SSPC Issue Brief

SILENT WINGS OVER VERMILION SKIES: *Contextualising SEAD and Loitering Munitions in the 2025 India-Pakistan Conflict*

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The issue brief provides an in-depth analysis of the 2025 India-Pakistan conflict, focusing on the strategic use of loitering munitions and Suppression of Enemy Air Defences (SEAD) in modern warfare. It examines the implications of the possible use of these technologies within the context of Operation Sindoor, which India launched in response to the Pahalagam terrorist attack, and the subsequent military exchanges between the two nations. The Brief also explores the use of loitering munitions, such as HARPY and Nagastra-1, during Operation Sindoor, emphasising their precision strike capabilities and reduced risk to personnel. These systems offer significant tactical advantages, including the ability to conduct prolonged missions, target selection, and minimal collateral damage, making them highly effective in asymmetrical warfare. Despite their advantages, loitering munitions face scrutiny regarding accountability, potential for civilian casualties, and the risk of escalating military responses due to their perceived lower risk. The conflict signifies a shift towards the use of unmanned, AI-enabled platforms in warfare, as both India and Pakistan adapt their military strategies to incorporate advanced technologies.

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INTRODUCTION

On April 22, 2025, a brutal terrorist attack mounted by five gunmen in Pahalgam, Jammu and Kashmir, claimed the lives of 26 tourists. The Resistance Front (TRF), an offshoot of Lashkar-e-Taiba (LeT), has been identified as the main perpetrator behind this assault.[1] In retaliation, India launched Operation Sindoor on May 7, 2025, targeting nine sites spread across Pakistan and Pakistan-occupied Kashmir (PoK). These sites, located in Muridke, Muzaffarabad, Kotli, Bhimber, Narowal, Sialkot and Bahawalpur, were selected based on credible intelligence inputs suggesting the presence of terrorist infrastructure run by groups like LeT and Jaish-e-Mohammad (JeM), and were hit using precision strikes to avoid damage to the civilian population and infrastructure.[2] India called these actions "focused, measured, and deliberately non-escalatory", aiming to hold the perpetrators accountable while avoiding direct attacks on Pakistani military facilities.

In the ensuing days, Pakistan and India have seen intense military exchanges, including missile and drone attacks. Pakistan reportedly targeted Indian civilian and military sites, while India neutralised these attacks using Integrated Counter-UAS Grid and Air Defence Systems. Notably, India had also operationalised a strategy consisting of Suppression of Enemy Air Defences (SEAD) missions at several locations within Pakistan, with 'reliable' confirmation that air defence radars and systems in Lahore had been neutralised.

While official sources have not confirmed which military systems were utilised during Operation Sindoor and the consequent military exchanges, there have been speculations regarding the use of loitering munitions. Within the Indian context, some reports have emerged claiming that the country's military may have employed these systems, such as the HARPY, HAROP, and Nagastra, for both the precision strike of the nine terror sites during Operation Sindoor, as well as SEAD efforts. Amid this high-stakes standoff, official statements and media briefings are saturated with this specific technical military jargon, which may have made it challenging for the public to grasp the unfolding events fully.

To help decode the language shaping this crisis, it is therefore important to understand exactly what loitering munitions are, their potential role in SEAD operations, and the debates around their capabilities of functioning without a human operator. This commentary, therefore, aims to clarify the strategic concepts and operational buzzwords dominating the headlines.

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[1] Shilpa Jamkhandikar, "What is The Resistance Front, the militant group linked to Pahalgam attack?" *Reuters*, April 23, 2025.

[2] Deeptiman Tiwary, "Explained: The 9 terror camps in Pakistan, PoK, struck in Operation Sindoor," *The Indian Express*, May 8, 2025.

Understanding SEAD and Loitering Munitions: A Brief Overview

SEAD, or Suppression of Enemy Air Defences, aims to destroy or disable the enemy's air defence systems (like surface-to-air missile launchers or radar sites) so friendly aircraft can operate safely. Sometimes, SEAD is also known as Destruction of Enemy Air Defences (or DEAD).

