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MISSILES IN THE RUSSIAN-UKRAINIAN WAR

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The monograph provides a comprehensive analysis of the use of missiles in the Russian-Ukrainian war of the first half of the twenty-first century. The article describes the technical characteristics of missiles and the main factors of their application. Particular attention is paid to the legal consequences of the use of missiles by the Russian-terrorist forces as instruments of crime. The article proposes creation of a military missile potential of Ukraine on the basis of a private initiative against state guarantees as a deterrent to the aggressor.

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FOREWORD

According to Ronald Reagan, totalitarianism is an evil empire¹. He used this thesis in relation to the Soviet Union. Which in today's conditions has transformed into the worst imperial tradition in the Russian Federation. On February 24, 2022, a full-scale invasion of Ukraine by Russian-terrorist forces was launched. This had brought the Russian-Ukrainian war, which began in early 2014, into its most severe phase². In this war, Ukraine is at the forefront of defending the values of the Western world – democracy, human rights and freedoms, the rule of law, etc. The whole civilized world is supporting Ukraine. For this, we extend our sincere gratitude to the people and governments of the United Kingdom, the United States, Poland, Lithuania, Slovakia, Bulgaria, Germany, France, Spain, Portugal, Latvia, Estonia, the Czech Republic, Romania, Greece, Finland, Sweden, Canada and more than 53 other countries. However, it is only the Ukrainian people who are directly defending Western values in this war with arms upon their hands. And they are paying for it with lives of their best heroes.



A part of the wall of St. Michael's Monastery (Kyiv) in memory of fallen defenders of Ukraine in the Russian-Ukrainian war

¹ <https://voicesofdemocracy.umd.edu/reagan-evil-empire-speech-text/>

The Ukrainian military needs weapons. Although we must emphasize that in the mid-twentieth century, the Ukrainian Insurgent Army, without any recognition or support from Western powers, was fighting solely against the Stalinist and subsequent Khrushchev regimes ². In other words, there is no shortage of courage and self-sacrifice on behalf of the Ukrainian people in their fight for independence. However, to defeat the Russian aggressor, the Ukrainian army needs a lot of weapons. And our partners are providing them to us.

However, when it comes to missiles with a range of more than 150 kilometers the Russian armed forces have several different types of such missiles. The Armed Forces of Ukraine have none of them at all. Combined with the superiority in quality and quantity of military aircraft, the Russian armed forces have a complete superiority. This allows Russian terrorists committing war crimes against the Ukrainian people with impunity killing and crippling of the Ukrainian citizens, including children and the elderly, etc. Without any indication of the potential ability the Armed Forces of Ukraine were able to deter the aggressor.

The first task of the monograph is to provide a comprehensive analysis of the availability and use of missiles in the Russian-Ukrainian war of the early twenty-first century. It proves that the Russian armed forces have a total advantage in this area. This allows them to use missiles with impunity as a means of perpetrating terrorist acts against the Ukrainian people, which is totally unacceptable.

The second objective of the monograph is to document the facts of war crimes committed by the Russian-terrorist forces, in which missiles were used as a weapon. As well as developing a framework for bringing the perpetrators (executors, customers and accomplices) to a just criminal accountability in accordance with the national and international law.

In the twentieth century, Ukrainian scientists, designers, engineers, technologists, and workers could design and produce some of the world's best military ballistic missiles. Unfortunately, due to the pacifist sentiments of the late twentieth century, this tradition failed in its continuation. Moreover, the existing missiles had been destroyed or transferred to the Russian Federation under international agreements. However, the design and production potential in Ukraine has been preserved. It could be realized through some private initiatives under state guarantees and financial resources of Ukrainian friends in the UK and other countries. Ukrainian

² https://essuir.sumdu.edu.ua/bitstream-download/123456789/55257/5/Troyan_OUN_UPA.pdf;jsessionid=F106A6B7CB37564ADEA340780DFF26D2

private business could produce missiles to deter the Russian terrorist aggressor. We count on your understanding and support for this partnership.

Accordingly, *the third task* of the monograph is to bring to broader international community an understanding of the need to attract sponsorship and investment funds for the design, testing and production of Ukrainian missiles to deter the Russian terrorist aggressor.

A team of Ukrainian designers and scientists

CHAPTER 1

TACTICAL MISSILES WITH A RANGE OF UP TO 300 KM

1.1. British «Brimstone» missile (up to 60 km)

According to the Ukrainian media ³ Brimstone missiles have been successfully used by the Armed Forces of Ukraine ⁴ since 2022⁶. This is a short-range tactical missile designed by a leading European missile systems developer MBDA (Matra BAE Dynamics Alenia).



Weight: 50 kg; Length: 1.8; Diameter: 188 mm⁵

The Brimstone is used as a warhead carrier for the Air-to-Surface (primary) and Surface-to-Surface (secondary) launch systems. It was designed for "strike and forget" use against armored vehicle clusters, using an active millimeter-wave radar homing head to ensure accuracy against moving targets. Experience gained in Afghanistan resulted in the addition of laser guidance. Thus, a crucial aspect of the latest version of Brimstone 2 Dual Mode is that the missile features a combined guidance system. It

³ <https://nv.ua/ukr/ukraine/events/raketi-brimstone-2-harakteristika-dalnist-vidi-i-cina-shcho-vidomo-infografika-50289213.html>

⁴ <https://nv.ua/ukr/ukraine/events/raketi-brimstone-2-harakteristika-dalnist-vidi-i-cina-shcho-vidomo-infografika-50289213.html>

⁵ <https://www.mbda-systems.com/product/brimstone/>

consists of a combination of a basic radar homing head capable of detecting ground targets and a classical semi-active laser system. The first allows a "strike and forget" mode, whereby the missiles exchange information during the salvo, which prevents two missiles from being aimed at the same target. The latter allows missiles to be guided, among other things, by illuminating a target, for example, from unmanned aerial devices.

This allows for the selection of specific and highest-priority targets when friendly forces or civilians are in the area of possible impact. The missile warhead is effective against armored vehicles. It has a 6.3 kg (14 lb) tandem warhead that uses a smaller initial charge of approximately 100 g (0.22 lb). From the reports of secondary sources, we can conclude that: BrimstoneI has a strike range of 20 km from an airplane and 12 km from a helicopter; BrimstoneII has a strike range, from an airplane – 60, a helicopter – 40, ground – 20 km. According to the Ukrainian media and Russian telegrams channels, Brimstone missiles are being successfully used by the Armed Forces of Ukraine ⁶.

Emamples of Brimstones application:

On May 17, 2022, a video of the successful use of Brimstone missiles by the Armed Forces of Ukraine against Russian military equipment was posted by instructor Pavlo Kashchuk, pseudonymously known as Combat-ua. According to him, such excellent British "Brimstone" missiles in the skillful hands of Ukrainian fighters with elements of military cunning tore down the turrets of Russian tanks in the rear and sowed panic among the Russian aggressors ⁷;

On June 9, 2022, in the Kharkiv region (near the village of Male Vesele), the Ukrainian military located and destroyed the agressor's equipment with Brimstone missiles ⁸.

The number of missiles available to the Armed Forces of Ukraine is not known, but in January 2023, Ukrainian media reported that Ukraine would have to receive 600 Brimstone missiles from the UK as part of military assistance⁹. The cost of a single missile is about 175,000 pounds (\$195,000).

⁶ https://defence-ua.com/news/stala_vidoma_versija_raket_brimstone_jaki_postachajutsja_do_ukrajini_vdvichi_krasche_nizh_ochikuvalos-9731.html

⁷ <https://mil.in.ua/uk/news/vijskovi-ukrayiny-zavdaly-udaru-po-okupantah-raketamy-brimstone/>

⁸ <https://mil.in.ua/uk/news/na-harkivshhyni-vijskovi-zastosuvaly-brimstone-po-okupantah/>

⁹ <https://tsn.ua/zbroya/dalnist-brimstone-2-ta-inshi-perevagi-ta-harakteristiki-raketi-2226070.html>



Ukrainian military uses low-tonnage trucks to launch Brimstone missiles

No cases of Brimstone missiles being used by the Ukrainian Armed Forces in violation of international humanitarian law have been recorded by Western intelligence, media, or the civil society actors.

To summ up, the British tactical missile "Brimstone-2" is being successfully used by the Armed Forces of Ukraine to destroy the armored targets of the Russian occupants at a distance of up to 40 km from the contact line. We are very grateful to the British people for their support. God bless Britain!

1.2. Soviet operational-tactical ballistic missile "Tochka-U" (up to 120 km)

“The Tochka-U 9K79-1” is a Soviet tactical missile system. This system is in operational service in Ukraine and the Russian Federation as a succession of the Soviet Union. The western name of the complex is SS-21B SCARAB-B. Range 15-120 km. The system uses missiles with warheads weighing 482 kg. The missiles and systems were manufactured at the Votkinsk Machine-Building Plant (Russia) and the Petropavlovsk Heavy Engineering Plant (Kazakhstan).

The Tochka-U missile system consists of a 9M79M missile with various types of warheads; a 9P129 or 9P129-1M launcher; a 9T218 or 9T128-1 transport and charging vehicle; a 9T222 or 9T238 transport vehicle; an automated test and inspection machine 9V819 or 9V819-1; a 9V844 or 9V844M maintenance vehicle; and a 9F370-1 arsenal equipment set.



Characteristics of the Tochka-U system are following: altitude of the missile trajectory – up to 26 km; standard deviation from the target – 95 m; range of the mobile launcher – 650 km; missile speed – 1100 m/s; launch weight of the missile – 2010 kg; thrust of the missile engine – 9788 kgf; operation time of the missile engine – 18-28 seconds; flight time to the maximum range: 136 s.; weight of the launcher (with the rocket and calculation) -18145 kg.; crew: 4 people. The launcher crew consists of four people: a crew chief, a deputy crew chief, a driver and an operator ¹⁰.

The Tochka-U is a 9M79-1 single-stage solid-propellant ballistic missile with a detachable warhead, which is controlled by an inertial onboard system. Serial production began in 1973. The missile is controlled by aerodynamic controls – wings and rudders of the original lattice design. In addition, the aerodynamic rudders are duplicated by gas-dynamic graphite rudders installed at the jet engine nozzle outlet. In this case, not only the ballistic trajectory is corrected, but also guidance is provided on its final section (including commands from the radar homing head). Gas-dynamic rudders provide control on the initial part of the trajectory, when aerodynamic rudders are not effective enough at low flight speeds. The missiles are equipped with a single-mode solid-fuel jet engine, which ensures the system's high readiness for combat use.

¹⁰ <https://inshe.tv/suspilstvo/2022-03-11/664191/>

Despite the fact that the production of these missiles was carried out in the Soviet era, the Tochka-U complex remains the single ballistic weapon today.

According to open sources, at the beginning of the full-scale invasion on February 24, 2022, about 50 systems remained in service with the Armed Forces of Ukraine. Russian-terrorist forces are armed with 100-150 self-propelled launchers with 1000-1500 missiles ¹¹.

For the Armed Forces of Ukraine, Tochka-U is the only missile capable of hitting military targets at a distance of more than 80 kilometers from the contact line (one hundred). For the Russian-terrorist forces, it is an additional one.

Examples of its application:

On March 24, 2022, in the seaport of the Ukrainian city of Berdiansk, temporarily occupied by the Russian-terrorist forces, the Ukrainian Tochka-U missile destroyed the Russian landing ship Saratov ¹²;

On June 17, 2022, the Armed Forces of Ukraine struck a Russian armed forces base in the occupied Nova Kakhovka in the Kherson region ¹³.

On March 19, 2022, the Ukrainian military shot down a Tochka-U missile near the city of Popasna using a portable anti-aircraft missile system "Stinger" ¹⁴.

Western intelligence agencies, the media, and civil society actors have not recorded any cases of the use of the 9M79M missile by the Ukrainian Armed Forces in violation of international humanitarian laws.

In contrast, on April 8, 2022, Russian-terrorist forces used a 9M79M missile with a 9H24 cluster munition near the railway station in Kramatorsk, Donetsk region, Ukraine. As a result, more than 60 civilians were killed ¹⁵. Dozens of people were injured, some of them became disabled, including children. One of the victims is an 11-year-old girl, Yana, who lost her limbs. Her prosthetics were successfully provided by American doctors, engineers and technicians ¹⁶.

¹¹ <https://missilery.info/missile/tochka>

¹² <https://focus.ua/uk/voennye-novosti/510702-rossiyskiy-korabl-saratov-v-portu-berdyanska-unichtozhili-raketoy-tochka-u-foto-video>

¹³ <https://mil.in.ua/uk/news/po-bazi-rashystiv-u-novij-kahovtsi-vidaryly-tochkoyu-u/>

¹⁴ <https://www.youtube.com/watch?app=desktop&v=aqC7BSw6ReE>

¹⁵ <https://www.radiosvoboda.org/a/news-pentahon-kramatorsk-tochka-u/31793582.htm>

¹⁶ <https://freeradio.com.ua/robliat-pershi-kroky-postrazhdali-vid-obstrilu-kramatorskohovokzalu-natalia-ta-iana-stepanenky-otrymaly-navchalni-protezy/>



Yana, an 11-year-old Ukrainian citizen, is undergoing rehabilitation in the United States. We are very grateful to the American people.

It should be noted that the Russian-terrorist forces use the Tochka-U system infrequently, as they have many other more effective missiles to attack the Ukrainian territory. The night of March 8-9, 2023, was a clear example of the missiles used by the Russian terrorists. According to the Commander-in-Chief of the Armed Forces of Ukraine Valeriy Zaluzhnyi, the enemy launched a massive missile attack on some critical infrastructure facilities in Ukraine and carried out 81 launches of missiles of various types: 28 launches of Kh-101/ Kh-555 air-launched cruise missiles; 20 launches of Kalibr sea-launched cruise missiles; 6 launches of Kh -22 air-launched cruise missiles; 6 launches of Kh-47 Kinzhal air-launched cruise missiles; 8 launches of the guided missiles: 2 – Kh-31P; 6 – Kh-59; 13 launches of S-300 anti-aircraft guided missiles; 8 launches of Iranian-made Shahed-136/131 attack drones.

The Air Forces of the 3rd Armed Forces of Ukraine, in cooperation with units of other subdivisions of Ukrainian Defense Forces, destroyed 34 cruise missiles out of 48 Kh -101/ Kh -555, "Kalibr" cruise missiles, as well as 4 Shahed-136/131 UAVs. As a result of organized

countermeasures, 8 Kh -31P and Kh -59 guided missiles failed to reach their targets.

Unfortunately, for the citizens of Ukraine, such nights, starting at 3:45 a.m. on February 24, 2022, would become an everyday occurrence. Once again, there are dead and wounded among the civilian population¹⁷. We are fully experiencing the situation that the nationals of the King of Great Britain experienced from 1939 to 1945¹⁸. Your heroic resilience inspires the citizens of Ukraine to resist. Your heroic resilience has inspired the citizens of Ukraine to resist.

