Elements of the Arena Active Protection System include ring of explosive panels at lower margin of turret ring and radar on turret roof.

Active Protective Systems:

Impregnable Armor or Simply Enhanced Survivability?

by Captain Tom J. Meyer

Why Develop Active Protective Systems (APS)?

Your task force's mission is to attack along Axis Mustang to seize OBJ Patton and destroy elements of the 152nd MRR in order to gain depth for the defense and prevent the enemy from attacking into 2nd BCT's northern flank. Your company team attacks with steady momentum and sets its support-by-fire positions. You observe the enemy in his BPs that your S2 had accurately templated, and order your Bradleys to target their TOWs on the enemy T-80s at a range of 2.5 km. They engage, and impact with a cloud of fire and smoke, but to your amazement, they have no effect. The enemy BMP-3s and T-80s immediately engage your positions with their laser-guided AT-10 and AT-11 missiles. Your Bradleys and a few tanks are hit and your team is being attritted at an alarming rate. How is this possible? Why were the TOWs ineffective?

Is this total fiction, or a real possibility in our not so distant future? Various types of active protection systems (APS) are employed by many armies worldwide. They currently do not pose a significant threat to our forces, but as these systems proliferate and technology improves, this picture may change radically.

In the context of armored vehicles, active protection is a defensive system designed to intercept, destroy, or confuse attacking enemy munitions. Active protection systems can be broken into two categories, "active" or "hard kill" systems and "countermeasure" or "soft kill" systems. An active or hard kill system engages and destroys enemy missiles or projectiles before they impact their intended target. It is a close-in system of antimissile defense that creates an active fire zone of protection at a safe distance around the vehicle.[1] Countermeasure, or soft kill, systems confuse and divert the inbound enemy missile with the use of munitions (obscurants), jammers, decoys, and signature reduction measures.

Why develop APS when tank survivability, lethality and mobility have increased dramatically over the last decade? Consider the following reasons:

- Current active protective systems (APS) are designed to counter antitank guided missiles (ATGM), not high velocity, high explosive (HE) or kinetic energy (KE) tank-fired munitions. A system that can defeat modern antitank weapons increases survivability for tank-on-tank duels.

- ATGM production, lethality and proliferation has far outpaced armor protection. This, coupled with advances in top-attack ATGMs and munitions launched by aerial platforms at ranges that far exceed that of direct support (DS) air defense systems, have multiplied the threat to the armor force.

- Latest-generation main battle tanks (MBT) stand at around 60-70 tons, and this figure (mostly driven by armor protection) is perceived by many combat developers as the maximum tolerable limit.[2] The addition of explosive reactive armor (ERA) packages would possibly exceed maximum tolerable suspension limits, thus degrading performance. Moreover, latest generation shaped-charged antiarmor weapons have been purposely developed to overcome ERA, through either tandem or triple warheads, ballistic caps, or a change in the attack profile.[3]

- Awaiting a qualitative breakthrough in armor or ERA is not an option for armored forces that are already outclassed by modern weaponry.

Drozd defensive launchers are visible at the outer edges of the turret, below and outside the smoke grenade launchers. Activated by a radar system that detects incoming rounds, the system's short-range self-defense rockets use fragmentation warheads. (All story photos taken at Omsk, Russia demonstration by Ron Dritlein of TACOM)

- It is simply less expensive to increase survivability by adding an ERA and APS package than by buying or developing new tanks in sufficient quantity. This is more cost-effective to Middle Eastern and Eastern European countries because these packages are fitted to T-55s, T-62s, and T-72s during routine retrofits and are light enough not to degrade automotive performance.

- Furthermore, the future antitank threat will, by definition, be omnidirectional, forcing tank designers out of their cozy frontal arc fixation and into trying to provide virtually the same level of protection all around their vehicles. [4]

Although many countries have developed soft kill or countermeasure systems, only Russia has moved from the concept to production stage to create a truly hard kill, or active system. Current Russian active protection and countermeasure systems include: Drozd, Shtora-1, and Arena.

Drozd

The first operational APS, named Drozd, was developed by the Soviet Union between 1977 and 1982. This system was installed on some 250 naval infantry T-55As (redesigned T-55ADs) in the early 1980s, and was designed for protection from ATGMs and antitank grenades.[5] It used primitive millimeter-wave radar sensors on each side of the turret to detect incoming rounds. A filter in the radar processor was intended to ensure that the system responded only to targets flying at speeds typical of ATGMs. These are engaged by one or more short-range rockets carrying fragmentation warheads (similar to mortar rounds), fired from four-round launchers (one on each side of the turret).[6] Drozd provides maximum overlap and protection only to the forward 60° portion of the turret, leaving the sides and rear vulnerable. The tank crew can change the orientation of the system by rotating the turret.