According to Mike Stuart, Director of Advanced Programs Business Development at the US aerospace and defence firm Northrop Grumman, "The criticality of SEAD/DEAD - most importantly the negating of the surface-to-air missile threat - is a basic tenet in warfare." He further states that SEAD provides 'freedom of manoeuvre on the battlefield', which helps in ensuring engagement at the point when it is needed.[3]

SEAD has a considerable tactical history, as the use of electromagnetic operations underwent significant evolution in the early 20th century. During World War II, Britain's air force made the first attempts to locate, suppress, and destroy enemy air defences using aircraft. After their success of integrating radar, communications, command centres and air defences into a total system during the Battle of Britain, the British adopted tactics to find and defeat similar German equipment. They further developed devices that would amplify and echo back the transmissions from German radar sites, essentially confusing the target radar operator as the radar would detect multiple false aircraft targets. This would suppress radars, giving space to bombers to act.[4]

It was, however, the Vietnam War that SEAD found growing relevance as a specific suppressive tactic within a contested environment. Specifically, the North Vietnamese Army had an established Integrated Air Defence System (IADS) dedicated to the denial of 'blue' freedom of air operations. US forces had, in turn, deployed specific assets to suppress the IADS, creating a precursor for SEAD. Post-Vietnam war saw rapid development in SEAD capabilities, and a commiserate deployment in air campaigns, including (but not limited to) Libya in 1986 (and 2011), the Persian Gulf War in 1991, Bosnia in 1995, Kosovo in 1999, and to a lesser extent Iraq in 2001 and 2003.[5]

While SEAD operations do lend significant air superiority, they are notoriously high-risk. These missions require air-to-ground anti-radiation missiles that may detect and approach radar sites. Another method of carrying them is by jamming radar signals to blind radar operators, and then striking them. For a combat pilot to carry out these actions, however, requires them to approach enemy assets that are

[3] "The Need for SEAD / DEAD," Northrop Grumman, April 14, 2025.

[4] "Operation Sindoor: Lahore Air Defence Radar Site Destroyed – NDTV Explains Suppression of Enemy Air Defence (SEAD) Missions," *NDTV*, May 8, 2025.

[5] Joseph Speed and Panagiotis Stathopoulos. "SEAD Operations of the Future: The Necessity of Jointness." *Journal of the Joint Air Power Competence Centre*, no. 26 (June 2018): 38–43.

designed to detect and shoot them. It is in this context that assets such as loitering munitions have found space in SEAD operations.

Loitering munitions, also known as 'Kamikaze drones' or 'suicide drones', are advanced Unmanned Combat Aerial Vehicles (UCAVS) equipped with explosive payloads, that are meant to 'loiter' over a target area, identify relevant targets, and then carry out precision strikes to eliminate them. Unlike traditional missiles, loitering munitions do not follow a predetermined flight path; they hover over an area for extended periods, collect intelligence either on the known target or identify any suitable alternative target, and then mount an attack on it. It should be noted that currently, most loitering munitions have autonomous mode capabilities.

Loitering munitions were originally a joint USA-West German project, intended to be an affordable radar-homing one-way attack munition designed to suppress or destroy enemy air defences. While the project had been discontinued, the technology continued to develop in West Germany in the form of Drohne Anti-Radar (DAR). However, it only saw military adoption when Israel Aerospace Industries (IAI) developed the HARPY system, which coincidentally had designs similar to Drohne. IAI would later develop the HARPY system further to create HAROP.

The technology has blossomed since, as multiple militaries, including those of China, Taiwan, and within Europe, have started manufacturing systems similar to HARPY. Iran had dedicated significant resources to developing a system identical to HARPY, resulting in the development of the Shahed drone series, that have become its major military export. Turkey has similarly recently developed its own Kargu and Bayraktar series of drones, which have found major demand. The Switchblade drones by the US, as well as the Polish Warmate and Gladius series, are other notable examples of loitering munitions that are currently operational globally.[6]

The loitering munitions have seen significant usage in major conflicts across the world. For instance, the Armenian forces had seen a considerable setback due to Azerbaijan's use of HAROP and Turkish Bayraktar TB2 UAVs to not only conduct intelligence, surveillance and reconnaissance, but to hit Armenian weapon systems during the Nagorno-Karabakh conflict in 2020[7]. Loitering munitions have also seen extensive usage in the Russia-Ukraine conflict, with Ukraine offsetting its relative disadvantage against the Russian military by conducting precision target strikes and Russia using swarm tactics and precision strikes on Ukrainian positions.

