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D.A. Novak[1], V.A. Yunda[2] *

[1] *Research center missile troops and artillery, Sumy*
[2] *Hetman Petro Sahaidachnyi National Army Academy, Lviv*

VIEWS ON THE POSSIBILITY OF EQUIPPING UNITS AND SUB-UNITS OF THE MISSILE FORCES OF THE ARMED FORCES OF UKRAINE WITH UNMANNED LONG-RANGE

The article presents a classification of military-purpose unmanned aerial vehicles and analyses the main characteristics and combat capabilities of existing long-range loitering munitions. Drawing on combat experience, it outlines their principal advantages and disadvantages relative to cruise and ballistic missiles. Considering the roles and primary tasks of the units and sub-units of the Missile Forces of the Armed Forces of Ukraine, as well as the specifics of their tactics of employment, the article draws conclusions on the feasibility and advisability of equipping these units with long-range loitering munitions and offers recommendations on their key characteristics.

Keywords: *strike and reconnaissance-strike unmanned aerial vehicles, long-range loitering munitions, units and subunits of the Missile Forces, missile armament, missile delivery systems, cruise and ballistic missiles.*

Problem statement

The latest type of military unmanned aerial vehicles, which are currently undergoing rapid development, are strike UAVs. The most promising direction for the development of this type of UAV is considered to be the creation of long-range loitering munitions capable of striking important enemy targets deep within their territory, moving towards their designated targets at relatively low speeds, along complex routes at different altitudes. [1]. Faced with the prospect of a protracted, exhausting war with a state that is militarily more advanced, many countries – including Ukraine – have begun to consider long-range loitering munitions as an alternative to missile systems. Thus, a perfectly reasonable question arises as to the feasibility and advisability of equipping units and subunits of the Missile Forces of the Armed Forces of Ukraine with long-range loitering munitions.

Analysis of recent research and publications

The missile forces are part of the missile forces and artillery of the Armed Forces of Ukraine. The missile forces include units and subunits equipped with missile weapons. Missile weapons are understood as a system of firepower assets – including missile complexes and large-calibre multiple launch rocket systems – whose primary purpose is the high-precision destruction of enemy targets.

Units and subunits of the missile forces perform the task of providing fire support to troops (forces) by delivering missile strikes against the enemy's main and most important targets, using missiles and rockets of various types. A distinctive feature of the units and sub-units of the Missile Forces is their ability to engage the enemy around the clock, in all weather conditions, and at short notice in order to achieve specific operational effects. [2, 3]. Based on the roles and primary tasks of the units and subunits of the Missile Forces, as well as the specifics of their tactics, missile weapons and their components must possess certain key attributes, the most important of which are reliability, mobility, and the speed and concealment of their deployment. The missile weapons currently employed by the Ukrainian Armed Forces generally meet the aforementioned requirements; however, there are a number of issues that still need to be addressed. The following issues may be regarded as problematic:

the dependence of the Armed Forces of Ukraine on the quantity and types of missile weapons supplied under the programme of material and technical assistance from partner countries;

the limited range of missile weapons available to the Armed Forces of Ukraine, with a range of up to 300 km;

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Новак Д.А. *ORCID ID: 0000-0002-4582-595X,* Юнда В.А. *ORCID ID: 0000-0002-8941-823X*

* Corresponding author *valera.yunda@ukr.net*

the inability of Ukraine's defence industry to meet the current demands of the Ukrainian Armed Forces in terms of high-precision missile and rocket production.

In order to resolve the issues outlined above, the feasibility of equipping the Missile Forces of the Armed Forces of Ukraine with long-range loitering munitions is being considered. To answer this question, it is necessary to analyse the key characteristics of this type of unmanned weaponry and assess their main advantages and disadvantages in comparison to 'traditional' missile systems (cruise and ballistic missiles).

Formulation of the article's objective

The purpose of the article is to define the classification of unmanned aerial vehicles for military use, analyse the main characteristics and combat capabilities of existing long-range loitering munitions, evaluate their key advantages and disadvantages in comparison to cruise and ballistic missiles, substantiate conclusions regarding the feasibility of equipping units and sub-units of the Missile Forces of the Armed Forces of Ukraine with long-range loitering munitions, and provide recommendations on their key properties.

Presentation of the main material

Today, loitering munitions (‘kamikaze drones’) include strike and reconnaissance-strike UAVs that hit targets with a built-in (integrated) warhead (WH) and self-destruct during the attack. The name of this type of UAV indicates their ability to remain in the air for long periods of time, including in standby (patrol) mode in a designated area, with the aim of immediately striking a detected target upon receiving a command from the operator. [1, 4]. As mentioned above, loitering munitions are considered a relatively new type of unmanned weaponry, although today there is already a wide range of such UAVs in existence and use, from small FPV drones to long-range ‘kamikaze drones’ capable of striking enemy targets hundreds or even thousands of kilometres deep into enemy territory.

