Krasnopol-M 155-mm

Krasnopol: A Laser-Guided Projectile

By Walter L. Williams and Michael D. Holthus

Technological advances in foreign precision weapons and their components are having a revolutionary impact on US combined arms doctrine and tactics. Currently there are three members of the family of advanced artillery munitions that are forcing a change in how we deploy and fight. They are semi-active laser-guided projectiles, course-corrected munitions and fuzes, and sensor-fuzed munitions.

The purpose of this article is not to discuss all these advanced artillery munitions. Rather, it focuses on the semi-active laser-guided projectile known as "Krasnopol"—the description of the projectile and its capabilities, its proliferation, the training required for it, employment of it and countermeasures to Krasnopol.

Description and Capabilities. Krasnopol is a Russian-developed and Russian-produced projectile designed to defeat armored vehicles; multiple rocket launchers; self-propelled artillery systems; command, control, communications, computers, and intelligence (C^4I) centers; defensive fortifications; bridges; and water crossings.

Fielded in 1987, Krasnopol provides cannon artillery units several advantages. First, these units can fire at individual targets—to include pinpoint targets such as tanks, infantry fighting vehicles (IFVs), field fortifications, etc.—with a high probability of a first-round kill. Thus, the traditional requirement for an area fire or artillery barrage is eliminated. Second, a tube artillery unit can fire at group targets using the same gun settings computed relative to the center of mass of the group target.

Third, the Krasnopol can be fired without meteorological and ballistic data at a range not to exceed 10 to 12 kilometers. This last capability stems from the "footprint" of the seeker (about 2,000 meters long and about 1,600 meters wide) that allows the projectile to "see" the designation spot regardless of Met-induced deviations coupled with sufficient projectile mobility to steer the projectile back to the designated target.

Krasnopol Variants. Krasnopol is produced in three variants derived from the 152-mm Krasnopol: the Krasnopol-M 152-mm, Krasnopol-155 (KM-1) and Krasnopol-M 155-mm (KM-2). (See the figure.)

The base round for the three variants is the Krasnopol 152-mm (3OF-39). It is a two-section projectile designed to operate with both towed (D-20, 2A36 and 2A65) and self-propelled (2S3, 2S5, and 2S19) guns and howitzers. Originally, it was designed for operation with the D-20 and 2S3 howitzers. The Krasnopol 152-mm requires a special charge when fired from 2A36 and 2S5 guns.

However, a drawback to this round is its incompatibility with the autoloader of the 2S19 and ammunition stowage cells on all self-propelled howitzers due to the projectile's length. This characteristic led to the development of the first variant, the Krasnopol-M 152-mm. This single-piece projectile is about 600-mm shorter than the original and fits into the 2S19 autoloader.

The second variant of the Krasnopol was the modification of the original round to allow it to be fired from 155-mm howitzers. The Krasnopol-155 (also known as KM-1) has a 155-mm slipping obturator and a bourrelet to ensure ballistic stability in larger bore howitzers. The third variant, Krasnopol-M 155-mm (also known as KM-2) was developed for use in 155-mm howitzers. It is based on the shorter Krasnopol-M 152-mm and has a slightly larger diameter obturator to fit the rifling on 155-mm cannons.

Comparison of Krasnopol to Copperhead. The information in the figure is from the Krasnopol producer and compares the operational characteristics of the Krasnopol, Krasnopol-M and the US Copperhead laser-guided munitions. Copperhead is the only artillery-delivered laser-guided munition in the US inventory.

Both the Krasnopol and Krasnopol-M are superior to the Copperhead in the areas of range, projectile weight, target types engaged, attack profile and operational field handling. However, there is a 15 percent range difference (three kilometers) between the Krasnopol and the Krasnopol-M.

Operating the Krasnopol. The Russians designed the Krasnopol to operate within an assigned sector or what could be referred to as a "shoot straight ahead" philosophy. A Krasnopol-equipped battery normally is assigned a specific operating frequency for the laser target designator. For example, in a Krasnopol-equipped battalion, Battery A would get one frequency, Battery B, a second frequency, and Battery C a third for operations within their respective sectors of operation.