The rising interest in loitering munitions is not coincidental; these systems offer significant tactical and operational advantages. These systems, capable of autonomous selection and engagement of targets,

[6] Fabian Hinz and Tom Waldwyn, "Europe comes full circle on loitering munitions". *IISS*, February 2, 2024

[7] Jack Watling and Sidharth Kaushal. "The Democratisation of Precision Strike in the Nagorno-Karabakh Conflict." *Royal United Services Institute*, October 22, 2020.

are considered Lethal Autonomous Weapon Systems (LAWS). LAWS (including loitering munitions) are a potent force multiplier, enabling a smaller number of human operators to accomplish missions that would otherwise require large crews or formations of manned platforms. Unlike humans, LAWS can operate for their entire operational life without fatigue, allowing them to conduct prolonged missions within contested environments without being hindered by human endurance limitations. This also means that these systems can be deployed on battlefields, which may prove dangerous to crewed assets, minimising risk to personnel. LAWS are also known to increase decision effectiveness by shortening the OODA loop (Observe, Orient, Decide, and Act), as they are capable of making decisions faster than humans, and depending upon the level of autonomy afforded to them, executing them as well. This significantly reduces cognitive load on the battlefield commander. Finally, LAWS can also be an effective deterrent, as their presence may mean that any adversarial action towards protected assets will be met with almost instantaneous, automated response, which may complicate the enemy's tactical calculus.

Additionally, loitering munitions have their specific advantages as well; they are more compact than missiles, and their loitering capability allows them to detect and track potential targets for an extended period before engagement. They are also relatively agnostic in terms of launching, as they can be launched from land, air, and sea and can be integrated with a variety of launch mechanisms ranging from man-portable to mechanical carriers. Their utility extends not only to lethality but also to reconnaissance. Loitering munitions have a lower cost compared to other conventional weapons, allowing for their deployment across various areas on the battlefield. Another advantage they have is the enhanced ability to distinguish between potential targets and non-combatants. Unlike mortar and artillery, the autonomous functionality of loitering munitions lets them identify a target and formulate feasible engagement sequences without the need for human input. However, the system does retain flexibility for an operator to abort a previously assigned target and switch to a more suitable one. These drones also provide targeted engagement and minimise collateral damage. Finally, the compact size, low radar cross section, and composite structure of loitering munitions make them particularly difficult to detect by radars and certain classes of sensors, which in turn makes it easier for them to breach enemy air defences. Even if they are detected, the cost of countering loitering munitions is higher for the enemy positions, since the per-unit cost of a missile from an air defence system would likely exceed that of a loitering munition.[8]

However, LAWS (and by extension, loitering munitions) have also come under significant scrutiny. LAWS are a subject of an international debate regarding accountability with respect to Laws of Armed Conflict (LAC) and International Humanitarian Law (IHL). However, loitering munitions. While the

[8] Ahmad Ibrahim, "Loitering Munitions as a New-Age Weapon System"*Centre for Strategic and Contemporary Research,* December 5, 2022

autonomous functions certainly offer operational superiority, particularly in highly electronically compromised and communication-denied environments, the lack of human control may mean that the munitions may choose to attack targets that they shouldn't, leading to escalation issues. There are also considerations regarding loitering munitions specifically, as while they do give asymmetrical advantages, they cannot be considered a substitute for large military assets.

Much like any autonomous system, loitering munitions also rely on datasets and algorithms, and any bias entering during programming, training or execution of the algorithm, or in the dataset itself, makes it prone to error and faulty functioning that could lead to them striking wrong targets (which may even lead to civilian casualties). There is also a real threat that the munition will attack the correct target but cause damage and fatalities to surrounding infrastructure and humans as unintended consequences. The United Nations Human Rights Office of the High Commissioner, for instance, has reported 12 deaths from loitering munitions in Ukraine in November 2024 alone.[9] There have also been concerns that loitering munitions may lower the threshold for military escalation; given that their use provides precise attacks on high-value targets with no risk to personnel, countries may perceive such strikes as 'less provocative', thereby creating potential for quicker and more frequent military responses.

Despite the concerns around their use, loitering munitions are proliferating at an astounding rate within global militaries. As evidenced by the fact that the number of countries producing these systems grew from 10 in 2017, to 24 in 2022, defence modernisation efforts and lessons learned in recent conflicts have led to a global surge in demand for these 'Kamikaze Drones', a trend that can be expected to continue in years to come. [10] The capability for asymmetrical warfare lent by these systems, their endurance, versatility, precision targeting, and cost-effectiveness, makes them indispensable for a variety of operations, including standoffs and SEAD/DEAD missions. Loitering Munitions, in short, have established a strong place for themselves as a conventional weapon category, reshaping tactical doctrines and force structures worldwide.

