpiles, some of which ended up in warehouses and garages (Bevan, 2012, pp. 9, 33). "These weapons included a number of MANPADS systems, which were stored under extremely insecure conditions," notes Bevan (Bevan, 2012, pp. 12–13). In its most extreme forms, political instability poses an existential threat to the state and, consequently, government control over its weapon stockpiles, including MANPADS. Regime collapse is particularly problematic since it can suddenly

Image 10. Contents of a depot in an undisclosed West African country.

render the contents of all depots—even those with comparatively robust PSSM practices—vulnerable to theft, loss, and diversion.

In Libya, stockpile security was comparatively robust, according to an EOD expert who visited depots in the eastern part of the country early in the 2011 conflict. Depots observed by the expert were fenced and well lit, and had sentry boxes and other indicators of large guard forces. A survey of their contents suggested that procurement was rational and systematized; most of the ammunition matched weapons in the current inventory. Missiles and gripstocks for MANPADS were stored together, which is not consistent with PSSM best practices, but batteries were stored separately.[101] These practices did little to protect the weapons during the conflict, however, as illustrated by the looting of the depots and the widespread and chaotic dispersal of their contents.

Challenges Confronting the Donor Community. Donor governments and their contractors also face a broad array of challenges, many of which are linked to the above-mentioned issues confronting host governments. Funding constraints are an oft-cited barrier to securing and destroying surplus and obsolete weapons. These costs can be staggering, as evidenced by international efforts to consolidate and dispose of Albania's massive stockpiles of surplus arms and ammunition.[102]

As illustrated by the data on MANPADS destroyed with foreign assistance in Table 2, surplus stockpiles of MANPADS are usually small compared to other munitions. Consequently, stockpiles of MANPADS are often destroyed in a much shorter time period and for a fraction of the total cost of destroying stockpiles of other munitions. The physical destruction of 500 surplus Bulgarian MANPADS in 2011 took 2–3 weeks, according to the Bulgarian Ministry of Defense.[103] In Cyprus, the destruction of 300 MANPADS took just four days.[104] The cost of destroying MANPADS depends on several factors, including the destruction method, materials used, and whether a demilitarization infrastructure is already in place. Industrial demilitarization can be fairly expensive. One Eastern European company reportedly charges $1,500 per unit to disassemble MANPADS at its facility and dispose of components.[105] In contrast, when destroyed with other munitions through open burn/open detonation, the unit cost of disposing of MANPADS is often negligible.

However, the cost of physically destroying MANPADS tends to be a small part of the overall cost of a given program, which usually includes destruction of other types of munitions, stockpile security improvements, and other assistance. These aid packages—which are often necessary for securing host government support for the project and for eliminating other dangerous munitions—increases the costs of missile destruction programs significantly, sometimes by many millions of dollars.

Nonetheless, even when packaged with other aid, the cost of securing and destroying MANPADS is not currently a major obstacle. Interviews with

government officials and EOD experts suggest that, in recent years, international assistance for MANPADS destruction is usually sufficient to meet demand from governments that lack the technical capacity or funding to destroy their surplus stockpiles.[106] Most of the funding for these programs comes from the United States,[107] which has spent tens of millions of dollars in recent years on destroying surplus, obsolete, and illicit MANPADS, and on improving PSSM at depots in which MANPADS are stored. These projects could become significantly harder to fund if the United States were to reduce its contributions. It is not clear whether other states could fund these programs, or fund them as consistently as the United States.

Logistical, administrative, and organizational challenges also hinder PSSM improvement and surplus weapons destruction projects. Obtaining certain materials can be difficult, particularly when they are subject to export controls. Commonly cited examples include explosives and igniters. When these items are not available from the host government or a vendor in the host country, contractors must import them and "deal with export controls, storage, and shipping, all of which delays operations and sometimes adds to the overall cost of operation."[108] Budget allocation constraints can also affect programming,[109] as can donor and host state regulations, poor coordination among host country officials, and linguistic challenges (King, 2011, pp. 14, 84).

Differing views on what is "surplus" and the tendency by some governments to view all weapons and ammunition as assets—even unserviceable and obsolete items—sometimes hinder efforts to destroy stockpiles of surplus or obsolete weapons, including MANPADS. In the words of one donor state official, for many host governments, "there is no such thing as a surplus weapon."[110] The nature of their perceived value varies from country to country. Some governments view their MANPADS stockpiles, including systems that are past their shelf lives and widely viewed as militarily obsolete, as potential sources of revenue. Other governments view them as critical air defense assets even though they may be of little use against modern jet fighters and other aircraft equipped with even basic countermeasures. These views are particularly common among governments with few other air defense assets.

These views and other factors can result in sudden and unpredictable changes to programs. In one recent example, the host government initially agreed to destroy between 50 and 100 second-generation SA-16s. When demolition operations were about to begin, the government informed the contractor that plans had changed: only one SA-16 was to be destroyed, along with 18 first-generation Blowpipes and 23 first-generation HN-5s. According to an EOD expert familiar with the program, "No formal explanation for the reduction in the overall number—and [changes to the] types of MANPADS—was ever provided."[111]

A lack of access to MANPADS and the depots in which they are stored is another, related barrier to securing and destroying surplus and obsolete missiles. As King and Diaz note, "gaining access to stockpiles is the most consistent

problem that the practitioners interviewed had to face" (King, 2011, p. 14). Other EOD experts interviewed for this study also identified the lack of access as a significant problem, citing recent examples in several different countries. At one Central African depot, "[t]hey allowed [the contractor] to count the MANPADS as they were brought out of the building but [the contractor] could not go inside to inspect [the depot]."[112] The impact of the lack of access varies from project to project. In some cases, such restrictions cause delays and complicate planning but eventually the project is completed and all designated MANPADS are secured or destroyed.[113] In other cases, the lack of access has thwarted efforts to secure MANPADS believed to be at immediate risk of theft, loss, or diversion. In Côte d'Ivoire, for example, UN inspectors have repeatedly been denied access to a depot suspected of containing MANPADS (Bevan, 2012, p. 34). In one Near Eastern country, an EOD expert discovered more than a dozen MANPADS during a site visit. The expert suspected that there were many more MANPADS in other facilities but was not given access to those facilities or provided with data on the host country's MANPADS inventory. The contractor later oversaw the destruction of ten SA-7s, but it is unclear what happened to the remaining missiles.[114]

Political forces can also hinder PSSM improvement and surplus weapons destruction programs. Because of the perceived strategic value of MANPADS, externally funded PSSM and destruction programs are often viewed as infringements on national sovereignty and as potential threats to national security. As a result, destruction programs are vulnerable to politicization, as illustrated by the case of Bolivia. In 2005, the United States assisted the Government of Bolivia with the destruction of Chinese HN-5 MANPADS that were reportedly in poor condition.[115] The missiles, which some within Bolivia viewed as the country's only meaningful air defense asset, were destroyed during the administration of Eduardo Rodríguez Veltzé, a former head of the Supreme Court who assumed the presidency after civil unrest forced the resignation of the previous president earlier that year. The destruction program came to light during presidential campaigning in late 2005, prompting candidate Evo Morales to accuse Rodríguez of "putting Bolivia under foreign domination" (Reuters, 2006). The resulting controversy led to the dismissal of the commander of the army and the resignation of the defense minister (Reuters, 2006). After Morales won the presidential election, Rodríguez was charged with treason and dozens of high-ranking officials were forced out of the military for alleged complicity in the destruction program (Bridges, 2006).

In Bolivia, the political changes that fueled—and were fueled by—the controversy surrounding the MANPADS destruction program occurred after the missiles had been dismantled. In other cases, such changes occur in the middle of destruction programs, sometimes with significant consequences. An EOD expert who worked in Libya recalls that early in the program, access to MANPADS—including MANPADS held by the militias—was "good." Contractor personnel

had escorted access to most sites and were able to disable MANPADS at some of the sites. However, when "the shooting war stopped, the political war started," and access to MANPADS held by the militias slowly evaporated. At one site to which the EOD team eventually gained access, the commander said he only knew the location of one of the 44 MANPADS previously reported at the site.[116]

The delay or derailment of PSSM and destruction programs is often explained by several, interrelated factors, including domestic politics. This complex interplay is evident in the stalled U.S.-funded program to destroy Nicaragua's large inventory of MANPADS. In 2003, Nicaraguan President Enrique Bolaños agreed to work with the United States to secure and destroy his country's stockpile of roughly 2,000 Soviet-era SA-series MANPADS, most of which were aging, first-generation SA-7s (Likins and Fisk, 2005). The first batch of 333 missiles was destroyed in May 2004, followed by two more batches in July and November (Lumpkin, 2004; AP, 2004). Shortly before the third batch was destroyed, however, Nicaragua's National Assembly, which was controlled by President Bolaños' political opponents, passed a law requiring approval by the Assembly of plans to destroy any additional missiles (*El Nuevo Diario*, 2004). The law was passed too late to stop the destruction of the third batch but subsequent efforts by President Bolaños to dispose of additional MANPADS failed.

The stalled program in Nicaragua highlights many of the challenges identified above and how they combine to hinder PSSM improvement and stockpile destruction programs. Concerns about national security and the regional military balance played a part, as evidenced by repeated references to the MANPADS as Nicaragua's only meaningful air defense asset and the failure of neighboring countries to disarm. The perceived threat from neighboring air forces was a persistent theme in the national debate over the destruction program (Godoy, 2005; Sandoval, 2005; IHS Jane's, 2011).

Nicaragua's complicated political history with the United States also shaped attitudes towards the program. In March 2005, the vice-secretary of the Sandinista National Liberation Front accused the United States of using the missile destruction program "once again to meddle in Nicaragua's internal affairs," which he attributed to U.S. fears of "a certain Sandinista victory in the upcoming elections" (Alemán, 2005), even though U.S. interest in assisting with destruction of the missiles predated the election by several years.

The program also became the focus of intense domestic political and institutional power struggles. In 2004, the National Assembly passed a law that stripped the presidency of the power to destroy the missiles. President Bolaños' veto of the law was promptly overridden by the Assembly (de Córdoba, 2005). Since then, various efforts to win the Assembly's approval for destruction of some or all of the remaining missiles have stalled. As summarized by Army Commander General Omar Hallesleven, "[t]he main problem with the missiles is that the issue has been politicized; it has been addressed in various instances and branches of government, but from a political slant" (IHS Jane's, 2006a).

Nearly a decade after the launch of the program in Nicaragua, follow-on efforts to dispose of additional MANPADS have failed, and more than 600 missiles approved for destruction by the Nicaraguan military remain in that country's arsenals—a testament to the complexity and fragility of assistance programs for securing and disposing of MANPADS.

