

Unleashing Fire and Fury: *The TOS-1A's Impact in the Russo-Ukrainian War*

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Introduction

As the Russo-Ukrainian War forges into its second year, the prevailing Western narrative surrounding the conflict fixates primarily on Russian setbacks. Highlighting the apparent demise of Russian forces, it stresses Russian equipment losses, faltering determination among frontline troops, extensive logistical setbacks, and corruption as the driving forces behind this perceived downfall. Undeniably, Russia has experienced significant setbacks and equipment losses on the Ukrainian battlefield. Open-source research group Oryx estimates that approximately 11,800 pieces of Russian equipment have been destroyed, abandoned, or captured since the war's inception.¹ However, the inclination of some Western military analysts to generalize the Russian military's underperformance based on personal biases and flawed analysis may have hindered their ability to recognize successful systems, thus leading to a dangerous tendency to underestimate the true potential of the Russian military.

Amidst underperforming Russian weaponry, the TOS-1A thermobaric rocket system has emerged as an effective tool extensively used by the Russian forces in offensive and defensive operations, guided mainly by a combination of unmanned aerial vehicle (UAV) assets and special operations forces. Even though scrutinizing the ongoing war to draw lessons learned could be premature, preliminary observations may



Figure 1 — Russian TOS-1A Solntsepek 220mm Heavy Flamethrower System
(Photos from OE Data Integration Network)

shed light on how Russia employed specific weapons in the first year of the war. Doing so requires a critical appreciation of Russia's military capabilities and the employment methods of one of Russia's go-to weapon systems. Harnessing open-sourced information and video analysis, this article examines a vast repository of information and footage capturing the persistent deployment of the TOS-1A in Ukraine, showcasing its strong impact that echoes across the battlefield.

History of the Soviet and Russian Thermobaric Weapons

The history of the TOS-1, the predecessor to the TOS-1A, can be traced back to 1971 when then-commander of the chemical forces and former artillery officer, General Vladimir Karpovich Pikalov, began coordination for his troops to employ a multiple-launched rocket system. While the Design Bureau of Transportation and Engineering began designing the vehicle, the Research Institute of Applied Chemistry in Sergei Posad, near Moscow, created the thermobaric warhead that would later be named MO.1.01.04.² An enhanced iteration of the MO.1.01.04 rocket was introduced as the MO.1.01.04M, which features an extended range and a heavier warhead. The warhead comprises a solution of liquid isopropyl nitrate encompassed by magnesium, encased around a bursting charge within the 220mm rocket.³⁻⁴ Upon activation by the MRV-U1 fuze, the bursting charge triggers the release of the isopropyl nitrate and magnesium solution into the surrounding atmosphere, which subsequently undergoes ignition, generating an immense blast overpressure capable of obliterating enemy bunkers and structures at a range of six kilometers. Magnesium serves as a fuel to the mixture and boosts heat production during detonation, creating the bright flash of light often seen in TOS-1A videos.⁵⁻⁶ The peak detonation temperature, soaring to 3,700 degrees Celsius, leads to a sustained post-detonation heat that perseveres even after the initial blast has dissipated.

Those affected by the blast pressure but not killed in the process endure severe injuries such as burst eardrums, internal organ damage, concussions, traumatic brain injuries (TBI), and burns.⁷ One TOS-1A salvo of 24 rockets can inflict devastating damage covering 200 by 400 meters.⁸ In Ukraine, Russian radiological, chemical, and biological defense (NBC) forces have employed TOS-1As with success, and heavy flamethrower systems play a pivotal role in augmenting combat capabilities, effectively bolstering the overall strength of Russian Ground Forces. The firepower unleashed by a salvo of two TOS-1A companies, consisting of six TOS-1A systems, is equivalent to the destructive impact of a salvo launched from a Smerch rocket battalion, typically comprising 18 multiple rocket launchers. Furthermore, according to Russian sources, the destructive potential of the TOS-1A matches the firepower unleashed during a 10-minute assault executed by a regiment equipped with 152mm howitzers, amounting to approximately 54 Msta 152mm self-propelled howitzers.⁹ The TOS-1A system consists of the BM-1 launcher and the TZM-T transport-loader vehicle, which carries additional rockets.¹⁰

