

Man-Portable Air Defence Systems (MANPADS)

Man-portable air-defence systems (MANPADS) are a class of relatively lightweight, short-range¹ surface-to-air missile (SAM) systems designed to engage low-flying aircraft. Some are crew-served (and are sometimes known as CREWPADS), but most are easily operated by a single individual and are shoulder-launched.

The initial development of MANPADS began in the 1950s. The earliest systems incorporated first-generation infrared (IR) ‘passive homing’ guidance systems that allowed the missiles to function as ‘fire and forget’ munitions. The first example to be fielded was the US FIM-43 ‘Redeye’, which was introduced during the Vietnam War. In 1968—a year after the introduction of the FIM-43—the Soviet Union issued the 9K32 Strela-2 (NATO reporting name: SA-7a ‘Grail’). In the decades that followed, the subsequently updated 9K32M Strela-2M (SA-7b) in particular proliferated across the globe (Rigual, 2014; USDoS, n.d.). By the end of the 1960s only two countries were producing MANPADS, although Sweden and the United Kingdom had begun to develop their own systems.

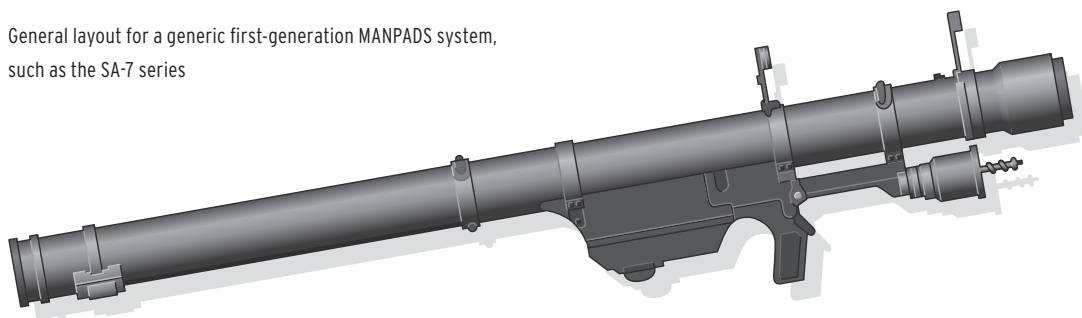
The 1970s saw a significant expansion of the MANPADS industry. The United States began developing the FIM-92 Stinger in 1972, and production began in 1979 (Parsch, 2002; Jane’s Information Group, 2006, p. 43). The Stinger would become famous for its use in Afghanistan in the 1980s (Phillips, 2011). Work on the Soviet 9K34 Strela-3 (SA-14 ‘Gremlin’) began in 1968, and it entered service six years later in 1974 (Jane’s Information Group, 2006, p. 30). Like their predecessors, these second-generation systems featured IR-seeking missiles, but unlike earlier ‘tail-chase’ systems, which were effective only when fired at the

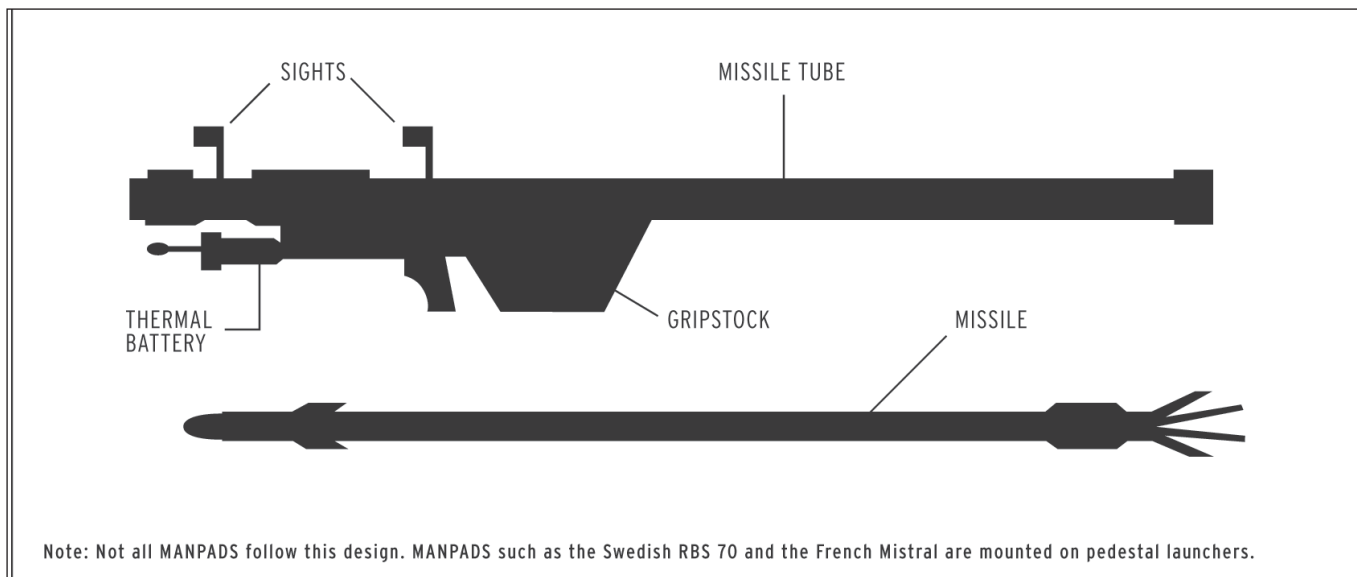
target from behind, the Stinger and SA-14 were capable of engaging targets head-on and from the side. Second-generation IR seekers also have a greater effective range and accuracy.