Anti-Missile Systems for Commercial Aircraft

Military and, to a lesser extent, civilian aircraft are equipped with a variety of anti-missile systems, including flare systems and laser jammers. Versions of these systems have been selectively installed on civilian aircraft for many years but there was little interest in wide-scale deployment on airliners until the Mombasa attack. Since then, interest in systems for commercial aircraft has grown, including within the U.S. and Israeli governments, which launched development and evaluation programs.[117] Multilateral institutions have also taken up this issue. The Wassenaar Arrangement attempted to address export control issues by inserting a special exemption for certain flare-based anti-missile systems into its widely used Munitions List.[118]

A DHS Evaluation of Anti-Missile Systems

Detailed accounts of the U.S. program to evaluate and develop anti-missile systems highlight the potential benefits, costs, and challenges of equipping commercial airliners with these systems. The purpose of the three-phase program was to "develop, demonstrate and evaluate technologies to protect commercial aircraft from MANPADS" (DHS, 2010, p. 6). To that end, the U.S. Department of Homeland Security solicited and reviewed 24 proposals for various systems, ultimately selecting two—Northrop Grumman Corporation's Guardian and BAE System's JETEYE—for development and evaluation. Both systems are based on directed infrared countermeasure (DIRCM) technology developed for installation on military aircraft. The systems employ various sensors that detect and track the incoming missile, and a laser that is fired at the missile seeker. The laser jams the seeker, "causing it to lose track of the aircraft and turn away" (DHS, 2010, pp. 6–9).

DHS subjected both systems to extensive testing. The first set of tests consisted of computer-based modeling and simulation, during which the Guardian and JETEYE were evaluated in "millions of engagement scenarios" (DHS, 2010, p. 13). The two systems were then subjected to hardware-in-the-loop testing, installed system testing, and live-fire testing.[119] During the live-fire tests "a total of 29 MANPADS missiles were fired at the DIRCM systems to demonstrate system effectiveness in countering [redacted] attacks. Overall, the systems worked well and defeated the missiles" (DHS, 2010, pp. iii, 15–16). Based on this testing, DHS concluded that "[b]oth systems meet Counter-MANPADS

Program effectiveness requirements and can defeat multiple missiles under many attack scenarios" (DHS, 2010, p. iii).

DHS also assessed "the suitability of the counter-MANPADS systems in a real-world airline operating environment" (DHS, 2010, p. 16). The two systems were installed on planes operated by Federal Express and American Airlines, which then flew regularly scheduled flights across the United States. During these flights, data on the reliability, availability, and maintainability of the anti-missile systems was collected (DHS, 2010, p. 17). Based on this and other data, DHS concluded that while "[b]oth systems meet Counter-MANPADS Program effectiveness requirements," they "currently fall short of Counter-MANPADS Program reliability requirements" (DHS, 2010, p. iii). These issues, along with the other obstacles identified below, may help to explain the widespread reluctance to equip airliners with anti-missile systems despite their apparent effectiveness.

Obstacles to Deploying Anti-Missile Systems on Commercial Airliners

The challenges associated with deploying anti-MANPADS systems on commercial airliners are numerous and complex, as illustrated by the DHS counter-MANPADS program. Among the biggest barriers to deployment is cost. DHS estimated that developing, installing, maintaining, and disposing of these systems during their 20-year life cycle would cost $2.2 billion if installed on 98 targeted wide-body passenger aircraft,[120] $6.8 billion if installed on all wide-body passenger aircraft in the U.S. fleet, and $43.3 billion if installed on all large passenger aircraft in the U.S. commercial fleet.[121] These estimates are based on several assumptions regarding export control relief, the ability to defer maintenance on malfunctioning systems, anticipated improvements in system reliability, fuel prices, drag, and other key variables. Changes to these variables could result in significant increases or decreases in costs. Reducing drag by 25% would reduce 20-year costs by an estimated $4 billion, for example, and doubling reliability would save an estimated $10 billion. On the other hand, if installation of the systems is completed outside of the regularly scheduled heavy maintenance visits, the costs could be significantly higher; DHS estimates that a separate, seven-day installation process would cost $300,000 per aircraft (DHS, 2010, pp. 51–52, 56). Assuming the savings associated with the reduction in drag and the improvements in reliability are realized and the systems are installed as part of regularly scheduled maintenance, equipping all large aircraft in the U.S. commercial fleet would still cost nearly $30 billion.

Preventing unauthorized access to these systems—and the highly sensitive technology that they employ—is another significant challenge. The Guardian and JETEYE are both based on technology originally produced for the military, which has invested millions of dollars in their development and relies on them for protecting aircraft in conflict zones and other areas where MANPADS pose

a significant threat. Thus, anti-missile systems deployed on commercial aircraft flying abroad would require protection from unauthorized access. DHS examined various technology protection measures, including anti-tamper devices, but the program was halted before reaching any definitive decisions.[122] Deployment of anti-tamper devices may not be sufficient in itself, however. A U.S. official familiar with this issue compared the devices to an office safe, which only delays unauthorized access for a certain period of time.[123] Airline industry representatives expressed concern that additional measures, such as 24-hour surveillance at foreign airports, may also be necessary—an expense that some of the representatives fear will be passed on to them.[124]

Export controls pose a related challenge. As DHS concludes:

> The current application of standard export licensing requirements under the International Traffic in Arms Regulation[s] will cause serious operational, logistical and financial problems for U.S. air carriers and an unsustainable burden on the U.S. export licensing system (DHS, 2010, pp. iv–v).

As mentioned above, members of the Wassenaar Arrangement added an exemption for certain systems to its widely used Munitions List. However, the exemption only applies to certain flare-based systems; laser jammers are still controlled as munitions. Since many states align their control lists with the Wassenaar Arrangement's Munitions List, export control restrictions could be a significant hindrance to the deployment of some of the most sophisticated and effective anti-missile systems.

4

Stepping Up Security: A Look to the Future

The international counter-MANPADS campaign launched after the Mombasa attack has prompted important changes to controls on the international trade in MANPADS and has significantly reduced the quantity of poorly secured and surplus MANPADS. Key export controls include transferring MANPADS only to governments and their authorized agents, case-by-case licensing of proposed exports of MANPADS, restrictions on re-exports of MANPADS, minimizing the use of non-governmental brokers, and substituting vehicle-mounted systems for MANPADS when exporting to states of concern. PSSM practices adopted by many states include storing missiles and launchers separately, ensuring 24-hour surveillance of stored MANPADS, conducting regular inventories of MANPADS stockpiles, and providing technical and financial assistance to other governments. Donor governments have worked with host governments to destroy thousands of surplus, obsolete, and poorly secured MANPADS, improve PSSM at depots holding MANPADS, and establish proper (senior-level) oversight of PSSM practices at these depots.

Despite these efforts, many MANPADS remain vulnerable to theft, loss, and diversion. Reducing this vulnerability requires action on several fronts, such as enforcing embargoes, securing borders, and dismantling trafficking networks and terrorist organizations. Many of these goals are not MANPADS-specific and are addressed elsewhere. This section focuses on three control strategies that are of particular relevance to counter-MANPADS efforts:

- securing existing inventories of MANPADS;
- expanding the use of on-site inspections of exported MANPADS; and
- increasing transparency in the international trade in MANPADS.

If rigorously implemented, the following recommendations would significantly reduce the number of vulnerable MANPADS, both today and in the future.

Securing Existing Inventories of MANPADS

The international community has significantly reduced the global inventory of surplus and poorly secured MANPADS, but there are still thousands of missiles sitting in depots that are of little practical use to modern militaries. Many

of these missiles are potentially vulnerable to theft, loss, and diversion. Securing and disposing of these MANPADS will require many years of patient and sustained effort. As explained above, PSSM improvement and surplus weapons destruction programs are fluid, dynamic processes that often take years to negotiate and implement, and they are easily derailed by forces that are beyond the control of donor states.

In this context, continued U.S. leadership is critically important. Most of the funding for securing and disposing of MANPADS comes from the United States, and it is unclear whether and to what extent other states would fill any gaps resulting from a reduction in U.S. assistance. While several states have funded PSSM improvement and destruction programs in recent years, the level of funding provided by these states is comparatively small. Collectively, they may be able to compensate for a significant reduction in U.S. assistance, but the opportunity cost of doing so could be high, particularly if funds are diverted from life-saving projects such as demining, removal of explosive munitions from depots in heavily populated areas, or the disposal of dangerous munitions and highly toxic substances, such as white phosphorus rounds and missile mélange.

Even with adequate and sustained funding, the handful of states that currently fund MANPADS-related PSSM improvement and destruction programs cannot secure every depot or destroy every remaining surplus missile. There are several potential host states in which diplomatic, political, or legal constraints preclude (or severely hinder) the establishment of assistance programs. Some of these states have large stockpiles of surplus or poorly secured MANPADS. To date, however, the governments that are best positioned to work with these states have done little to secure or destroy their MANPADS. Assistance from these governments may be the only way to establish (or restart) threat mitigation programs in some of these states.

Another important step is for exporting states to pay greater attention to existing MANPADS stockpiles in importing states prior to transferring new systems. As noted above, the Wassenaar Arrangement's Elements and the OSCE Principles urge exporting states to ensure that potential importers adopt measures to effectively and securely dispose or destroy MANPADS that "are or become excess to national requirements." The agreements provide no instructions on how to implement this provision, however, and research conducted for this study reveals significant differences in implementation. Some states thoroughly assess existing stockpiles and work with importing governments to dispose of surplus MANPADS while others take few, if any, steps to minimize the accumulation of surplus MANPADS by importing states.

Revising the Elements and related guidelines to clarify and elaborate on member states' responsibilities under this provision would help to expand and harmonize implementation. The revisions should call on exporting states to conduct a thorough pre-license assessment of existing MANPADS stockpiles and

work with the importer to identify and dispose of any surplus MANPADS. As part of the assessment, the exporting state should work with the importer to:

- compile a complete list of the importing state's existing inventory of MANPADS;
- assess the serviceability of existing MANPADS;
- identify MANPADS that are unserviceable or surplus to the needs of military and security forces, or that will be rendered surplus as a result of the proposed transfer;
- officially declare as "surplus" or "unserviceable" any items identified as such; and,
- develop a plan for disposing of all MANPADS and components deemed surplus or unserviceable.

The first step is fairly straightforward: the exporting state would ask the potential importing state for a complete list of all its MANPADS, including complete systems and major components (i.e., missiles and launchers) as part of the licensing review process. Failure to provide a list—or the submission of a list that contains errors or is incongruous with existing knowledge of the importing state's national inventories—would prompt additional scrutiny of the proposed transfer by the exporting state.

Once the list is received, the exporting state would work with the importing state to assess the serviceability of existing MANPADS stockpiles. Many militaries routinely conduct such assessments and therefore, in most cases, little more than reviewing the records from the latest assessment would be required. When assessments are needed and the importing state lacks the capacity to perform them, the exporting company (or a sub-contractor) could conduct the assessment, passing the cost on to the importing state in the final contract.

While the serviceability of stockpiled MANPADS can be tested, there is no universally applicable formula for determining what is "surplus." National requirements for MANPADS vary significantly from country to country and depend on several factors. Most small island nations have little need for MANPADS and do not have them in their national inventories. In contrast, large states with more complex national security needs may require hundreds of MANPADS. The needs of importing states—and the number of MANPADS that exceed those needs—are best determined on a case-by-case basis, which should be reflected in the wording of the revised provision.