Legal Consequences of the use of the Tochka-U Missile by Russian-Terrorist Forces

The Ukrainian special service claims to have received irrefutable evidence of the Russian occupiers' involvement in the shelling of the Kramatorsk railway station. The missile strike on April 8, 2022, killed 61 people and injured 121 others¹⁹.

In addition, the Russian terrorist forces have repeatedly struck civilian targets with Tochka-U missiles with cluster warheads. In particular: on February 24, 2022, a Russian Tochka-U missile with a cluster warhead fired at a hospital in Vuhledar, killing 4 people²⁰. On March 1, 2022, the Russian armed forces shelled residential areas of Mariupol with a Tochka-U missile with cluster munitions. There were 21 wounded, the number of dead remains unknown²¹. On April 22, 2022, Sloviansk was shelled using rockets with a cluster warhead of the Tochka-U complex. The occupiers destroyed a secondary school building and several residential buildings²². Therefore, the Tochka-U missile system is used by the Russian-terrorist forces as a means of commitment of a crime.

¹⁷ <https://fakty.com.ua/ua/ukraine/20230309-syreny-po-vsij-ukrayini-u-mykolayevi-ta-odesi-prolunaly-vybuhy/>

¹⁸ https://www.bilibili.tv/en/video/2046316789?bstar_from=bstar-web.homepage.recommend.all

¹⁹ <https://news.liga.net/ua/politics/news/ekspertiza-podtverdila-cto-tochkoy-u-po-vokzalu-kramatorska-bili-iz-ordlo-sbu>

²⁰ <https://www.slovoidilo.ua/2022/02/24/novyna/suspilstvo/vijska-rosiyi-obstrilyaly-likarnyu-vuhledari-ye-zhertvy>

²¹ <https://www.ukrinform.ua/rubric-ato/3417267-okupanti-obstrilali-mariupol-raketou-tocka-u-nacgvardia.html>

²² <https://www.unian.ua/war/obstril-slov-yanska-okupanti-vikoristali-raketniy-kompleks-tochka-u-foto-novini-vtorgnennya-rosiji-v-ukrajinu-11797272.html>

In terms of national criminal legislation (Ukraine²³, Russia²⁴) and war crimes for violating the laws and practices of war is suspected of committing a crime:

the perpetrators of the crime: servicemen of the combat crew of the Russian-terrorist forces who entered the coordinates into the Tochka-U guidance system;

accomplices to the crime: military personnel who ensure preparations for the launch of missiles;

the organizers of the crime: the commanders of the Russian-terrorist forces who ordered the use of the Tochka-U missile system against civilian infrastructure – namely, in the case of the Kramatorsk railway station.

From the perspective of the national legislation of Russia²⁵ and international humanitarian law, the following perpetrators stand suspected of committing crimes against humanity: Russia's political, military and administrative leadership, which initiated and/or supported the unprovoked military invasion of Ukraine by the Russian-terrorist forces, made the decision to destroy Ukraine's civilian infrastructure. They include the initiator of the genocide against the Ukrainian people, the Supreme Commander-in-Chief of the Armed Forces of the Russian Federation, Mr

²³ **For example**, a Russian military pilot who crossed the state border of Ukraine on March 6, 2022, in a combat aircraft and bombed a radio and television station in Kharkiv was sentenced by a Ukrainian court to 12 years in prison under Article 438 "Violation of the Laws and Customs of War" of the Criminal Code of Ukraine. <https://www.slovoidilo.ua/tag/virok>

²⁴ Article 361 of the Criminal Code of the Russian Federation on acts of international terrorism stipulates that committing an explosion, arson or other acts outside the territory of the Russian Federation that endanger the life, health, freedom or inviolability of citizens of the Russian Federation with the aim of violating the peaceful coexistence of states and peoples or directed against the interests of the Russian Federation, as well as threatening to commit such acts, shall be punishable by imprisonment for a term of ten to twenty years or life imprisonment. http://www.consultant.ru/document/cons_doc_LAW_10699/0994b72ccab34fae773ced2c837691518a3e3dca/

Article 356 "Use of Prohibited Means and Methods of Warfare" of the Criminal Code of the Russian Federation states that cruel treatment of prisoners of war or civilians, deportation of civilians, looting of national property in the occupied territory, the use of means and methods prohibited by international treaties of the Russian Federation in an armed conflict are punishable by imprisonment for up to twenty years. http://www.consultant.ru/document/cons_doc_LAW_10699/8054a66d213c5d4e82e7a4a5fa84470e7059322b/

²⁵ Article 353 of the Criminal Code of the Russian Federation, "Planning, Preparation, Unleashing or Waging an Aggressive War," provides that: planning, preparation or unleashing an aggressive war is punishable by imprisonment for a term of seven to fifteen years. Waging an aggressive war is punishable by imprisonment for a term of ten to twenty years.

Putin, and all the members of the Security and Defense Council of the Russian Federation. As well as other people who are direct perpetrators, instigators and facilitators of the killing and crippling of individuals²⁶. For example, the Russian propagandists Vladimir Solovyov²⁷ and Olga Skabeyeva²⁸.

We have no doubt that all the suspects of killing, crippling and injuring civilians with missiles and other means of committing a crime²⁹, whose guilt is established by the national and international courts will receive fair punishment. For this purpose, surprisingly, the Russian Federation has existing criminal law provisions. Accordingly, after the overthrow of the anti-human Putin's regime, any other government in Russia or in individual state entities on the territory of the former Russian Federation will be forced to bring Mr Putin and other war criminals to justice. A new Russian court will have legal grounds to prosecute individuals under the substantive national rules which were in force at the time of the crimes. In addition, some active measures are being taken to establish a special international court for international criminals from the Russian Federation. In particular, in our opinion, it was for this purpose that since March 2023 US Attorney General Merrick B. Garland, US Ambassador-at-Large for Global Criminal Justice Beth Van Schaack, European Commissioner for Justice Didier Reynders, International Criminal Court Prosecutor Karim Asad Ahmad Khan, Minister of Justice, Head of the Office of the European Union Public Prosecutor Laura Codruța Kövesi, Attorney General of Spain Álvaro García Ortiz, Attorney General of the United Kingdom Victoria Mary Prenti, Attorney General of Estonia Andres Parmas, Attorney General of Latvia Juris Stukāns, Attorney General of Lithuania Nida Grunskine, Special Representative on Sexual Violence in Conflict Pramila Patten have been visiting Ukraine³⁰.

²⁶ Article 357 "Genocide" of the Criminal Code of the Russian Federation stipulates that the actions aiming at the complete or partial destruction of a national, ethnic, racial or religious group as such by killing members of that group, causing serious harm to their health, forcibly preventing childbearing, forcible transfer of children or other forced transfer of children, forced resettlement or other creation of living conditions calculated to disadvantage members of this group – shall be punishable by imprisonment for a term of twelve to twenty years with restriction of liberty for up to two years, or life imprisonment, or the death penalty. http://www.consultant.ru/document/cons_doc_LAW_10699/b21e235ab7f2ffdb9921d73f1d1828628780cf10/

²⁷ <https://www.obozrevatel.com/ukr/person/2535.htm>

²⁸ <https://glavcom.ua/ru/think/pozor-skabeevoj-kak-simvol-russkoj-propahandy-895653.html>

²⁹ <http://www.ssaals.com.ua/?p=8664>

³⁰ <https://www.radiosvoboda.org/a/news-ukraina-heneralni-prokurory/32298256.html>

All war criminals, as well as those who have committed crimes against humanity, will be brought to rightful criminal responsibility.

Thus, the Tochka-U operational-tactical ballistic missile is used in the war by the Armed Forces of Ukraine as the principal means of striking military targets at a distance of more than 80 kilometers from the contact line. Russia uses it as an additional means of committing terrorist acts against civilian infrastructure. However, the missile is outdated and has unsatisfactory accuracy of striking targets (about 100 meters).

Currently, no new Tochka-U missiles and systems are being produced. However, they are subject to the maintenance regime in both Ukraine and Russia to restore combat capability. In Ukraine, the number of such missiles is rather limited. In Russia, there are a lot of them. Thus, Russia has a significant potential for their further use as a means of committing terrorist acts against civilian targets in Ukraine.

1.3. Soviet missile Kh-59M "Ovod" (up to 290 km)

The Kh-59M "Ovod" (AS-13 Kingbolt) is a Russian medium-range air-to-surface missile of Soviet origin. The design of the Kh-59 guided missile was carried out by the Raduga Design Bureau. Flight development testings of the Kh-59 Ovid missile was conducted in 1975-1977. It has been in service since 1980. It has a launch weight of 900 kg and a warhead of up to 320 kg. Currently, Kh-59 modifications are produced and modernized by the Tactical Missile Arms Corporation, which includes the Raduga Design Bureau. The Kh-59 Ovid and its versions are designed to destroy ground and surface targets covered by air defense that can be visually detected by the operator during the day in normal weather conditions. There are also some options for round-the-clock and anti-ship applications. The latest versions of the missiles (Kh-59MK2) have a launch range of up to 285 km. The Kh-59MK2 missiles have a high accuracy (3-5m) and a powerful warhead (320/283 kg). They are quite effective. The carriers of the Kh - 59M missiles are Russian combat aircraft Su-24M, Su-17M3/22M4, Su-25, Su-30, Su-34, Su-27SM, Su-35, Su-57 ³¹.

The relatively low speed (900-1050 km/h) and altitude of the missiles (50-300 m) allow them to be detected and hit by S-300 and Buk-M1 anti-aircraft missile systems, as well as MiG-29 and Su-27 fighters. The Kh -

³¹ <http://war-russia.info/index.php/nomenklatura-vooruzhenij/403-aviatsiya/oruzhie-aviatsii/rakety-vozdukh-poverkhnost-strategicheskie-skr-takticheskie-tnr-protivokorabelnye-pkr-protivoradiolokatsionnye-prr/2500-kh-41-moskit-mv-3m-80mv-asm-mss-1998-g-2>

59MK2 missiles have already been shot down by Ukraine's surface-to-air defense systems³².



*Kh-59MK2 missile, illustrative image*³³

The cost of the Kh-59M has not been disclosed, but in any case it is less than a long-range cruise missile. At the same time, the Russian Armed Forces cannot switch to massive bombardments with these missiles, as the last attempt resulted in the destruction of some aircraft carrying the missiles. In this situation, the use of modernized versions of the Kh-59 is a sort of compromise. At the same time, neither the stocks of modernized Kh-59 Ms nor the number of pilots who know how to use them are unknown³⁴.

Practice of applying the Kh-59 missile:

On April 3, 2022, during the large-scale Russian invasion, Russian troops struck an elevator located in the village of Kostiantynivka with an Kh-59 missile. No casualties were reported;

³² https://defence-ua.com/weapon_and_tech/jak_rashisti_vikoristovujut_raketi_h_59_kotri_bojatsja_tumanu_ta_doschu-7464.html

³³ https://defence-ua.com/weapon_and_tech/jak_rashisti_vikoristovujut_raketi_h_59_kotri_bojatsja_tumanu_ta_doschu-7464.html

³⁴ <https://www.unian.net/war/h-59-ovod-cto-eto-za-raketa-i-pochemu-rf-nachala-ee-ispolzovat-novosti-vtorzheniya-rossii-na-ukrainu-11866278.html>

On May 26, 2022, an Kh-59 missile was shot down by an anti-aircraft missile unit of the Ukrainian air defense system;

On May 29, 2022, two Russian Kh-59MK missiles were destroyed in the sky over Donbas;

On May 30, 2022, an Kh-59MK missile was downed in the Donetsk region.

On June 2, 2022, the Ukrainian S-300PT system destroyed the Kh-59MK;

On August 28, 2022, an Kh-59 missile struck a public restroom on the outskirts of Novovorontsovka, Kherson region;

On September 10, 2022, a Russian Kh-59 missile was shot down over the Dnipro region;

On September 26, 2022, an Kh-59 missile was fired at Kryvyi Rih airport;

On October 27, 2022, an Kh-59 missile was shot down over the Dnipro region;

On December 6, 2022, the Russian Federation fired an Kh-59 missile at the village of Novotavrisheske, Zaporizhzhia region. The strike caused a fire in a residential and outbuilding;

On December 22, 2022, a Russian Kh-59 missile was shot down in the sky over Mykolaiv region;

On January 23, 2023, anti-aircraft missile units destroyed two Russian Su-25 attack aircraft, a Ka-52 attack helicopter, two Kh-59 guided missiles and an Orlan-10 UAV³⁵.

So, the Kh-59M Ovod (AS-13 Kingbolt) missile, despite being developed in the last century, is actively used by the Russian armed forces. It heoretically has a high accuracy of hitting targets. However, in practice, most of the launched Kh-59 missiles are destroyed by the Ukrainian air defense system. The damage caused by these missiles that struck their targets was not commensurate with their cost.

1.4. Russian S-300s used as a surface-to-surface ballistic missiles (up to 300 km)

S-300 – SA-10 Grumble, SA-12 Giant/Gladiator, SA-20 Gargoyle, a family of short- and medium-range air defense systems. They are in operation in the Armed Forces of Ukraine, Russia, Belarus and some other countries. They are employed for air defense. However, since the beginning of the full-scale invasion, the Russian Federation has been using them as **surface-to-surface** ballistic missiles.

³⁵ <https://t.me/zsuwar>

The basic system was adopted in 1979. The range of the anti-aircraft version is 100, 200 or 300 km, depending on modification. There are numerous modifications³⁶.

The 5V55K missile is radio-controlled. It weighs up to 1,500 kg and is equipped with a 133-kilogram warhead. The 5V55R and 48N6 missiles with a warhead weighing up to 144 kg are also used. It should be noted that Defense Express in a separate article described in detail the capabilities of the S-300 in terms of strikes on ground targets, which, in their opinion, are ineffective due to the unsatisfactory accuracy of target engagement. Nevertheless, as a terrorist weapon against the civilian population, the missiles are causing a lot of harm to the Ukrainian people. According to media reports, the S-300 receives its coordinates from the Army's reconnaissance divisions. Belarusian media claim that the S-300 uses the target coordinates set before launch to guide the onboard inertial system. The coordinates can be updated during the flight via a radio channel. In the final phase, the missile uses semi-active radar homing to reach the target. S-300s were used to strike the ground targets in Luhansk, Donetsk, Kherson, Zaporizhzhia and Mykolaiv regions of Ukraine³⁷.



Missiles 48N6E2, 9M96E and 9M96E2

The destruction range of air targets for 5V55K and 5V55R is 75 km. The precise range when launched along a ballistic trajectory to destroy ground targets is unknown.

Russia has developed new anti-aircraft missiles 48N6 and 40N6, which are used with the S-400 air defense system. The 48N6 missile, depending on which version it is, can destroy air targets at distances ranging from 150 km to 250 km. The warhead weighs 140 to 180 kg.

³⁶ <https://missilery.info/missile/c300pmu1>

³⁷ <https://texty.org.ua/fragments/107285/rosiya-obstrilyuye-nazemni-cili-raketamy-s-300-ne-cherez-bezporadnist-vona-vykorystovuyeh-yih-yak-zbroyu-teroru/>

For the 40N6 missile, the manufacturer, Almaz-Antey, reports a range of up to 380 km. However, this is a very expensive missile, which was approved for service in 2018. It has not yet been put into mass production ³⁸.