Figure 2 — TOS-1 Buratino



Soviet forces extensively employed thermobaric weaponry during their operations in Afghanistan, demonstrating efficacy in neutralizing adversarial forces concealed within caves and fortified positions. In May 1985, Junior Sergeant S. V. Mgar used his man-portable system (RPO) to destroy a fortified Mujahideen strongpoint near Khost, killing four fighters and destroying a mortar system.¹¹ In 1987, a Soviet patrol in Logar Province was attacked from several caves on a mountain slope close to their base. After hours of suppressing enemy forces with small arms and mortars, the unit commander, Sergeant A. V. Sergunov, engaged the enemy with his RPO, killing five Mujahideen and destroying a machine gun and a recoilless rifle that had pinned down his patrol from 500 meters away. During that pivotal era, the Soviet military possessed astute insights into the undeniable advantages of harnessing thermobaric weapons in combat situations. After years of rigorous testing and refinement, the TOS-1 system stood poised for deployment in Afghanistan's challenging theater of war.

In 1988, the USSR launched operations across the Panjir Valley, with elements of the 108th and 201st Motorized Rifle Divisions playing the leading role. On 12 February 1989, three days before the famous video of Lieutenant General Boris Gromov, commander of the 40th Army, crossing the "Friendship Bridge" in Afghanistan, the Soviets deployed the TOS-1 in a devastating attack on a mountain range as their last soldiers withdrew from Soviet garrisons.¹² During combat operations in cities and mountainous terrain in Chechnya, Russian forces used the TOS-1 in the battle for Grozny and Komsomolskoye, proving themselves well in combat operations.¹³

Today, operators typically undergo three months of comprehensive training on the TOS-1A system, which includes immersive sessions within a BM TOS-1A simulator.¹⁴ This training regimen covers many critical aspects, such as firing calculations, scenario-based exercises, safety protocols, and tactical deployment. The simulator familiarizes the crews with the technical intricacies of the TOS-1A, ensuring they are well-versed in its operations. Furthermore, the simulator trains new crews in communication protocols, significantly streamlining the overall training process while reducing associated costs.¹⁵ Russian NBC forces prioritize training for the TOS-1A crews, engaging in rigorous exercises to sharpen their proficiency. For example, the TOS-1A has consistently featured in all annual strategic military exercises since 2018, including Zapad 2021, where Russian forces conducted a large-scale exercise close to the Ukrainian border six months before the invasion of Ukraine began.¹⁶

Offensive Operations

Since the beginning of the "special military operation," Russian Ground Forces have deployed the TOS-1A to disturbing effects by providing direct fire support to advance ground forces during offensive operations. The first images of Russian forces crossing the Ukrainian-Belarusian checkpoint on 24 February 2022, show a company-size element advancing with T-72 tanks, MT-LBs, trucks, and TOS-1As.¹⁷ Generally seen at the NBC defense regiments within the Russian armed forces, the TOS-1A heavy flamethrower company typically supports the army group, combined arms armies, tank armies, or army corps.

On the offense, Russia has opted to deploy a single BM-1 launcher with 8-12 rockets across the line of contact, often using artillery to cover the TOS-1A movement close to the line before firing. On 28 February, four days after Russian troops crossed into Ukraine, 70 Ukrainian soldiers from the 91st Support Regiment were killed by Russian artillery and TOS-1A rockets in Okhturka, Sumy Oblast.¹⁸ On 4 March, Sergeant Sergei Gubarev, whose unit came under intense Ukrainian artillery fire after attempting to cross a river in northern Ukraine, deployed his TOS-1A and, according to Russian sources, cleared the way for his unit when he destroyed 14 Ukrainian weapons in the Chernihiv area. After the TOS-1A attack, Gubarev's motorized rifle brigade crossed the river without damage.¹⁹ During the well-known battle of Mariupol, Russian and "DNR" forces used the TOS-1A to dislodge Ukrainian troops from the Azovstal Iron and Steel Works plant along the Sea of Azov after it became clear that Ukrainian forces were well entrenched inside the plant.²⁰

As the Russian military refocused its efforts on the Donbas following its unsuccessful attacks on Kyiv, the TOS-1A was used extensively in the offensives in Izyum, Lysychansk, and Mykolaiv Oblast (near the village

of Ochakiv) to name just a few sites.²¹ In a notable example, the 1st Army Corps bombed the city of Pisky for seven days in early August. As Ukrainian reinforcements entered the small village from the northwest, around Stepova Street, the Russian 1st Army Corps deployed a TOS-1A to destroy Ukrainian fortified positions. Immediately after using the TOS-1A, the 1st Army Corps resumed its attack westward, breaking through the Ukrainian positions downtown.²² According to Russian sources, the TOS-1A played a critical role in the breakthrough, and by late August, DNR forces controlled the village and hoisted the Soviet flag near the city's center. The breakthrough in Pisky is significant as the tactical employment of the TOS-1A broke Ukrainian defenses in an area where Ukraine had seven years to prepare.²³