The provision should also stipulate that MANPADS and key components deemed excess to the importing state's needs should be officially declared "surplus," stored separately, and taken out of service. The same is true for unserviceable MANPADS. The importing state would also provide a plan to the exporting state for disposing of any MANPADS deemed surplus or unserviceable. The method of disposal should be determined by the importing state. While destruction is often the best option, surplus and obsolete MANPADS serve several

useful purposes. As noted above, they are used for, among other purposes, training EOD personnel and developing anti-missile systems for aircraft. Some later-generation systems that are still serviceable may also be militarily suitable for use by other states. Thus, the revised provision would oblige exporting states to require disposal of MANPADS identified as surplus but would not specify how the surplus MANPADS are to be disposed.

By establishing an expectation that exporting states will actively account for existing MANPADS stockpiles before transferring new systems, the proposed revisions to the Elements and related guidelines would facilitate the disposal of surplus MANPADS, possibly including missiles that are currently out of reach of donor states. It would also help to prevent future accumulation of excess MANPADS, thereby complementing existing destruction programs.

Expanding the Use of On-Site Inspections

A critically important but underutilized control measure is the routine on-site inspection of exported MANPADS. As noted above, the Wassenaar Arrangement's Elements and the OSCE Principles call on exporting states to reserve the right to confirm that importers are adhering to end-use assurances, which "may include on-site inspections of storage conditions and stockpile management" (WA, 2007, para. 3.8).[125]

While several exporting states reserve the right to conduct such inspections, few routinely exercise this right, and only the United States conducts annual physical inspections of all exported MANPADS. On-site inspections, including annual inventories, serve several critical purposes, all of which are difficult or impossible to accomplish in other ways. Pre-shipment inspections provide exporters with an opportunity to assess PSSM at proposed storage facilities first-hand, thereby taking some of the guesswork out of the licensing review process and allowing them to spot—and correct—any deficiencies in PSSM before the exported missiles arrive.

Post-shipment inspections enable exporters to:

- identify cases of theft and loss, and any shortcomings in PSSM that could lead to theft or loss;
- monitor compliance with re-export restrictions; and
- verify that MANPADS are held only at approved storage facilities and have not been moved to less secure locations.

No other control measure can accomplish these objectives, or accomplish them as consistently and with as much certainty as on-site inspections.

Interviews with government officials reveal several reasons why states do not conduct on-site inspections. Some view them as unnecessary, assuming that robust vetting of potential transfers and the limiting of MANPADS exports to trusted governments is sufficient. Other states expressed concerns about the

costs and resource requirements of inspections. Given many exporters' reluctance to engage in activities that could be perceived by the importing state as intelligence-gathering or as an infringement on their sovereignty, anticipated opposition from importing states is probably another contributing factor.

While rigorous and selective export authorization procedures are important safeguards, they are not substitutes for on-site inspections. Even the most robust pre-license reviews that do not include such inspections cannot provide the same level of detail about the conditions at storage facilities as an on-site visit. Furthermore, pre-license reviews only provide a snapshot of conditions as they exist at that moment. They cannot fully anticipate changes that could negatively affect the security of exported MANPADS in the future.

Similarly, limiting MANPADS sales to trusted partners is not a substitute for inspections. U.S. inspectors have found violations of PSSM requirements at facilities in states with robust laws and regulations, including at the U.S. military's own depots. These problems included discrepancies in inventory records, broken alarm systems, and inadequate fencing (GAO, 1994, pp. 7, 10).

Provisions requiring importers to notify the exporting state of "compromise, unauthorized use, loss, or theft" of MANPADS are also important, but they assume that the importing state will detect and report every incident. Embassy staff or intelligence organizations of exporting states that do not regularly conduct on-site inspections may eventually learn of unreported diversions, but not as consistently or with the certainty provided by annual physical inventories. Furthermore, embassy staff and intelligence analysts are unlikely to detect the specific shortcomings in PSSM that lead to diversion, many of which would be identified during on-site inspections. The same is true for violations of re-export restrictions and the placement of MANPADS in unauthorized facilities by the importing state.

Finally, the deterrent effect of *potential* inspections is not a substitute for actual inspections. The possibility of on-site inspections may deter recipients from engaging in deliberate or systematic violations of end-use restrictions, but many of the problems discovered during U.S. inspections are neither deliberate nor systematic. These problems appear to be the result of apparently isolated logistical and organizational failures rather than the willful, systemic disregard for PSSM and end-use restrictions that are likely to be deterred.

Another concern expressed by some government officials is the cost of on-site inspections. Data on the U.S. Defense Department's Golden Sentry program is instructive in this regard. As explained above, the U.S. Defense Department requires U.S. officials to conduct a complete on-site physical inventory by serial number of nearly all exported Stinger missiles and gripstocks each year. This requirement applies not only to Stinger MANPADS exported from the United States but also Stingers co-produced in other countries and Stinger missiles used with vehicle-mounted systems. Thus, the United States inspects more than 8,000 missiles each year. According to the U.S. Defense Department, the cost

of inspecting these missiles (per Combatant Command) in 2008 ranged from six hours of staff time and $2,600 in travel costs to 1,916 hours of staff time and $71,000 in travel costs.[126] These figures include the cost of inspecting the approximately 30% of exported Stinger missiles that are used only with vehicle-mounted systems.

The cost of inspections for other governments would depend on several factors, including the size of the exporting state's embassy network, the quantity of exported MANPADS still in service, and the geographic distribution of exported MANPADS. For states that lack an extensive embassy network, on-site inspections would be more costly. Data on exported MANPADS currently in service and their distribution within importing states is too sparse to provide an estimate of the likely annual costs of on-site inspections for other exporting states. However, given that most major exporters have extensive embassy networks, the cost of annual on-site inspections for most exporters is not likely to be substantially higher than costs incurred by the United States military. While not trivial, these costs are not as significant as commonly assumed.

The U.S. experience also sheds some light on concerns about importer sensitivities. The states that have imported Stinger missiles despite the inspection requirements are geographically and politically diverse, suggesting that importing states may be more amenable to such inspections than is often assumed. As of 2004, the United States had exported Stinger missiles to 16 countries[127] along with Taiwan (GAO, 2004, p. 24). This group includes states with which the United States has complex diplomatic relationships. Despite these differences, U.S. officials say they have full access to Stinger missiles and gripstocks in all importing states.[128]

Thus, for most exporting states, the cost and difficulty of conducting routine on-site inspections of exported MANPADS are small in comparison to the benefits of inspections, which often cannot be obtained through other control measures.

Increasing Transparency in the International Trade in MANPADS

As discussed above, the Elements and related guidelines have no formal enforcement mechanisms. Thus, it is up to member states and the public to ensure that governments act in ways that are consistent with key provisions. Detailed, complete, and up-to-date information on international transfers of MANPADS is critical to fulfilling this role. Access to data on MANPADS transfers has improved since 2002 as a result of new intergovernmental and public reporting requirements, the most notable of which is the creation of a separate subcategory on MANPADS transfers in the UN Register of Conventional Arms. Despite these improvements, there are still significant data gaps. Below is a brief

assessment of these gaps and recommendations for closing them. Since most data exchanged between governments is confidential and is therefore difficult to assess, this section focuses on public reporting.

Official publicly available data on arms transfers, including MANPADS, is reported through several mechanisms, including annual national reports on arms transfers, regional reports and reporting mechanisms, and the UN Register. National reports on arms transfers can be very useful but many states do not routinely publish such reports, and the data that is published is often aggregated in ways that preclude the tracking of individual items. The same limitations apply to many regional reports on arms transfers.

The best source of official data on MANPADS transfers is the UN Register. As part of annual data submissions to the UN, importing and exporting states are to report on transfers of complete MANPADS and any gripstocks that are exported separately during the previous calendar year. While reporting by UN member states is far from complete, it does routinely include data from major producers and exporters of MANPADS. The specificity of the reports varies from country to country, but many identify the exporter, importer, quantity, and model of transferred MANPADS.

While significantly better than most other sources of official data, the data submitted to the UN Register suffers from several gaps that hinder public understanding of the international trade in MANPADS. States are not required to submit data on:

- transfers of missiles for MANPADS when not exported as complete systems (i.e., when the transfer consists only of missiles);
- transfers of parts and components for MANPADS, except for launchers; or
- transfers of accessories for MANPADS.

Revising reporting requirements to capture these transfers would significantly improve public understanding of the global MANPADS trade. The difficulty of implementing such requirements would vary from item to item. Reporting on transfers of missiles not captured through existing requirements would presumably have few cost and resource implications for member states. For most exporters, these transfers are thoroughly documented and are relatively few in number. The budgetary and administrative burden of reporting on all transfers of missiles compatible with MANPADS would thus be minimal for most reporting states.

Expanding reporting requirements to include parts and accessories for MANPADS would be significantly more challenging. Data on transfers of many of these items is currently aggregated with data on other, unrelated items. Disaggregating and reporting on parts and accessories exported specifically for use with MANPADS could be extremely difficult and resource-intensive for member states, especially when the parts are widely used in the manufacture of commercial products. The "unsubstantial mechanical parts" for MANPADS

gripstocks exported to Egypt are good examples (see Image 11). Attempting to account for and report on all transfers of such items would be prohibitively expensive for many states. For these reasons, the revised reporting requirement should be limited to a small number of sensitive items that would significantly enhance the utility or lethality of MANPADS for terrorists and other unauthorized end users, such as thermal weapon sights.

Another notable shortcoming of data on MANPADS transfers—and of the UN Register more generally—is the result of non-reporting by UN member states, which has increased in recent years. The reasons why states do not report to the UN Register range from concerns about unfair scrutiny of their arms transfers to perceived risks to national security.[129] These concerns are reflected in reporting rates. At its peak in 2001, only approximately two-thirds of UN member states submitted data to the UN Register, meaning that many arms transfers went unreported even in that banner year. The current list of non-reporting states includes Iran and North Korea, both of which produce MANPADS, along with dozens of other countries with MANPADS in their national inventories, all of which are potential re-exporters. Convincing many of these states to provide regular, detailed information on their arms transfers is likely to be difficult. Furthermore, the UN Register and other official reporting mechanisms do not capture covert government-sponsored arms transfers, arms transfers between and within terrorist and insurgent groups, or MANPADS that are lost, stolen, or looted from government facilities and subsequently smuggled across national borders. Tracking the proliferation of MANPADS therefore requires a multi-pronged approach, including better utilization of the open-source intelligence that is increasingly available on the Internet.