The Russian-terrorist forces mostly strike Ukrainian cities in the frontline regions with S-300 systems. In particular, Zaporizhzhia (approximately 35-40 km from the contact line), Kharkiv (45-50 km from the border with Russia), Kostiantynivka (35 km from the contact line), Sloviansk, Kramatorsk (45 km from the contact line) and surrounding settlements of megacities are regularly shelled. However, even at short distances, the S-300 shelling demonstrates low accuracy.

The S-300 and S-400 can be fired at ground targets along a ballistic trajectory. In a very simplistic way, a missile rises high up at a great distance and then falls down in an arc at an even greater speed. As a result, it takes only a few minutes from firing to impact. The speed of the S-400 missile is over 4000 km/h, the speed of the S-300 missile is over 3000 km/h. It was these missiles – S-400 or S-300 – that were fired. To destroy missiles flying along a ballistic trajectory, specialized missile defense systems are needed, such as the American Patriot, French-Italian SAMP-T ³⁹.

S-300 modifications: "Fort" – 5B55RM, SA-N-6 "Grumble" missile (1983); "Reef" – 5B55RM, SA-N-6 "Grumble" missile; "Ford M" – 48N6, SA-N-6 "Grumble" missile with 48N6 missile (1990) ⁴⁰.

The 5V55RM anti-aircraft missile is a solid-propellant single-stage vertical-launch missile that is launched using a conventional aerodynamic scheme with a gas-dynamic deflection system. It is guided by a combined control system. It hits the target with a high-explosive warhead with a radar fuze.

The 48N6 anti-aircraft missile with a directional warhead is unified with the S-300PM land-based system. The missile is larger than the 5V55RM, and the B-203A launcher was developed for it. The 48N6 missile has a maximum range of 150 km, but the control system that existed in 1993 allowed a range of only 93 km.

The 48N6E2 missile is unified with a similar missile used in the S-300PMU2 ground-based system. The long-range kill zone is increased up to 200 km. Ballistic missile interception efficiency was improved ⁴¹.

³⁸ <http://djuc-ast.narod.ru/index/0-15>

³⁹ <https://chas.news/current/s-300-s-400-yak-rosiya-obstrilyue-ukrainski-mista-z-kompleksiv-ppo>

⁴⁰ <http://war-russia.info/index.php/nomenklatura-vooruzhenij/68-vmf/oruzhie-vmf/kompleksy-pvo/2555-zrk-s-300f-fort-5v55rm-48n6-sa-n-6-grumble-1984g>

⁴¹ <https://focus.ua/uk/voennye-novosti/545321-vs-rf-mogut-bit-po-kievu-nazemnymi-s-400-kakie-rayony-stolicy-v-opasnosti-karta>

Legal Consequences of the application of the S-300 S-400 missile by the Russian-Terrorist Forces

When they use ballistic missiles for purposes other than their intended mission by striking ground targets in populated areas the Russian-terrorist forces a priori commit acts bearing signs of war crimes.

After all, even if the S-300 (400) operators enter the coordinates of military targets, the likelihood that the missile will hit them is not that high. However, there is well-founded information that Russian-terrorist aggressors sometimes deliberately plan to strike civilian infrastructure. Accordingly, almost all missiles fired at Ukrainian settlements strike residential buildings, public places, and civilian infrastructure.

Examples: On July 7, 2022, Russian-terrorist forces attacked the civilian population of Donetsk region with S-300, Uragan, Grad missiles, artillery, and tanks. There were 28 enemy attacks in 16 localities. The towns of Avdiivka, Krasnohorivka, Bakhmut, Toretsk, Zhelanne, Vesela Dolyna, Kalynove, Karlivka, Karpivka, Klishchivka, Kodema, Lastochkino, Maksymilianivka, Netaylove, Pervomayske, and Solovyove came under fire. 47 civilian objects were destroyed: 27 residential buildings, including 4 multi-apartment buildings, a school, a kindergarten, a technical secondary school, a college, a hospital, a social services center, an administrative building, a power transformer, and wheat fields. The police and the Security Service of Ukraine opened criminal proceedings based on Article 438 (violation of the laws and customs of war) of the Criminal Code of Ukraine ⁴²;

On November 23, 2022, the occupants fired S-300 missiles at the maternity ward of a hospital in the city of Vilniansk, Zaporizhzhia region. A newborn baby was killed and doctors were injured ⁴³.

On December 5, 2022, in the village of Novosofiyivka, Zaporizhzhia region, a missile fired from an S-300 killed an elderly couple who were in the street and seriously injured three people, including a young child ⁴⁴.

On December 29, 2022, three men were killed in the Kharkiv region due to Russian shelling. The occupiers shelled peaceful towns and villages with S-300 and Iskander missiles and artillery ⁴⁵;

⁴² <https://www.facebook.com/UA.National.Police/posts/367057632230940/>

⁴³ <https://www.vinnitsa.info/news/rosiys-ki-viys-kovi-vbyly-novonarodzhenoho-khlopchyka-u-zaporiz-kiy-oblasti.html>

⁴⁴ <https://vikna.tv/video/ukrayina/obstril-novosofiyivky-5-grudnya-naslidky-obstrilu-zaporizhzhya/>

⁴⁵ <https://times.kharkiv.ua/2022/12/29/rosijska-raketa-vbila-dvoh-pratsivnikov-infrastruktornogo-ob-yekta-v-chuguyivskomu-rajoni/>

On February 18, 2023, Russian armed forces killed and injured civilians in the Donetsk region. Ukrainian police documented 25 strikes in the Donetsk region. The occupiers fired from aircraft, S-300, Grad, and artillery. 13 settlements were under fire. Residential buildings and infrastructure were damaged. The enemy fired shells at the cities of Avdiivka, Bakhmut, Krasnohorivka, Pokrovsk, Toretsk, Chasiv Yar, Keramik, Pivdenne, villages of Berdychi, Ivanopillia, Karlivka, Lastochkino, and Severne. 34 civilian objects were destroyed and damaged – 24 residential buildings, administrative buildings, educational institutions, and vehicles. Police and the Security Service of Ukraine launched criminal proceedings under Article 438 (violation of the laws and customs of war) of the Criminal Code of Ukraine. The police evacuated another 486 people, bringing the total number of people evacuated since the start of the mandatory evacuation to over 42,880, including 5,929 children and 2,193 people with disabilities ⁴⁶;

On February 19, 2023, Russian-terrorist forces with S-300, Grad, artillery, mortars and tanks struck the cities of Kramatorsk and Avdiivka. They killed three civilians and wounded one ⁴⁷.

Consequently, tactically, ballistic missiles fired from S-300 systems are used, as a rule, in a territorial strip located up to 60 kilometers from the line of contact or the state border with the Russian Federation. They are used in combination with cannon and rocket artillery. The accuracy of hitting military targets is unsatisfactory. Civilians are the victims of S-300 missiles. In general, it can be concluded that the S-300 missiles used in the surface-to-surface system are a means of committing terrorist acts.

The subjects suspected of committing crimes for violations of the laws and customs of war, the means of which are S-300 missiles, in addition to the perpetrators and commissioners of crimes, may include designers and engineers (as accomplices), who modernized the S-300 anti-aircraft missile system, which is legitimate from the point of view of international humanitarian law, into a means of terrorist attack upon civilian objects and infrastructure on a surface-to-surface basis, leading to indiscriminate military strikes.

⁴⁶ <https://www.npu.gov.ua/news/armiia-rf-vbyla-ta-poranyla-tsyvilnykh-meshkantsiv-politseiski-zadokumentuvaly-25-udariv-po-donechchyni>

⁴⁷ <https://freeradio.com.ua/doba-na-donechchyni-okupanty-hatyly-po-zhytlovomu-sektoru-ta-infrastrukturi-vbyly-trokh-tsyvilnykh/>

CHAPTER 2

SHORT-RANGE MISSILES 300-1000 km

2.1. Ukrainian project for operational and tactical complex "Grom-2" (up to 500 km)

Grom-2 (export name) or Sapsan is a Ukrainian operational and tactical missile system that is currently under development by the Pivdenne Design Bureau. It has been under development since 2013 on the basis of previous developments under the Borysfen and Sapsan projects. The system is based on a solid-fuel ballistic missile. The range is declared to be 280 km, and the possibility of creating a version with a radius of up to 500 km has been announced.

The characteristics of the system were announced in 2016. The operational and tactical missile system "Grom" is being developed to engage single and group stationary targets at ranges from 50 to 280 km. The warhead of the single-stage ballistic missile is designed to weigh 480 kg. The warhead could be made in a monoblock or cluster design. The monoblock design uses a high-explosive or penetrating fragmentation ampoule. The cluster warhead is equipped with high-explosive fragmentation warheads.

The estimated area of destruction of the missile when using a high-explosive fragmentation device is more than 10,000 m², and a cluster charge is 2-3 hectares. The weight of the missile with a 7.2-meter-long launcher is 3.5 tons. The missile's onboard control system is inertial, equipped with navigation and guidance systems of various types (radar, opto-electronic). A number of sources claim that the range of 280 km is a formal restriction for the export version of the missile, and that the range of the system can be increased to 450-500 km for the needs of the national army.

A missile can fly not only along a predictable ballistic trajectory, but also along an aeroballistic trajectory. In this trajectory, the missile makes unpredictable "jumps" to evade enemy anti-missiles. This should help in overcoming enemy air defense systems of any complexity⁴⁸. So far, the Hrom radar has not been approved for service in Ukraine. The best option for structuring units equipped with the Grom tactical missile system would be batteries of 2-3 mobile launchers and a mobile command post. The missile planned for use in the Grom air defense system was developed by

⁴⁸ https://defence-ua.com/news/jakbi_zsu_mali_otrk_grim_2_z_tisjacheju_raket_zhodnih_bojovih_dij_ne_bulo_b_rechnik_komanduvannja_ps_zsu-8303.html

Yuzhnoye SDO with universal characteristics. When used in other systems, its characteristics allow it to hit ground, sea and air targets, depending on the warhead and guidance system installed. The rocket engine is 15D365. According to 2015 data, the rocket's characteristics are as follows: total weight – 3 tons; specific thrust impulse – 264 seconds; maximum pressure in the combustion chamber – 131 kgf/cm²; thrust – 17500 kgf. The missile was designed with 4 types of homing heads: electron-optical; infrared; radar combined, which includes the capabilities of electron-optical and radar, operating in the 3-mm range. Specifications: Range: minimum: 50 km; maximum: 280 km (export version), up to 500 km (for the Armed Forces of Ukraine) ⁴⁹.



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As a result, if implemented in practice, the project of the Pivdenne Design Bureau (Dnipro, Ukraine) and the Grom-2 operational and tactical complex could provide the Armed Forces of Ukraine with an effective means of deterring the Russian terrorist aggressor.

2.2. Ukrainian project of a short-range ballistic missile "Sagaidak" (up to 500 km)

The Sagaidak short-range multi-purpose operational and tactical missile system (product RKK.500-1) with the Hetman hypersonic quasi-ballistic hybrid missile (product RT-500-1), manufactured by the private

⁴⁹ <https://focus.ua/uk/voennye-novosti/523361-otrk-grom-2-kak-by-izmenil-voynu-raketnyy-kompleks-esli-by-ego-finansirovali-foto>

⁵⁰ <https://armyinform.com.ua/2019/09/29/dlya-operativno-taktychnogo-kompleksu-grim-2-zibraly-12-raketnyh-dvyguniv/>

company Science&Space LLC (Kyiv-Dnipro), has technical characteristics higher than the Russian Iskander-M and a much lesser production cost. Ukraine has all the conditions for designing and manufacturing this type of military product at the expense of private companies with state guarantees.

The system is mobile, but it can be used in a fixed position, as well as on an offshore platform or an airplane. Missile launch from the launch container. The technical concept with the results of ballistic design was developed by the Ukrainian private company Science & Space LLC (Kyiv-Dnipro). The main parameters of the system are: maximum guaranteed range of 500 km, weight of the warhead 480÷500 kg.



Option of placing RT-500-1 on a car of a Czech company Tatra 815-6ZVR8T 43 400 10x10.1R (length 11.55 m). Military special equipment. It is used for Uragan MLRS.

The purpose of the RT-500-1 is to engage ground/sea targets at maximum range at speeds exceeding 4.2 speeds of sound (4.2M); destroy strategic bombers at a distance of up to 250 km at any altitude. The submitted technical proposal for the RKK.500-1 is aimed at expanding the nomenclature of the State Design Bureau "Luch" in Ukraine, with the development of supersonic and hypersonic speeds. Ready-made technical solutions of the State Design Bureau "Luch", which are mass-produced for the RK-360MC "Neptune" and other projects, can be used for the development and operation of the RKK.500-1. These include: the RKP-360

control center, the modernized USPU-360 launcher (possible variants), the modernized TZM-360 transport and loading vehicle, the modernized TM-360 transport vehicle; in the RT-500-1 product, an inertial onboard control system using GPS data, a combined targeting system, a system for detonating a live charge (150 kg) that initiates an additional 350 kg of explosives, and more.

The use of off-the-shelf components reduces the time and cost of the complex project. The project can be implemented through a combination of initiatives of public and private organizations and has been unofficially named "People's Rocket".

RT-500-1 is a quasi-ballistic single-stage rocket with a hybrid rocket engine and gas nozzle control (nitrogen gas at a pressure of 190 kgf/cm²). It can be used as a weapon and as a sounding rocket for scientific researches.

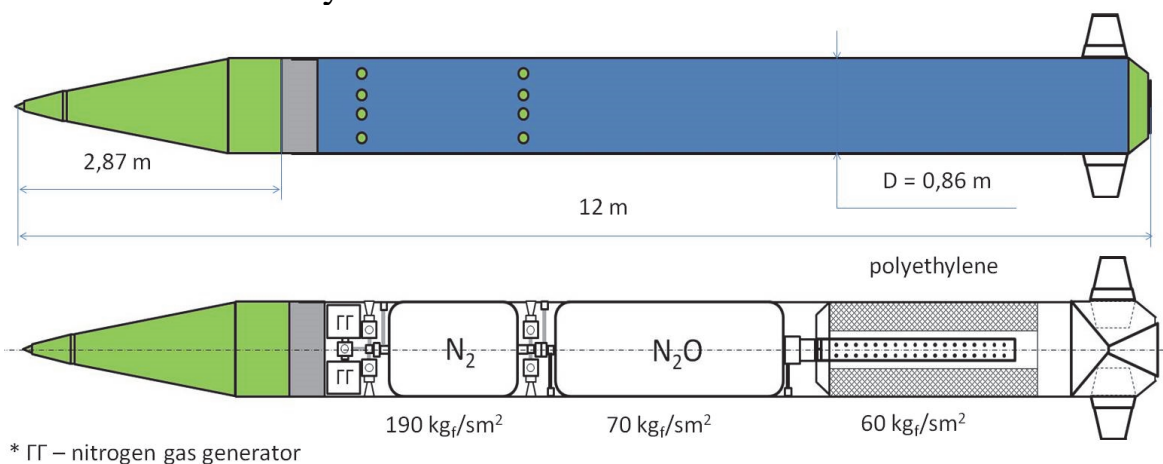
When manufactured at the factory, the RT-500-1 is placed in a disposable square-section transport and launch container, which is then installed on the launcher of the RKK.500-1 complex.

