



JULY 2026

Rebuilding to Reconquer

Can Russia's Defense Firms Deliver?

AUTHORS

Maria Snegovaya

Tina Dolbaia

Nicholas Fenton

Max Bergmann

CONTRIBUTORS

Samuel Bendett

Cory Woodall

A Report of the CSIS Europe, Russia, and Eurasia Program

CSIS

CENTER FOR STRATEGIC &
INTERNATIONAL STUDIES

JULY 2026

Rebuilding to Reconquer

Can Russia's Defense Firms Deliver?

AUTHORS

Maria Snegovaya

Tina Dolbaia

Nicholas Fenton

Max Bergmann

CONTRIBUTORS

Samuel Bendett

Cory Woodall

A Report of the CSIS Europe, Russia, and Eurasia Program

© 2026 by the Center for Strategic and International Studies. All rights reserved.

No part of this publication may be reproduced or transmitted in any form or by any means without permission in writing from the Center for Strategic and International Studies (CSIS). CSIS does not take specific policy positions; accordingly, all views expressed herein should be understood to be solely those of the author(s).

Center for Strategic & International Studies
1616 Rhode Island Avenue, NW
Washington, DC 20036
202-887-0200 | www.csis.org

ISBN: 979-8-9951068-6-9 (pb)
979-8-9951068-7-6 (ebook)

Cover: ILYA PITALEV/SPUTNIK/AFP/Getty Images

Acknowledgments

The authors would like to extend special thanks and recognition to the contributors of the report—Samuel Bendett, non-resident senior associate with the CSIS Europe, Russia, and Eurasia Program, and Cory Woodall, research intern with the program.

Further, the authors would like to thank a wide group of experts, scholars, and practitioners who provided important feedback and insights for this report, including Kateryna Bondar, Federico Borsari, Mathieu Boulègue, Bryan Clark, Jeffrey Fischer, Dmitry Gorenburg, Jason P. (JP) Gresh, Craig Kennedy, Janis Kluge, Alexander Kolyandr, Kate Koren, Pavel Luzin, Tomas MalmLöf, Paul Schwartz, Pavlo Shkurenko, Thomas Withington, the Snake Island Institute team (particularly Maryna Hrytsenko and Catarina Buchatskiy), the CSIS Missile Defense Project team (particularly Tom Karako and Wes Rumbaugh), as well as participants of the CSIS virtual expert workshop.

The authors are also grateful to Weifeng Zhong for his assistance with Russian procurement data collection and analysis, and to Illia Perehontsev and Hovsep Seferian for their help with research assistance.

Finally, the authors are thankful to colleagues from the CSIS iDeas Lab and the CSIS publications team, including Joseph Bermudez and Jennifer Jun, for providing satellite imagery analysis, and Kelsey Hartman, Phillip Meylan, Leena Marte, and William Taylor for their swift help with report editing, visualization, and publication.

This publication was funded in 2025 by the Russia Strategic Initiative, U.S. European Command. The views expressed in this publication do not necessarily represent the views of the Department of War or the U.S. government.

Contents

Introduction	1
Key Takeaways	6
Uralvagonzavod	10
Almaz-Antey Concern	21
Concern Radio-Electronic Technologies (KRET)	36
Kalashnikov	46
Ushkuynik	58
Conclusion: Takeaways and Implications for NATO	66
About the Authors and Contributors	70
About CSIS	72
Endnotes	73

Introduction

There is rising concern in the West that Russia could be ready to militarily attack NATO countries by the end of this decade.¹ Crucial to this fear is Moscow's defense industrial reconstitution, as it rebuilds capacity and prioritizes specific weapons systems. In the post-2022 period, to make up for battlefield losses and meet future demand, Moscow has expanded its domestic arms production, putting defense enterprises at the center of this effort. While production targets under the State Armament Program 2027-2036 remain undisclosed, official statements highlight core strategic priorities. These include boosting defense industrial productivity and vertical integration (i.e., consolidation of supply chains) across research and development (R&D) and production; scaling manufacturing of autonomous and robotic systems and building out unmanned forces; expanding artificial intelligence (AI) and advanced command and control systems; strengthening electronic warfare (EW) capabilities; and promoting arms exports.²

Is Russia able to meet these goals? This report addresses that question by examining how stated priorities translate into industrial practice. It finds that, after four years of war, Russia's defense industrial base has been significantly reshaped: It can adapt rapidly under combat conditions by scaling production of weapons and systems that prove effective on the battlefield, combining Soviet-style resource allocation with selective market mechanisms.