The posting online of photos and videos taken in conflict zones and other hotbeds of weapons proliferation has resulted in a notable increase in the quantity and quality of images of illicitly held weapons in the public domain. Fifteen years ago, the few images of illicit weapons that were available came from

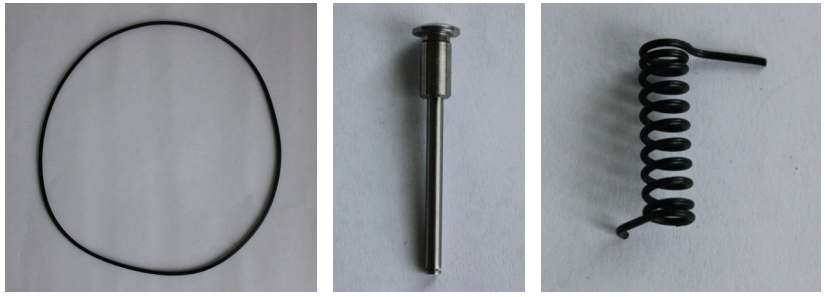

Image 11. Parts for MANPADS exported from Bulgaria. © Republic of Bulgaria

government agencies and professional journalists. Governments release such photos only selectively, and illicitly held weapons are often of little interest to photojournalists. Consequently, publicly available images of illicit weapons were comparatively rare, and the photos that were published were often of little analytic value. Now, video footage and photos of these weapons are posted online by a wide array of individuals ranging from ordinary citizens with cell phones to the illicit end users themselves. The images often show the weapons from different angles, which allows for the identification of the make and model. The speed with which these images are made available has also increased dramatically; analysts tracking arms proliferation in Syria, for example, are able to locate the emergence of new weapon systems on the battlefield in near real-time.

Social media is also increasing the collective capacity to analyze these images. Through Facebook and other social networking services, private analysts, journalists, and field researchers are able to pool expertise and resources in unprecedented ways. The collective analytical capacity of these loose global networks now far exceeds that of any single individual or group working in isolation. Yet the full potential of these networks has yet to be realized. Little dedicated funding is available for data gathering and analysis of this nature and therefore most of it is done on top of funded projects. Funding specifically for collaborative online research on weapons proliferation would enable these networks to more thoroughly and systematically analyze the hundreds of photos and videos of illicitly held weapons posted online each day.

At the same time, participants in these networks need to consider the ways in which their efforts could be misused. As the quantity and quality of information on illicit weapons that is available online expands, and the ease with which this information can be accessed and aggregated increases, so does its potential utility to terrorists, arms traffickers, and other criminals. Analysts need to carefully review the images, documents, and analysis on illicit weapons that they intend to publish, and withhold information that (1) would facilitate unauthorized acquisition or use of these weapons, (2) is not readily available in the public domain, and (3) has comparatively little analytical value or relevance to policy-making. The development of best practice guides for conducting such assessments would help to raise awareness of these issues and to standardize the research community's approach to self-vetting.

Conclusion

The global counter-MANPADS campaign has yielded significant progress on several fronts. Tens of thousands of surplus, obsolete, and poorly secured MANPADS have been destroyed, and depots holding thousands of additional MANPADS are more secure. Through the adoption and revision of the Wassenaar Arrangement's Elements and related guidelines, the international community has embraced increasingly robust controls on the storage and transfer of MANPADS. Responses to the questionnaire on implementation of the Elements and related guidelines reveal widespread adoption of many key provisions, including transfer controls and stockpile security. Complementing these efforts are new reporting requirements for transfers of MANPADS, which have improved government and public understanding of this trade. Efforts to protect planes from MANPADS have also yielded significant results, including development (or modification) of anti-missile systems for use on commercial aircraft and a better understanding of challenges associated with the large-scale deployment of these systems.

Despite this progress, the MANPADS threat persists. Hundreds, possibly thousands, of MANPADS looted from military facilities in Iraq, Libya, and Syria remain at large, and the complete collapse of Bashar al-Assad's regime would likely result in the loss of government control over many additional missiles. While most illicitly held MANPADS are aging, first-generation missiles, recent reports from Syria and Yemen reveal the illicit proliferation of modern Russian and Chinese MANPADS as well. Furthermore, at least some older systems are still functional, and—in the wrong hands—they pose an acute threat to unprotected military and civilian aircraft.

These findings highlight the need for a renewed commitment to securing existing MANPADS and ensuring that new MANPADS are properly controlled. The international community needs to maintain and, when possible, expand efforts to identify and eliminate excessively large stockpiles of MANPADS, with a particular focus on states with weak or potentially unstable regimes. In the current era of government austerity, this will be challenging. Expanding the donor community to include arms exporters and regionally influential states that hitherto have contributed little to threat mitigation efforts would help to ease the financial burden on existing donor states and may facilitate the establishment or resumption of assistance programs in countries where such efforts are affected by political sensitivities.

Amending the Elements and related guidelines to more clearly and explicitly incorporate right-sizing into member states' export policies and practices would further these efforts. Ideally, the new (or amended) provisions would call on exporting states to conduct a thorough assessment of the MANPADS stockpiles of all potential importing states, and to work with importers to dispose of any

surplus or unserviceable MANPADS. This would not only help to reduce existing surplus stockpiles but would also prevent excessive stockpiling in the future.

Greater use of on-site inspections, including post-shipment inspections, would help to improve PSSM at facilities holding MANPADS. As noted above, few states conduct regular on-site inspections of exported MANPADS even though such inspections are the surest way of identifying violations of storage requirements and retransfer restrictions. While inspections are not cost-free, data on the U.S. Golden Sentry program suggests that the logistical, financial, and political barriers to implementing rigorous inspection requirements are not as daunting as commonly (often implicitly) assumed.

Finally, greater transparency in the authorized and illicit trade in MANPADS would improve public understanding of how states implement—and fail to implement—the Elements and related guidelines on MANPADS. Revising UN Register reporting practices to include data on transfers of key components and accessories would provide a more complete accounting of the international trade, including of exports to regions affected by instability and to governments with weak stockpile security and retransfer controls. Similarly, more resources for private researchers engaged in collaborative efforts to collect, share, and analyze open-source images of illicit MANPADS would enhance their ability to identify the provenance of these weapons, thereby increasing accountability among the states that manufacture and export MANPADS that are later lost, stolen, or diverted.

If fully implemented, the measures outlined above would significantly reduce the number of surplus and poorly secured MANPADS in the global inventory, including missiles that are currently out of reach of existing PSSM improvement and destruction programs. These measures would also help to ensure that future generations of MANPADS are properly controlled. They are not a panacea; export controls and stockpile security practices are never 100% effective and even the most robust control regimes occasionally fail. But rigorous and consistent implementation of these and other counter-MANPADS measures would minimize opportunities for theft, loss, and diversion, thereby helping to ensure that the legacy of the "wake-up call" from Mombasa is a significant, enduring reduction in the MANPADS threat.

Endnotes

1. While many small arms and light weapons can be used in terrorist attacks on commercial airliners, MANPADS are particularly well-suited for this purpose. They have a significantly longer effective range than rocket-propelled grenades and most firearms. Moreover, MANPADS, which are guided, are more likely to hit fast-moving targets than non-guided weapons. Their warheads are specifically designed to maximize damage to critical aircraft subsystems, making them more effective against airliners than the high-explosive anti-tank warheads used in many rocket-propelled grenade launchers and anti-tank guided weapons. These characteristics—combined with the portability, concealability, and ease of use of MANPADS—explain why analysts view the terrorist threat to civilian aviation posed by MANPADS as more acute than the threat posed by other weapons.
2. Most respondents to a questionnaire distributed to members of the Asia-Pacific Economic Cooperation forum, the Organization of American States, the Organization for Security and Co-operation in Europe, and the Wassenaar Arrangement indicated that their governments define MANPADS as "surface-to-air missile systems designed to be man-portable and carried and fired by a single individual" and "other surface-to-air missile systems designed to be operated and fired by more than one individual acting as a crew and portable by several individuals." A small number of respondents indicated that they define MANPADS solely as "surface-to-air missile systems designed to be man-portable and carried and fired by a single individual" or that their governments did not have a specific definition of MANPADS. For details on the questionnaire and the methodology used for this report, see Section 3.
3. The latest generation of missile for the Swedish RBS 70 has a "combined blast/fragmentation and shaped charge warhead," which is reportedly effective against light and medium armed vehicles. The Bolide missile's shaped charge can reportedly penetrate up to 200 mm of steel armor (Goodlad, 2011).
4. These countries were Bulgaria, China, the Czech Republic, Egypt, the Federal Republic of Yugoslavia, France, Germany, Iran, Japan, North Korea, Pakistan, Poland, Romania, Slovakia, Sweden, Switzerland, Russia, the United Kingdom, and the United States. The German firm Lenkflugkörpersysteme GmbH served as the prime contractor for the European Stinger Project Group.
5. Author interview with a government official, January 2012.
6. A small number of additional states have reportedly produced MANPADS under license or developed components for existing MANPADS.
7. According to the U.S. Defense Department, co-production of Stinger missiles "has stopped permanently." Author interview with U.S. Defense Department officials, June 2012.
8. There are reports that Vietnam has assembled Russian SA-18 MANPADS but the author was unable to verify these claims (IHS Jane's, 2002).
9. Whether Iran's Misagh-1 and Misagh-2 are indigenously developed systems or variants of Chinese systems is unclear.
10. The Javelin is described as a semi-automatic command line-of-sight system.
11. While later-generation models of MANPADS are often more capable than their predecessors, modifications to older-generation systems—either at the time of production or as upgrades—blur the line between generations to some extent. For example, the Russian MANPADS manufacturer, KBM, has offered an upgrade for the SA-7b that replaces the standard (single-channel) IR seeker with a dual-channel unit. See O'Halloran and Foss (2011, p. 39).
12. France reports to the UN Register but does not identify the model of exported missiles.
13. For more information, see UNROCA (n.d.) and SIPRI (n.d.).
14. As of January 2012.
15. Author correspondence with a Bulgarian government official, January 2012.