Situating Loitering Munitions within Operation Sindoor and India–Pakistan military engagement

Operation Sindoor aimed to neutralise terror networks operating across the Line of Control and inside Pakistani territory. This required striking certain time-sensitive targets without triggering full-scale retaliation, making the operation extremely complex. Most of the 9 sites in question were within 30 km range from the LoC and IB, with Bahawalpur being a notable exception (at 100km from IB). India had

[9] United Nations Human Rights Monitoring Mission in Ukraine. "Ukraine: Protection of Civilians in Armed Conflict. November 2024 Update." December 10, 2024.

[10] Ingvild Bode and Tom F. A. Watts. "Loitering munitions: flagging an urgent need for legally binding rules for autonomy in weapon systems." *Humanitarian Law & Policy Blog* (International Committee of the Red Cross), June 29, 2023.

also attacked Pakistan's air defence systems on May 8 and targeted several airbases on May 10. While there has yet to be any official disclosure from the Indian government regarding the weapons used for this mission, loitering munitions have been speculated as one of the possible ways to have executed the strike. In particular, the following loitering munitions have been highlighted:

- **HARPY and HAROP:** Developed by Israel Aerospace Industries (IAI), HARPY and HAROP come with an anti-radiation homing system, which gives them the capability to hover at high altitudes and autonomously strike and destroy radar-emitting targets. HAROP, in particular, has a higher speed, endurance and range compared to HARPY, as well as a man-in-loop feature (HARPY is entirely autonomous) that gives it more control and flexibility. HAROP also has a broader range of systems it can target, while HARPY can only target active radars. These munitions are suited for SEAD operations, as they offer a high degree of stealth, pinpoint accuracy, and minimal risk of casualties. Notably, HAROP drones are manufactured within India through a joint venture of IAI and the Adani group, under the epithet of 'Agnikaa'.
- **Nagastra-1**: Developed as India's first indigenous advanced loitering munition, Nagastra-1 was developed by Pune-based Solar Industries. It is highly portable and suitable for field deployment due to its lower weight and modularity of components.[11] Notably, Nagastra-1 has a parachute recovery mechanism, which makes it easier for the operator to abort the mission, recover and reuse the munition later. It features both remote control and autonomous functionality, with ranges of 15 km and 30 km, respectively. As mentioned before, most of the targets of Operation Sindoor were within a 30km range, which makes Nagastra-1 a plausible choice for strikes as well. Nagastra-1 also offers an additional advantage of being relatively cheaper than drone candidates such as HARPY and HAROP.
- **Skystriker:** The Skystriker munitions have been developed by Israel's Elbit Systems and manufactured within India by Alpha Design Technologies, a subsidiary of the Adani Group. These systems notably have an electric propulsion system that helps reduce noise, making them suitable for covert missions at low altitudes. Its range of 100 km affords it the capability for long-range precision strikes.[12]
- **Warmate:** Developed by the Polish WB electronics, Warmate drones are 'micro loitering munitions'. These have relatively short range and endurance, but provide a highly targeted strike capability. Notably, Indian infantry units in forward posts had been equipped with

[11] "Nagastra-1: India's First Indigenous Loiter Munition Set for Mass Induction." *Indian Defence Research Wing*, December 03. 2024

[12] "This Bengaluru-Based Company Manufactured the Suicide Drone Used in Operation Sindoor to Punish Pakistan." *The Economic Times*, May 08 2025

> Warmate drones under an emergency procurement program, making this the first known combat use of these systems in a large-scale coordinated mission.[13]

As mentioned earlier, it is difficult to determine details of the use of these systems in Operation Sindoor, but there is certainly a high possibility and practicality behind their deployment. Operation Sindoor aimed to neutralise terror networks operating across the Line of Control and inside Pakistan's territory. Given the complexity and time sensitivity of the mission, as well as the absolute need to ensure non-retaliation, loitering munitions may have provided several advantages. Firstly, every munition mentioned above has a high degree of precision strike capability, which meant limited collateral damage and ensured that the attacks were focused primarily on terrorist camps, and could avoid or minimise damage to any of the surrounding civilian population or infrastructure. Secondly, their speed, stealth, endurance, and range would afford India the ability to conduct SEAD missions across Pakistan's territory. HAROP drones, with their ability to home in on radar emissions, may have been instrumental in neutralising the country's air defence systems.

Nevertheless, the reports on the use of loitering munitions and drones in Operation Sindoor underscore their growing strategic importance, as well as the tactical flexibility afforded by them. With these systems possibly debuting in combat roles in the Indian context, they will likely feature and find their roles expanded in future conflicts, especially against technologically advanced adversaries.