To evaluate these dynamics, the report focuses on five case studies that cover a broad cross-section of Russia's defense sector: four major, well-established defense enterprises—Uralvagonzavod, Almaz-Antey, KRET, and Kalashnikov—and a new defense player, Ushkuynik. Together, these firms play central roles in the design, production, scaling, and supply of key systems—tanks and other

armored vehicles (Uralvagonzavod), air defense systems (Almaz-Antey), electronic warfare (KRET), artillery and precision weapons (Kalashnikov), and drones (Ushkuynik). The report analyzes the internal and external factors shaping their production dynamics—including historical background and organizational structure, scale of production both before and after the full-scale invasion, revenue and procurement patterns (where possible), labor constraints, and evolving networks of foreign suppliers—and assesses what these trends imply for Russia’s ability to meet current wartime and future reconstitution goals.¹

After four years of war, Russia’s defense industrial base has been significantly reshaped: It can adapt rapidly under combat conditions by scaling production of weapons and systems that prove effective on the battlefield, combining Soviet-style resource allocation with selective market mechanisms.

With the exception of Ushkuynik, which was founded after 2022, all analyzed companies trace their roots to the Soviet military industrial complex. One company is a direct descendant of its Soviet predecessor (Uralvagonzavod), while others emerged in the 2000s and 2010s through the consolidation of multiple Soviet-era defense manufacturers operating in related sectors (Almaz-Antey, KRET, and Kalashnikov). The primary driver of that consolidation was the dire state of Russian defense firms in the 1990s following the Soviet collapse—a period marked by a dramatic reduction in state defense orders and funding that left many companies to decay and shed their workforce.³ To address this problem, in the early 2000s, the Kremlin initiated a federal program aimed at reducing the size of Soviet-era defense entities by closing down some and amalgamating the rest into larger defense holdings. As a result, defense conglomerates like Almaz-Antey and Rostekhnologia (later renamed Rostec) were formed.⁴ Almaz-Antey developed outside the Rostec structure, encompassing dozens of subsidiaries, while Rostec gradually absorbed Uralvagonzavod, KRET, and Kalashnikov (among many other companies), along with their respective subsidiaries. The case studies of Uralvagonzavod, Almaz-Antey, KRET, and Kalashnikov show that this integration led to more adaptive functioning of Russia’s defense industrial complex pre-2022, creating an effective base for the defense industrial expansion following the full-scale invasion.⁵

I Dara Massicot and Richard Connolly define reconstitution as “a process by which a military unit is restored to a sufficient level of combat capability after sustaining losses in combat. Reconstitution is accomplished through replenishing a unit with personnel, equipment, and other critical enabling components. Reconstitution begins during wartime and continues in the postwar period, as military and civilian leaders make procurement and recruiting investments to restore wartime losses.” Note that this report addresses the weapons and equipment side of the Russian reconstitution question and does not discuss issues with replenishing military personnel. Dara Massicot and Richard Connolly, *Russian Military Reconstitution: 2030 Pathways and Prospects* (Carnegie Endowment for International Peace, September 2024), https://assets.carnegieendowment.org/static/files/Massicot-Reconstitution-final_10-1.pdf.

Three strengths of Russia's defense industrial sector have stood out in the post-2022 period. **First, so far, it has demonstrated an ability to produce at the scale needed to sustain a war of attrition.** Russian firms are not waiting for long-term contracts, unlike Western firms, which tend to require such financial guarantees in order to ramp up production. In addition to refurbishing and fielding weapons from their large Soviet-era stockpiles, the analyzed companies have also showcased capacity to expand production of battle-tested weapons systems, as well as to produce more advanced systems, even in limited quantities. They have also doubled down on workforce training programs to address labor shortages.