16. See also Harding (2005).
17. For the purposes of this study, the term "documented" is used to refer to cases of reported illicit MANPADS activity in which there are (1) independent, corroborating accounts of the activity from two or more credible sources, or (2) photographs or video footage of the illicit MANPADS. In view of the inherent limitations of open-source documentation on illicit MANPADS, the actual number of countries in which illicit MANPADS activity occurred is likely to be significantly higher.
18. For the purposes of this study, illicit MANPADS activity includes possession, transfer, and usage of MANPADS by non-governmental entities that are not officially authorized to conduct such activity on behalf of the government of the state in which the activity occurred. The terms "illicit" and "illicitly held" are used interchangeably in this report.
19. These countries are Afghanistan, Chad, Colombia, Egypt, France, Georgia, Iraq, Kenya, Lebanon, Liberia, Libya, Nicaragua, Pakistan, the Republic of Macedonia, Russia, Somalia, Sri Lanka, Sudan, Syria, Tajikistan, Thailand, and Yemen.
20. While there are no known examples of complete, functional MANPADS found outside of government control in the United States, authorities have recovered components and accessories. In 2008, a member of the Florida National Guard was sentenced to 18 months of probation for stealing a "Stinger missile-firing simulator" from his vehicle during a training exercise (Kalfrin, 2008). At a weapons collection event held in January 2013, Seattle police recovered an expended launch tube for a U.S. FIM-43 MANPADS (Le, 2013).
21. Libyan rebels also captured a limited number of missiles for the Pakistani Anza II system, photographs of which were posted online by analyst Nic Jenzen-Jones (2013). It is not clear whether the rebels acquired gripstocks for the missiles.
22. Foreign variants of the SA-7 include the Chinese HN-5, the Egyptian Sakr Eye, the Romanian CA-94, and the Yugoslav S-2M/A.
23. See Schroeder (2007); Schroeder, Stohl, and Smith (2007, p. 124); and Rajapaksa (2011).
24. As mentioned above, the possibility that some of the older models were modified or upgraded complicates assessments of the threat that these systems pose.
25. Shelf life estimates for SA-7b MANPADS and foreign variants range from ten to 22 years. Markings on the launch tubes of illicitly held missiles photographed in Afghanistan, Iraq, Libya, Somalia, Sudan, and elsewhere reveal production dates ranging from the early 1970s to the mid-1980s. If these missiles are representative of the broader population of illicit SA-7s, many are past their estimated shelf lives.
26. Evidence of operational SA-7s outside of government control include the loss of several aircraft to SA-7 attacks in Iraq and assessments of SA-7s and their components conducted by explosive ordnance disposal (EOD) experts in Iraq and elsewhere.
27. It is unclear whether gripstocks were found with the missiles. See Jenzen-Jones (2013).
28. See Felter and Fishman (2008, pp. 11, 12); Fox and Sheikhly (2007); Baker (2007a); CENTCOM (2011); and MNF-I (2007).
29. There have been numerous media reports of illicitly held Stinger missiles or components found in countries other than Afghanistan, but there is little hard (photographic) evidence to support these claims. See, for example, Khan (2005) and Sung-ki (2009). The term "Stinger" is sometimes inaccurately used as a generic reference to "MANPADS" as a category of weapons. Thus, some of the items described as "Stinger missiles" in media reports may in fact be other models of MANPADS.
30. See Yousaf and Adkin (2001, pp. 88, 171, 178); Schroeder, Stohl, and Smith (2007, pp. 68–85); and Coll (2004, p. 11).
31. See Schaffer (1993) and Hunter (1996; 2001).
32. Some of the MANPADS may have been distributed to Iraqi forces prior to the arrival of U.S. troops.

33. Information on the countries of origin was collected from emptied MANPADS crates analyzed by *New York Times* reporter C.J. Chivers, who posted photos of the crates online. See Chivers (2011).
34. Other evidence reportedly linking this shipment to Iran includes Iranian-produced munitions found with the MANPADS and the nationality of the crew members, who were reportedly Iranian. See Worth and Chivers (2013).
35. According to data compiled by the Brookings Institution, 75 U.S. military helicopters were downed in Iraq from May 2003 through February 2011. At least half were brought down by enemy fire (O'Hanlon and Livingstone, 2011).
36. A UK military inquiry into the attack confirmed that the weapon used was a MANPADS but did not reveal the model (UKMOD, 2006).
37. As revealed in the 2006 conflict with Israel, Hezbollah is capable of acquiring and deploying comparatively sophisticated weapons on a scale that far exceeds that of most other armed groups. During the conflict, Israeli targets came under fire from hundreds of anti-tank guided missiles and rockets, including later-generation Russian Kornet missiles and RPG-29 "Vampir" rockets; thousands of artillery rockets; and anti-ship missiles (IHS Jane's, 2006b).
38. "Anti-aircraft missiles" recovered from an arms cache in the Mexican state of Coahuila in 2012 were actually rocket-propelled grenades, as revealed by photographs of the seized items. See Prensa Latina (2012).
39. For an in-depth account of counter-MANPADS efforts prior to the Mombasa attack, see Schroeder, Stohl, and Smith (2007).
40. Author interview with UK government officials, December 2011.
41. The term "members" is used in this report to refer generally to the participating states of the Wassenaar Arrangement and the OSCE, member states of the OAS, and member economies of APEC.
42. While not all regions of the world are represented in the responses to the questionnaire, detailed information on the key controls was obtained on most producing and major exporting states, which account for most of the international trade in MANPADS. Supplemental information on national PSSM practices was obtained from government officials, representatives from multilateral institutions, and private EOD experts with experience in several different regions.
43. For additional information on implementation of the Elements, see Saferworld (2010).
44. Note that there are several minor differences in the wording of the Elements and the related guidelines. For example, whereas several provisions of the Elements and the OSCE Principles refer to "Participating States," the corresponding provisions in the guidelines adopted by APEC and the OAS refer to "economies" and "member states," respectively.
45. The question reads, "Does your government permit the international transfer of MANPADS only to foreign governments or agents specifically authorized to act on their behalf?"
46. The role of brokers is one of the best-documented aspects of the illicit arms trade. Elaborate brokering schemes involving shell companies, flags of convenience, and false documentation orchestrated by arms traffickers such as Viktor Bout have been documented in numerous UN reports. In several of these cases, the diverted weapons included MANPADS. See Schroeder, Close, and Stevenson (2008).
47. The wording of the question on brokering in the questionnaire differs from the wording of the Elements and related guidelines in that the clause "unless specifically authorized to on behalf of the government" was omitted from the questionnaire for clarity. The question reads, "Does your government prohibit the use of non-governmental brokers or brokering services when transferring MANPADS?"
48. One of the four states indicated that it was introducing new legislation "that will control brokering services."

49. Two of the respondents indicated that they do not export MANPADS.
50. Several states indicated that the question was "not applicable" because they do not export MANPADS. One state responded "not applicable" but did not indicate why.
51. In Russia, for example, export requests involving MANPADS are reviewed by the Ministry of Defense, Foreign Ministry, Federal Service for Intellectual Property, Ministry of Finance, Federal Security Service, and Foreign Intelligence Service (Pyadushkin, 2012, p. 5).
52. See EU (2008).
53. Author interview with a U.S. Defense Department official, June 2012.
54. There is no comparable provision in the guidelines adopted by members of APEC or the OAS.
55. Author interview with a former U.S. government official, March 2012.
56. Author interview with a former UK government official, April 2012.
57. The report uses a definition from a 2007 U.S. Joint Chiefs of Staff publication: "a device included in or attached to a nuclear weapon system to preclude arming and/or launching until the insertion of a pre-scribed discrete code or combination. It may include equipment and cabling external to the weapon or weapon system to activate components within the weapon or weapon system" (Bonomo et al., 2007, p. 88).
58. Author correspondence with a government official, May 2012.
59. According to a UK official, such assurances are not always embraced by potential arms importers: "Some importing governments refuse to provide these assurances, delaying the sale by many months and, in some cases, probably resulting in lost sales." Author interview with a UK government official, January 2012.
60. Author interviews with government officials, January 2012.
61. Author interview with a U.S. government official, June 2012.
62. Several states indicated that this information is considered sensitive and cannot be released.
63. Author interview with a government official, May 2012.
64. Author interview with Bulgarian government officials, January 2012.
65. Author interview with a Russian government official, June 2012.
66. The relevant provisions in the APEC and OAS guidelines read: "the exporting [economy/state] will satisfy itself of the [recipient's] willingness and ability to implement effective measures for […] disposal or destruction of excess stocks to prevent unauthorized access and use." See APEC (2004) and OAS (2005).
67. The exact wording of the question is: "Does your government require importing states to dispose of or destroy MANPADS stocks that are excess to national requirements?"
68. Author interview with a Russian government official, June 2012.
69. Author interview with a U.S. government official June 2012. See also DSCA (n.d.c).
70. Arms transfer controls in many of the countries not assessed as part of this study are rudimentary or non-existent. These problems are well documented in other studies and replicating their work is beyond the scope of this project. Furthermore, available data on the global production and trade in MANPADS suggests that members of APEC, the OAS, the OSCE, and the Wassenaar Arrangement account for the vast majority of MANPADS produced and exported in recent years. Thus, it is their transfer controls, including post-shipment controls, that will have the greatest impact on the global MANPADS trade for the foreseeable future.
71. Author interview with an OSCE official, January 2012.
72. Author interviews with a former UK government official, April 2012; a U.S. government official, May 2012; and a government official, January 2012.
73. Author interview with a former UK government official, April 2012.
74. Author interview with a former U.S. government official, March 2012.

75. Author interview with a former UK government official, April 2012.
76. As noted above, these provisions are excluded from the guidelines adopted by APEC and the OAS.
77. Author interview with a former UK government official, April 2012.
78. Given the likely cost of retrofitting existing MANPADS and concerns expressed by military officials about the functionality of MANPADS equipped with technical-use controls, inclusion of these caveats is not surprising and may have been necessary to secure support for the provision during negotiations.
79. Author interview with a former U.S. government official, March 2012.
80. In 2005, a Russian government official informed the author that "Russia is exploring possibilities of developing launch control devices for its MANPADS. However, technical experts note that this measure will be very expensive. Moreover, such devices will greatly complicate the process of military use of MANPADS [in] the theatre."
81. Author interview with a former U.S. government official, March 2012.
82. Author interview with a U.S. government official, May 2012.
83. See WA (2007, para. 3.9). Note that the Elements differ somewhat from the APEC and OAS guidelines with respect to scope and wording.
84. This figure includes states that have only CREWPADS in their inventories.
85. Two respondents indicated that they "do not know" the answer to this question. Four other respondents did not provide specific answers because they do not have MANPADS in their inventories.
86. As reported by respondents.
87. One of the two states that perform inventories every six months noted that MANPADS are "checked" once a week. This usually means counting the number of MANPADS present. Of the remaining respondents, one responded "do not know" to this question, and four did not provide specific answers because they do not have MANPADS in their national inventories.
88. Interview with Bulgarian government officials, January 2012. See also Gobinet (2012, p. 90).
89. Since the destruction of its 233 obsolete MANPADS in 2004, the Cambodian government has reportedly purchased 50 FN-6 missiles from China (SIPRI, n.d.).
90. Assessments in Burundi, for example, "contributed directly" to the U.S. State Department's decision to fund the destruction of 312 MANPADS (Marek, 2011, p. 11).
91. In February 2012, Assistant Secretary of State Thomas Countryman told reporters that Syria had "tens of thousands" of MANPADS missiles. He did not indicate which models of MANPADS were imported by Syria, or whether his estimate was for Syria's current inventory or its total estimated imports (Birch, 2012).
92. Author correspondence with James Bevan, May 2012.
93. Author interview with a former UN Monitoring Group member, April 2012.
94. Bevan also visited facilities in Guinea and the Democratic Republic of the Congo that were in "extreme disrepair" (Bevan, 2012, pp. 9, 33–34).
95. Author interviews with EOD experts, May 2012.
96. In response to the questionnaire, officials from an Eastern European country indicated that "[a]t present we have insufficient capabilities in terms of ensuring security in accordance with international requirements. In all places of storage of MANPADS it is necessary to install modern monitoring systems to compensate the human factor, fire fighting systems, intrude[r] detection, and alarm systems." Assessments of PSSM conducted by the UN Development Programme, the NATO Maintenance and Supply Agency (NAMSA), and other organizations have revealed problems at storage facilities in several other Eastern European countries. In one Central Asian country, missiles and gripstocks for MANPADS were stored together because the room in which they were stored was considered the most secure in the storage facility (author interview with an OSCE official, June 2012).