The frequency setting on most of the rounds ranges from three (for the Krasnopol) to 30 (for the Krasnopol-M). There is a switch at the base of the 3OF-39 and the KM-1 Krasnopol projectiles that the operator turns to set the frequency.

The Krasnopol-M has six switches on the outside of the projectile that set the following: time of flight to ballistic cap removal (two switches), glide/ballistic mode (one switch), frequency setting (two switches), quick or delay fuze setting (one switch).

Normally, the frequency setting switches are adjusted upon receipt of the projectiles at the unit ammunition supply point and before being stored in the howitzer. However, the time of flight, glide/ballistic mode and fuze settings are mission dependent. Therefore, these settings are prepared before firing a mission.

These three settings must be accomplished in less than one minute during the prep for firing. For example, one crewmember may be adjusting the frequency while another is simultaneously

preparing the charges. Therefore, the difference in the Krasnopol and Copperhead preparation times is not significant.

The 2K25 Krasnopol complex includes the 3OF-39 Krasnopol projectile; a 1D22, 1D20 or 1D15 laser target designator (LTD); and the 1A35 shot synchronization system (1A35K command device and 1A35I observation post device). Normally, an LTD operator aims a laser at a target and one to two rounds are fired for target engagement. A signal confirming the firing of the projectile is transmitted from the firing unit (via a communications link from the 1A35K to the 1A35I) to the battery command observation post (COP).

The LTD operator continues to illuminate the target with a laser beam during the terminal phase of Krasnopol's flight. The Krasnopol's gyroscopic homing head locks onto the target beam, and aerodynamic control surfaces (on the projectile body) guide the projectile to the target. Once the target is destroyed, the LTD shifts to another target and continues to engage either planned targets or targets of opportunity.

Most foreign users are employing Krasnopol in the manner in which it was intended—that is, engaging dug-in fighting positions. Infantry with crew-served weapons, anti-tank guided missiles positions and observation posts, entrenched or with overhead cover, are notoriously difficult to destroy with indirect fire, even when fires are observed. One or two Krasnopol projectiles can destroy these positions quickly, and the number of rounds dramatically reduces the chances of counterfire.

Laser Warning Devices. Although the observers have to be able to see the target to designate it, the infrared laser pulses are invisible to the naked eye. The pulses are only visible if observed through a platinum-silicide (PtSi) CCD camera (similar to a home video camera) or night-vision devices operating in the near-IR spectrum (0.7 to 3.0).

Laser-warning receivers mounted on vehicles and equipment can detect the laser pulses. Various open-source publications disclose that western laser-warning receivers are more sensitive than Russian laser-warning receivers.

In several instances, laser-warning receivers have been mounted on various former East European armored vehicles. However, there are no laser warning receivers fielded on US Army armored vehicles.

Proliferation. The original Krasnopol and its variants are proliferating rapidly. The projectile has been sold to at least 12 countries in Africa, the Middle