In late October 2022, a rifleman and medic with the Ukrainian 59th Separate Mechanized Rifle Brigade found himself in a firefight with members of the Russian 40th and 155th Naval Infantry Brigade who attacked from the southeast corner of Pavlivka, south of Vuhledar. Both brigades had taken massive losses as Russian forces continued to press the attack to take the village, aiming to gain a foothold close to Vuhledar. While repelling Russian attempts to capture the small town, Ukrainian forces intercepted Russian communications stating that Russian naval infantry was preparing to bring a BM-1 launcher to the front line to reduce Ukrainian defensive positions in the city. The rifleman's position, a building in the city's center, became the target of the incoming salvo of 16 rockets, impacting within 50 yards of Ukrainian lines. Even though Ukrainian forces intercepted Russian communications and took cover in the basement of the town's cultural center, Russian forces inflicted significant damage, killing four and wounding five Ukrainian soldiers. The employment of the TOS-1A created a breach in Ukrainian lines, which Russian forces promptly capitalized on. Recognizing the situation's urgency, Ukraine mustered reinforcements from neighboring settlements. Nevertheless, after enduring five months of continuous conflict in the area and the devastation of two Russian naval infantry brigades taking the small city, Pavlivka eventually fell to advancing Russian forces by mid-November.²⁴

The TOS-1A has demonstrated greater efficacy in urban environments, where enemy forces tend to concentrate in significant numbers around fortified structures, which the system can then target to devastating effects. In Bakhmut, private military company (PMC) Wagner and Russian Airborne Forces effectively employed the TOS-1A against Ukrainian strongholds, demonstrating the Russian ability to deliver significant firepower in urban areas.²⁵⁻²⁶ In early April 2023, Ukrainian forces utilized Soviet-era buildings with interconnected fields of fire as part of their defenses in the downtown area located 75 meters northwest of the bridge over Horbatova Street and the Bakhmutka River. Since the buildings provided good fields of fire, gaining ground across the river proved difficult for PMC Wagner. In April, its forces deployed a TOS-1A to break through entrenched Ukrainian positions across the Bakhmutka River, creating a 300-meter gap in Ukrainian lines.²⁷ Using the TOS-1A allowed PMC Wagner to make significant progress, covering a distance of 1.25 kilometers in just one day, a significant achievement considering the previous challenges in the city. By effectively coordinating combined attacks with infantry and armor and employing electronic warfare equipment to disrupt enemy reconnaissance capabilities, the TOS-1A can effectively dismantle fortified positions, proving its worth in urban combat.

Defensive Operations

Russia has also utilized the TOS-1A thermobaric rocket system in defensive operations in Ukraine, employing the system against amassing troops in the open, deterring enemy advances, and maintaining a strong defensive posture, often using the weapon in a final protective fires role at close distances to prevent Russian lines from being overrun.²⁸ In March 2022, in one of the first instances in which Russia acknowledged the use of the TOS-1A in Ukraine, the Russian Ministry of Defense recognized Lt. Alexei Zoteyev, a TOS-1A platoon commander, for repulsing a Ukrainian counterattack destroying 10 Ukrainian vehicles and killing 40 soldiers.²⁹ In the aftermath of the Ukrainian rout of Russian troops in Kharkiv Oblast, Russian Ground Forces switched its focus to defensive operations, utilizing the TOS-1A in final protective fires roles, often at very close ranges, in last-ditch efforts to halt Ukrainian assault forces and prevent significant breaches of Russian lines.³⁰

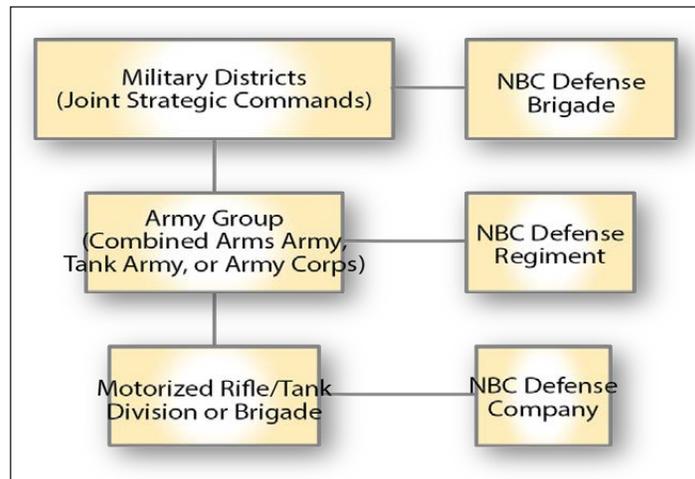


Figure 3 — Russian NBC Defense Units (Graphics courtesy of Dr. Charles Bartles, Foreign Military Studies Office)