Second, and tightly linked to the first point, the urgency of meeting battlefield needs has created pressures to adapt quickly. This has fostered a dynamic where Russia is constantly testing, learning, and evolving its weapons and equipment, often against state-of-the-art Western systems, thereby improving their quality and performance. Almost all of the analyzed companies have incorporated unmanned systems into their production lineup. Within the Kalashnikov ecosystem, its subsidiary, ZALA Aero, exemplifies this dynamic by integrating frontline experience into unmanned system design, producing increasingly advanced variants, including AI-enabled solutions, and moving toward a more automated "kill chain." Similar learning effects are reflected in the improved performance of Almaz-Antey's surface-to-air missile systems, as well as the company's post-2022 prioritization of drone manufacturing, and KRET's efforts to adapt and iterate EW systems.

Third, Russia has partially mitigated the stifling aspects of Soviet-era industrial production by injecting elements of market competition into the defense sector. While these companies and their subsidiaries often cooperate on system and component design and production, they also often compete in emerging defense sectors, including the drone industry. For instance, U.S.-based Russian military analyst Pavel Luzin has suggested that Rostec and Almaz-Antey will likely compete for control of the drone manufacturing facility in the Alabuga Special Economic Zone, as each seeks to dominate this sector.⁶ External inputs also remain critical. Foreign actors—notably China, as well as numerous states across the former Soviet region and Global South—provide essential components to these factories, often rerouted from Western producers, helping them sustain and expand production.

Thanks to these strengths, the Russian defense industry maintains significant capacity for the scaling of production, along with wartime adaptation and iterative innovation, particularly with regard to unmanned aerial vehicles (UAVs) and EW systems. When it comes to many critical platforms—such as loitering munitions, air defense, EW, and low-cost UAVs—Russia seemingly has the ability to maintain high levels of production, at least in the medium term. Of concern for NATO is that in the near term this creates a defense industrial asymmetry between NATO and Russia that is advantageous to Moscow. Russia's defense industry will likely be operating at or near a wartime operational tempo, while NATO's defense industry may still generally be operating at a peacetime tempo. This could give Russia the upper hand, at least in the immediate term, in a hypothetical NATO-Russia clash. Russia's asymmetrical strengths, including tolerance for high casualties,

large-scale drone production, and effective tactical implementation of EW systems, could help the Kremlin offset its conventional inferiority vis-à-vis the Western alliance in the near term.

That being said, Russia's strengths should not be overestimated. In a recent interview, the head of Sweden's Military Intelligence and Security Service, Thomas Nilsson, emphasized his agency's conviction that the Russian defense industry remains rife with corruption and dependent on state-backed lending in a context of economic stagnation.⁷ This report's findings echo these concerns, with labor shortages and opportunities for corruption particularly apparent. But despite these major issues, the Russian defense base continues to press ahead, adapting to challenges, leveraging deep resources, and integrating market incentives into the legacy Soviet industrial base. As the saying goes, Russia is never as strong as one fears, but never as weak as one may hope.

The report's findings are grounded in extensive desk research, drawing on statements from top Russian state officials, announcements issued by the analyzed companies and different Russian state agencies and Russian and Western academic, industry, and policy journals. These sources are used inductively to draw broader conclusions about the trends uniting the five company cases. Further, the report incorporates takeaways from a CSIS expert workshop and one-on-one interviews with analysts of the Russian defense industry and economy, which helped the authors identify overall trends underpinning Russia's defense industrial sector and determine the list of defense companies examined in this report. Finally, where possible, the report includes unique analyses of satellite imagery and Russian customs and procurement data.¹¹

Several caveats are, however, in order. Many claims about production increases and capability gains—presented by the authors of this report, as well as found in relevant Western analyses—rely on Russian official or state-linked sources and should be treated with caution, as such figures are most likely overinflated, selectively reported, and/or politically motivated. As such, they are best treated as indicative rather than definitive and, where possible, cross-checked against customs records, satellite imagery, Russian procurement data (which also comes with limited visibility), and other observable trends. In addition, the macroeconomic outlook underpinning defense production may be more vulnerable than official sources suggest, particularly given the opaque structure of

