small arms survey

Research Notes WEAPONS & MARKETS

NUMBER 16 • UPDATED JUNE 2017

Anti-tank Guided Weapons

The term 'anti-tank guided weapon' (ATGW) is applied to a range of weapons, including guided mortar projectiles[1] and guided artillery projectiles, but is most commonly used to describe portable guided missiles. The more specific term 'anti-tank guided missile' (ATGM) is also encountered. These weapons were originally designed to disable armoured vehicles, but are frequently employed against other targets, such as personnel, light vehicles, and hardened structures. ATGWs are distinguished from unguided anti-tank weapons, such as the RPG-7 and M72 LAW,[2] by the incorporation of targeting and guidance systems. The missiles fired by ATGM systems are precision-guided munitions that are capable of altering their course during flight in order to more precisely strike a target (Cross et al., 2016). ATGWs offer users the ability to engage targets from greater distances and with greater accuracy than is possible with unguided anti-tank light weapons. These systems vary greatly in terms of lethality, portability, and guidance. Ranges of 2,000–5,000 m are common for most ATGMs; however, modern systems may be capable of extreme stand-off ranges, as in the case of the Israeli Spike-ER, which is effective at ranges of up to 8,000 m (Jones and Ness, 2013).

Three distinct generations of ATGWs have been developed since the 1950s, with each generation largely corresponding to advances in guidance methods. The earliest, 'first-generation' ATGMs operated on the 'manual command to line-of-sight' (MCLOS) principle, requiring an operator to manually guide the missile to target. Broadly speaking, first-generation ATGMs were guided to the target after launch by a wire in the rear of the missile that linked it to the firing unit. The operator often used a joystick to manually control the direction of the projectile. This system required a high degree of skill to operate, and generally necessitated controlling the missile's flight through a magnifying periscope or binocular sights from a fixed position (Fulmer, Jenzen-Jones, and Lyamin, 2016). Independently of their relative effectiveness, a drawback of first-generation models was that the gunner had to remain in the same position while the warhead was in flight. If the target was not effectively neutralized or if other opposing forces were within attacking range, the ATGW operator was often vulnerable.

Spike series ATGW

The earliest first-generation ATGWs were developed when advances in tank armour made traditional anti-tank guns, recoilless weapons, and rocket launchers less effective. During the Second World War the Germans employed the X-7, the first MCLOS system and a precursor to modern ATGMs (Gander, 2000, pp. 136–52). After the war the French SS.10 and German Cobra, both modelled on the X-7, were the first ATGWs available for export, although they remained in production for only a short time (Jane's, 1975, p. 743; 1985, p. 51). In 1963 the 9K11 Malyutka (NATO reporting name: AT-3 'Sagger') became the first Soviet-made man-portable ATGW.[3] The Malyutka was widely exported and, subsequently, widely copied. China, for example, developed a series of missiles in the 1970s and 1980s based on this weapon incorporating upgraded guidance systems and payloads (Jane's, 2009). Early missiles were fired from rails (such as the 9M11) or boxy metal housings (such as the SS.10), while later, slimmer missiles were fired from self-contained launch tubes, effectively making the launcher a reloadable weapon and the missiles in its tube the ammunition.

Second-generation systems, which operated on the semi-automatic command to line-of-sight (SACLOS) principle, saw significant improvements in performance. With these systems, after the missile is launched the operator keeps the weapon's sight trained on the target, and automatic guidance commands are sent to the missile via wire, radio, or laser beam. SACLOS systems require significantly less operator training to achieve proficiency compared to