The missile consists of two main parts:

- the main part, which does not detach from the missile in flight, contains a control system, targeting, fuzing system, etc.; a double-action warhead, namely, an initiating charge weighing 150 kg from the R-360 air-to-air missile and a main charge weighing 330÷350 kg, which allows eliminating any target (tandem cumulative warhead);

- propulsion system, containing separate modules, namely, a transition compartment between the head unit and the propulsion system with control system actuators (gas nozzles with electropneumatic valves), as well as a nitrogen gas generator; a nitrogen receiver tank module, which is pre-filled with nitrogen gas at a pressure of 190 kgf/cm² at a Ukrainian gas manufacturing plant; Transition compartment between the receiver tank module and the oxidizer tank module containing valves and reducers; oxidizer tank module pre-filled with nitrous oxide (N₂O) at 40 kgf/cm² – which is a liquid – at a Ukrainian gas production plant; a transition compartment between the oxidizer tank and the hybrid rocket engine with an oxidizer supply system to the engine combustion chamber and a powder ignition system; a hybrid engine module with polyethylene fuel (with an admixture of 17% carbon black), which has an internal channel where the oxidizer spray nozzle is located, and also has a nozzle and aerodynamic stabilizer that decomposes after the rocket leaves the launch container; the engine does not require thermostat control during operation.

The missile consists of separate parts and modules and has no external body. Preliminary dimensions of the RT-500-1: length up to 12 m, diameter 0.86 m, head length 2.87 m. Starting weight 4.1 tons (fuel weight 3 tons). Engine parameters at a pressure in the combustion chamber of 60 kgf/cm²: engine thrust of up to 15 tons, specific thrust impulse of 247 seconds (gas outflow rate from the engine nozzle of 1599.59 m/s). Combustion products at the nozzle cross section: carbon oxides, nitrogen, oxygen, water vapor. The ballistic design of the RT-500-1 with these parameters was carried out, and the calculations confirmed the main parameters of the RT-500-1 in terms of range with a maximum flight altitude of 180 km. The field service life of the RT-500-1 rocket launcher is up to 70 years, unlike the Iskander rocket launcher – 3 years ⁵¹.



Dimensions of the RT-500-1 product and rocket scheme.

The main body of the RT-500-1 contains structural elements of the 9NZZ (RA17) (TO/9NZZ) main body of the 8K14 (8K14-1) – P-17 (OP/8K14) – Elbrus (Skad) product. The design of the RT-500-1 is supposed to use avionics RK-360MC Neptune and units for liquid and gas paths of the propulsion system manufactured by Yuzhmash (Dnipro) ⁵².

So, the Ukrainian project "Sahaidak" (500 km) with a hypersonic quasi-ballistic hybrid missile "Hetman" by the Ukrainian private company Science & Space LLC (Kyiv-Dnipro) could provide the Armed Forces of Ukraine with an effective weapon to deter the Russian aggressor from committing terrorist acts. However, the lack of funding prevents the development of design concepts.

⁵¹ <http://www.ssaals.com.ua/?p=9146>

⁵² <http://www.sciencespace.com.ua/>

2.3. Soviet missile Kh-22 "Storm" (Burya) (up to 600 km)

The Kh-22 "Storm" (Burya) (AS-4 Kitchen, K-22 missile system) was developed by Soviet designers to strike carrier groups and aircraft carriers, primarily those of the United States and the United Kingdom. The missile is a supersonic (flight speed 6M) long-range air-launched anti-ship missile. It can carry a high explosive charge. It was adopted in 1973 and is in use only in the Russian Armed Forces.



Manufacturer: Rainbow Design Bureau. Currently, the Dubna Machine-Building Plant near Moscow (plant No. 256). It is a branch of the Mikoyan Design Bureau, which produces cruise missiles Kh-22, Kh -32, Kh -55, Kh -58, Kh -59M. 9 modifications are known in total, the latest is the Kh -32, Kh -22B.

The development of the K-22 aviation missile system based on the Tu-22 supersonic bomber with the Kh -22 Burya long-range supersonic cruise missile began in 1958. Later, the K-22N weapon system with Kh -22N/NA/NP missiles for the Tu-22M3 and Tu-95K-22 carriers was developed⁵³.

⁵³ <https://uk.wikipedia.org/wiki/%D0%A5-22>

Ukraine inherited a significant number of nuclear weapons: ballistic and cruise missiles, their carriers, etc. However, in the first years after regaining its independence, Ukraine voluntarily renounced its nuclear status, and later its strategic aviation, under the guarantees of the world's nuclear powers. In 2000, Ukraine transferred the Kh -22 cruise missiles and missile launchers that were in service with the Ukrainian Air Force as part of the Long-Range Aviation Group of the Armed Forces to the Russian Federation. This number included 386 Kh -22 missiles. In 2001, Ukraine began liquidating 60 Tu-22 heavy bombers (17 Tu-22M2 and 43 Tu-22M3) and 423 Kh -22 cruise missiles.

The elimination of Tu-22 and Kh-22 cruise missiles was carried out in accordance with the Agreement between Ukraine and the United States on Assistance to Ukraine in Eliminating Strategic Nuclear Weapons and Preventing the Spread of Weapons of Mass Destruction, signed on October 25, 1993, and the Agreement between the Ministries of Defense of Ukraine and the United States on Providing Ukraine with Material and Technical Facilities, Services and Appropriate Personnel Training in Connection with the Elimination of Strategic Nuclear Weapons, dated December 5, 1993⁵⁴.

Between 2002 and 2006, 60 Tu-22 aircraft (17 Tu-22M2s and 43 Tu-22M3s) were eliminated at the airfields of the Air Force of the Armed Forces of Ukraine in Mykolaiv, Poltava, Pryluky and Bila Tserkva, and 401 Kh -22 cruise missiles were eliminated at the Ozerne airfield (Zhytomyr region). The elimination of the remaining Kh -22 cruise missiles was completed in March 2006. Three Tu-22 heavy bombers and seven mock-ups of Kh -22 cruise missiles (without internal stuffing) remained as museum exhibits in Ukraine. In 2016, the Russian Armed Forces adopted the Kh -32 missile, a deep modernization of the Kh -22 with a new engine and new electronics, a smaller warhead, and an increased range.

In the early 2000s, missiles of the Kh -22 type were decommissioned, but in May 2018. The Ministry of Defense of the Russian Federation announced its decision to return them to service with a profound modernization to the level of the Kh -32. Thus, 32 Kh -22 missiles were to be modernized over the next three years.

According to the British Ministry of Defense, the Russian Federation was forced to resort to the massive use of poorly adapted Kh -22 and Kh -32 missiles to strike ground targets during the war due to the lack of high-precision cruise missiles designed to perform these tasks. The low accuracy

⁵⁴ <https://chas.news/current/chim-taki-nebezpechni-raketi-h-22-yakimi-rosiya-atakue-ukrainu>

of the Kh -22 and Kh -32 missiles against ground targets led to numerous civilian casualties.

According to the Office of the Prosecutor General of Ukraine, the only unit capable of using Kh-22 missiles is the 52nd Heavy Bomber Aviation Regiment (Kaluga region, Shaykivka village, Shaykivka airfield) ⁵⁵.

According to the data provided by the Minister of Defense of Ukraine Oleksiy Reznikov, in November 2022, Russia still had 120 missiles of the Kh -22 and X Kh -32 (modernized Kh -22) types. The enemy managed to use up 250 missiles in Ukraine. It should not be forgotten that the manufacturer of these missiles continues to produce them in an upgraded form.

The missile is equipped with a liquid rocket engine. In technical terms, preparing the missile for use is labor-intensive and extremely dangerous due to the use of highly toxic rocket fuel components. The rocket technicians' equipment includes a protective suit made of thick rubber and an insulating gas mask. Serious precautions are taken during the refueling process – an emergency team is on standby⁵⁶.

The weight of the high explosive warhead (charge H) is about 900 kg, of which the weight of the explosive is about 600 kg. This amount of explosive was enough to destroy a typical factory shop or railroad bridge. When detonated, the axis of the cumulative jet is directed downward. When firing at an area, the carrier aircraft in flight determines the position of the target using radar and other navigation equipment on board the carrier. After decoupling from the aircraft, the fuel components spontaneously ignite and the missile begins to accelerate with a simultaneous climb (depending on the selected program, which determines the nature of the missile's flight path, which is set before decoupling).

After reaching the set speed, the missile engine was switched to the marching mode. When firing at specific targets, the homing head monitors the target in two planes and issues control signals to the autopilot. When the antenna angle in the vertical plane reaches a predetermined setting during tracking, a signal is issued to transfer the missile to dive at the target at an angle of 30 degrees to the horizon.

During the dive phase, the control is carried out in the vertical and horizontal planes by signals from the homing system equipment. The H charge is detonated upon engagement with the target, and the M charge is

⁵⁵ <https://chas.news/current/chim-taki-nebezpechni-raketi-h-22-yakimi-rosiya-atakuje-ukrainu>

⁵⁶ <https://fakty.com.ua/ru/ukraine/20230301-pidgotovka-do-zapusku-trudomistka-i-duzhe-nebezpechna-radyanski-krylati-rakety-h-22-harakterystyky/>

detonated by a signal from the homing system equipment. The range of detection of a cruiser-type target by the carrier aircraft is 340 km. The range for capturing and tracking the same target is 250-270 km. *Circular possible divergence of Kh -22 missiles when firing over an area – 5000 m*⁵⁷.

This turns the Kh-22 missile into a terrorist strike weapon exclusively. After all, with such low accuracy, using it as a weapon to hit military targets of the Armed Forces of Ukraine is practically an impossible mission. Since the beginning of Russia's full-scale military aggression, more than 210 missiles of this type have been fired at the territory of Ukraine. None of them were shot down by the air defense systems of the Armed Forces of Ukraine⁵⁸.

The Kh-32 is a Russian air-launched surface-to-air cruise missile with a range of up to 1000 km and a speed of 4-5,400 km/h, developed by the Raduga Design Bureau. The basic model of the Kh-22. Main differences from the Kh -22: the Kh -32 missile is made in the Kh -22 body with a different more powerful engine, while their geometric dimensions are identical. A new interference-protected radar-inertial guidance system with radio command correction and terrain reference (from a radio altimeter) is installed. Instead of an autopilot, an automatic control system is installed. Tactical and technical characteristics: carrier-Tu-22M3M; 3.5-4.6 M (from 4000 to 5400 kilometers per hour or 1.1-1.5 km/s); Launch range – 600-1000 km; Range of capture of the GNSS radar – 200-300 km (when launched from a wider range, an external targeting indication of the approximate area of the target is required before the GNSS target is captured); Maximum flight altitude – 40 km⁵⁹.

Here are the most resonant examples of the use of the Kh-22 and Kh-32 missiles by Russian-terrorist forces:

On June 27, 2022, a missile attack was delivered on the Amstor shopping and entertainment center in Kremenchuk, Poltava region. At the time of the attack, there were about a thousand people there. A total of 29 body fragments were found on the territory of the destroyed shopping center, 20 were declared dead, and 65 people were registered as injured;

⁵⁷ <http://авиару.рф/aviamuseum/dvigateli-i-vooruzhenie/aviatsionnoe-vooruzhenie/sss/aviatsionnye-rakety/upravlyaemye-rakety/ur-vozduh-poverhnost/krylataya-raketa-h-22/krylataya-raketa-h-22-burya/>

⁵⁸ <https://www.bbc.com/ukrainian/news-64281161>

⁵⁹ https://defence-ua.com/weapon_and_tech/chim_vidriznjajutsja_mizh_soboju_raketi_h_22_ta_h_32_jakimi_rashisti_bili_po_kremenchuku_ta_sergijivtsi-8135.html

On July 1, 2022, Kh-22 missiles struck the village of Serhiivka, Odesa region, and smashed into a recreation center. They killed 21 people injuring 38 civilians ⁶⁰;

On January 14, 2023, an Kh-22 cruise missile fired from a Tu-22m3 bomber over the Kursk region near the border with Ukraine struck a multi-story residential building in Dnipro. Forty-six people were killed, 80 were wounded, and 9 went missing. According to the investigation, the bodies of the missing persons were vaporized by the high temperature and poisonous fuel of the Kh-22 missile ⁶¹.



Dismantling of the ruins of a house after a rocket attack by the Russian Federation in Dnipro, January 14, 2023. Photo: Taras Ibrahimov ⁶²

Hence, the Kh-22 missiles are a powerful weapon of destruction. They are used by the Russian armed forces as a means of terrorism against Ukrainian civilians. With a very low accuracy of hitting targets (up to 5000 meters), it is almost impossible to use them against military targets. Ukraine does not have missile defense systems that could shoot down Kh-22 missiles.

⁶⁰ https://defence-ua.com/weapon_and_tech/chim_vidriznjajutsja_mizh_soboju_raketi_h_22_ta_h_32_jakimi_rashisti_bili_po_kremenchuku_ta_sergijivtsi-8135.html

⁶¹ <https://suspilne.media/359008-u-dnipri-raketa-vlucila-u-zitlovij-budinok-so-vidomo/>

⁶² <https://suspilne.media/359008-u-dnipri-raketa-vlucila-u-zitlovij-budinok-so-vidomo/>

Those suspected of committing crimes for violation of the laws and customs of war, the means of which were Kh-22 missiles, are the perpetrators (crew members of long-range strategic aviation aircraft), customers (the highest military-political and military leadership of Russia) and accomplices, as the entities that were engaged in launching and preparing for the launch of Kh-22 missiles. The special subjects suspected of committing this crime are the programmers who guided the missiles at Ukrainian targets. Thanks to the Bellingcat team and its partner The Insider and Der Spiegel, a group of three dozen Russian military engineers ⁶³.

2.4. Russian operational and tactical missile system "Iskander" (up to 700 km)

A family of the latest operational and tactical missile systems with ballistic and cruise missiles with a range of 500-700 km of targets of the surface-to-surface type "Iskander (9K720, SS-26 Stone). There are varieties: Iskander, Iskander-E, Iskander-K, Iskander-M. The complex was developed at the Kolomna Machine Building Design Bureau. The Iskander missile system is designed to strike small-sized and planar targets deep in the enemy's operational territory with conventional warheads.