II This study analyzes 78,520 deduplicated procurement contracts spanning 2019-2026, matched to 352 Russian INNs (unique taxpayer identification numbers) across five defense entities—Uralvagonzavod, Almaz-Antey, KRET, Kalashnikov, and Ushkuynik—along with their named affiliates. Two application programming interface (API) sources were used: the clearspending API (which carries 2019-2025 records) and the gosplan v2 REST API (covering 2024-2026 records). These sources are merged at the row level using contract_id. Intragroup financing contracts (OKPD2 prefix 64, covering treasury operations between holdings and their financial partners) are filtered out upstream as non-procurement, even though they appear in the procurement data; approximately 243 such contracts, worth roughly 502 billion rubles, were excluded. Entity-level analysis uses EGRUL (Единый государственный реестр юридических лиц/the Russian Federal Tax Service registry) for incorporation dates, OGRN, OKVED activity codes, and registered regions, covering 333 of 352 in-scope INNs (95 percent) for incorporation date, 321 of 352 (91 percent) for OKVED. Where direct queries to egrul.itsoft.ru hit rate limits, secondary sources (zachestnyibiznes.ru and sbis.ru) were used to backfill the gaps. A key caveat is the “visibility cliff”: Russian Government Decree 301 of 2022 authorizes customers to redact defense-adjacent procurement records, producing a sharp drop in visible contract counts from 2022 onward (with a roughly 50 percent spend drop in 2022 and an additional 97 percent drop in 2023).

military financing and reliance on state-backed lending. The ability of state-owned defense firms to deliver ultimately depends on the state's capacity and political willingness to continue channeling resources to these firms, despite mounting fiscal pressures, debt burdens, and increasing strain on civilian segments of the economy.⁸

The report opens with a synthesis of the study's key takeaways, followed by five chapters, each providing an in-depth examination of each selected company's historical background, organizational structure, post-2022 performance, key products and production figures, and current challenges—ultimately drawing on these indicators to assess each company's continued ability to respond to Russia's current and future reconstitution needs. The conclusion draws out implications for NATO in light of Russia's defense industrial sector remaining on a wartime footing and its ongoing adaptation and reconstitution trajectory.

Key Takeaways

The following points capture the research team's central findings:

- 1. Consolidation accelerated under wartime pressures:** Since the 2000s, the Russian leadership has driven a program of consolidation and vertical integration within the defense industry by combining various firms focused on design, R&D, production, and procurement into large holding companies under state control. Two of these conglomerates are Almaz-Antey and Rostec, the latter of which controls roughly two-thirds of the Russian defense industry, including major firms discussed in this report—Kalashnikov, KRET, and Uralvagonzavod.⁹ In the post-2022 period, Almaz-Antey, Kalashnikov, and KRET have shown evidence of accelerated consolidation, incorporating or coordinating smaller players from related fields. The synergies and synchronization from continued consolidation are central to the Kremlin's ongoing reconstitution efforts.¹⁰

The Kremlin is unlikely to allow important defense firms to fail, as Putin's regime has repeatedly intervened to rescue key strategic industries. The main risk is therefore not individual firms going bankrupt, but mounting financial strain within state-tied banks, increasing the risk of future bailouts and the crowding out of civilian sectors of the economy.

2. **State-backed financing linked to expansion, not profits:** Given the lack of consistent profitability within the Russian defense sector (with official regulations capping firms' profit margins), this metric cannot be used as the main indicator of performance.¹ Instead, the sector is sustained through direct budget support and state-subsidized lending, much of which is classified. By some estimates, the scale of state-backed corporate borrowing in Russia is estimated to have ballooned to over \$446 billion, with much of that money directly and indirectly supporting Russia's war effort in Ukraine.¹¹ Certain Soviet-era practices appear prevalent, including regulated prices, soft budget constraints, and prioritization of output, though coordination occurs through financial and contractual mechanisms, rather than centralized, command-style planning.¹² The Kremlin is unlikely to allow important defense firms to fail, as Putin's regime has repeatedly intervened to rescue key strategic industries. The main risk is therefore not individual firms going bankrupt, but mounting financial strain within state-tied banks, increasing the risk of future bailouts and the crowding out of civilian sectors of the economy.
3. **Capacity expansion after 2022:** CSIS open-source research identifies capacity expansion across several key Russian defense firms since 2022. Satellite imagery identified noteworthy infrastructure expansion at both the Kalashnikov production site in Izhevsk and the Obukhov plant owned by Almaz-Antey. Additionally, procurement data, while increasingly censored since 2022, indicate plans for and commitments to facility expansion, including signed construction contracts, across multiple defense holdings and suppliers. While some firms, like Uralvagonzavod, may be hitting expansion limits, others, such as Kalashnikov and Almaz-Antey, report growth.
4. **Ongoing UAV-driven innovation:** The Russian defense industry has embraced the drone revolution in warfare. New players like Ushkuynik specialize in drone production, and legacy firms like Kalashnikov, Almaz-Antey, and even Uralvagonzavod increasingly lean into the development of unmanned systems, including the innovative integration of applied AI. Open-source research suggests expanded UAV production at existing plants, along with the creation of new entities specializing in UAV development. Combined with Russia's expanding experience in drone warfare, EW, and attritional combat, this may give the Kremlin a temporary asymmetric advantage before NATO can sufficiently increase production of ammunition, air defense systems, drones, and counter-UAV capabilities.
5. **Multiplying training programs in the face of a chronic labor shortage:** Russia's chronic labor shortage (both skilled and unskilled), exacerbated by wartime conditions, has fueled inflation and constrained defense industrial expansion. Major regime figures continue to highlight the manpower challenge, and all of the analyzed defense firms have