A Russian soldier fires a Kornet ATGW during a training exercise.
Photo credit: Mil.ru

an MCLOS system and substantially outperform first-generation systems, with accuracy rates exceeding 90 per cent (Berman and Leff, 2012; Fulmer, Jenzen-Jones, and Lyamin, 2016). Moreover, second-generation missiles often have effective ranges of between 2,500 and 5,500 m with warhead armour penetration of up to 900 mm, almost twice the range and effectiveness of first-generation models (Jane's, 2007, pp. 445–509). The United States introduced its second-generation ATGM, the tube-launched, optically tracked, wire-guided missile (TOW), in 1968. France and Germany jointly began producing the second-generation *Missile d'infanterie léger antichar* (infantry light anti-tank missile, or MILAN) shortly thereafter. Since then, US manufacturers have fielded several improved variants of the original TOW. By 2009 more than 660,000 TOW missiles and 15,000 launchers had been procured by national armed forces, making the system the most widely deployed of all ATGWs (Gander, 2000, p. 140; Jane's, 2009).

Despite the advances offered by SACLOS models, operators remained vulnerable to counter-attack due to their immobility. Third-generation guidance systems addressed this problem through the use of passive seekers that guide a missile to the target with no in-flight input from the operator.[4] First developed in the 1980s, these 'fire-and-forget' (FaF) guidance systems allow the operator to reposition immediately after firing. Moreover, FaF systems are often lighter and capable of being broken down into smaller component parts for transportability. One prominent example of an ATGM using a passive seeker is Israel's Spike. The Spike family of missiles includes the MR (medium range), LR (long range), and ER (extended range) variants that are capable of engaging targets at ranges of 2,500, 4,000, and 8,000 m, respectively (Jane's, 2009). The latest generation of ATGWs, including the Javelin and the Swedish Saab Bill 2, also tend to employ a top-attack approach in which the missile executes a 'pop-up' manoeuvre just prior to impact, with the warhead engaging the top of the vehicle, typically the weakest point of an armoured target (Jones and Ness, 2013).

The costs of ATGWs vary considerably. The basic TOW and MILAN missiles, as well as other SACLOS missiles, were reportedly priced at around USD 10,000 apiece in 2007. In 2015 one source put the cost of a TOW 2 missile at nearly USD 60,000. Third-generation systems cost even more (FI, 2007; 2015).[5] While data on unit costs for some systems is available, little is known about the price of many ATGWs. Even when it is possible to obtain information on values for certain contracts, a missile's or launcher's specific price is hard to calculate. Licensing agreements under which unit costs change over time add to the opaque nature of ATGW pricing (see Box 1).

Many of the countries that earlier produced MCLOS systems have chosen to stop production for a variety of reasons: low hit probability, gunner vulnerability, a limited ability to penetrate modern armour, and sufficient stockpiles to satisfy demand. Roughly half of the ATGMs produced are essentially copies of another country's design, such as the 9K11 Malyutka (AT-3 Sagger), TOW, and Spike. As with man-portable air defence systems (MANPADS), ATGWs are held by a great number of states. By one account, more than 100 countries have imported ATGWs for their inventories

Box 1 Licensing agreements and offsets: the case of the Spike in Poland

Israel has exported Rafael's Spike series of ATGWs to several countries since Singapore first purchased the system in 1999. Sales have subsequently been made to Finland, the Netherlands, Poland, Spain, and other states. Between 2000 and 2009 at least 432 Spike missiles, launchers, and complete systems were imported by countries worldwide. This figure remains relatively low because several of these purchases have included licensed production and offset agreements. For instance, a December 2003 deal between Poland and Israel worth PLN 1.487 billion (USD 512 million) covered the sale of 2,675 missiles and 264 launchers with substantial local manufacture involved. The Israeli manufacturer provided initial materials for the Spike-LR, with the Polish company ZM Mesko and Polish partners responsible for producing numerous components. The missiles' warheads, rocket engines (launch booster and sustainer), and launch tubes are among the parts made in Poland, while Rafael supplies the thermal imager, firing post, tripod, and simulators. Under the offset agreements ZM Mesko will deliver 2,000 warheads and motors to Rafael. ZM Mesko has also been able to use some technologies received from Rafael to improve or develop other indigenous projects, such as the Mesko Pirat series ATGWs.