At a depot in Central America assessed in 2009–10, EOD experts found 250-pound (110 kg) bombs stored in a building located approximately 100 yards (100 m) away from an international airport. Other evidence of poor PSSM practices included large quantities of obsolete ammunition, such as ammunition for weapons that were no longer in the national inventory (106 mm recoilless rifle rounds); ammunition in damaged storage crates; exposed propellant; and depot personnel "who did not know exactly what they had." In another Central American country, the security at depots visited by EOD experts was "marginal at best." There were locks on the doors but security systems were often missing or broken and lighting was not functional (author interview with EOD expert, May 2012). It is not known whether the countries assessed had MANPADS in their inventories.

97. Author interview with an EOD expert, June 2012.
98. See Bevan (2012).
99. See also King (2011).
100. Author interview with an EOD expert, May 2012. Bevan encountered similar problems in Côte d'Ivoire. The presence of at least three SA-7b missiles or systems in military storage facilities was confirmed even though the Government of Côte d'Ivoire has not listed MANPADS in its declarations to the United Nations Operations in Côte d'Ivoire or the UN Group of Experts on Côte d'Ivoire. Bevan suspects this is due to the "chaotic state of Côte d'Ivoire's military organization following regime change, and the absence of any comprehensive inventory in the years before." As a result, concludes Bevan, "the presence of these weapons is probably not well known within the Ivorian military establishment" (Bevan, 2012, p. 33).
101. Author interview with an EOD expert, May 2012.
102. The Albanian government inherited an aging, Soviet-era stockpile of 100,000 tons of ammunition stored in depots scattered throughout the country. Many of these depots were in "god-awful places," recalled one EOD expert. Among the most challenging were depots in remote mountainous regions that were placed in tunnels with tiny openings. To collect and dispose of the munitions, the government and its partners assembled a workforce of thousands of people, including a demilitarization infrastructure consisting of nearly a dozen (dis)assembly lines at multiple factories (author interview with an EOD expert, March 2012). See also Gobinet (2012, pp. 37–60).
103. Author interview with Bulgarian officials, January 2012.
104. Author interview with an OSCE official, June 2012.
105. Author interview with an EOD expert, March 2012. The reported program cost of destroying 1,000 MANPADS in Nicaragua was $300,000. An additional $200,000 was spent on PSSM improvements. See Schroeder, Stohl, and Smith (2007, p. 126).
106. Author interviews with government officials and EOD experts, January–May 2012, and with an OSCE official, June 2012.
107. Author interview with an OSCE official, June 2012; author correspondence with a NAMSA official, May 2012.
108. Author interview with an EOD expert, June 2012. While not related to MANPADS specifically, the German government's experience in Cambodia also highlights the logistical difficulties of obtaining supplies. See King (2011, p. 91).
109. Author interview with a government official, April 2012. See also King (2011, p. 80) and USHR (2006).
110. Author interview with a government official, May 2012.
111. Author interview with an EOD expert, June 2012.
112. Author interview with an EOD expert, May 2012.
113. Author interview with an EOD expert, May 2012.
114. Author interview with an EOD expert, June 2012.

115. The *Miami Herald* obtained a copy of the Bolivian military's report on the incident, which concluded that the missiles "had effectively wound up in a bad state." As summarized by the *Miami Herald*, the missiles posed a safety hazard and had failed two test firings (Bridges, 2006).
116. Author interview with an EOD expert, June 2012.
117. The Israeli government did not respond to the author's requests for additional information about their program.
118. To be included in the exemption, the system must receive a civil Type Certificate (or ICAO-approved equivalent) and be equipped with software protection and anti-tamper devices that "forc[e] the system not to function when it is removed from the 'civil aircraft' in which it was installed" (WA, 2012, sec. ML4.c (note)).
119. As part of this testing, a JETEYE system was installed on a Boeing 767-200 that repeatedly flew into Memphis International Airport while being "targeted" by a missile simulator. "This demonstration showed the JETEYE system could successfully detect a threat missile in a high clutter commercial airport environment" (DHS, 2010, p. 15).
120. The report indicates that the 98 aircraft would be those designated "higher risk" but the criteria for determining which planes are at higher risk is either missing or redacted from the publicly available version of the report (DHS, 2010, p. 35).
121. Under this scenario, anti-missile systems would be installed on all wide- and narrow-body aircraft in the U.S. commercial fleet that are the size of a Boeing 737 or larger. DHS estimates "a unit acquisition cost of $1 million for the 1000th unit delivered and installed, which includes the cost of B-kit and A-kit components, as well as the installation labor" (DHS, 2010, pp. 32, 35).
122. Author interview with a U.S. government official, May 2012.
123. Author interview with a U.S. government official, May 2012.
124. Interviews with airline industry representatives, April 2012.
125. As noted above, this provision is not included in the guidelines adopted by APEC and the OAS.
126. U.S. Defense Department officials interviewed by the author in June 2012 indicated that these costs have increased by approximately 5% since 2008.
127. These countries are Bahrain, Denmark, Egypt, France, Germany, Greece, Israel, Italy, Japan, the Netherlands, Pakistan, Portugal, Saudi Arabia, Switzerland, Turkey, and the United Kingdom.
128. Author interview with a U.S. Defense Department official, June 2012.
129. Author interview with a former UK government official, April 2012.

Bibliography

Abdulle, Sahal. 2007. "Belarus Says Plane Shot Down in Somalia." Reuters. 24 March. <http://www.reuters.com/article/2007/03/24/idUSL24233043>

Alemán, Filadelfo. 2005. "Sandinista Official Says U.S. Is Meddling." Associated Press. 22 March.

Al-Shorfa. 2012. "Iraqi Army Seizes Cache of Missiles and Rockets in Samarra." 11 May.

AP (Associated Press). 2004. "Nicaragua Destroys Missiles U.S. Feared Could Aid Terrorists; Court Blocks Further Action." 24 November.

—. 2005. "Anti-Aircraft Missile Found in Nicaragua Mechanic Shop." 12 January.

APEC (Asia-Pacific Economic Cooperation). 2004. APEC Guidelines on Controls and Security of Man-Portable Air Defense Systems. <http://fas.org/asmp/campaigns/MANPADS/APECguidelines1.pdf>

Atareb Syriafree. 2012. "غنايم الفوج 46 الله اكبر" YouTube. 19 November. <http://www.youtube.com/watch?feature=player_embedded&v=spiD0PASzzI>

Australian DFAT (Department of Foreign Affairs and Trade). 2008. "Man-Portable Air Defence Systems (MANPADS): Countering the Terrorist Threat." June. <http://www.dfat.gov.au/security/manpads_countering_terrorist_threat.pdf>

Australian DOD (Department of Defence). 2012. "Afghan and Australian Special Forces Find Massive Weapon Cache in Uruzgan." 7 June. <http://news.defence.gov.au/2012/06/07/afghan-and-australian-special-forces-find-massive-weapon-cache-in-uruzgan/>

Baker, Fred W. III. 2007a. "Despite Risks, Air Still Safest Travel in Iraq." American Forces Press Service. 13 February. <http://www.defense.gov/News/NewsArticle.aspx?id=3037>

—. 2007b. "Air Cav Crews See Higher-Tech Attacks, Weapons from Iran." American Forces Press Service. 19 October. <http://www.defense.gov/News/NewsArticle.aspx?ID=47855>

BBC News. 2004. "Missiles Found in Anti-Eta Raids." 5 October. <http://news.bbc.co.uk/2/hi/europe/3717070.stm>

Bevan, James. 2012. *The MANPADS Threat on the African Continent*. Unpublished background paper. Washington, D.C.: Federation of American Scientists. April.

Binnie, Jeremy. 2012. "Syrian Rebels Obtain Igla-S MANPADS." *Jane's Defence Weekly*. 14 November.

Birch, Douglas. 2012. "US Closely Watching Syrian Chemical Weapons." Associated Press. 16 February. <http://www.boston.com/news/nation/washington/articles/2012/02/15/us_very_closely_watching_syrian_chemical_weapons/>

Bonomo, James, et al. 2007. *Stealing the Sword: Limiting Terrorist Use of Advanced Conventional Weapons*. Santa Monica: RAND Corporation. <http://www.rand.org/pubs/monographs/MG510.html>

Bridges, Tyler. 2006. "Missile Puzzle: Who OK'd Deal?" *Miami Herald*. 14 March.

Cagle, Mary. 1974. *History of the Redeye Weapon System*. Historical Monograph AMC 78M. Huntsville, Ala.: Army Missile Command. 23 May. <http://www.fas.org/asmp/campaigns/MANPADS/2005/redeye.pdf>

CENTCOM (United States Central Command). 2011. "Documents and Photographs of Weapons Seized from Arms Caches in or Near Baghdad from September 2008 until September 2009." Released 19 May 2011 under the U.S. Freedom of Information Act.

Chivers, C.J. 2011. "Reading the Refuse: Counting Qaddafi's Heat-Seeking Missiles, and Tracking Them Back to Their Sources." *At War*. Blog. 26 July. <http://atwar.blogs.nytimes.com/2011/07/26/reading-the-refuse-counting-col-qaddafis-heat-seeking-missiles-and-tracking-them-back-to-their-sources/?_r=0>

Coll, Steve. 2004. *Ghost Wars: The Secret History of the CIA, Afghanistan, and Bin Laden, from the Soviet Invasion to September 10, 2001*. New York: Penguin Press.

de Córdoba, José. 2005. "Nicaragua Faces Pressure by U.S. over Missiles." *Wall Street Journal*. 22 February.

DHS (United States Department of Homeland Security). 2004. "Fact Sheet: Countering Missile Threats to Commercial Aircraft." 6 January. <http://www.fas.org/asmp/campaigns/MANPADS/DHSfactsheet6Jan04.htm>

—. 2005. *Securing the Nation against Man-Portable Air Defense Systems: Report to Congress in Response to the Intelligence Reform and Terrorism Prevention Act of 2004*. December. <http://www.fas.org/asmp/campaigns/MANPADS/2007/securing_the_nation_against_MANPADS.pdf>

—. 2010. *Counter-MANPADS Program Results: Fiscal Year 2008 Report to Congress*. 30 March. <http://www.fas.org/programs/ssp/asmp/documents/DHSMANPADSReport.pdf>

DOS (United States Department of State). 2004. "Our Other Half: Small Arms, Light Weapons, and MANPADS." *Safe Passage*, Vol. 1, Iss. 4. December. <http://2001-2009.state.gov/t/pm/wra/40291.htm>

—. 2011. "MANPADS: Combating the Threat to Global Aviation from Man-Portable Air Defense Systems." Updated 27 July. <http://www.state.gov/t/pm/rls/fs/169139.htm>

—. 2012. *Treaties in Force: A List of Treaties and Other International Agreements of the United States in Force on January 1, 2012*. January. <http://www.state.gov/documents/organization/202293.pdf>

DSCA (United States Defense Security Cooperation Agency). 2011. "Finland: Reprogrammable Micro-Processor (RMP) Block 1 Anti-Aircraft Missiles." News Release. 31 October. <http://www.public.dsca.mil/major-arms-sales/finland-%E2%80%93-reprogrammable-micro-processor-rmp-block-1-anti-aircraft-missiles>

—. n.d.a. "Man-Portable Air Defense Systems: Non-NATO." In *Defense Security Cooperation Agency Manual*. 5105.38-M; A6. <http://www.dsca.osd.mil/samm/ESAMM/ESAMM/A06/LOANote-069.htm>

—. n.d.b. "Man-Portable Air Defense Systems: NATO+3." In *Defense Security Cooperation Agency Manual*. 5105.38-M; A6. <http://www.dsca.osd.mil/samm/ESAMM/ESAMM/A06/LOANote-068.htm>

—. n.d.c. "FMS Case Development." In *Defense Security Cooperation Agency Manual*. 5105.38-M; C5. <http://www.dsca.osd.mil/samm/ESAMM/C05/5.htm>

—. n.d.d. "End-Use Monitoring (EUM)." In *Defense Security Cooperation Agency Manual*. 5105.38-M; C8. <www.dsca.osd.mil/samm/ESAMM/ESAMM/C08/8.htm#C8.4.>

El Nuevo Diario (Managua). 2004. "Nicaraguan President to Face Charges over Destruction of Missiles." 27 November.