I Official regulations cap firms' profit margins at around 1 percent on "brought-in" costs (i.e., costs for goods or services from outside suppliers) and 20 percent on firms' own costs (or up to 25 percent, in some cases). "Норма прибыли по государственному оборонному заказу" [Profit norm under the State Defense Order], Consultant.ru, https://www.consultant.ru/law/podborki/norma_pribyli_po_gosoboronzakazu/; Nureev and Busygin, "Economic Sanctions"; and "Meeting with CEO of Rostec State Corporation Sergei Chemezov," Kremlin.ru, August 7, 2023, <http://en.special.kremlin.ru/events/president/news/71993>.

expanded training programs and the labor pools they recruit from—including junior workers, prisoners, and veterans.¹³ Reportedly, the defense sector added 600,000-700,000 workers from 2023 to 2024, bringing total employment to 5 percent of the workforce at 3.8 million laborers. However, these figures remain below state targets.¹⁴ In response to labor shortages, all companies analyzed in this report have established or expanded in-house training facilities, as well as cooperation with secondary and higher education institutions, to build a younger workforce pipeline.

- 6. Prioritization of military over civilian production:** While the Kremlin has spent years encouraging defense firms to diversify their businesses by expanding into civilian sectors, since 2022, state firms appear to have consistently prioritized war-related production.¹⁵ However, over the long term, defense firms will likely try to maintain a presence in the civilian economy to diversify their revenue streams, with drone producers best positioned to leverage their war-related expertise after a hypothetical return to peacetime.
- 7. Dependencies on imported components mitigated through sanctions circumvention:** All analyzed defense firms, despite publicly pledging to decrease external dependencies, remain heavily reliant on foreign-produced critical components.¹⁶ Sanctions continue to hinder expansion by gumming up supply chains and raising procurement costs, though firms have increasingly adapted through circumvention networks. Russian defense firms exploit opaque and multilayered corporate structures and inconsistent sanctions enforcement to procure restricted goods through intermediaries in China, Hong Kong, and other jurisdictions. Customs data reviewed by CSIS also identifies India as a possible supplier of critical electronics. The persistence of these networks is illustrated in recent CSIS research showing that about half of the AI-enabling components retrieved from downed Russian UAV systems originate from U.S. firms.¹⁷
- 8. Marketing combat-tested weapons and equipment to customers in the Global South:** With Russian arms export data now largely classified and few new arms deals reported in open sources, assessing the scale of Russia's post-2022 export portfolio is difficult. Given the prioritization of domestic defense orders amid labor shortages and sanctions pressure, Russia's arms exports are unlikely to return to pre-2022 levels any time soon. However, Russian UAV and applied AI technologies continue to be battle tested in Ukraine, generating growing interest among foreign states, particularly in the Global South. At least some analyzed firms, including Almaz-Antey and Kalashnikov, have actively marketed their battle-tested weapons and equipment at international arms exhibitions. Iran's recent successes using technologies and tactics honed in the Russia-Ukraine war will likely only increase this interest.
- 9. Defense industrial adaptation and reconstitution through scalable systems:** The company case studies in this report demonstrate the Russian defense industry's significant capacity for adaptation and the sector's evolution toward a focus on attritional warfare and the production of low-cost, scalable systems. Russia appears capable of maintaining high levels of production for selected systems like precision-guided munitions, air defense, and EW for the foreseeable future. That allows the Kremlin, for now, to maintain its