Characteristics	Krasnopol (3OF-39 & KM-1)	Krasnopol-M (KM-2)	Copperhead
Caliber (mm)	152/155	152/155	155
Firing System (The systems on this row are presented as examples for each projectile caliber.)	Towed: D-20, 2A36, 2A65, TR-1, M198, G-5 SP: 2S3, 2S5, 2S19, M109 Series, AU-FI	Towed: D-20, 2A36, 2A65, M114A2, M198, G-5; TR-1 SP: 2S3, 2S5, 2S19, M109 Series, G-6, AU-F1, FH-77B	Towed: M114A2, M198 SP: M109A2/3, M109A6
Range (Km)	20	17-20*	16
Warhead Type	Frag-HE	Frag-HE	HEAT
Length (mm)	1,300	955	1,370
Weight (Kg): Projectile	50	43	62
Warhead	20.5	20	22.5
Explosive	6.5	6.2	6.7
Targets Engaged	Armored Vehicles, C^4I Posts, Field Fortifications	Armored Vehicles, C^4I Posts, Field Fortifications	Armored Vehicles
Target Attack Profile	Diving Top Attack	Diving Top Attack	Laser Illuminated Point
Range Assist	Rocket Motor	Base Bleed	None
Guidance: Initial Phase	Free Flight	Free Flight	Free Flight
Middle Phase	Inertial	Inertial	Inertial
Terminal Phase	Semi-Active Laser Homing	Semi-Active Laser Homing	Semi-Active Laser Homing
Max Field Storage Time without Shipping Case	No Restrictions	No Restrictions	No longer than 72 hours inside SP artillery systems in polyethylene bag.
Seeker Head Protection While Handling the Projectile	Protected by a nose cap discarded in flight.	Protected by a nose cap discarded in flight.	None. The seeker head must be protected from impact.
Pre-Fire Preparation	Connect both parts of the projectile.	Same as a standard conventional munition.	Before loading, seeker dome and tail fin slots must be inspected for damage and contamination.
Requirements for Loading	Same as a standard conventional munition.	Same as a standard conventional munition.	No sand, dust or moisture. The projectile must be protected from impact with other surfaces.

*Depends on the length of the gun tube and charge scheme of firing the weapon. It has been reported that Krasnopol-M eventually exceeded 22 kilometers when fired from 155-mm/52 caliber cannons.

Legend: **C^4I** = Command, Control, Communications, Computers and Intelligence; **Frag-HE** = Fragmentary High Explosive; **HEAT** = High-Explosive Antitank; **SP** = Self Propelled

Krasnopol and Copperhead Comparative Operational Data

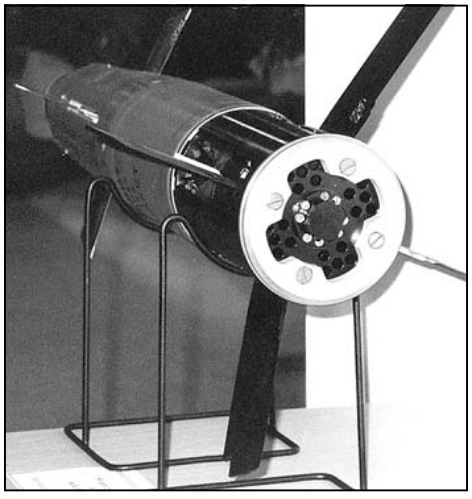
East and Asia. At least nine other countries are considering purchasing the projectile. The Russians have used the Krasnopol in combat in Chechnya and Dagestan. Additionally another foreign buyer recently reported destroying eight of 10 tanks engaged during a combat situation.

Known buyers include China, India, Ukraine and Belarus. China is currently producing both the 3OF-39 Krasnopol and the 155-mm version of the Krasnopol-M.

India, in particular, is an interesting case study. Reportedly India fired between 500,000 and 700,000 medium-caliber artillery projectiles in the recent fighting in the Kargil Region. In spite of these vast expenditures, many of the insurgent positions still had to be assaulted and destroyed by Indian infantry soldiers.

The Indian purchase of the Krasnopol is noteworthy in its scope (initial purchase of 1,000 projectiles with associated laser designators) and potential impact on future operations in the Kargil Region and near the Siachen Glacier. These remote areas are served by rudimentary road networks that make the resupply of large amounts of artillery ammunition expensive and difficult.

Cost-Effectiveness. While Krasnopol may cost $30 to $55 thousand (US) per projectile, conventional ammunition is not cheap, especially when considering the quantities necessary for target destruction or neutralization. Indian officials shopping for replacement ammunition expect to pay between $800 to $1,200 (US) per complete 155-mm round for basic high-explosive (HE) projectiles. Russian calculations indicate the Krasnopol can be 20 to 50 times as effective as conventional HE projectiles.



The Krasnopol-M projectile showing base-bleed gas ports and deployed fins.