Drozd suffered from several shortcomings. Its radar was unable to determine threat elevation levels adequately, and the self-defense rockets would almost certainly have caused unacceptably high levels of collateral damage — particularly to accompanying dismounted infantry.[7] The system costs around $30,000 and is reported to have been around 80 percent successful against rocket propelled grenades (RPGs) in Afghanistan.[8]

Shtora-1

Shtora-1 is an electro-optical jammer that jams the enemy's semiautomatic command to line of sight (SACLOS) antitank guided missiles, laser rangefinders and target designators.[9] Shtora-1 is actually a soft kill, or countermeasures system. It is most effective when used in tandem with a hard kill system such as the Arena, which is discussed later.

During the International Defense Exposition (IDEX) held in Abu Dhabi in 1995, the system was shown fitted to a Russian T-80U and a Ukrainian T-84 MBT. The first known application of the system is the Russian T-90 MBT that entered service in the Russian Army in 1993.[10]

The Shtora-1 system comprises four key components, the electro-optical interface station, which includes a jammer, modulator, and control panel; a bank of forward-firing grenade dischargers mounted on either side of the turret that are capable of firing grenades dispensing an aerosol screen; a laser warning system with precision and coarse heads; and a control system comprising control panel, microprocessor, and manual screen-laying panel. This processes the information from the sensors and activates the aerosol screen-laying system. [11]

Shtora-1 has a field of view of 360-degrees horizontally and -5 to +25-degrees in elevation. It contains 12 aerosol screen launchers and weighs 400kg. The screening aerosol takes less than 3 seconds to form and lasts about 20 seconds. The screen laying range is between 50-70 meters. [12]

The Shtora system jammers are the two boxes at either side of the gun tube. Grenade dischargers are at the rear of the turret.

The system is activated when the laser warning system detects the threat laser system. The tank commander (TC) presses a button that automatically orients the turret in the direction of the threat. It then triggers the grenade launchers. The aerosol screen is effective over a frequency band of 0.4-14 Em. The composition of this cloud is claimed to screen the tank against laser rangefinders and designators and is also claimed to be sufficiently hot to seduce IR homing weapons away from the MBT. The electro-optical jammers, designated TShU1-7, introduce a spurious signal over the 0.7-2.5 Em band, into the guidance circuitry of the incoming ATGM through the use of a coded pulsed IR jamming signal. The jammers provide coverage over 20 degrees in azimuth on each side of the main armament and through 4 degrees of elevation, and is effective within 2 seconds of target identification. It is claimed to be effective against Western ATGMs such as TOW, HOT, MILAN and Dragon, as well as Eastern Bloc ATGMs such as the AT-3. The TShU1-7 has a specified life of 1,000 hours, a mean time between failures (MTBF) of 250 hours, and a radiation source of 50 hours.[13]

Shtora-1 has three methods of operation: fully automatic, semiautomatic/target designation, and manual and emergency mode. According to the manufacturer, the system reduces the hit probability by the following factors: TOW and Dragon, Maverick, Hellfire, and Copperhead laser seeker systems by a factor of 4-5:1; MILAN and HOT by 3:1; Artillery and tank projectiles fired from systems with laser rangfinders by 3:1.[14] There is no reference to success against the Russian AT-4 and AT-5 or cannon-launched laser beam riders like the AT-10 and AT-11.

Shtora-1 is currently installed on the T-80UK, T-80U, T-84 and T-90 MBTs and offered for installation on other armored vehicles during retrofit. It is available for sale on the open market.

Arena

The Arena defense aid suite (DAS) was developed by Russia around 1993 and currently has no counterpart. The Russians have demonstrated the system to the Germans and French, and it is reported to have performed as advertised. The French were involved in further development of the system, as of 1997. [15]

Arena is intended to protect tanks from antitank grenades and ATGMs and top-attack munitions, including ATGMs launched from aerial platforms. When these threaten the MBT, the computer system automatically activates the active defense system with a reaction time of .05 seconds.[16] Arena is fully automatic and provides a very high degree of protection through 300° with a dead area to the rear of the turret.