Sources: Dąbarowski (2016); Holdanowicz (2004; 2007); Jane's (2005)

An Israeli school bus damaged by a Kornet missile fired by Hamas. 7 April 2011. © REUTERS/Baz Ratner

since 1950 (SIPRI, n.d.). Significantly, ATGWs have also been documented in illicit arms markets organized around social media platforms (Jenzen-Jones and Rice, 2016; Jenzen-Jones and McCollum, 2017). Despite this, the international community continues to expend more energy and resources on securing and destroying MANPADS—both under and outside state control—than on similar measures for ATGWs.

A wide range of non-state armed groups across the political and ideological spectrum possess ATGWs. Although available reporting is limited, at least several dozens of non-state armed groups are believed to have held ATGWs at some point since 1998 (Rigual, 2014). Some groups possess or have possessed only first-generation MCLOS systems, although a substantial number now possess second-generation SACLOS models. Only a very small number of third-generation systems have been documented outside of state control. Those in possession of SACLOS ATGWs include militias in Iraq, Syria, Ukraine, and Yemen (ARES, 2017). Hezbollah, for instance, has received hundreds of missiles for 9K111 Fagot (AT-4 'Spigot'), 9M131 Metis-M (AT-13), 9M113 Konkurs (AT-5), and 9K135 Kornet (AT-14 'Spriggan') models and their copies from Iran and Syria (Wezeman et al., 2007, p. 410; SIPRI, n.d.). In April 2011 Hamas notoriously hit an Israeli school bus with a Russian-designed Kornet missile (CNN, 2011). The 9K135, a relatively advanced laser-guided system available with both tandem HEAT and thermobaric warheads, or its 9M133 series missiles have also been documented in the hands of pro-Russian separatists, moderate and Islamist Syrian rebel groups, separatist groups in South Sudan, and Houthi forces in Yemen (ARES, 2017; Ferguson and Jenzen-Jones, 2014; Jenzen-Jones, 2015b; Smallwood, 2014; UNSC, 2017).

While ATGWs will continue to be developed to fulfil their initial role as anti-armour systems, designers will likely place greater emphasis on defeating fortified targets, such as bunkers and other fighting positions. Designers can also be expected to focus on increasing portability (e.g. reduced weight and smaller sizes), technical sophistication (e.g. non-line-of-sight targeting), and cost effectiveness. ■

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. 6–41. The first edition was updated by Eric G. Berman and Jonah Leff. The second edition was updated by N.R. Jenzen-Jones.

Notes

1 For a discussion of guided mortar systems, see Jenzen-Jones (2015a).

2 *Ruchnoy Protivotankovyy Granatomyot* ('hand-held anti-tank grenade launcher') and Light Anti-tank Weapon, respectively.

3 While the 9K11 was deployed on several platforms, its predecessors—the 3M6 Schmel (AT-1 'Snapper') and 3M11 Fleyta (AT-2 'Swatter')—were *only* launched from armoured vehicles or helicopters.

4 The seeker functions by continuously comparing target data captured before launch to what the seeker sees using pattern recognition algorithms, and manoeuvring the missile appropriately. Different seeker types may be used, including infrared, millimeter wave, and others.

5 The significant increase in ATGWs' costs—combined with the complexity of learning how to operate these advanced systems—have resulted in procurers' growing reliance on simulators for training purposes.

References

ARES (Armament Research Services). 2017. Conflict Materiel (CONMAT) Database. Confidential. Perth: ARES.

Berman, Eric G. and Jonah Leff. 2008. 'Light Weapons: Products, Producers, and Proliferation.' In Small Arms Survey. *Small Arms Survey 2008: Risk and Resilience*. Cambridge: Cambridge University Press, pp. 6–41.

CNN. 2011. 'Hamas Claims Responsibility for Missile Strike on Bus that Wounded Boy.' 7 April.