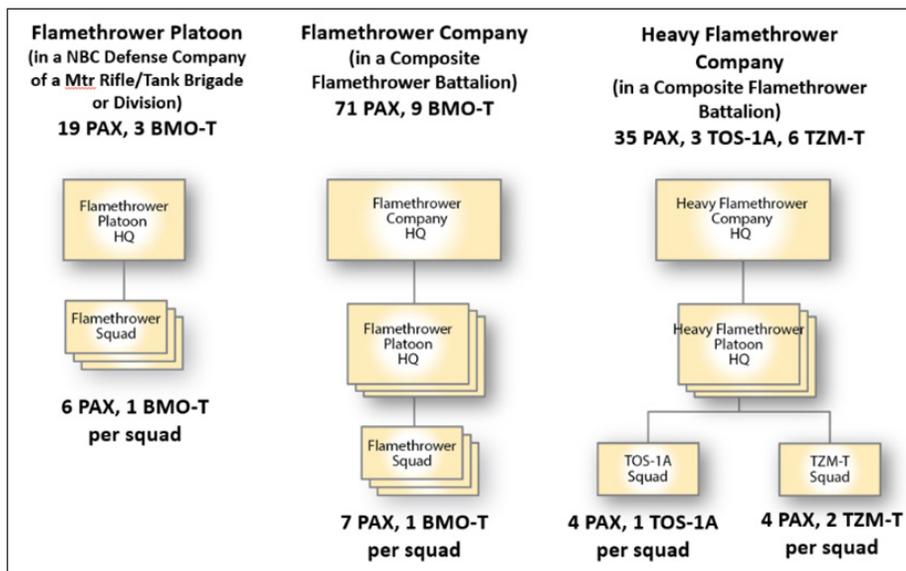


Figure 4 — Composition of Russian Flamethrower Platoons and Companies

For instance, in the late stages of the Ukrainian counteroffensive in Kharkiv, Russia's 752nd Guards Motorized Rifle Regiment, Third Motorized Rifle Division employed the TOS-1A to halt Ukraine's 92nd Mechanized Rifle Brigade, which had just captured Novoselivke, 20 kilometers northwest of Svatove. Feeling pressure on their flanks, Russian troops deployed the TOS-1A against the attacking 92nd Mechanized Brigade.³¹ In a gripping video that circulated on social media capturing a decisive assault, the footage reveals a Ukrainian company-sized element moving towards an assembly line close to Russian defenses. Positioned between a southern rail line and an expansive open field to the north, their movement toward Russian lines was carefully concealed by the protective cover of a dense tree line. Using a reconnaissance UAV to spot Ukrainian forces, Russian Ground Forces deployed the TOS-1A to, what can be seen from the video, good effects and shows its effectiveness in a final protective fires mode. The Ukrainian troops withdrew after the attack, in which Ukrainian forces took heavy casualties. Two weeks later, the Russian 20th Combined Arms Army again executed a final protective fires mission with a TOS-1A against the 92nd Mechanized Brigade in Novoselivke, inflicting casualties again. Likewise, in late November, the Ukrainian General Staff reported that Russian troops had employed the TOS-1A in Stelmakhivka, 14 kilometers from Svatove, to defend the Svatove-Kreminna line from ongoing assaults.³²

The TOS-1A's firepower and the Russian military's effective employment have rendered it a prime target for Ukrainian commanders, drawing the attention of artillery, reconnaissance assets, and UAVs. In their pursuit, Ukrainian units stationed near the forward line of troops appear to have dedicated considerable resources to locating and neutralizing TOS-1A systems after enduring months of relentless targeting. On 14 February 2023, Telegram channels began showing a video of the Ukrainian 72nd Mechanized Brigade destroying a TOS-1A and its ammunition supply point using artillery.³³ In another clip released on social media by the Ukrainian SBU Alpha team, a Russian TOS-1A is destroyed by a first-person view (FPV) loitering munition near the front line.³⁴