The system is switched on from the commander's control panel, then operates automatically. On completion of the serviceability self-control check, the system operates in combat mode. All information on the modes of operation and status of the system and its integrated units is displayed on the control panel.

In combat mode of operation, the multidirectional radar mounted on the roof of the MBT constantly scans for approaching ATGMs and locates any target approaching within 50 meters of the tank within the designated speed band. The radar then operates in the target-tracking mode, locking onto the target at between 7.8 and 10.06 meters from the tank, and enters target data into the computer. After processing this data, the computer selects the countermunition (CM), one of the rounds of protective ammunition that are housed in 20 silos around the turret, and fires a small projectile (similar to a Claymore mine) into the path of the approaching ATGM. At the determined moment, the computer generates command signals via a converter unit to the selected ammunition. The ammunition detonates 1.3 to 3.9 meters from the target, generating a directed field of destructive elements, which destroy or disable the target to levels which are no longer dangerous. After .2-.4 seconds, the system is ready to repel the next target.[17]

Arena will not respond to false images or targets such as: small caliber projectiles, targets flying away from the tank, targets outside of the 50 meter envelope, or slow-flying objects, such as pieces of earth. Additionally, the system does not respond to shells or projectiles exploding around the tank, or targets whose trajectory does not cross a protected portion of the tank.[18] The concern for dismounted infantry is considered, with a danger zone identified 20-30 meters around the tank. Arena is day- and night-capable and operates in any climate or terrain. Arena is reportedly effective against TOW, HOT, MILAN and Hellfire, as well as man-portable AT-4 and LAW 80. Again, there is no reference to its effectiveness against Russian-designed

ground-launched ATGMs or cannon-launched ATGMs. By mid-1997, the Arena system remained at the prototype stage and is understood not to have completed its developmental phase.[19]

Arena is expensive, costing around $300,000 per copy. [20]

Drozd and Shtora-1 are designed to be used with hull and turret ERA packages. Tanks equipped with Arena have ERA packages mounted on the hull. If the system's munitions are not effective in stopping the incoming projectile, the tank is still protected by ERA. Arena's ammunition panels, located around the turret, act as the turret's ERA, providing protection if the selected ammunition fails to function.

IFVs versus Tanks

There are several possible reasons why the Russians have not mounted APS on BMPs or other IFVs. A hard kill system may not destroy the entire incoming projectile. Tank base armor and ERA provide protection against any residual fragments that may survive a hard kill detonation. BMPs do not have this level of protection, or the suspension systems capable of carrying additional armor plating and ERA. Additionally, the cost factor makes it more advantageous to protect tanks, rather than IFVs. The BMP-3 can be replaced for $800,000, while a T-80U costs around $2 million.

Western "Countermeasure Systems"

It appears that the Russians developed Drozd to counter RPG and ATGM threats in Afghanistan. Shtora and Arena followed, with the hope of sales to former Soviet arms customers. While many nations have developed soft kill systems, few have shown any interest in hard kill systems until recently. Research and development costs, coupled with dwindling defense budgets and a perceived lack of an antiarmor threat to modern armor seems to account for this lack of interest.

Next-generation soft kill systems will include a laser warning receiver (LWR) that automatically cues the system to the incoming projectile. Currently, this is not a characteristic of all soft kill systems. The Japanese were actually the first to introduce laser warning receivers combined with a countermeasure system on first line AFVs. Their Type 90 tank includes a soft kill system. Sweden is currently developing a sensor-initiated hard kill system for its armored fighting vehicles. France and Israel currently employ systems similar to Shtora-1 on their tanks. Poland has developed and employs soft kill systems on AFVs. The UK, Canada, Israel, and the U.S. are all researching hard and soft kill systems.

The GALIX System

The French Galix countermeasure system mounted on the Leclerc MBT consists of an electrical control unit and launching tubes set into the rear of the turret. Galix is turret mounted and provides 360° protection. It can fire 80mm smoke rounds, anti-personnel rounds, or decoy rounds out to 30-50 meters, in single rounds or in salvoes. The Galix system reaction time is less than one second and is reported to protect Leclerc against any known weapon on the battlefield.[21]

The Galix 13 smoke round can produce a smoke screen that includes visual and multi-band screening agents, over an arc of 120° to the front of the vehicle, that can last up to 30 seconds. This screen can blind any optically or IR-controlled weapon system. The IR decoy deviates the trajectory of antitank missiles controlled by an IR seeker. It is operated from the top of the vehicle and is efficient for more than 10 seconds. [22] A major shortfall of the Galix system is the lack of an LWR to alert the crew and automatically cue the system.