According to the accepted classification shown in Table 1, all military UAVs can be divided into tactical and operational-tactical (Class I and II UAVs) as well as operational and strategic (Class III UAVs) based on their range of application [5 - 7].

Table 1

Classification of unmanned aerial vehicles

<table>
<tr><th>Class</th><th colspan="2">Level</th><th colspan="2">Radius of action</th><th>NATO category</th></tr>
<tr><td rowspan="3">I</td><td rowspan="3">Tactical</td><td>Micro</td><td colspan="2">up to 5 km</td><td>Micro</td></tr>
<tr><td>Mini (Battlefield UAV)</td><td colspan="2">from 5 to 25 km</td><td>Mini</td></tr>
<tr><td>Small</td><td colspan="2">from 25 to 50 km</td><td>Small</td></tr>
<tr><td>II</td><td colspan="2">Operational-tactical</td><td colspan="2">from 50 to 200 km</td><td>Tactical</td></tr>
<tr><td rowspan="2">III</td><td colspan="2">Operational</td><td rowspan="2">over 200 km (outside the line-of-sight radio coverage area)</td><td>up to 500 km</td><td>MALE</td></tr>
<tr><td colspan="2">Strategical</td><td>over 500 km</td><td>HALE</td></tr>
</table>

UAVs belonging to Class III (with a range of over 200 km) are also classified as long-range unmanned aerial vehicles.

An analysis of the main characteristics of existing loitering munitions indicates that a typical long-range ‘kamikaze drone’ usually has an aircraft-like design, is equipped with a piston internal combustion engine (e.g. ICE), has an inertial guidance system (IGS) that is adjusted by signals from satellite navigation systems (SNS) and is launched from a runway (RWY) or a launcher mounted on a self-propelled launcher (SPL) or other chassis (platform) (see Table 2) [8, 9].

The results of the analysis also indicate that for a significant number of long-range ‘kamikaze drones,’ the ability to conduct aerial reconnaissance and loitering is not provided for or is not used in favour of ensuring long-range target engagement. In addition, in terms of their characteristics and combat capabilities, modern long-range loitering munitions are rapidly and steadily approaching missile weapons, primarily cruise missiles. According to some military experts, this trend in the development of long-range strike UAVs has led to the creation of a new type of weapon – missile drones, which combine the advantages and main capabilities of both strike UAVs and cruise missiles. [9]. In general, cruise missiles (CM) are defined as a type of missile weapon in which wings are used to generate lift, and a turbojet engine (TJE) is used as a power plant, which allows CMs to fly at subsonic speeds (600–900 km/h) along various trajectories, including complex ones that follow the terrain. [10].

The main advantages of long-range loitering munitions over ‘classical’ cruise and ballistic missiles include [5, 7, 11]:

low life cycle cost (cost of development, purchase, operation, disposal, etc.) – the main and most significant advantage;

extremely high manoeuvrability (ability to fly complex trajectories using different speed modes);

Table 2

Main characteristics of modern long-range loitering munitions

Name	Country of manufacture	Operating range, km	Take-off weight, kg	Weight of WH, kg	Control system type (guidance)	Engine type	Cruising speed, km/h	Ability to conduct reconnaissance
Shahed-131 (Geran-1)	Iran (rf)	~900	135	15	IGS with correction from SNS	ICE	180	Not provided
Shahed-136 (Geran-2)		~1500	200	~50			185	
Shahed-238 (Geran-3)		~1200	380	~50	IGS with correction from SNS with IR or radar homing head	TJE	480	
UJ-26 Bober	Ukraine	~1000	~150	20	IGS with correction from SNS	ICE	80	
E-300 Enterprise		675- 3100	540	до 300			~150	
Liutyi		~1500	~300	до 75	IGS with correction from SNS and with optical homing head		~150	
AQ-400 Scythe		750	100	32			144	
Palyanytsya		~650	~300	до 100	IGS with correction from SNS	TJE	~450	
Bars		~700	~140	22			~350	
IAI Harpy	Israel	~1000	125	32	Combined (optical-electronic with radar)	ICE	185	up to 3 hours
IAI Harop		~1000	135	16-23	Combined (optical-electronic with IR camera)		185	up to 6 hours
Harpy NG		~1000	160	15	Combined (optical-electronic with radar)		185	up to 9 hours
ALS-50	India	~1000	no data available	до 30	IGS with correction from SNS		no data available	no data available
Gremlin	the United States	~1200	680	~66	Combined (optical-electronic with IR camera)	TJE	650	Provided (products are under development)
Vila 1	Serbia	~300	300	~70	IGS with correction from SNS		no data available	
RCM2	Germany	~500	~340	~50	IGS with correction from SNS and with IR homing head		no data available	

ability to fly at low and ultra-low altitudes (up to 50 m);

relatively small size (together with the ability to fly complex trajectories at extremely low altitudes, making them difficult to detect and destroy by most existing air defence systems);

the ability to establish large-scale production in a relatively short period of time;

the possibility of use by large groups (‘flocks’), which significantly increases the probability of overcoming the enemy's air defence and the probability of hitting targets deep within the combat formations of its troops (forces).