EU (European Union). 2008. Council Common Position 2008/944/CFSP of 8 December 2008 Defining Common Rules Governing Control of Exports of Military Technology and Equipment. *Official Journal of the European Union*. L 335/99. 13 December. <eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:335:0099:0099:EN:PDF>

Felter, Joseph and Brian Fishman. 2008. *Iranian Strategy in Iraq: Policy and "Other Means."* Appendix C. Occasional Paper. West Point, N.Y.: Combating Terrorism Center.

Fiszer, Michal and Jerzy Gruszczynski. 2004. "On Arrows and Needles: Russia's Strela and Igla Portable Killers." *Journal of Electronic Defense*. 1 January.

Forero, Juan. 2010. "Venezuela Acquires 1,800 Antiaircraft Missiles from Russia." *Washington Post*. 11 December. <http://www.washingtonpost.com/wp-dyn/content/article/2010/12/11/AR2010121102586.html>

Fox, Mark and Tahseen Sheikhly. 2007. "Rear Adm. Mark Fox and Dr. Tahseen Sheikhly, Sept. 23." Press Conference. 23 September.

G8 (Group of Eight). 2003. "Enhance Transport Security and Control of Man-Portable Air Defence Systems (MANPADS): A G8 Action Plan." Adopted at the June 2003 G8 summit. <http://www.g8.fr/evian/english/navigation/2003_g8_summit/summit_documents/enhance_transport_security_and_control_of_man-portable_air_defence_systems_-_manpads_-_a_g8_action_plan.html>

—. 2004. "G8 Secure and Facilitated International Travel Initiative (SAFTI)." 9 June. <http://www.fas.org/asmp/campaigns/MANPADS/safti.pdf>

GAO (United States General Accounting Office). 1994. *Inventory Management: Handheld Missiles Are Vulnerable to Theft and Undetected Losses*. GAO/NSIAD-94-100. September. <http://www.gao.gov/products/NSIAD-94-100>

—. 2004. *Further Improvements Needed in U.S. Efforts to Counter Threats from Man-Portable Air Defense Systems*. GAO-04-519. May. <http://www.gao.gov/new.items/d04519.pdf>

Gibson, Charles. 2002. "Israeli Flight Targeted Missiles Fired." ABC News Transcripts. 28 November.

Gilmore, Gerry. 2003. "Chinook Tragedy Won't Deter Troops' R&R Program." American Forces Press Service. 3 November. <http://www.defense.gov/News/NewsArticle.aspx?ID=27855>

Gobinet, Pierre. 2011. *Significant Surpluses: Weapons and Ammunition Stockpiles in South-east Europe*. Special Report No. 13. Geneva: Small Arms Survey. December. <http://www.smallarmssurvey.org/fileadmin/docs/C-Special-reports/SAS-SR13-Significant-Surpluses.pdf>

—. 2012. *Capabilities and Capacities: A Survey of South-East Europe's Demilitarization Infrastructure*. Special Report No. 15. Geneva: Small Arms Survey. April. <http://www.smallarmssurvey.org/fileadmin/docs/C-Special-reports/SAS-SR15-South-East-Europe-Demilitarization.pdf>

Godoy Z., Hazel. 2005. "SAM-7 Issue to National Dialogue." *El Nuevo Diario* (Managua). 23 February.

Goodlad, Ben. 2011. "Update: RBS-70 Next Generation Shown to International Audience." *Jane's Missiles & Rockets*. 18 October.

Gyurosi, Miroslav. 2010. "Slovak Air Force MANPADS Crews Fire from Vehicle." *Jane's Missiles & Rockets*. 2 November.

Harding, Thomas. 2005. "Britain Buys Russian Surface-to-Air Missiles in Fight against Terrorism." *Daily Telegraph* (London). 13 December. <http://www.telegraph.co.uk/news/uknews/1505361/Britain-buys-Russian-surface-to-air-missiles-in-fight-against-terrorism.html>

Hunter, Thomas. 1996. "Man-portable SAMS: The Airline Anathema." *Jane's Intelligence Review*. October.

—. 2001. "The Proliferation of MANPADS." *Jane's Intelligence Review*. September.

ICAO (International Civil Aviation Organization). 2004. *Threat to Civil Aviation Posed by Man-Portable Air Defence Systems*. A35-WP/50. 28 July. <http://www.fas.org/asmp/campaigns/MANPADS/ICAOwp050_en.pdf>

—. 2007. *Threat to Civil Aviation Posed by Man-Portable Air Defence Systems*. A36-WP/26. 3 July. <http://legacy.icao.int/icao/en/assembl/a36/wp/wp026_en.pdf>

IHS Jane's. 2002. "Russia to Sell Igla to Vietnam." *Jane's Defence Weekly*. 28 February.

—. 2006a. "Nicaragua Could Retain 400 MANPADS." *Jane's Missiles & Rockets*. 1 January.

—. 2006b. "Israeli Armour Fails to Protect MBTs from ATGMs." *Jane's Defence Weekly*. 25 August.

—. 2011. "Nicaragua." *Jane's World Armies*. 23 August.

Isby, David. 2007. "Ukraine Delivers SAMs to US for Anti-Missile Studies." *Jane's Missiles & Rockets*. 3 December.

— and Doug Richardson. 2011. "Russia Details SAM Developments." *Jane's Missiles & Rockets*. 5 April.

Jehl, Douglas and David E. Sanger. 2004. "U.S. Expands List of Lost Missiles." *The New York Times*. 6 November. <http://www.nytimes.com/2004/11/06/politics/06weapons.html?_r=0>

Jenzen-Jones, N.R. 2013. "Anza Mk-II MANPADS in Libya." *Rogue Adventurer*. Blog. 27 January. <http://rogueadventurer.com/2013/01/27/anza-mk-ii-manpads-in-libya/>

Kalfrin, Valerie. 2008. "Stinger Simulator Theft Lands Guardsman Probation." *Tampa Tribune*. 4 September. <http://www2.tbo.com/news/news/2008/sep/04/me-missile-theft-lands-guardsman-probation-ar-128680/>

Kay, David. 2003. "Statement on the Interim Progress Report on the Activities of the Iraq Survey Group." 2 October. <https://www.cia.gov/news-information/speeches-testimony/2003/david_kay_10022003.html>

Keyser, Jason. 2002. "Passengers Say They Thought Loud Boom Was Sign of Technical Mishap." Associated Press. 28 November.

Khan, Riaz. 2005. "Pakistani Authorities Seize Six Stinger Missiles, Rockets, Bombs from Home in Northwest." Associated Press. 26 September.

King, Benjamin, ed. 2011. *Safer Stockpiles: Practitioners' Experiences with Physical Security and Stockpile Management (PSSM) Assistance Programmes*. Occasional Paper No. 27. Geneva: Small Arms Survey. April.

Knights, Michael. 2007. "Unfriendly Skies: Iraq's Sunni Insurgents Focus on Air Defence." *Jane's Intelligence Review*. May.

Le, Phuong. 2013. "Missile Launcher Shows up at Seattle Gun Buyback." Associated Press. 29 January. <http://usnews.nbcnews.com/_news/2013/01/29/16754974-missile-launcher-shows-up-at-seattle-gun-buyback?lite>

Likins, Rose and Daniel Fisk. 2005. "Protecting Global Aviation: Keeping Nicaraguan Man-Portable Air Defense Systems Out of the Hands of Terrorists." Briefing at the Washington Foreign Press Center, Washington, D.C. 24 June. <2001-2009.state.gov/t/pm/rls/rm/49432.htm>

Lumpkin, John. 2004. "Nicaragua Assures Rumsfeld It Will Destroy Soviet-Era Anti-Aircraft Missiles." Associated Press. 12 November.

Marek, Anne. 2011. "Cold Leftovers." *The Shield: The Official Mazazine of DTRA/SCC-WMD*, Vol. 1, Iss. 3. Fall. <http://www.dtra.mil/Documents/PDFs/shield_Fall2011_web.pdf>

Marrouch, Rima. 2012. "Syrian Rebels Gaining Ground against Assad's Air Power." *Los Angeles Times*. 11 December. <http://articles.latimes.com/2012/dec/11/world/la-fg-syria-rocket-man-20121212>

Military Council (المجلس العسكري). 2013. "الدفاع الجوي التابعة للمجلس العسكري بحلب تتسقط مروحية بمنغ كتيبة" YouTube. 25 February. <http://www.youtube.com/watch?feature=player_embedded&v=x_IhHBTocRQ#!>

Millar, Stuart and Richard Norton-Taylor. 2002. "A Boom and a Vapour Trail as Missiles Just Miss Their Mark." *Guardian*. 29 November. <http://www.guardian.co.uk/world/2002/nov/29/terrorismandtravel.kenya1>

MNF-I (Multi-National Force–Iraq). 2007. "Iranian Support for Lethal Activity in Iraq." PowerPoint presentation. 11 February.

Noticias RCN (Colombia). 2012. "Video prueba que las Farc tienen misiles que pueden derribar aeronaves." 9 December. <http://canalrcnmsn.com/noticias/video_prueba_que_las_farc_tienen_misiles_que_pueden_derribar_aeronaves>

OAS (Organization of American States). 2005. Recommended Guidelines for Control and Security of Man-portable Air Defense Systems. 7 June. <http://www.fas.org/asmp/campaigns/MANPADS/2005/OASmanpads.pdf>

O'Halloran, James and Christopher Foss, eds. 2011. *Jane's Land-based Air Defence 2011–2012*. Coulsdon, Surrey, UK: IHS Jane's.

O'Hanlon, Michael and Ian Livingstone. 2011. "Iraq Index: Tracking Variables of Reconstruction & Security in Post-Saddam Iraq." Washington, D.C.: Brookings Institution. Updated 25 February.