Israeli Developments

The Merkava 3 MBT is fitted with the Laser Warning System 2 (LWS-2) advanced threat warning system. The system provides an alert whenever optical radiation is aimed at the vehicle from any direction and warns against a possible enemy presence and attack intentions in real time. The indication includes the type of radiation, such as IR searchlight, laser rangefinder, or laser designator. The Merkava 3 is believed to be the first MBT fitted with a threat warning system as part of its standard production.[23]

The Israeli POMALS system operates similarly to Shtora-1, and is designed as an add-on or retrofit package. It features the LWS-2 that identifies incoming radiation emitted by laser designators/rangefinders or IR sources. The 60mm launch tubes are mounted on the turret to fire a wide variety of munitions that produce countermeasure options, including visible or IR smoke grenades, chaff/flare decoys, HE and antipersonnel grenades, and special munitions. POMALS can be upgraded to incorporate an IFF system.[24] POMALS is currently in its prototype stage.

The Third Eye laser warning system was designed for instantaneous detection of laser rangefinders, designators, and IR searchlights. It indicates the direction and type of threat on a display screen provided for the TC. An audio warning is also provided through the vehicle intercom net. It can differentiate between the various lasers and is insensitive to explosions, flashes, or smoke. According to the manufacturer, the Third Eye system has been in operational use with the Israeli Defense Forces (IDF) and has proven its performance and reliability under field conditions.[25] The effectiveness of these systems is unclear. It is also unclear whether the three Merkava Mk 3 MBTs recently destroyed by the Hezbollah with either AT-3s, AT-4s, or TOWs, were equipped with any countermeasure devices.[26]

United Kingdom Developments

The UK Defense Research Agency is collaborating with British companies under the Ministry of Defense (MoD) and Industry Defensive Aids Systems (MIDAS) program of applied research into low-risk technology that could defeat current precision-guided weapons such as antitank missiles. An extensive trial of available equipment aboard an armored fighting vehicle in the autumn of 1995 successfully demonstrated all aspects, from warning to countermeasures, operating under a central controller architecture.[27]

MIDAS involves system and integration studies, together with investigations of sensor and countermeasure technologies. These include radar and laser warning receivers; electro-optical (IR and ultraviolet) and acoustic sensors for initial detection; confirmation devices such as pulse-Doppler radars; soft kill response (defensive maneuvering, decoys, jammers, and rapid-blooming multispectral obscurants); and hard kill weapons.[28]

Sanders Missile Countermeasures Device (MCD) AN/VLQ-8A jammers were developed in the U.S. at the time of the Gulf War, and 1,000 units were delivered to the Army. However, they were only fielded to the M2A2 ODS Bradley as of 1996. Last year, Lockheed Sanders took the development of IR jammers/decoys a step further by combining one with electro-optical detectors and successfully us-

"Current generation APSs do not possess the capability to engage and destroy kinetic energy projectiles. However, as technological advances in fire control and detection increase, next generation APSs will most likely engage and destroy both ATGMs and kinetic energy projectiles."

ing it on a moving vehicle to decoy an attacking missile.[29]

Boeing**,** under contract with the Defense Advanced Research Projects Agency (DARPA), is developing a small, low-cost, fully self-contained active defense system for military vehicles and high value assets. The system, designated the "SLID," for "small, low-cost interceptor device," will provide protection from missile and artillery threats. Threats are defeated at stand-off ranges of up to 250 meters and include ATGMs, HEAT rounds, mortar rounds, and artillery shells. Boeing is also evaluating advanced SLID applications, including protection of assets from anti-radiation missiles, cruise missiles, and unmanned aerial vehicle threats.[30]

Counter Active Protective Systems (CAPS)

The U.S. military is not sitting idly while APS technology improves and proliferates world-wide. The CAPS program is designed to counter this threat to our armor force. The purpose of the CAPS program is to demonstrate a suite of technologies that, when applied to current and future Army antitank missiles, will neutralize the effectiveness of threat tanks equipped with any one of a variety of APSs. Technology components of the CAPS suite are expected to include electronic countermeasures, advanced long-standoff warheads, decoys, ballistic hardening countermeasures, and RF electronic countermeasures. These will be demonstrated in a modular component form by FY 98 and in prototype by FY 99 and FY 00. A variety of long-standoff warhead technologies are to be demonstrated by FY 98. This effort is designed to neutralize the effectiveness of threat tanks equipped with any one of a variety of APSs. Funding for this program is around $9.7 million over the next three years.[31]