Characteristics of the system: deviation from the planned target is 10-30 m, or 5-7 m for the Iskander-M system; launch mass of the missile: 3,800 kg; warhead weight: 480 kg; length 7.2 m; diameter 920 mm; missile speed after the initial part of the trajectory: 2,100 m/s. Maximum overloads during the flight are 20-30G (the missile maneuvers in flight both in height and in the direction of flight). The maximum trajectory height is 50 km; flight time for a minimum range of 50 km. 23 s.; flight time to a maximum range of 500 km. 238 s.; minimum range of target destruction is 50 km; maximum range of target destruction by ballistic missile is 500 km, by cruise missile R-500 it is up to 700 km; guidance system Inertial system + GLONASS, Optical DBN.

The complex includes six types of vehicles (51 units per a missile brigade): Self-propelled launcher (9P78-1) 12 pcs. Designed to store, transport, prepare and launch two missiles at a target. The Iskander can be made on the basis of a special wheeled chassis manufactured by the Minsk Wheeled Tractor Plant (MZKT-7930). GVW is 42 tons, payload is 19 tons,

⁶³ <https://novosti-n.org/ua/news/Staly-vidomi-imena-navidnykiv-raket-RF-na-ob-yekty-Ukrayiny-253889>

highway/road speed is 70/40 km/h, fuel range is 1000 km. The crew consists of 3 members.

Transportation and loading vehicle (9T250 (9T250E) 12 pcs.) – Designed to transport two additional missiles. The vehicle is built on the MZKT-7930 chassis and is equipped with a cargo crane. Gross combat weight is 40 tons. The crew consists of 2 members.

Command and Control Vehicle (C&CV) (9C552) 11 pcs. – Designed to control the entire Iskander complex. It is mounted on the KAMAZ 43101 wheeled chassis. Radio station R-168-100KAE "Aqueduct". The crew consists of 4 operators. Characteristics of the capabilities of the command and staff vehicle: maximum range of radio communication in the parking lot / on the march: 350/50 km; task calculation time for missiles up to 10 seconds; command transmission time up to 15 seconds; number of communication channels up to 16; deployment (folding) time up to 30 minutes; continuous operation time 48 hours.

Maintenance and inspection machine – designed to check onboard equipment of rockets and instruments, to carry out routine repairs. It is built on a KAMAZ wheeled chassis. It weighs 13.5 tons, deployment time does not exceed 20 minutes, automated routine check cycle time for missile onboard equipment is 18 minutes, crew size is 2 persons.

An information preparation unit (9C920,) mounted on a KAMAZ 43101 vehicle, designed to determine target coordinates and prepare flight tasks for missiles with subsequent transmission to the launcher. The PPI is integrated with intelligence assets and can receive tasks and assigned targets from all necessary sources, including a satellite, aircraft or drone. The crew consists of 2 personnel.

Combat life support vehicles 14 pcs. – Designed to accommodate, rest and feed combat crews. It is built on the KAMAZ 43118 wheeled chassis. The vehicle includes a rest compartment and a utility compartment. The rest compartment has 6 wagon-type berths with folding top beds, 2 lockers, built-in lockers, and an opening window. The amenity compartment has 2 lockers with seats, a folding lifting table, a water supply system with a 300-liter tank, a water heating tank, a water pump, a drainage system, a sink, a clothes and shoe dryer⁶⁴.

The Iskander-M (9K720) is a version for the Russian Armed Forces, with two missiles on the launcher. The official range is 500 km, but according to expert estimates, it can travel up to 700 km.

⁶⁴ <https://vikna.tv/ru/dlia-tebe/vijna-v-ukrayini/rakety-iskander-harakteristiki-ballisticheskoy-rakety-iskander/>

Flight altitude 6-50 km. Controllable throughout the flight. The trajectory is pseudo-ballistic and difficult to predict. The missile is made using low radar visibility technology and also has a radio-absorbing coating. Predicting the target during an early interception attempt is further complicated by intensive maneuvering during its takeoff and descent onto the target.

When descending onto the target, the missile maneuvers with an overload of 20-30 units, descending at a speed of 700-800 m/s – these figures exceed or are on the verge of reaching capabilities of the best missile defense systems in Ukraine.

To summarize, the Iskander-M tactical missile system has a number of advantages over its analogs. It has high capabilities to hit a target and overcome modern missile defense systems. This is a very dangerous weapon for the Ukrainian people.

There is a further modification of the 9K720M1 "Iskander-M1" – a version with a self-propelled launcher 9P701 carrying 4 cruise missiles 9M729.

There are at least two main modifications of cruise missiles for the Iskander-M operational and tactical complex: the R-500/9M728 cruise missile (developed by the Novator Design Bureau, Yekaterinburg) with a maximum range of up to 500 km. And the 9M729 (initially codenamed SSC-X-8 by the US Department of Defense, but in early 2017 it became SSC-8) with a maximum range (according to estimates) of up to 2500 km, based on the Kalibr-NK sea-launched cruise missile.

Work on the R-500 missile has been underway at least since 1998. The first launch of the R-500 missile with a 9P78-1 self-propelled launcher was carried out at the Kapustin Yar test site on May 29, 2007. State tests of the complex were scheduled to begin in 2008 and to be adopted in 2009. However, the missile was finally adopted by the 9M728 in 2013.

The main problem, however, is the 9M729 missile, which is likely a land-based modification of the 3M14 Kalibr cruise missile (US and NATO code name SS-N-30A). This modification violates the Intermediate-Range Nuclear Forces Treaty because a cruise missile with a range of 2,500 kilometers falls within the definition of a ground-launched intermediate-range cruise missile.

There are also reasons to believe that the differences between the 3M14 (Kalibr for the Russian military, with a range of up to 2500 km), 3M14E (export version of Kalibr with a maximum range of 300 km), 9M728 and 9M729 are not significant enough, and all these missiles form a single family of cruise missiles that have a similar design and dimensions.

Because ballistic missile launchers are extremely similar to cruise missile launchers (which violate the treaty), this makes it difficult to track cruise missile launchers, and under the terms of the treaty, all Iskander-M launchers should be considered as violating the Intermediate-Range Nuclear Forces Treaty ⁶⁵.



Iskander-M – 9K720 ⁶⁶

The body of the Iskander 9M723 missile geometrically consists of two parts: the rear cylindrical part, which is taken up by the engine, and the front conical part (which houses the warhead, targeting system and other equipment), ending in a pointed fairing. This shape shifts back the so-called pressure center, the point on the longitudinal axis of the missile through which the equivalent of all aerodynamic forces passes.

The more farther this pressure center is, the more it is shifted backward from the center of mass, the greater the stabilizing moment of the air and the more stable the rocket is – such a body will be stabilized in the incoming flow.

⁶⁵ https://defence-ua.com/weapon_and_tech/otrk_iskander_vsi_nadzdbnosti_z_kategoriji_shou_zbroji-6581.html

⁶⁶ <https://inshe.tv/suspilstvo/2022-03-11/664191/>

High supersonic flight speeds, up to hypersonic speeds with Mach number $M = 7$, heating the flow compressed by the rocket above 1000 °C. Therefore, the aerodynamic rudders are made of heat-resistant metals. To protect the body from heat, it is covered with a thick layer of polymer heat shielding. It also acts as a radio-absorbing coating, reducing the missile's radar visibility. Much attention has been paid to the reduction of the effective scattering area and the missile's low visibility. The body has virtually no protruding parts, visible joints and holes. The Iskander missile's gas-dynamic rudders, which are inserted into the engine's jet stream, are also heat-resistant. They perform well when aerodynamic forces are low – in the first seconds of acceleration, or weaken with altitude and air thinning. Gas-dynamic rudders are four small fins inserted into the engine jet stream. They are mounted on the nozzle section and act in accordance with the aerodynamic rudders. Such a construction was used in the German Fau-2 missile and is working properly in the Iskander missile. Having obtained the angle of attack in the nozzle supersonic jet, they create forces acting on the bottom of the rocket and rotate it.

This is the name given to the combination of the flight path with the target point. The navigation segment of the control system contains an inertial measurement unit. It is based on three accelerometers – devices that continuously and accurately measure current accelerations along three perpendicular spatial axes. Integrators convert the accelerations into velocities along the three axes, and after integrating them twice, into three coordinates in space. Thus, the inertial unit of the control system is able to know the current spatial velocity of the missile, its magnitude and direction in space, as well as the current coordinates of the missile. The angular position of the missile in space is measured by gyroscopes.

The control system compares the measured and programmed data (speed and coordinates) for the current second, determining the magnitude of the discrepancies. And it issues commands to the rudders: how to rotate the rocket relative to the center of mass and flow, how to move it in space to bring its position to the calculated one. Navigation information also comes through some other channels – from the GLONASS system, from a radar or optical homing head.

The 9M723 aeroballistic missile of the "Iskander" complex has the following main parameters: missile length – 7.3 m; body diameter – 0.92 m; weight – 3.8 tons; range – 400 km; accuracy (possible circular deviation):

without homing system – 30-70 m; – with homing system – five to seven meters ⁶⁷.

High-precision subsonic missile P-500 (9M728) is a Russian cruise missile designed for the Iskander system capable of overcoming missile defense systems. The development of the R-500 missile began in 1996 by the Yekaterinburg Novator Design Bureau. State tests of the missile began in 2008, and in 2009 it was accepted into service. As an official representative of the Russian Federation said in early 2013, the R-500 missile is an improved version of the Soviet C-10 Garnet system with a range of up to a thousand kilometers, and the 3M14E missile, according to him, is an export version of the R-500 ⁶⁸.

Examples of application: According to the Ukrainian Military Portal, since the beginning of Russia's invasion of Ukraine: On February 24, 2022, ballistic and cruise missiles from the territory of the Republic of Belarus were fired daily at the Iskander-M air defense system. It is probable that they had struck Ukrainian airfields at the very beginning of the invasion on February 24, 2022, and attacked a civilian airport in Zhytomyr on February 27, 2022. At the same time, experts noted that some of the hits were inaccurate or inappropriate, which indicates failed launches of Iskander-M missiles or the use of outdated Tochka-U air defense systems.

According to Ukraine's military leadership and the media, the Russian army used Iskander missiles when shelling Kyiv and other Ukrainian cities. On the night of March 2 to March 3, 2022. Kyiv was fired upon with P-500 (9M728) missiles from the Iskander system. Several missiles were shot down by air defense systems. On March 9, an Iskander ballistic missile was launched in the direction of Kramatorsk. The missile was shot down by Ukrainian air defense, and the fragments fell down. As it turned out, the missile had a cluster warhead. On March 14, Russian troops attacked residential areas in Kharkiv, including with Iskander missile systems. According to the Defense Staff, the attacks were carried out from the territory of the Russian Federation ⁶⁹.

Analysis of the observation data shows that up to 4 launches can occur within 10-20 minutes. More than 20 launches may take place during a day.

On May 27, 2022, an Iskander-K cruise missile launched from the Rostov region struck barracks of the National Guard of Ukraine in the Dnipro region. About 10 people were killed. About 30-35 people were wounded.

⁶⁷ <https://naked-science.ru/article/tech/raketa-iskander>

⁶⁸ <https://vpk.name/library/f/r-500.html>; <http://militaryrussia.ru/blog/topic-304.html>

⁶⁹ <https://t.me/milinua>

On May 28, 2022, the Russian occupiers hit the town of Merefa in the Kharkiv region with missiles and destroyed a solar power plant. It was built on a former landfill on loan money and had managed to operate for only a year and a half. The Iskander missiles struck the power plant, creating sinkholes six meters deep and 11 meters in diameter. It is completely out of commission, with panels and transformers only partially intact. The station was shot at from the direction of Russian Belgorod.

On May 31, 2022, the occupiers attacked the city of Sloviansk, Donetsk region. The shelling damaged 7 high-rise residential buildings and a school. Three people were killed and six were injured.

On June 18, 2022, the Russian military shelled Kharkiv. The industrial zone of the city was hit. A 9B899 heat trap (decoy target) from an Iskander ballistic missile was found at the site of the strike. 16 вересня 2022 р., Ukrainian air defense units of the East Air Command destroyed three Iskander-K cruise missiles in the Dnipro region ⁷⁰⁷¹.

To summarize, the Iskander family of tactical missile systems with a range of 500-700 km with surface-to-surface missiles is one of Russia's most effective missile weapons. The missiles are highly accurate. However, the stated characteristics of the ability to overcome air defense systems are overstated. After all, launched missiles are often downed by the Ukrainian armed forces. Traditionally, Iskanders have been used in most cases against civilian infrastructure in Ukraine. As a result, civilians are killed and injured.

It should be emphasized that in most cases, the Armed Forces of Ukraine and the Ukrainian people are vulnerable to missiles launched from Iskander systems. Ukraine's missile defense system is only being created, and the similar Ukrainian missiles (Grom-2 and Hetman) could become a deterrent to the Russian aggressor, are being developed and tested.

International sanctions or those imposed on Russia are saving Ukraine from a massive attack by Iskander missiles. Russia has already spent the vast majority of its high-precision Iskander missiles on striking civilian targets in Ukraine. And the Russian Federation's industry can produce a limited number of new ones. As of January 2023, according to intelligence, there were 52 Iskander missiles left ⁷².

⁷⁰ <https://t.me/milinua>

⁷¹ <https://fakty.com.ua/ua/ukraine/20230101-shho-take-raketna-systema-iskander-ta-yaki-ukrayinski-mista-nymy-obstrilyala-rosiya/>

⁷² https://lb.ua/society/2023/01/07/541739_reznikov_oprilyudniv_dani_shchodo.html

2.5. Ballistic missiles of the Islamic Republic of Iran Fateh-110 and Zolfaghar (up to 700 km)

There is no information about the Islamic Republic of Iran's actual supplies of ballistic missiles to Russia. Nevertheless, this possibility cannot be completely ruled out.

If they happen to be built, they will most likely be without launchers. Fateh-110: range – 300 km, weight of warhead (explosive) – up to 650 kg. Zolfaghar: range – 700 km, weight of the warhead (explosive) – up to 580 kg.

It is possible that the Russian armed forces could use Iskander launchers for the Fateh-110 missile. However, the Zolfaghar missile is fundamentally different from the Russian 9M723 and 9M728 ballistic missiles for the Iskander tactical missile system. The main difference is that it has a warhead that is separated from the upper stage. The situation is the same in other respects: without Iranian launchers, the launch of these missiles will be deemed problematic ⁷³.



Zolfagha and Dezful missiles ⁷⁴

This means that the Islamic Republic of Iran's Fateh-110 and Zolfaghar ballistic missiles (300-700 km), if supplied to the Russian armed forces, will become an undesirable but predictable weapon that the Ukrainian Armed Forces are ready to neutralize.

⁷³ <https://nv.ua/ukraine/events/rossiya-poluchila-rakety-ot-irana-ili-net-chto-ob-etom-izvestno-i-chto-delat-ukraine-ekspert-50295545.html>

⁷⁴ <https://www.radiosvoboda.org/a/fateh-110-zolfaghar-rakety-rosiya/32130181.html>

CHAPTER 3 ANTI-SHIP MISSILES

3.1. Russian anti-ship missile Kh-35 "Zvezda" (up to 260 km)

The newest anti-ship missile, the Kh-35 Zvezda (Product 78, 3M24; NATO code AS-20 Kayak/SS-N-25 Switchblade), is a Russian turbojet subsonic cruise missile. It can be launched from airplanes, helicopters, surface ships (3K24 Uran missile system) and shore-based mobile missile systems (3K60 Bal, NATO code SSC-6 Sennight). It is designed to destroy ships with a tonnage of up to 5,000 tons. Shipboard and shore-based versions are launched using a launcher. It has been in service since 2003 ⁷⁵.