OSCE (Organization for Security and Co-operation in Europe). 2003. *Best Practice Guide on National Procedures for Stockpile Management and Security*, Annex C. FSC. GAL/14/03/Rev. 2. 19 September. <www.osce.org/fsc/13637>

—. 2004. Decision No. 3/04: OSCE Principles for Export Controls of Man-Portable Air Defence Systems (MANPADS). FSC.DEC/3/04 of 26 May. <www.osce.org/fsc/32593>

—. 2008. Decision No. 5/08: Updating the OSCE Principles for Export Controls of Man-portable Air Defence Systems. 26 May. <http://www.osce.org/fsc/32082>.

Prensa Latina. 2012. "Arsenal with Anti Aircraft Rocket Seized in Mexico." 17 September.

Pyadushkin, Maxim. 2011. "Libyan SA-24 Can't Be Used as MANPADS." *Aviation Week*. 29 March.

—. 2012. *Russia's Implementation of Key Provisions of the Wassenaar Arrangement's Elements for Export Controls on MANPADS*. Unpublished background paper. Washington, D.C.: Federation of American Scientists. 20 April.

Rajapaksa, Gotabaya. 2011. "Full Text of the Speech Made by Secretary Defence Mr. Gotabaya Rajapaksa at the Inaugural Session of the Galle Dialogue Maritime Conference as Follows." Colombo: Ministry of Defence of Sri Lanka. 17 August. <http://www.defence.lk/new.asp?fname=20100806_12>

Rebels Deir al-Zour. 2013. "لاول مرة صواريخ تقبل مظادة للطيران للتصدي لطيران السدي" YouTube. 11 February. <http://www.youtube.com/watch?feature=player_embedded&v=PZgIZqAB7Ao>

Reuters. 2006. "Bolivia's Defense Chiefs Ousted in Missile Scandal." 18 January. <http://www.washingtonpost.com/wp-dyn/content/article/2006/01/18/AR2006011800124.html>

Saab. n.d.a. "RBS70 Man-Portable Air-Defence Missile System: Turning Threats into Targets." <http://saabaerotech.org/en/Air/Weapon_Systems/Ground_Based_Air_Defence_Missile_Systems/RBS_70/Features/>

—. n.d.b. "RBS 70 NG VSHORAD: Background." <http://www.saabgroup.com/Campaigns/RBS-70-New-Generation/Background/>

Saferworld. 2010. *Controlling the Transfer of Man-portable Air Defence Systems: A Guide to Best Practice*. <http://www.saferworld.org.uk/resources/view-resource/499>

Sandoval, Consuelo. 2005. "Nicaraguan Opposition Legislator Rejects US Pressure to Destroy Missiles." *El Nuevo Diario* (Managua). 2 March.

Sawer, Patrick, Harriet Arkell, and Ed Harris. 2002. "'Al Qaeda' Missile Horror." *London Evening Standard*. 28 November. <http://www.standard.co.uk/news/al-qaeda-missile-horror-7222219.html>

Scarborough, Rowan. 2005. "Nicaraguans Seize Missile during Sting." *Washington Times*. 27 January. <http://www.washingtontimes.com/news/2005/jan/27/20050127-122517-1306r/>

Schaffer, Marvin. 1993. *Concerns about Terrorists with Manportable SAMs*. Santa Monica: RAND Corporation.

Schroeder, Matt. 2007. "Rogue Missiles: Tracking MANPADS Proliferation Trends." *Jane's Intelligence Review*. November.

—. 2008. "Black Market Missiles Still Common in Iraq." *Missile Watch*, No. 3. 8 December. <http://www.fas.org/programs/ssp/asmp/issueareas/manpads/Missile_Watch_3_Black_market_missiles_still_common_in_Iraq.pdf>

—. 2010. "North Korean Arms Shipment Included MANPADS, Thai Report Confirms." *Missile Watch*, Vol. 3, Iss. 1. February. <http://blogs.fas.org/security/2010/02/missile-watch-february-2010/>

—, Helen Close, and Chris Stevenson. 2008. "Deadly Deception: Arms Transfer Diversion." In Small Arms Survey. *Small Arms Survey 2008: Risk and Resilience*. Cambridge: Cambridge University Press. <http://www.smallarmssurvey.org/fileadmin/docs/A-Yearbook/2008/en/Small-Arms-Survey-2008-Chapter-04-EN.pdf>

— and Benjamin King. 2012. "Surveying the Battlefield: Illicit Arms in Afghanistan, Iraq, and Somalia." In Small Arms Survey. *Small Arms Survey 2012: Moving Targets*. Cambridge: Cambridge University Press. <http://www.smallarmssurvey.org/fileadmin/docs/A-Yearbook/2012/eng/Small-Arms-Survey-2012-Chapter-10-EN.pdf>

—, Rachel Stohl, and Dan Smith. 2007. *The Small Arms Trade: A Beginner's Guide*. Oxford: Oneworld Publications.

Shapiro, Andrew. 2012. "Addressing the Challenge of MANPADS Proliferation." Remarks. Stimson Center, Washington, D.C. 2 February. <http://www.state.gov/t/pm/rls/rm/183097.htm>

Shenon, Philip. 2003. "U.S. Is Inspecting Overseas Airports for Missile Threats." *The New York Times*. 7 August. <http://www.nytimes.com/2003/08/07/international/worldspecial2/X07MISS.html>

Sherman, Robert. 2003. *The Real Terrorist Missile Threat and What Can Be Done About It.* FAS Public Interest Report. Vol. 56, No. 3. Autumn. <http://www.fas.org/faspir/2003/v56n3/missile.htm>

Sinodefence.com. 2009. "QianWei 1 Shoulder-Fired Air Defense Missile." 20 February. <http://www.sinodefence.com/army/surfacetoairmissile/qianwei1.asp>

SIPRI (Stockholm International Peace Research Institute). n.d. Arms Transfers Database. <http://www.sipri.org/research/armaments/transfers/databases/armstransfers>

Special Forces Regiment 9 (الفرقة التاسعة قوات خاصة). 2013. "حلب استعداد بصواريخ كوبرا وايغا للطيران الحربي فاروق." YouTube. 22 February. <http://www.youtube.com/watch?feature=player_embedded&v=8aR_EmA8SO0>

Sung-ki, Jung. 2009. "Korean Unit Exposed to Attacks from Somali Pirates." *Korea Times*. 18 May. <http://www.koreatimes.co.kr/www/news/nation/2009/05/205_45106.html>

UKFCO (United Kingdom Foreign & Commonwealth Office). 2006. *Global Opportunities Fund: Annual Report 2005–2006*. November.

UKMOD (United Kingdom Ministry of Defence). 2006. *Board of Inquiry Final Report Dated 20 Jun 06: Aircraft Crash—Lynx AH MK 7 (XZ614) of 847 NAS In Basra, Iraq 06 May 06.* <http://www.fas.org/asmp/campaigns/MANPADS/2007/boi_lynx_xz614_main_report.pdf>

UNGA (United Nations General Assembly). 2004. Prevention of the Illicit Transfer and Unauthorized Access to and Use of Man-Portable Air Defence Systems. A/RES/59/90 of 3 December 2004. <http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/59/90&Lang=E>

—. 2005. Prevention of the Illicit Transfer and Unauthorized Access to and Use of Man-Portable Air Defence Systems. A/RES/60/77 of 8 December 2005. <http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/60/77>

—. 2007. Prevention of the Illicit Transfer and Unauthorized Access to and Use of Man-Portable Air Defence Systems. A/RES/62/40 of 5 December 2007. <http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/62/40&Lang=E>

—. 2013. *United Nations Register of Conventional Arms: Report of the Secretary-General—Addendum*. A/67/212/Add.2 of 30 January 2013. <http://www.un.org/ga/search/view_doc.asp?symbol=A/67/212/Add.2>

UNROCA (United Nations Register of Conventional Arms). n.d. "The Global Reported Arms Trade." <http://www.un-register.org/HeavyWeapons/Index.aspx>

UNSC (United Nations Security Council). 2007. *Report of the Monitoring Group on Somalia Pursuant to Security Council Resolution 1724 (2006).* S/2007/436 of 18 July 2007. < http://www.un.org/ga/search/view_doc.asp?symbol=S/2007/436>

—. 2008. *Report of the Monitoring Group on Somalia Pursuant to Security Council Resolution 1766 (2007).* S/2008/274 of 24 April 2008. <www.un.org/ga/search/view_doc.asp?symbol=S/2008/274>

—. 2011. *Report of the Monitoring Group on Somalia and Eritrea Pursuant to Security Council Resolution 1916 (2010).* S/2011/433 of 18 July 2011. <http://www.un.org/ga/search/view_doc.asp?symbol=S/2011/433>

U.S. Army (United States Army). 2011. "Data on Weapons Seized, Discovered, or Collected from Weapons Caches in Afghanistan from September, 2006 through September, 2008." 4 April.

U.S. Congress (United States Congress). 1987. "U.S. Congressional Record: Senate." 24 September.

USHR (United States House of Representatives). 1988. "Making Appropriations for the Department of Defense: Conference Report (H.R. 4781)." Report 100-1002. 28 September.

—. 2006. "The Terrorist Threat from Shoulder-Fired Missiles." Hearing before the Subcommittee on International Terrorism and Nonproliferation of the Committee on International Relations. 30 March. <http://www.fas.org/irp/congress/2006_hr/manpads.pdf>

WA (Wassenaar Arrangement Secretariat). 2000. Elements for Export Controls of Man-Portable Air Defense Systems (MANPADS). 1 December. <www.wassenaar.org/publicdocuments/docs/oth_manpads.pdf>

—. 2003. Elements for Export Controls of Man-Portable Air Defence Systems (MANPADS). <www.wassenaar.org/2003Plenary/MANPADS_2003.htm>

—. 2007. Elements for Export Controls of Man-Portable Air Defence Systems (MANPADS). <www.wassenaar.org/publicdocuments/2007/docs/Elements for Export Controls of Manpads.pdf>

—. 2011. *Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies: Basic Documents.* January.

—. 2012. *The Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies: List of Dual-Use Goods and Technologies and Munitions List.* WA-LIST (12) 1. 12 December. <http://www.wassenaar.org/controllists/2012/WA-LIST%20%2812%29%201/15%20-%20WA-LIST%20%2812%29%201%20-%20ML.doc>

Worth, Robert and C.J. Chivers. 2013. "Seized Chinese Weapons Raise Concerns on Iran." *The New York Times*. 2 March. <http://www.nytimes.com/2013/03/03/world/middleeast/seized-arms-off-yemen-raise-alarm-over-iran.html>

Yousaf, Mohammad and Mark Adkin. 2001. *Afghanistan—The Bear Trap: The Defeat of a Superpower*. Havertown, Pa.: Casemate.

Zdobinsky, Michal. 2007a. "Czech Republic Looks to US to Help Destroy SA-7B MANPADS." *Jane's Missiles & Rockets*. 1 September.

—. 2007b. "Czech Forces Receive Final RBS 70 Systems." *Jane's Missiles & Rockets*. 30 October.

FAS

Federation of American Scientists