Since the 1970s more than 30 countries have manufactured complete MANPADS systems, produced important components, or upgraded certain aspects of an existing system such as target acquisition (Small Arms Survey, 2008, pp. 34–35). Many of these systems were produced under licence; however, others have been produced without a formal licensing arrangement.

Licensed and unlicensed production (with the latter often achieved through reverse engineering), primarily of early Soviet models, largely explain the increase in states’ production of MANPADS. The issue of licensing is sensitive and contentious for the Russian Federation and many former Warsaw Pact countries. The Russian Federation claims that current MANPADS systems are being produced illegally in some of the latter countries. Those accused retort, however, either that no such licence is required² or that the models being produced are their own missiles, i.e. that they reflect years of indigenous improvements (Small Arms Survey, 2007, pp. 20–21). For some producers there is no pretence of any licence having existed. In the late 1970s, for example, the Egyptians produced a reverse-engineered copy of the SA-7 called the Ayn-al-Saqr. In 1974 the Egyptian government allegedly supplied China and North Korea with a small number of SA-7s in appreciation for their support during the 1973 Yom Kippur War. Subsequently, both countries produced their own versions of the weapon (Jane’s information Group, 2006, p. 10). There are also reports that the US Stinger has been reverse engineered, albeit not as widely as Soviet models.³

General layout for a generic first-generation MANPADS system, such as the SA-7 series





MANPADS are broadly categorized according to their guidance systems: passive IR seekers or semi-automatic command to line-of-sight (SACLOS) guidance.⁴ The earliest models of IR-seeking MANPADS missiles (passive systems) could engage targets at altitudes of around 2,000–3,000 m and from slant ranges⁵ of about 4,000 m (Jane’s Information Group, 1985; 2006). They were often inaccurate and highly susceptible to basic countermeasures. Early systems were only effective when fired from behind the target aircraft, because the latter’s hot engines and, to a lesser extent, airframe could be identified and tracked by these systems’ limited-spectrum IR seeker. SACLOS systems are most commonly guided to their targets by radio signals (for example, the British Javelin⁶) or laser beams (the Swedish Bofors⁷ RBS 70). These so-called second- and third-generation systems, like the Soviet 9K38 Igla (SA-18) and Chinese FN-6, are capable of engaging target aircraft from the front, rear, and side (‘all-aspect’ tracking), and are typically

better at distinguishing the target from simple countermeasures such as pyrotechnic flares and background radiation. While SACLOS guidance was incorporated into some systems fielded in the 1980s, passive IR seekers remained the norm.

Later-generation MANPADS are faster and have a longer range than their predecessors. Today’s most advanced MANPADS can effectively engage aircraft at ranges of up to 8,000 m from multiple directions and at altitudes of up to 5,000 m (Saab, 2015). Some high-velocity missiles can travel at more than Mach 3 (Thales, 2012). Improvements to warhead design and the use of proximity fuses have also increased the lethality of MANPADS. The Saab BOLIDE missile features an ‘all-target’ warhead with a limited capability to engage lightly armoured targets such as certain helicopters, ground-attack aircraft, and even ground vehicles (Saab, 2016).

Designers have also sought to make missiles more accurate and increase their resistance to countermeasures.

The Russian 9K333 Verba, for example, features a three-channel seeker, enhancing accuracy and improving the seeker’s ability to filter out interference, thus improving its performance against countermeasures.⁸ Other relatively recent advances include the incorporation of MANPADS into automated command-and-control systems, which allows for the use of targeting data from large radar and other platforms, and the integration of MANPADS into wider air defence networks.