Bal coastal missile system with X-35 missile ⁷⁶

The Kh-35 Zvezda missile is operational in the Russian Navy. No evidence of the use of the Kh-35 missile in the Russian-Ukrainian war of the early twenty-first century has been found in open sources. This is due to the fact that the Naval Forces of the Armed Forces of Ukraine are manned mainly by a mosquito fleet ⁷⁷.

⁷⁵ <https://missilery.info/missile/uran>

⁷⁶ https://defence-ua.com/minds_and_ideas/chomu_rf_udarami_oniks_ta_h_35_po_ukrajini_znischila_oboronu_indiji_ta_teper_mozhe_vikinuti_tsi_raketi_na_zvalische-7471.html

⁷⁷ <https://armyinform.com.ua/2022/06/05/peremogu-nad-rosiyeyu-na-mori-mozhna-zdobuty-v-asymetrychnyj-sposib/>

Examples of application: On April 23, 2022, Russian troops fired an Kh-35 missile from the Bal coastal complex at the city of Mykolaiv⁷⁸. Kh-35 missiles from the respective coastal missile systems were repeatedly used by the Russian aggressor to destroy the infrastructure for the storage and export of agricultural products from Ukraine⁷⁹.

This means that Russia's latest anti-ship missile, the Kh-35 Zvezda (7-260 km), did not prove effective in the Russian-Ukrainian war of the first half of the 21st century.

3.2. Ukrainian anti-ship missile system "Neptune" (up to 280 km)

This is the RK-360MC Neptune anti-ship system adopted by Ukraine in 2020 (Navy and Army). It is designed to destroy warships with a tonnage of up to 5000 tons. It uses the R-360 cruise missile.

It can be used for land, sea, and air deployment. During Russia's large-scale invasion of Ukraine in 2022, the Neptune was used for the first time in an operational environment. On April 14, 2022, two missiles struck the Moskva missile cruiser, the flagship of the Russian Black Sea Fleet⁸⁰.

Developed and manufactured by the State Design Bureau "Luch" with the involvement of related companies such as Orison-Navigation, Impulse, Vizor, Arsenal Central Clinical Hospital, Radionics, Telekart-Prylad, UkrInnMash, Motor Sich OJSC, and the Czech company Tatra.

The complex has a lot in common with foreign counterparts: the American Harpoon, the French Exocet, the Japanese ASM-2, the Swedish RBS-15, the British Sea Eagle, and the Turkish Atmaca.

The length of the rocket with the accelerator is 5050 mm. The launch weight of the missile is about 870 kg, the warhead weighs 150 kg. The missile has a cruciform folding wing. The warhead type is a high-explosive fragmentation warhead of penetrating type, weight – 150 kg. The warhead is activated by a fuze during contact with the target or remotely by non-contact sensors.

The missile's homing head was developed by the Radionics Research and Production Enterprise. It has ultra-high viewing angles and is capable

⁷⁸ <https://www.ukrinform.ua/rubric-regions/3465723-obstril-mikolaeva-vorog-udariv-protikorabelnou-raketou-z-teritorii-krimu.html>

⁷⁹ <https://gordonua.com/ukr/news/war/rosijani-4-veresnja-vipustili-ponad-10-raket-po-ukrajini-dvi-zbili-ppo-povitrijani-sili-zsu-1624530.html>

⁸⁰ https://defence-ua.com/weapon_and_tech/raketa_neptun_scho_potopila_moskvu_staje_populjarniju_i_v_ameritsi-6986.html

of seeing and engaging a target at a distance of 50 km. It is resistant to enemy radar interference.



Division of the RK-360MC Neptune complex

The missile has two engines – a launch engine and a propulsion engine. The launch engine is a launch booster taken from an anti-aircraft missile. It is solid-fueled and has been modified to launch the cruise missile from the launch container and provide it with initial acceleration to speeds where the main engine can engage. The main engine is an MS-400 turbojet engine manufactured by Motor Sich (Ukraine).

The missile is housed in a transport and launch container (TLC) with dimensions of 5,300×600×600 mm. The missile can be deployed on land, sea, or air carriers. The maximum range is up to 300 km. Speed – 900 km/h.

The most famous use of the Neptune anti-ship missile system took place on April 13, 2022, when the Ukrainian military used two missiles to destroy the flagship of the Russian Black Sea Fleet, the Moskva missile cruiser. It was 120 kilometers from the city of Odesa when it appeared on the operator's radar. At 14:06, the first of two missiles was launched. Later, the second missile was launched. They hit the cruiser on the port side in the area of the running bridge, the cabin and the forward engine room. A day

later, on April 14, 2022, the flagship of the Black Sea Fleet, Moskva, went down⁸¹.

However, Neptune's main merit lies not only in the sinking of the Russian navy's flagship for the first time in a century. At the beginning of the Russian invasion of Ukraine, it was the presence of the Neptune anti-ship missile system in the arsenal of the Ukrainian Armed Forces that was one of the factors that prevented the Russian aggressor from landing on the shores of Odesa region.

Therefore, the modern Ukrainian anti-ship missile system "Neptune" with a range of up to 280 km is an effective means of destroying maritime targets. It was the presence of the R-360MC Neptune in the Armed Forces of Ukraine that largely prevented Russian landing ships from approaching the shores of Odesa region and landing on the coast in early 2022. The R-360 Neptune cruise missile has shown its high efficiency⁸².

For several months, Neptune anti-ship missile systems defended the Ukrainian coastline on their own. Eventually, they were aided by anti-ship missiles from the United States, the Harpoon.

3.3. American anti-ship missile "Harpoon" (up to 315 km)

Ukraine currently has in service the US AGM/RGM/UGM-84 Harpoon anti-ship missile. "The Harpoon is a versatile anti-ship missile that can be used by surface ships, submarines, and aircraft.

The Harpoon's ultra-low altitude capability, active homing radar head and powerful warhead make it an effective weapon against surface targets.

Structurally, the Harpoon consists of four parts. The nose of the missile is the main (instrumentation) compartment, followed by the warhead, the main engine and the tail compartment.

The instrument compartment houses the missile's guidance and flight control systems and is covered with a special radio-transparent hood.

The missile is guided by the AN/DSQ-28 active homing radar head, which provides independent search, acquisition and targeting. The range of detection of a destroyer-type target is 40 km in clear weather and 23 km in rainy weather, and the range of detection of a missile boat-type target is 18 and 10 km, respectively. The homing head is activated on a predefined

⁸¹ <https://armyinform.com.ua/2023/04/13/rozsekrecheni-detali-operacziyi-znyshhennya-krejsera-moskva/>

⁸² <https://mil.in.ua/uk/news/kb-luch-prystupylo-do-vyrobnytstva-drugogo-dyvizionu-neptun/>

flight path. To protect against electronic warfare systems, it has a hopping operating frequency that changes in a random pattern. On the initial and marching (sub-adult) sections of the trajectory, flight control is carried out automatically using a navigation system, radio altimeter and digital computer.



*Harpoon launch from the Mk-141 launcher from the Royal Australian Navy ship HMAS Warramunga*⁸³

The WDU-18/B penetrator warhead weighs 222 kg and is 0.9 meters long. It is installed on all missile modifications except AGM-84H/K, which is equipped with a 360 kg WDU-40/B warhead. The warhead body is made of steel to protect the warhead from destruction when it encounters an obstacle. The detonation of the 97.5 kg of DESTEX explosives contained in the missile warhead does not occur immediately, but with a certain delay, so that the explosion occurs inside the ship.

Behind the missile warhead is a fuel tank and a Teledyne CAE J402 jet engine, which has a thrust of 300 kgf (2.9 kN) and enables the missile to reach a speed of 855 km/h. The engine uses JP-10 fuel.

⁸³ <https://www.psdinfo.store/post/harpoon>

The RGM/UGM-84 rockets use the A/B44G-2 or -3 solid-propellant booster, which is located in the tail of the rocket and provides 53 kN of thrust, operating for 2.9 seconds. The tail section also houses the mechanisms and actuators of four control rudders, which can provide a ± 30 -degree turn based on autopilot signals.

The Harpoon anti-ship missile system can be launched from AERO-65 and AERO-7/A bomb carriers, MK 6, MK 7 (anti-shock) and MK 12 (thick-walled) containers, MK 8, MK 112 ASROC and MK 116 TARTAR ship launchers, or from submarine torpedo tubes.

There are two options for use: bearing and range launch, and range launch. The first mode is used if the ship's location is known, and the radar homing head is activated at the final stage of flight. This method allows the missile to remain undetected by the enemy ship's systems for a longer time. The second option is used when the exact location of the target is unknown. In this case, the missile is launched in the direction of the target's likely location, and the homing head is activated at the initial stage of flight and searches for the target independently. However, in this case, the enemy can detect the missile launched at him much earlier than in the first option. If the target is not found, the missile will be commanded to self-destruct ⁸⁴.

Application: On June 17, 2022, in the Black Sea, two Harpoon missiles hit the rescue tugboat of the Russian Black Sea Fleet Vasily Bekh, which was transporting weapons and ammunition to the captured Zmeinyi Island. On board the tug was a Tor anti-aircraft missile system, which was intended to provide air and missile defense for the tug. On the same day, according to the head of the Odesa military regional administration, Maksym Marchenko, the hit vessel Vasyl Bekh sank ⁸⁵.

Thus, the introduction of Harpoon anti-ship missiles into service with the Ukrainian Armed Forces has voided Russian terrorists' plans to land on the coast of Odesa region. Since the Harpoon systems were put on alert, Russian warships have never safely approached the Ukrainian-controlled coastline closer than 300 kilometers. We are very grateful to the American people and other Western countries for supplying Ukraine with Harpoon missiles. God bless America!

⁸⁴ <https://missilery.info/missile/harpoon>

⁸⁵ <https://www.unian.net/war/vasiliy-beh-unichtozhen-harpoon-chto-eto-za-sudno-chernomorskogo-flota-rf-i-pochemu-ego-unichtozhenie-vazhno-novosti-vtorzheniya-rossii-na-ukrainu-11871525.html>

3.4. Soviet (Russian) anti-ship missile P-800 "Oniks" – (up to 800 km)

The P-800 Oniks (3M55, export name – Yakhont, US and NATO classification – SS-N-26 Strobile) is a Soviet / Russian supersonic, universal medium-range anti-ship missile designed to combat surface naval groups and single ships in conditions of strong fire and electronic engagement. It can also be used against ground targets, and the range of the target can be increased.

The development of the fourth-generation operational and tactical anti-ship system began in the late 1970s. Unlike previous Soviet SSBNs, which were relatively limited in their carrier specialization, the new system was originally conceived as universal: it was intended to be deployed on submarines, surface ships and boats, aircraft, and coastal launchers.

The missile is designed according to a conventional aerodynamic scheme. The solid propellant rocket engine is located in the combustion chamber of a straight-through jet engine and is separated by the incoming air flow at the end of the launch stage. Tactical and technical characteristics: rocket length 8 m; rocket launch weight 3000 kg; max: 884 m/s (M 2.6); control system: inertial + radio altimeter on the marching section; all-weather monopulse active-passive radar, radio frequency frequency (RF) control system on the final section; warhead weight: 200 kg ("Yakhont"), 300 kg ("Oniks")⁸⁶

Due to the short sub-flight time and long range of the homing head, the Yakhont missile system does not impose strict requirements on the accuracy of target information. A high altitude view of the entire target area allows for preliminary targeting of missiles at group of ships and the selection of false targets. The main advantage of the Yakhont missile is its targeting program, which allows it to act against a single ship on a "one missile, one ship" basis or as a "flock" against a flock of ships. It is in the salvo that all the tactical capabilities of the system are revealed. The missiles themselves distribute and classify targets according to their importance, choose the attack tactics and plan. The autonomous control system includes data on both enemy electronic warfare countermeasures and methods of evading air defense weapon fire. After destroying the main target in the ship group, the remaining missiles attack the other ships in the group, eliminating the possibility of two missiles hitting the same target.

⁸⁶ https://news.liga.net/ua/region_news/news/pvo-v-odesskoy-oblasti-perehvatila-nochyu-sverhzhukovye-rossiyskie-rakety-oniks

To prevent mistakes in maneuver selection and the defeat of a given target, the missile's onboard computer has electronic portraits of all modern ship classes. The missile is enclosed in a sealed transportation and launch container⁸⁷.

Ukrainian air defense systems have learned to destroy Oniks missiles. Thus, on June 14, 2022, two Oniks were shot down over Odesa region, launched from the Crimean coastal missile system⁸⁸.

Russian forces had used supersonic cruise missiles of the Oniks type in the southern regions of Ukraine. Most cases were recorded in Odesa and Mykolaiv regions (about 20), while the total number of missiles that were confirmed (shot down by the Ukrainian air defense forces – 40% of those detected, or dropped on land) was about 40. The missiles are usually launched in flocks of 4 from the temporarily occupied territory of Ukraine, the Autonomous Republic of Crimea. However, not all of them reach the area of Ukrainian air defense. About 30 percent fell into the sea due to old age and unsatisfactory technical regulations. Ukraine's media reports that the use of Onyx missiles have resulted in no significant collateral damage or casualties^{89 90}.

Examples of application:

On April 30, 2022, the Bastion-P coastal missile system fired at Odesa airport from the territory of Crimea⁹¹;

On May 9, 2022, four Onyx missiles from the territory of Crimea attacked a facility in the city of Artsyz, Odesa region⁹².

Thus, the Soviet (Russian) anti-ship missile P-800 "Oniks" has shown low efficiency in the Russian-Ukrainian war.

⁸⁷ https://testpilot.ru/russia/chelomei/p/800/index_1.php

⁸⁸ https://lb.ua/society/2022/06/14/519971_ppo_zapobigla_raketnomu_udaru.html

⁸⁹ <https://t.me/odesacityofficial>; <https://t.me/mykolaivskaODA>

⁹⁰ <https://t.me/mykolaivskaODA>

⁹¹ <https://tsn.ua/ato/odesu-bulo-obstrilyano-z-teritoriyi-krimu-detali-udaru-2050327.html>

⁹² https://lb.ua/society/2022/05/09/516183_odesku_oblast_obstrilyali_raketami.html

CHAPTER 4 INTERMEDIATE-RANGE MISSILES

4.1. Russian Kalibr cruise missile (up to 2600 km)

"Kalibr" is a family of modern cruise missiles developed by OKB-8 (Novator NPO). The anti-ship cruise missile of this family has the NATO code designation SS-N-27 "Sizzler", and the SS-N-30 for ground targets. Export versions of the system are called Club (Club-A, Club-M, Club-K, Club-S). It has been in operation since 2012.