Cross, Kenneth, Ove Dullum, and N.R. Jenzen-Jones with Marc Garlasco. 2016. *Explosive Weapons in Populated Areas: Technical Considerations Relevant to Their Use and Effects*. ARES Special Report No. 1. Perth: Armament Research Services (ARES).

Dąbrowski, Marek. 2016. 'Pirat ATGM—A Nexus Between Spike and Anti-tank Grenade Launchers.' Defence24. 14 December.

Ferguson, Jonathan and N.R. Jenzen-Jones. 2014. *Raising Red Flags: An Examination of Arms & Munitions in the Ongoing Conflict in Ukraine*. Research Report No. 3. Perth: Armament Research Services.

FI (Forecast International). 2007. 'Missile Forecast.' November.

—. 2015. 'Raytheon BGM-71 TOW.' June.

Fulmer, Kenton, N.R. Jenzen-Jones, and Yuri Lyamin. 2016. 'Introduction to the 9M113 Konkurs ATGM.' *The Hoplite* (ARES company blog). 28 July.

Gander, Terry. 2000. *Anti-tank Weapons*. Wiltshire: Crowood Press.

Holdanowicz, Grzegorz. 2004. 'Poland Wins Contract to Build Spike-LR Anti-tank Missiles.' *Jane's Missiles and Rockets*. Coulsdon: Jane's Information Group. 1 February.

—. 2007. 'ZM Mesko Completes Spike-LR Missile Tests.' *Jane's Missiles and Rockets*. 1 November.

Jane's (Jane's Information Group). 1975. *Jane's Infantry Weapons 1975*. Coulsdon: Jane's Information Group.

—. 1985. *Jane's Weapon Systems 1985–1986*. Coulsdon: Jane's Information Group.

—. 2005. 'Polish Live-firing Debut for Rafael's Spike-LR.' *Jane's International Defence Review*. Coulsdon: Jane's Information Group. 1 April.

—. 2007. *Jane's Ammunition Handbook 2007–2008*. Coulsdon: Jane's Information Group.

—. 2009. 'ATGWs Still Hit the Spot: Anti-tank Guided Weapons.' *Jane's Defence Weekly*. 7 September.

Jenzen-Jones, N.R. 2015a. *Guided Mortar Systems*. Research Note No. 51. Geneva: Small Arms Survey.

—. 2015b. 'Kornet Anti-tank Guided Weapon Captured from Sudanese Armed Forces.' *The Hoplite* (ARES company blog). 17 January.

— and Ian McCollum. 2017. *Web Trafficking: Analysing the Online Trade of Small Arms and Light Weapons in Libya*. Working Paper No. 26. Geneva: Small Arms Survey.

— and Graeme Rice. 2016. *The Online Trade of Light Weapons in Libya*. Dispatch No. 6. Security Assessment in North Africa (SANA). Geneva: Small Arms Survey.

Jones, Richard D. and Leland S. Ness. 2013. *IHS Jane's Weapons: Infantry 2013/2014*. London: IHS Jane's.

Rigual, Christelle. 2014. *Armed Groups and Guided Light Weapons: 2014 Update with MENA Focus*. Research Note No. 47. Geneva: Small Arms Survey.

SIPRI (Stockholm International Peace Research Institute). n.d. SIPRI Arms Transfers Database. Accessed 11 April 2017.

Smallwood, Michael. 2014. 'Kornet Anti-tank Guided Weapon Captured by Syrian Islamist Rebels.' *The Hoplite* (ARES company blog). 26 September.

UNSC (United Nations Security Council). 2017. *Final Report of the Panel of Experts on Yemen*. S/2017/81. 31 January.

Wezeman, Siemon, et al. 2007. 'International Arms Transfers.' In SIPRI. *SIPRI Yearbook 2007: Armaments, Disarmament and International Security*. Oxford: Oxford University, pp. 387–439.

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First published: April 2012
Second edition: June 2017

Credits

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