Conclusion

The 2025 Indo-Pakistan conflict has marked a historical moment for modern warfare, as it saw possibly the first 'drone' war between two nuclear-armed nations. Beyond India's use of drones for Operation Sindoor, we also saw Pakistan unleashing 'Bunyaan al-Marsoos', wherein over 500 low-cost drones (primarily Chinese commercial-grade drones and Turkish YIHA and Asisguard Songar systems) were launched at 36 military and strategic Indian sites across May 8 and 9, 2025.[14] While India's use of drones and loitering munitions in combat shows their capability for precision strike, experts believe that Pakistan used drones in the same context for 'stress test', resource expenditure, and reconnaissance. These exchanges indicate that unmanned, AI-enabled platforms are increasingly dominating asymmetrical engagements, offering persistent loitering and rapid target acquisition while minimising risk to human pilots.

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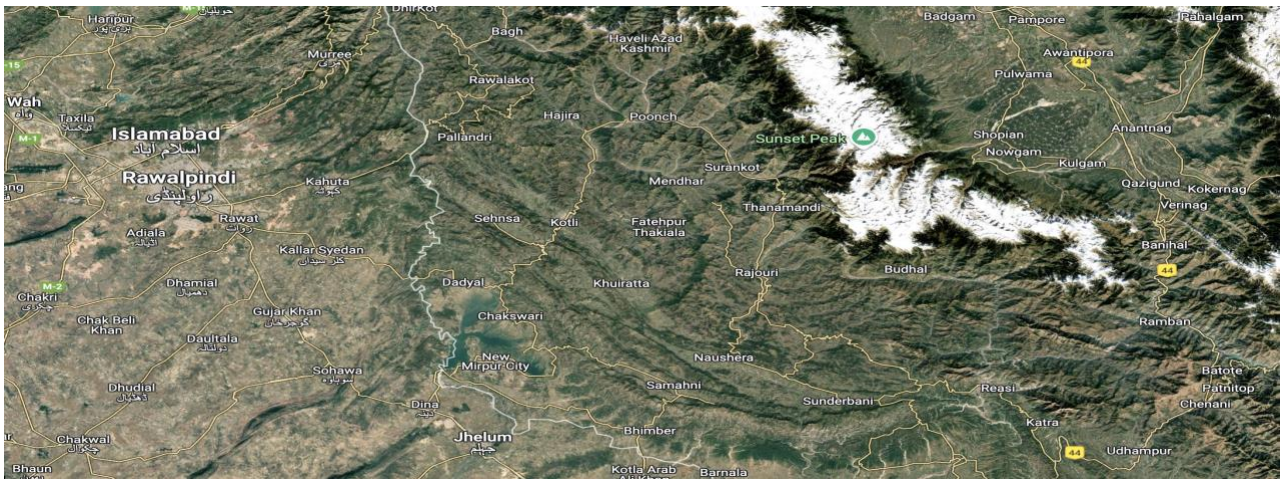
[13] "Operation Sindoor Strike: India's Precision Strikes Signal Paradigm Shift in Counterterrorism Doctrine, Backed by Next-Gen Missile Arsenal." *The Asia Live*, May 08, 2025

[14] "India-Pakistan News: China's PL-15, Turkish Drones Used by Pak Revealed in Operation Sindoor." *DNA India*, 8 May 2025. Also See, Ravi Shankar, "Cheap Drones, Expensive Lessons: Pakistan's New Hybrid Warfare Playbook." *Bharat Shakti*, 9 May 2025

The exemplification of the expanding role of new-age technologies in warfare was not limited to loitering munitions: reports indicate how India's multi-layered air-defence architecture, consisting of the long-range S-400 Triumf, medium-range Akash batteries, and dedicated anti-drone systems, had been instrumental in repelling the swarm sent by Pakistan. This structure highlighted the importance of the fusion of autonomous weaponry across both offensive and defensive domains. Notably, much like loitering munitions, S-400 Triumf is a lethal autonomous weapon system in its own right, employing automated radar tracking and engagement protocols that confer limited autonomy to it. This conflict, thus, provided a glimpse into a future of holistic military infrastructure, with conventional systems, such as missiles, artillery, and missile defence systems working in tandem with newer technologies, including LAWS.

More importantly, there is little doubt herein that the two countries are witnessing a doctrinal shift in their approach to warfare; while artilleries and conventional weapons continue to play a prominent role in cross-border skirmishes, the tactical calculus now also includes low-cost, asymmetric warfare aimed at precision, surveillance and disruption.



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The views expressed in this article are personal.

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