No official data on tactical and technical characteristics are publicly available, but it is known from non-secondary sources that depending on the modification, the range of the Kalibr cruise missile is between 50 and 2600 km. The missile is accurate and has a warhead of 450 kg⁹³.

The Kalibr missile is widely used by Russian-terrorist forces to hit civilian infrastructure in Ukraine. This is done from a sea-based platform with both surface and submarine components. These include: submarines of the projects 877 "Paltus", 677 "Lada", 971 "Shchuka-B", 885 "Yasen" and 955 "Borey"; Russian warships: frigates of projects 22350, 11356 and missile ships of project 11661. According to the Naval Forces of the Armed Forces of Ukraine, as of February 19, 2023, 10 Russian ships are on combat duty in the Black Sea, including two Kalibr cruise missile carriers, with a total volley of eight missiles, the press service of the Naval Forces of the Armed Forces of Ukraine reported. There is one enemy ship in the Sea of

⁹³ <https://orel-tara.ru/drugoe/kalibr-raketa-harakteristiki.html>

Azov, 10 enemy ships in the Mediterranean, including 5 Kalibr cruise missile carriers, a total of 72 missiles ⁹⁴.

In general, Russian Kalibr missiles are effective. Open sources cite the following facts of their striking some Ukrainian ammunition depots ^{95 96 97}.

However, the Russian invaders would have not been themselves if they had not committed terrorist acts with the help of Kalibr missiles, among other things:

On April 26, 2022, Russian terrorists struck three times with Kalibr missiles on the city of Zaporizhzhia ⁹⁸;

On July 14, 2022, the city of Vinnytsia was attacked with Kalibr missiles. Two missiles were shot down, three hit objects of civilian infrastructure: an office center, a parking lot, and a residential building. 23 people were killed and 64 hospitalized ⁹⁹. One of them is a four-year-old girl Liza with a Down syndrome. In order for the girl to be fully rehabilitated, her mother fought for her from the very beginning of her life. Liza died on the spot. Her life was cut short by a Russian Kalibr precision missile programmed and fired by Russian terrorists. The mother of the murdered child was taken to intensive care in serious condition ¹⁰⁰.



Four-year-old girl Liza with a Down syndrome before and after being killed with a Russian Kalibr missile ¹⁰¹

⁹⁴ <https://www.radiosvoboda.org/a/news-vms-rosiyski-korabli/32278213.html>

⁹⁵ https://t.me/UAF_official/158

⁹⁶ https://t.me/UAF_official/94

⁹⁷ https://t.me/UAF_official/62

⁹⁸ https://24tv.ua/po-zaporizhzhyyu-prileteli-tri-kalibri-zagynuv-elektrik-poraneno_n1963536

⁹⁹ <https://zaxid.net/news/>

¹⁰⁰ <https://zmina.info/news/pid-chas-raketnogo-obstrilu-vinnyczi-zagynula-dytyna-z-syndromom-dauna-yiyi-maty-u-reanimacziyi/>

¹⁰¹ <https://www.radiosvoboda.org/a/photo-liza-dytyna-vbyta-raketoyu-vinnytsia/31945307.html>

So, the Kalibr cruise missile (2600 km) is a modern, precise means for Russians to hit targets in Ukraine. It has proven to be highly effective. Ukrainian means show satisfactory results in downing them. Some missiles reach their targets. The Russian-terrorist forces use them in most cases to hit civilian infrastructure. As a result, civilians, including children, are killed.

4.2. Russian hypersonic aircraft system Kh-47M2 "Kinzhal" (up to 3000 km)

The Kh-47M2 Kinzhal is a Russian hypersonic air defense missile system. After successful tests, it was put into service and on December 1, 2017, began performing combat duty at the airfields of the Southern Military District. The size and appearance of the Kinzhal missile is similar to the Iskander ballistic missile.

For the first time, the missile system was presented using a modified MiG-31 as a launch vehicle. In July 2018, the TASS agency reported on the integration of the Kinzhal system with the Tu-22M bomber. Presumably, one Tu-22M will be able to carry 3 Kinzhal missiles (similar to the Kh-22 cruise missiles), and the operational radius will increase from 2000 to 3000 kilometers.

The MiG-31K is capable of carrying one such missile and hitting targets at a distance of 2000 kilometers. Tu-22M3 aircraft can be equipped with 4 Kinzhal missiles, with a range of over 3000 km. The stated maximum speed of the missile is up to 4080 m/s (14688 km/h). The flight altitude at the moment of reaching hypersonic speed is allegedly 20 km, and the weight of the warhead is 500 kg.

Tactical and technical characteristics: carrier (launcher): MiG-31/ SU-57 (prospective carrier) and TU22M; missile: hypersonic with nuclear or conventional warhead; maximum range: over 2000 km (over 3000 km for TU-22M); maximum speed: M 10 (12350 km/h) ¹⁰².

Main characteristics of the Kinzhal missile: year of adoption: 2018; type: aeroballistic; length: 7.7 m; weight of the warhead: 500-800 kg; speed: 14688 km/h or 4080 m/s; maximum range: 2000 km + carrier flight range; accuracy 1 m; number as of January 1, 2023 ¹⁰³.

¹⁰² <https://fakty.com.ua/ua/ukraine/20230309-u-10-raziv-vyshhe-shvydkosti-zvuku-dalnist-urazhennya-3-tys-km-shho-take-raketnyj-kompleks-kyndzhal/>

¹⁰³ <https://mc.today/balisticheskie-i-krylatye-vysokotochnye-i-giperzvukovye-kakimi-raketami-rossiya-obstrelivaet-ukrainu-i-pochemu-samye-starye-iz-nih-osobenno-opasny/>



The application of the Kh-47 Kinzhal missiles. Russia claims that the first combat use of the Kinzhal missile system took place in Ukraine on March 19, 2022, when the occupiers announced the launch of hypersonic missiles at Ivano-Frankivsk region. The Russians claimed that they had allegedly destroyed an underground military depot where aviation and related ammunition was stored, and on the same day, a Kizhal missile destroyed fuel depots in Kostiantynivka, Mykolaiv region¹⁰⁴. Ukraine did not confirm this information. On May 9, 2022, Russia fired three Kinzhal missiles at Odesa region, injuring two people¹⁰⁵. Another attack with Kinzhal missiles took place on August 7, 2022, when the enemy struck at facilities in Vinnytsia region^{106 107}. On March 9, 2023, Russia used 6 Kinzhal air-launched missiles during massive launches at Ukrainian civilian infrastructure.

In addition:

On September 14, 2023, the occupants launched a missile attack, including two "Daggers", on the hydraulic structures of Kryvyi Rih. Russian terrorists tried to create an emergency in the region by flooding the city. As a result of this missile strike, the water level in the Ingulets River rose, and more than a hundred houses were flooded. The population was partially evacuated;

On October 15, 2022, the Russians fired one Kinzhal missile at an energy infrastructure facility in the Kyiv region;

¹⁰⁴ <https://www.unian.ua/world/raketa-kindzhal-shcho-vidomo-pro-rosiysku-giperzvukovu-raketu-novini-svitu-11759509.html>

¹⁰⁵ <https://chas.news/current/kindzhal-scho-vidomo-pro-giperzvukovii-raketnii-kompleks-rosiiskoi-armii>

¹⁰⁶ <https://fakty.com.ua/ua/ukraine/20230309-u-10-raziv-vyshhe-shvydkosti-zvuku-dalnist-urazhennya-3-tys-km-shho-take-raketnyj-kompleks-kyndzhal/>

¹⁰⁷ <https://tsn.ua/ru/ato/kinzhal-giperzvukovoy-raketnyy-kompleks-osobnosti-i-harakteristiki-2251960.html>

On January 26, 2023, Russians hit critical and energy infrastructure facilities in Kyiv and Zaporizhzhia with two Kinzhal missiles.

In total, according to Ukrainian military analysts, more than 80 Kinzhal missiles had been fired at the territory of Ukraine during the full-scale invasion¹⁰⁸

It should be emphasized that all cases of using the Kinzhal missile were successful. According to the available information, no cases of shooting down a Kinzhal missile by Ukrainian air defense systems have been made public.

Thus, the Kh-47M2 Kinzhal hypersonic aircraft system is a successful and effective modern development of Russia. Ukrainian air defense forces are practically unable to shoot them down. The long range (3000 km), powerful payload (500 kg), and highest precision (1 meter) make the Kinzhal missile one of the most dangerous weapons of the Russian-Ukrainian war.

However, according to military analysts from the United States and the United Kingdom, Russia's use of the "Kinzhal" has a political rather than a military tactical purpose¹⁰⁹. After all, the use of such an expensive, rare and high-tech system to destroy an ammunition depot most likely signaled and demonstrated the intention and ability to escalate, rather than the desire to achieve a specific military goal. In addition, it should be emphasized that the number of such missiles is limited, and it is difficult to build them under the international sanctions environment. Therefore, sanctions against the Russian Federation are working and need to be strengthened.

4.3. Soviet cruise missile Kh-55 / Kh-555 (up to 3500)

The Russian Armed Forces are armed with the Soviet strategic aviation cruise missile Kh-55 (Product 120, RKV-500, NATO codification – AS-15 Kent). It was developed at the Raduga Design Bureau in Dubna in late 1970 and early 1980 to be used to arm strategic bombers.

The first launch of the Kh-55 from a converted Tu-95M-5 aircraft took place on February 23, 1981. The aircraft travels at subsonic speeds at extremely low altitudes, avoiding terrain.

¹⁰⁸ <https://www.slovoidilo.ua/2023/03/10/infografika/bezpeka/kyndzhaly-koly-ta-skilky-hiperzvukovyx-raket-rosiya-zastosuvala-proty-ukrayiny>

¹⁰⁹ <https://www.unian.ua/world/raketa-kindzhal-shcho-vidomo-pro-rosiysku-giperzvukovu-raketu-novini-svitu-11759509.html>

The missile is designed to be used against strategically important stationary surface targets with known coordinates. The Kh-55 is carried by Tu-95 and Tu-160 strategic bombers.

Technical characteristics of the missile: length 6 m; wingspan 3 m; launch weight 1200 kg; warhead weight 410 kg; range 2500-3000 km; flight speed 720-830 km/h; precision 100 m ¹¹⁰.

The missile was manufactured by the Kharkiv Association (Ukraine), as of 1991. Ukraine had about 1000 Kh-55 missiles. In 1999, Ukraine transferred 575 Kh-55 and Kh-55SM missiles to the Russian Federation according to an international agreement.

Example of application: On March 18, 2022, allegedly Russian Kh-55 missiles struck an aircraft repair plant in Lviv ¹¹¹.

Kh-555 – this modification has a heavier warhead and additional wings to balance it out. The development of this missile lasted until the mid-2000s, and it was only approved for service in 2010. The Kh-555 missile is much heavier than the Kh-55, as the high-explosive or cluster warhead effective for such a weapon is much heavier than a nuclear warhead. That is why the Kh-555 is larger in weight and size, but has a shorter range of up to 250 km. At the same time, the weight of the warhead ranges from 200 to 400 kg. The Kh-555 also has a different guidance system. In addition to inertial navigation, a full-fledged Tercom system with a radio and optical channel, as well as satellite navigation, was added ¹¹².

On March 18, 2022, allegedly Russian Kh-55 missiles struck an aircraft repair plant in Lviv.

The Russian Armed Forces are massively using Kh-55 cruise missiles in the shelling of Ukraine. For example, on October 11, 2022, Russian-terrorist forces fired 13 Kh-55 missiles at Southern Ukraine, most of which were destroyed by the Ukrainian air defense system. In practice, Russia uses this type of outdated missile as a decoy to test the capabilities of the Ukrainian air defense system. There have been documented cases of shooting down Kh-55 missiles with simulated charges ¹¹³.

¹¹⁰ <https://arsenal-info.ru/pub/rakety-vozduh-zemlya/h-55-h-55sm-h-65-h-555-as-15-kent>

¹¹¹ https://zaxid.net/okupanti_zavdali_raketniy_udar_po_aviaremontnomu_zavodu_u_lvovi_n1538721

¹¹² <https://arsenal-info.ru/pub/rakety-vozduh-zemlya/h-55-h-55sm-h-65-h-555-as-15-kent>

¹¹³ <https://t.me/zsuwar>



Kh-55SM missile

In other words, the Soviet strategic air cruise missile Kh-55 is outdated for modern warfare. Its use has shown low efficiency in hitting targets. In most cases, missiles of this type are shot down by Ukrainian air defense forces.

CHAPTER 5 STRATEGIC MISSILES

5.1. Russian cruise missile Kh-101 (up to 5500 km)

Kh-101 is an air-to-ground strategic cruise missile with radar-avoidance technology. Developed by the Raduga Design Bureau (1995-2013). The engine is located inside the missile. The missile is made on a new technological basis and, according to Russian officials, has exclusively Russian components. It uses a combined guidance system: an inertial system with optoelectronic correction; a homing head is used at the end stage. It can receive comprehensive information on both the route and target coordinates. Unlike previous generation missiles, it is possible to change the target while the missile is already flying. Tactical and technical characteristics of the missile: speed – up to 720 km/h; weight – 2,400 kg; weight of the warhead – 960 kg; length – 7.4 m.

Around the end of November 2022, the Ukrainian Defense Forces began detecting L-504 radar trap devices in the wreckage of missiles. In this way, Russian engineers are looking for a way to break through air defense.

According to the test results, the missile has a circular probable deviation of 7 meters at a range of 5500 km. Theoretically, the missile is capable of destroying moving targets with an accuracy of up to 10 meters ¹¹⁴.

The aggressor first used the Kh-101 on March 6, 2022. The invaders launched them for air strikes at the airport in Vinnytsia and at the military airfield in Havryshivka. One missile was shot down by a machine gun. Later, on April 23, six Kh-101 missiles were fired at Odesa. Ukrainian air defense shot down two missiles. The shelling killed eight people, including a three-month-old baby. On October 10, 2022, the Russian Armed Forces fired approximately 84 cruise missiles at Ukraine. A week later, on October 11-18, the occupants attacked Ukraine again. Among the missiles launched were Kh-101s. On November 15, 2022, the invaders fired about 100 missiles at the territory of Ukraine, including Kh-101 cruise missiles. Traditionally, they were launched from the Caspian Sea region and Rostov region, Volgogradsk ¹¹⁵.

¹¹⁴ <http://militaryrussia.ru/blog/topic-440.html>

¹¹⁵ <https://fakty.com.ua/ua/ukraine/suspilstvo/20230309-mozhut-litaty-na-vidstani-do-55-tys-km-okupanty-obstrilyaly-kyyiv-raketamy-h101/>



Strategic Russian bomber TU-95 with X-101 missiles on external suspension¹¹⁶

Thus, the Kh-101 strategic cruise missile (5,500 km) is a modern means of striking targets with high accuracy. Ukrainian air defense systems show satisfactory results in destroying them. Most of all, Kh-101 missiles are used by the Russian-terrorist forces not to hit the targets of the Armed Forces of Ukraine, but civilian infrastructure, causing civilian casualties.