Other "hidden" aspects of cost effectiveness include the Krasnopol's ease of handling, storage and transport as compared to conventional ammunition; less tube wear when firing it; and reduced crew fatigue.

Although laser-guided projectiles may be more expensive than conventional HE projectiles on a one-for-one basis, they are more cost effective than conventional projectiles in many cases. In fact, some fire missions, particularly destruction missions at long ranges, only can be accomplished with laser-guided projectiles.

Ease of Firing Table Addendum. Virtually any modern 155-mm howitzer can fire Krasnopol (KM-1) and Krasnopol-M (KM-2) fitted with a 155-mm diameter slipping obtruding band. Before they can be employed in combat, however, a firing table addendum must be prepared for the propelling charges and the howitzer used.

The test team must determine the muzzle velocity for each charge used to fire the Krasnopol and the chamber pressure/acceleration associated with the firing. A ballistically matched dummy projectile (commonly referred to as a slug) is fired with two crush gauges placed in the chamber. A radar is used to determine the muzzle velocity, and the crush gauges are used to derive the chamber pressure/acceleration.

Once the muzzle velocity at a given elevation is determined, a computer can be used to calculate the firing table. This is checked or verified by firing working Krasnopol projectiles and checking the achieved range versus the calculated range.

Training. Russian and other nations' artillery units train under realistic field conditions to use laser-guided munitions. The training includes both gun crews and LTD operators engaging and destroying stationary and moving targets.

The targets are arrayed as a threat or foreign army would deploy forces on the battlefield. Thus, the LTD operator learns the skills required to determine targets and conditions that either enhance or degrade the use of the munition.

Predicting when a target will enter a kill zone is a very difficult task when using a laser-guided munition. Therefore, LTD operators learn how to plan kill zones along avenues of approach or counterattacks to engage and destroy moving targets.

Timeliness is critical during the engagement of a moving target. The likelihood of a Krasnopol achieving a first-round hit is severely reduced if the projectile is not delivered on time. Even the likelihood of a second-round hit is diminished due to the variation in location of a moving target. Therefore, the employment of the Krasnopol is enhanced through the training of units in preplanning kill zones.

Before the engagement, the LTD operator conducts a terrain reconnaissance of the kill zone using the laser rangefinder on the target designator. The LTD operator predetermines the points of engagement covered by the Krasnopol's seeker footprint (one-kilometer radius or a two-kilometer diameter). The gun range and azimuth settings are calculated (in advance) by the battery fire direction center (FDC) and recorded by the gun crew chief. This translates into a higher probability of a first-round hit and the destruction of the moving target. LTD operators and firing units train to the standard of achieving a direct hit on a moving vehicle on the first or second shot.

Another technique is to target an obstacle, wait until the lead element stops to clear the obstacle, then fire the projectiles at the halted vehicle.

Russia is exporting training and doctrinal employment packages to foreign Krasnopol buyers.

Employment. There are many variations in the types of equipment sets for Krasnopol firing units. The various tactical situations and firing systems dictate the overall employment of the Krasnopol.

FM 100-60 Armor- and Mechanized-Based Opposing Force: Organization Guide—soon to be replaced by *FM 7-100.5 Opposing Force (OPFOR) Organization Guide*—lists a typical OPFOR 152-mm self-propelled howitzer battalion as having four sets of the Krasnopol-M. Each set is composed of the LTD (1D22, 1D20 or 1D15), the 1A35 shot synchronization system and 50 projectiles per LTD. Thus, a total of 200 Krasnopol projectiles are fielded to a typical 152-mm self-propelled howitzer battalion.

One battery of the battalion can be designated as the special-weapons or Krasnopol battery. The Krasnopol battery commander designates one pla-

toon (possibly on a rotating basis to maintain crew proficiency) as the principal Krasnopol firing unit. A Krasnopol platoon's basic load consists of the Krasnopol, smoke and illuminating rounds. The Krasnopol firing platoon might retain 140 Krasnopol projectiles while the 60 remaining projectiles are distributed throughout the battalion at a rate of four Krasnopols per tube. One LTD is distributed to each battery COP (three per battalion) and the battalion's mobile reconnaissance post.