MANPADS and their missiles have been built in large numbers and exported widely, sometimes without stringent controls or oversight. As of the end of 2016 at least 105 countries—in addition to non-state actors—possess (or have possessed) these weapons (SIPRI, n.d.). While states hold most MANPADS, more than 72 non-state armed groups in more than 20 countries possess or have possessed MANPADS (Rigual, 2014). This is the result of deliberate government policy, seizure on the battlefield, lax export controls, and poor stockpile security. Illicit MANPADS have even been offered for sale on social media platforms (Jenzen-Jones and Rice, 2016). The majority of MANPADS held by non-state actors are first-generation models, particularly the SA-7b (Rigual, 2014; USDoS, n.d.). Non-state actors have, however, acquired and used second- and third-generation models in recent conflicts. In Syria, for example, rebel groups possess Russian 9K338 Igla-S



A 9K32M Strela-2M MANPADS and its 9M32M SAM.

Source: US Department of Defense



A Swedish Saab RBS 70 NG CREWPADS firing a BOLIDE 'all-target' SAM.
Source: Saab

and Chinese FN-6 MANPADS, among other types (Schroeder, 2014).

Governments control the export and stockpiling of MANPADS, and operate monitoring and buyback programmes in conflict-affected states in order to prevent illicit proliferation and mitigate the threat from diverted missiles. Nevertheless, many governments and regional organizations deem the stockpile management procedures for tens of thousands of these weapons to be inadequate (Schroeder, 2007). The United States alone has destroyed more

than 34,000 MANPADS in more than two dozen countries and has improved security in depots holding thousands more missiles.⁹ While such initiatives have eliminated part of the proliferation threat, they are not a panacea. Destroying surplus stocks does little to address the threat from missiles already outside of government control, and buyback programmes never retrieve every diverted missile. As a result, a number of 'technical use controls' have been proposed for guided light weapons, ranging from the ability

to remotely disable systems to a comparatively sophisticated 'controllable enabling' model, similar to the permissive action links (PAL) used with some nuclear weapons (Jenzen-Jones, 2015).¹⁰ While these controls remain largely theoretical, the latest iteration of the Polish PPZR Grom MANPADS includes 'anti-proliferation measures' that require an 'activation code' to be entered via a keypad (Schroeder, 2015; Jenzen-Jones, 2015).

MANPADS are designed to function for many years, which makes many old models still viable. A shelf life of ten or even twenty years is not unheard of, although storage conditions can affect a system's longevity.¹¹ The two SA-7b MANPADS missiles fired at an Israeli airliner in Mombasa, Kenya, in 2002 were manufactured in the 1970s (UN, 2003, pp. 29–30; Richardson, 2003). In some cases where batteries are no longer functioning or unavailable, non-state actors have used improvised batteries or other power sources. This technique has been documented in Syria, Libya, and elsewhere.¹² Such innovations and the continued proliferation of factory-made systems and components to non-state groups underscore the persistence of the MANPADS threat. ■

Sourcing

This Research Note is based on Eric G. Berman and Jonah Leff, 'Light Weapons: Products, Producers, and Proliferation', *Small Arms Survey 2008: Risk and Resilience*, Cambridge: Cambridge University Press, pp. 7–41. The first edition was updated by Eric G. Berman and Matt Schroeder. The second edition was updated by N.R. Jenzen-Jones.

Notes

- 1 Short-range SAMs generally have maximum ranges of less than 10,000 m. Medium- and long-range SAMs have maximum ranges more than ten times those of short-range models.
- 2 Particularly in cases where technology was transferred to former Soviet republics and client states, and a commercial licensing model did not exist.
- 3 For example, a Greek industrialist affiliated with the licensed production of the Stinger shared proprietary information on the missile with the Soviet Union (Anastasi, 1987a; 1987b).



A Libyan rebel holds a man-portable air defence system in Ras Lanouf, eastern Libya. March 2011.
Source: AP Photo/Hussein Malla

- 4 Other guidance types have seen limited use, including the hybrid SACLOS–MCLOS (manual command to line-of-sight) guidance system of the British Blowpipe.
- 5 ‘Slant range’ is the ‘line-of-sight’ distance between the weapon and target (in contrast to the vertical altitude of the target).
- 6 Not to be confused with the US anti-tank guided missile of the same name.
- 7 Now Saab.
- 8 Improving on the seeker deployed on the Igla series, which uses two separate IR sensors that cross-check against each other, the Verba’s seeker uses three such sensors, making it even harder for a target aircraft to confuse or nullify the system using decoys (Karpa, 2014).
- 9 Small Arms Survey correspondence with the US Department of State, 15 March 2017.
- 10 The effects could vary, but could include enabling the weapon for a limited and predetermined period of time. Because a PAL would be relatively complex, it could feasibly include other technical-use controls, such as biometric requirements or remote-kill switches (Jenzen-Jones, 2015).
- 11 The thermal batteries used in MANPADS have long shelf lives, but once they are activated to power up the missile and guidance system they only function for a period of minutes at most.
- 12 See, for example, Smallwood (2014).

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