Amidst Ukraine's much-anticipated summer counteroffensive, Russian forces swiftly deployed the TOS-1A during the commencement of Ukrainian assaults. An exemplary instance unfolded during the initial days of the counteroffensive, where Russian forces engaged elements of the 9th Ukrainian Corps near the village of Lobkove, situated in Zaporozhzhya. Citing Russian sources, the TOS-1A was employed multiple times to impede Ukrainian forces from consolidating their positions and launching mass attacks. In the village of Pyatikhatki, located south of Lobkove, Russian forces unleashed 96 rockets upon Ukrainian forces as they broke out from Lobkove.³⁵ Russian special operations forces functioned as forward observers, compensating for the obstruction caused by Ukrainian electronic warfare equipment, which hindered the use of drones. Furthermore, on the left bank of the Dnipro River, Russian forces extensively utilized the TOS-1A to forcefully dislodge a Ukrainian bridgehead, exhibiting its devastating effectiveness.

Lastly, recent accounts from Ukrainian soldiers highlight the psychological impact of the TOS-1A during combat operations in Ukraine. Soldiers have reported enduring long-term neuropsychiatric damage resulting from traumatic brain injuries sustained during thermobaric attacks. The consequences of such injuries can encompass a range of physical and psychological symptoms, including fatigue, tremors, confusion, nightmares, and impaired vision. The overwhelming toll of widespread combat can further exacerbate these conditions. The TOS-1A's unmistakable appearance and its well-documented devastating capabilities may instill fear in enemy forces, effectively deterring them from launching subsequent aggressive assaults.³⁶

Limitations

Despite its effectiveness on the Ukrainian battlefield, the TOS-1A has been hampered by significant limitations throughout the conflict. Diverging from most missiles' and multiple rocket launch systems' design that allocate a large segment of their length to the engine and propellant, the TOS-1A predominantly allocates its entire length to the thermobaric mixture. Because of this, the system's restricted range of six kilometers presents a formidable obstacle, leaving it susceptible to detection by contemporary sensors as the system must deploy close to the line of contact.³⁷⁻³⁸ In particular, the proliferation of UAVs has made it easier to detect and track the movements of large, slow-moving vehicles such as the TOS-1A, leaving them vulnerable to artillery fire and coordinated attacks. Notably, the vehicle is equipped with four 81mm Toucha 902B grenade launchers, which discharge ZD-6 smoke grenades, capable of generating an extensive smoke screen spanning up to 30 meters in width and 10 meters in height for 60 seconds. The BM-1 can also create a smoke screen through exhaust fuel injection.

Despite all these upgrades, the TOS-1A system still faces significant challenges regarding battlefield detection. Additionally, the TOS-1A has limited armor protection, ranging from 30-60mm around the hull roof, floor, and sides, and reportedly only able to withstand up to 12.7mm cartridges. This leaves the system vulnerable to artillery, anti-tank-guided missiles, and grenades.³⁹ Another significant limitation is the TOS-1A's reliance on the aging T-72 chassis, which has been known to suffer mechanical failures during combat operations in Ukraine.⁴⁰

Russian method of employment reflects their astute awareness of the TOS-1A's vulnerabilities. Instead of utilizing the system in numbers that would potentially cause greater devastation, Russian forces frequently

opt for employing the BM-1 launcher as a single launcher.⁴¹ This approach enables commanders to position the TOS-1A near the front line, avoiding undue attention to the movement of multiple systems that Ukrainian forces could target and neutralize. Additionally, Russia's TOS-1A inventory, conservatively estimated at approximately 48 units according to Jane's World Armies' open-source reporting, faces challenges in production due to constraints resulting from losses in Ukraine and the existence of rival programs for the T-72 chassis and the 220mm rockets. This complex scenario makes replacing the current losses in Ukraine, currently standing at seven units, a complicated and formidable undertaking.

Conclusion

While it is true that Russian forces have faced significant challenges in Ukraine, generalizing Russian failures is not only inaccurate but also potentially dangerous. As with any military conflict, there are nuances in personnel and equipment performance. In this case, the TOS-1A has proven to be a formidable weapon. In defensive operations, it has halted Ukrainian advances and inflicted heavy casualties. Similarly, when used in offensive operations, the TOS-1A has enabled Russian forces to create gaps in Ukraine's defensive lines, which Russian Ground Forces have exploited to gain ground. To fully comprehend the war in Ukraine, it is imperative to avoid biases and groupthink and evaluate each aspect of the conflict on its merit. Underestimating the effectiveness of a particular system could lead to improper planning and the unnecessary loss of Ukrainian lives. Thus, a complete and unbiased analysis of the weapons employed in the war is crucial to understand the situation and make informed decisions.

Notes

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