The LTD operator uses a concealed location to position the LTD within a 30-degree arc left or right of the gun target line and no more than seven kilometers (preferably five kilometers) from the target. The LTD operator follows standard fire mission procedures in determining the target coordinates.

During engagement, each gun (in the Krasnopol platoon) fires one Krasnopol projectile in succession, either on the LTD operator's command or on a predetermined time sequence with less than 30 seconds between projectiles per designator. Upon destruction of the initial target, the LTD operator shifts the designator to subsequent targets upwind (from the previous engagement) to reduce smoke and dust interference with the designator.

Countermeasures and Counter-Countermeasures. A major shortcoming of employing the Krasnopol (as well as other laser-guided munitions) is the requirement to illuminate the target with the laser beam for five to 15 seconds. Long target illumination times enable enemy targets equipped with laser warning detectors to employ countermeasures that prevent the target from further illumination by the laser beam. Thus, the guidance of the Krasnopol is disrupted, and the target survives the engagement.

The most effective means of protection are laser-warning detectors that automatically cue grenade launchers to fire a number of smoke grenades within two to three seconds after detecting a laser beam. A smoke cloud builds up around the vehicle six to eight seconds after firing. The cloud bends or reflects the laser beam and provides a false homing point for the Krasnopol. In essence, an effective laser protection screen is deployed around the target within eight to 11 seconds after laser detection.

The LTD operator can counter this countermeasure by using an initial laser offset procedure. This procedure requires the LTD operator to first determine a land feature or easily referenced landmark within the kill zone. The operator surveys the kill zone for background conditions that may cause backscatter (from other reflecting surfaces) that would provide the target an early warning of the LTD laser beam.

The LTD operator then lases at the predetermined offset point (15 to 20 meters from the target) at the beginning of the fire mission. The LTD operator or his assistant is alerted to the Krasnopol's appearance in the target area beam either by a "munition approach" light-emitting diode on the 1A35 shot synchronization equipment or a blinking signal light in the optics of the LTD. The LTD operator begins shifting the laser target designator crosshairs toward the center of the target four to five seconds after the signal prompt. He shifts the laser beam from the offset point to the target two to three seconds before the terminal phase of projectile flight.

The offset procedure takes six to eight seconds. Thus, the Krasnopol potentially can hit and destroy the target before the target can employ laser countermeasures. The offset procedure requires a skilled LTD operator due to the requirement for increased hand-eye coordination during the laser beam shifting process.

Another countermeasure procedure is called "fake" or "decoy" designation. The objective of this procedure is to make the vehicle crew react and employ countermeasures, such as smoke grenades, against a LTD position that is at a different angle than the actual LTD position.

This procedure requires two LTD operators or one LTD operator and an observer equipped with a laser rangefinder. Once the target has entered the kill zone, the first LTD operator or the observer lases the target to make the laser-warning receiver cue the vehicle crew to employ smoke grenades as a countermeasure. As the smoke cloud builds up around the vehicle with an orientation toward the perceived LTD position, the second LTD operator lases the target from a different angle and the firing battery fires the Krasnopol projectiles for the engagement.

Conclusion. The United States demonstrated during Desert Storm that the force that initially attains and maintains fire superiority has the advantage of freedom of maneuver and reduced casualties from enemy artillery fire. The Krasnopol and Krasnopol-M provide users the ability to destroy targets at lower expenditure rates and shorter firing times with substantial reductions in the logistical burden.

155 mm Krasnopol-M with stabilizing fins deployed and nose cap/fuze removed.

The proliferation of these rounds is providing potential US adversaries a means to attack and destroy targets ranging from thinly protected C^4I systems to armored vehicles at a critical place and time on a future battlefield. As a niche technology, Krasnopol and other laser-guided projectiles are potential force multipliers for otherwise relatively low-technology forces (including guerrilla forces or terrorists) against a more advanced force across a wide spectrum of conflicts.

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