¹¹⁶ <https://army-today.ru/tehnika/x-101-i-x-102>

CHAPTER 6

INTERCONTINENTAL MISSILES

This class includes a number of missiles operated by the Russian Federation ¹¹⁷. The possibility of using some of them against Ukraine is not ruled out.

The Russian Federation has intercontinental ballistic missiles that are potentially dangerous for Ukraine and its allies:

- mobile and mine "Yars" (Topol-M modification);
- solid-fueled Bulava (Topol-M modification) and liquid-fueled Liner and Sineva, restored old Soviet missiles for nuclear submarines;
- The new Sarmat ICBM (Russian copy of Satan).

6.1. Russian intercontinental ballistic missile Yars

6.1.1. The PC-24 Yars (SS-27 Mod 2 according to NATO classification) is a Russian solid-propellant intercontinental ballistic missile of mobile and silo-based design with a separate warhead with individual guidance units.

It was developed by the Moscow Institute of Thermal Engineering. It is a modification of the Topol-M missile. The manufacturer is Votkinsk Plant OJSC.

Commissioned in 2010. The range is 11,000 km. The diameter of the missile is 2 m and its length is 20.9 m. The weight of the mobile missile is 49 tons.

6.1.2. Yars-S is a modernized mobile missile system, the characteristics of which were disclosed in 2021. Yars-S is armed with solid-fuel ballistic missiles of 1.86 meters in caliber and 17.8 meters in length. The launch weight of the carrier is 46 tons with a payload weight of 1.25 tons. As stated, the system can hit targets at a range of up to 10 thousand kilometers. The carrier can carry from 3 to 6 warheads

6.1.3. Avangard (other names of the development period: RS-26, Rubizh) is a mobile surface-to-air missile system with an intercontinental ballistic missile. It is a further development of the Yars project (RS-24 Yars) with new guided warheads. Compared to the RS-24 Yars, the autonomous launcher of the RS-26 missile system is significantly lighter

¹¹⁷ <http://asljournal.org/9-9/>

(80 tons compared to 120 tons for the Yars). The missile can be launched at targets at a range of 2000-6000 km.

The Avangard missile system was put into mass production. The Avangard missile system is supposed to be mine-based. On December 17, 2022, it became known that a regiment armed with the Avangard missile system was put on combat duty in Russia. The regiment is deployed in the Yasenskoye missile formation of the 13th Missile Division of the Strategic Missile Forces, which is located in the Orenburg region. As of September 2021, Russia had a total of 110 RS-24 Yars missiles in service – 90 (10 regiments) mobile and 20 (2 regiments) silo-based ¹¹⁸.

So, the Russian Federation has a powerful arsenal of intercontinental ballistic missiles. The use of which cannot be ruled out on the territory of Ukraine and our allies. The Ukrainian people and the Armed Forces of Ukraine are potentially prepared for such unfavorable developments.

¹¹⁸ <https://c-okrug.ru/granatomet/yars-raketnyj-kompleks-harakteristiki.html>

CHAPTER 7

MISSILES WITHOUT RANGE LIMITATION

7.1. Ukrainian project of the XXX-1 orbital kinetic missile

In response to the threat of Russia's use of weapons of mass destruction and/or intercontinental ballistic missiles against Ukraine or our allies, a technical proposal has been developed to create a single-stage liquid-phase orbital kinetic missile in Ukraine that is not a weapon of mass destruction: the XXX-1 missile hits a target at a speed of 22.7 M, similar to a meteorite.

The developer of the Technical Proposal is Science & Space LLC (Kyiv – Dnipro). The single-stage missile is launched from a mobile launch table. Its purpose is to launch a cargo into a circular solar-synchronous orbit with a height of 586 km: cargo – 200 kg After entering orbit, the engines are turned on and the rocket is directed to the target without range limitation. After targeting, the engine turns off and turns on again at an altitude of 60-80 km, the hypersonic speed of hitting the target is more than 22.7 M: when it hits a concrete bunker, a missile silo cover, a mobile missile system, the ship is triggered by explosives (the principle of cumulative charge) Like a meteorite, it penetrates the target and the materials evaporate to form a crater at the site of the rocket's impact.

When launching a payload into space, a Gomanian transitional orbit is used with a repeated double engine start. At the new apogee, the rocket's engine is switched on again during inertia flight, and at the reached altitude the rocket remains in a circular orbit until the command to destroy the target. The missile is on combat duty.

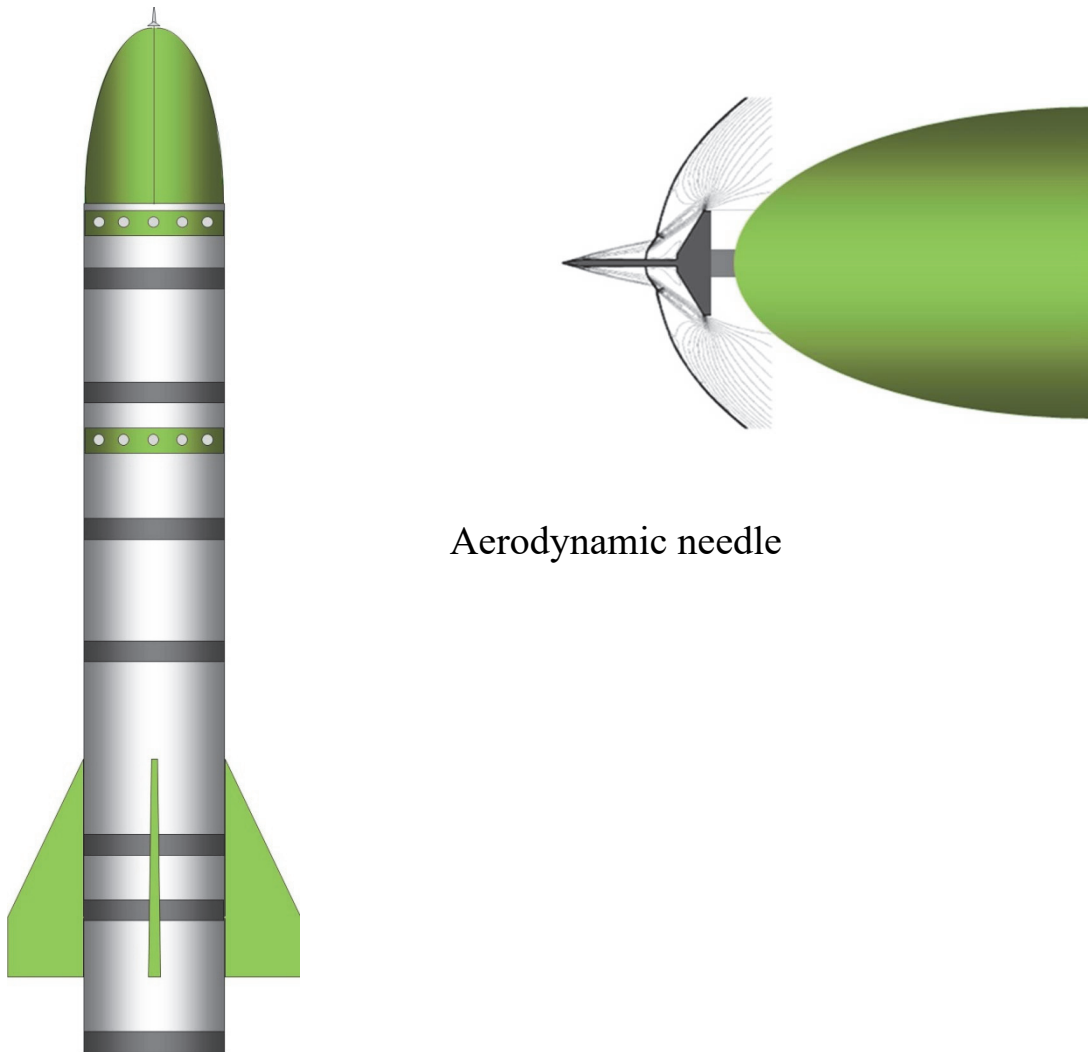
A single-stage missile performs the function of the first and second stages of a traditional launch vehicle and the upper stage (third stage) to launch a satellite into a given orbit. The design requires an optimal ratio of parameters, weight and area of the rocket midsection (rocket diameter). The GS-10 engine (developed by Science & Space LLC) is used.

A launch truss is used to hold the rocket upright before launch. The rocket is transported by a wheeled vehicle.

The rocket is driven by gas engines – nitrogen under pressure is supplied to the control nozzles.

The altitude of the circular orbit is 586 km, the initial speed of descent from orbit is ≈ 7800 m/s (22.7 M), the final dive speed is over 7800 m/s (22.7 M) – the rocket engine operates, excluding braking in dense layers of the atmosphere, and hitting the target. When a 200 kg metal ingot is hit,

even without the effect of the cumulative charge and the weight of the rocket structure (1.5 tons), energy is released in excess of $E_{200} = 1.2 \cdot 10^{10}$ J. The average range of the rocket during ballistic flight is 800 km. To reduce aerodynamic drag during flight in dense atmospheric layers, a nose hypersonic aerodynamic needle is used: use of a blunted fairing toe and aerodynamic needle (connected and disconnected main seal jumps during hypersonic flow, more than M 7) ¹²¹



Aerodynamic needle

In general, it should be noted that the deterrent to the development of this type of weapon is not only finances, but also Ukraine's international obligations. However, in the event that the Russian armed forces use weapons of mass destruction or intercontinental ballistic missiles against Ukraine or our allies, the XXX-1 Orbital Kinetic Missile project will be finalized and used against any military facilities of the Russian Federation, regardless of their location.

AFTERWARDS

Ukraine is at the forefront of the defense of Western democracy against the totalitarian Russian plague. It is no exaggeration to say that the future of the entire world order depends on the outcome of this war. Will other state dictatorships launch wars of aggression?

Several times in its history, the Russian empire, thanks to its weapons, terror, bribery and propaganda, became the gendarme of Europe. We should not forget that in 1814 Russian troops entered Paris and in 1945 they stormed Berlin. For many decades after that, the peoples of Europe suffered from rape, plunder, violation of rights and freedoms, and the imposition of totalitarianism in general.

For the sake of completeness, we should honestly note that some of the Russian occupation troops who moved towards Europe along with other enslaved peoples of Russia for several centuries were ethnic Ukrainians. Unfortunately, Ukrainians fought on both sides in almost all the wars waged by Russia against European states after 1654.

Whenever Russia's wars of conquest toward Europe or Turkey began, the Ukrainian people always stood in its way. Since the twenty-second century, Russia has waged more than 40 of such wars, large and small ones.

Whenever the Russians had managed to conquer Ukraine, they would not stop. They kept going. In other words, Russia's war with Ukraine in 2022 was supposed to be a prelude to the conquest of Lithuania, Estonia, Latvia, Moldova, Kazakhstan, Poland, Romania, Slovakia, Bulgaria, Finland, Hungary, and so on to the West, South, and North until the aggressor's military potential was completely exhausted.

Using his classic tactics of a berm of fire and throwing thousands, tens of thousands, hundreds of thousands, millions of his Russian serfs (zombified, disenfranchised Russian citizens) at the positions of the armed forces of democratic states, Putin is able to seize one democratic state after another.

However, on August 24, 1991. Ukraine regained its independence. We had some time to prepare for the war. And for the first time for several centuries, on the way to Europe, the Russian aggressors faced not just the Ukrainian people, but the Ukrainian people united with its monolithic independent sovereign state. With its own Armed Forces and civil society. The special military operation (as Putin calls the war in Ukraine), which promised to capture Kyiv in a few days and the whole of Ukraine in a couple of Sundays, has been going on for more than a year. We have already recaptured more than half of the territory that had been occupied after

February 22, 2022. The Armed Forces of Ukraine and the entire Ukrainian people are preparing to liberate the entire territory of Ukraine within the internationally recognized borders of 1991.

There is no longer any doubt that after Ukraine's victory, the Russian Armed Forces will not advance further this year (2023). Thanks to the courage and sacrifice of the Ukrainian people, and no doubt Western assistance, other countries in Europe and Asia that are Russia's neighbors can temporarily rest in peace.



The military burial quarter of the heroes who died in the Russian-Ukrainian war at the cemetery of one of the small towns of Mohyliv-Podilskyi (population before the war: about 50 thousand people) in Vinnytsia region.

However, Russia has a tendency to restore its military potential after its defeats. And after some time, it will start its imperialist wars again. Unfortunately, the international community is not yet ready to support the independence of the national republics and some other subjects of the Russian Federation that are striving for independence. All of this, in our

opinion, proves beyond doubt that not only Ukraine, but also other democratic countries should be preparing for the next war.

As the experience of this war has shown, missile superiority does not lead to victory for the Russian aggressor. However, it enables the Russian leadership to commit massive acts of terrorism, kill tens of thousands children, the elderly, or other civilians of Ukraine with impunity, destroy infrastructure, destroy churches, educational institutions, cultural institutions, etc.

Ukraine has traditionally developed and built some of the world's best intercontinental ballistic missiles. However, in the first decade of independence, pacifist sentiments toward Russia dominated both Ukrainian and European society. Ukraine's missile potential did not develop satisfactorily. Nevertheless, it has been preserved.

Ukrainian designers are ready to develop and produce new modern short-range tactical missiles. However, all financing, both public and popular (volunteer), is used to support the current expenses of the Armed Forces of Ukraine. It is impossible to find Ukrainian public or private funding for advanced missile development. That is why we are appealing to the Western community, especially our friends from the UK, for financial assistance to finalize and establish production of Ukrainian short-range ballistic missiles to deter the Russian aggressor in this and future wars.

APPEAL

Dear friends and partners, Ukrainian designers and manufacturers of ballistic missiles are requesting financial assistance to complete the design, testing and fielding of the Sagaidak mobile-launched tactical missile system with a Hetman single-stage ballistic missile.

The Hetman missile is intended for the defense of Ukraine as a ballistic deterrent ("striking") weapon against the Russian aggressor with a range of up to 500 km and a warhead with a payload of 500 kg.

The project is low-budget and feasible within the capabilities of the Ukrainian industry. The flight speed of $M = 4.8$ can be considered as an analog of the Russian Iskander, with a slightly lower cost.

Project financing: The minimum required costs for the development of the product before it is put into mass production are \$600,000 (including the purchase of materials, components, and prototypes). Taking into account the allied companies that will be involved in the major part, about \$1 million.

The full term of work is 6 months due to the intensification of work under the martial law.

Form of participation in financing: sponsorship or investment.

Please transfer sponsorship funds to the charity fund in the UK.

For investment questions, please contact:

Prof. Valentyn Halunko

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Current account in USD: EDRPOU code 43549593

UA213052990000026002036212283

We made similar missiles in the past era. Our allies are making them now. However, ballistic missiles have a range of 500 kilometers. Ukraine will not be provided with them. We can build them ourselves. The probability of implementing the Sagaidak missile system is 99%. The cost of the first successful test is estimated at \$1 million. An agreement will be signed with the investor. He will be paid 10% of the profits + 1% of the sales of missile systems (his successors).

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