The systems mentioned are not failure proof, nor do they provide 100 percent protection to all areas of the host tank against an ATGM threat. Hard and soft kill systems have not rendered ATGMs obsolete. It is unlikely they have been tested against the full range of ATGMs available on the open market, especially TOW II, Hellfire, Maverick, or Javelin. Moreover, there is little reference to their ability to engage and destroy simultaneous threat engagements. There is also no reference to the employment, or effectiveness, of any of the Russian systems in Chechnya. Arena is not yet in its production stage and Drozd and Shtora-1 are abundant, but have not proliferated extensively. These are simply additional protection systems that enhance survivability.

Current generation APSs do not possess the capability to engage and destroy kinetic energy projectiles. However, as technological advances in fire control and detection increase, next generation APSs will most likely engage and destroy both ATGMs and kinetic energy projectiles. Technologically advanced countries will continue R&D into advanced APSs called defensive aid suites (DAS). DAS are a collection of hard and soft kill subsystems that operate together, providing an integrated defense against antiarmor precision weapons. ERA and base armor provide the last tier of a DAS. These advances will pose a significant threat to our ability to acquire, engage, and destroy threat armored vehicles.

Shtora-1 and Drozd performance video tapes are available at the Threat Office, Directorate of Force Development, USAARMC.

Notes

[1]Kashin, Valery, "Arena: Active Protection System For Tanks," *Military Parade,* May-June 1996, p. 2.

[2]Bonsignore, Ezio and Ian Bustin, Towards "Electronic Armour," *Military Technology,* Dec. 1993, p. 10.

[3]Ibid, p. 10.

[4]Ibid, p. 11.

[5, 6, 7]Hewish, Mark and Leland Ness, "Shoot First, Ask Questions Later: Smart Tanks Learn To Fend For Themselves," *Jane's International Defense Review,* Mar. 1996, p. 34.

[8]Danussi, Gerry, Captain, U. S. Army, National Ground Intelligence Center (NGIC) Analysts. Personal Interview, 16 Jan 1998.

[9]Russian Armored Vehicle sales brochure, from the International Defense Exposition (IDEX) 97, Provided to the Threat Branch, Directorate of Force Development, USAARMC from the National Ground Intelligence Center (NGIC), July 1997.

[10]*Jane's Armour and Artillery Upgrades 1997-1998,* p. 158.

[11, 12, 13, 14]Ibid, p. 159.

[15, 16]Ibid, p. 158.

[17, 18] Kashin, p. 3.

[19] *Jane's Armour and Artillery,* p. 85.

[20] Danussi interview.

[21]Ferrard, Stéphane and Gérard Turbé, *The Leclerc System,* Quercy S.A: 1'Imprimerie Tardy, 1992, p. 37.

[22]Ibid, p. 38.

[24]Bonsignore and Bustin, p. 12.

[25]*Jane's Armour and Artillery,* p. 154.

[26]Blanche, Ed. "Hezbollah Turns Up the Heat on Israel," *Jane's Pointer,* Oct 1997, p. 6.

[27]*Jane's Armour and Artillery,* p. 154

[28]Hewish and Ness, p. 35.

[29]Ogorkiewicz, R.M., "Transforming the Tank," *Jane's International Defense Review,* Oct 1997, p. 40.

[30]http://www.boeing.com/defense-space/missiles/slid/slid.htm

[31]http://www.fas.org/spp/military/docops/defense/dtap_dto/we_dto.htm#WE.13.02.A.

Captain Tom J. Meyer, an Intelligence officer, has served as a Chapparal and Stinger platoon leader, battery XO, and assistant S3 with 5th Battalion, 3rd Air Defense Artillery, 8ID (M); as G2 operations officer with 7ID (L); as S2 with 1st Battalion, 23rd Infantry (Mech) and company commander with the 502nd MI battalion at Fort Lewis. Currently, he is the Fort Knox Threat Manager and Threat Branch Chief, for the Directorate of Force Development at the U.S. Army Armor Center. He holds a BBS in Political Science from Hardin-Simmons University and is a graduate of ADOBC, MIOAC, CAS3 and CGSC.

E-mail: meyert@ftknoxdfd-emh13.army.mil Phone: DSN 464-7563 or commercial 502-624-7563.