The main disadvantages of long-range loitering munitions compared to conventional (‘classical’) missile weapons are generally considered to be:

lower accuracy and radio-electronic security class of navigation devices (reduces strike accuracy);

relatively insignificant weight of the warhead (affects the list of targets and requires the allocation of more resources to hit targets with a specific level of effect);

low flight speed (affects the speed of target engagement and limits the use of this type of weapon in reconnaissance and strike complexes);

engine noise (a demasking feature which, together with the relatively low speed of strike UAVs with conventional piston engines, increases the likelihood of their detection and destruction by both anti-aircraft weapons and enemy small arms).

In addition, the disadvantages of this type of strike UAV include the fact that some long-range 'kamikaze drones' require a runway for launch and are characterised by lengthy pre-launch preparation times, including the need to refuel the UAVs, which in turn significantly reduces the level of operational readiness and stealth of their use, as well as the survivability of units.

Conclusions

The results of the analysis allow us to draw the following conclusions:

1. Long-range loitering munitions (strike and reconnaissance-strike UAVs) are a new and relatively inexpensive type of long-range weapon that has a number of significant advantages over 'classical' missile weapons (cruise and ballistic missiles).

2. Taking into account the purpose, the main tasks and tactical features of missile units, as well as the significant limitations of the Armed Forces of Ukraine in terms of the number and types of missiles supplied under the material and technical assistance programme from partner countries, it is possible and advisable to consider equipping the missile forces of the Armed Forces of Ukraine with long-range loitering munitions of domestic and foreign production. This type of unmanned weapon should be considered not as an alternative, but as a supplement to the existing and prospective missile weapons of the Armed Forces of Ukraine.

3. When selecting the type of promising long-range loitering munitions to equip the units and subunits of the Ukrainian Armed Forces' missile troops, priority should be given to domestically produced drone missiles with turbojet engines and a range of over 200 km.

4. Long-range loitering munitions, which will be considered for equipping and use by the missile forces of the Armed Forces of Ukraine, must have the following combat and operational characteristics:

combat power that will ensure the destruction of the entire list of typical targets identified for the missile forces of the Armed Forces of Ukraine. To this end, monoblock (high-explosive and high-explosive fragmentation) and cassette-type warheads should be included in the nomenclature of combat equipment for long-range loitering munitions;

operational efficiency and concealment of use, for which long-range loitering munitions should not require launch pads or artificial surfaces for launch, be launched into the air from a launcher or TLC (Transport and Launch Container), and have fuel tanks in their design that do not require refuelling and maintenance during pre-launch preparation;

mobility due to the installation of a starting device or TLC on the SPL, made on the chassis of high-clearance vehicles;

reliability of operation, etc.

Further research should focus on training qualified personnel in the combat use of long-range loitering munitions to the benefit of the units and subunits of the Ukrainian Armed Forces' missile forces.

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ПОГЛЯДИ НА МОЖЛИВІСТЬ ОСНАЩЕННЯ ЧАСТИН І ПІДРОЗДІЛІВ РАКЕТНИХ ВІЙСЬК ЗБРОЙНИХ СИЛ УКРАЇНИ БЕЗПІЛОТНИМИ ЗАСОБАМИ УРАЖЕННЯ ВЕЛИКОЇ ДАЛЬНОСТІ

Д.А. Новак, В.А. Юнда

У статті надано класифікацію безпілотних авіаційних засобів військового призначення, проведено аналіз основних характеристик та бойових можливостей існуючих баражуючих боєприпасів великої дальності. З урахуванням досвіду ведення бойових дій наведено їх основні переваги та недоліки порівняно із крилатими та балістичними ракетами. З огляду на із призначення та основні завдання частин і підрозділів ракетних військ Збройних Сил України, а також особливості тактики їх застосування зроблено висновки стосовно можливості та доцільності їх оснащення баражуючими боєприпасами великої дальності та надано рекомендації щодо їх основних властивостей.

Ключові слова: *ударні та розвідувально-ударні безпілотні літальні апарати, баражуючі боєприпаси великої дальності, частини та підрозділи ракетних військ, ракетне озброєння, ракетні засоби ураження, крилаті та балістичні ракети.*