current pace of expenditure in Ukraine while rebuilding reserves—albeit without signs of a strategic large-scale penetration of Ukrainian lines. Low-cost attritional capabilities like UAV production are increasingly emphasized, whereas legacy heavy platforms like tanks are decreasing in importance. In the context of a hypothetical conventional clash with NATO, Moscow, while remaining the weaker party, would seek to erode NATO’s superiority asymmetrically—through mass attrition, potential tolerance for heavy casualties, extended drone use, and contestation of the electromagnetic spectrum.

Uralvagonzavod

Synopsis

Uralvagonzavod (UVZ) remains Russia's sole manufacturer of main battle tanks today. Following the Soviet collapse, UVZ faced near-bankruptcy from the 1990s through 2016 despite significant civilian production, state cash injections, subsidized private loans, and foreign sales. Rostec's 2017 acquisition revitalized UVZ, enabling the concern to increase production capacity.

Since Russia's full-scale invasion of Ukraine, UVZ has significantly ramped up modernization of legacy armored vehicles and, in some cases, also increased new production, shifting to 24/7 operations and expanding its workforce while reducing civilian production. Although combined new and refurbished T-90M output has reportedly risen to about four times prewar levels, most tanks deployed to active armored units have come from refurbished Soviet-era stockpiles (like the T-72 variants) rather than new manufacturing. Modernization and reactivation of stored platforms rather than large-scale new production have therefore remained central to Russia's wartime armored reconstitution effort.

Still, corruption, depletion of readily reconditioned reserves, sanctions-driven cost increases, and lower quality of foreign and domestic substitution of critical tools and components seem to have impacted UVZ, increasing dependence on Chinese suppliers and alternative procurement channels. Arms exports decreased after 2022 as war production reached capacity. Accordingly, while UVZ may continue to modernize its existing tanks based on battlefield lessons, mass production of advanced new tanks will likely remain constrained, thus limiting Russia's ability to rebuild its armored reserves.

BACKGROUND

Uralvagonzavod was founded in Nizhny Tagil, in Russia's Ural region, in 1936, and, by the end of World War II, became the world's largest producer of main battle tanks (MBTs).¹⁸ In the decade before the collapse of the Soviet Union, UVZ produced an estimated average of 4,000 tanks per year.¹⁹ Throughout the 1990s, Uralvagonzavod faced severe financial difficulties and tank production rates plummeted to fewer than 30 per year.²⁰ The large inheritance of Soviet stockpiles, together with the protracted economic crisis of the 1990s, meant that the Ministry of Defense (MOD) awarded only limited orders for new tanks.²¹ The company adapted to reduced defense orders by increasing civilian production, mostly of railcars.²² UVZ's ability to secure key contracts for the T-90 MBTs throughout the 1990s and early 2000s helped it avoid bankruptcy, with the T-90 becoming a "lifeline" for Russian tank manufacturing.²³

In the mid-2000s, Uralvagonzavod experienced a state-supported recovery driven by defense orders and exports, but remained financially fragile and dependent on government demand, including injections of state funds, private loans, and other interventions.²⁴ For example, UVZ received extensive state support after the 2008 financial crisis, including billions of rubles in guarantees, debt restructuring, and investment funding.²⁵ Despite this assistance, by late 2016 the company again faced financial strain due to a sharp reduction in railcar demand, mounting debt (nearing 200 billion rubles, or \$3 billion at that time), sanctions following the 2014 Russian intervention in Ukraine, and declining revenues.²⁶ Against this backdrop, President Putin issued a decree in December 2016 that led to Rostec's acquisition of UVZ in 2017.²⁷

ORGANIZATIONAL STRUCTURE

By the late Soviet period, tank production was divided between four major plants: Uralvagonzavod, Omsktransmash, Kirov Plant, and Kharkiv Malyshev Plant. After the dissolution of the Soviet Union, Russia's only manufacturers of MBTs were Uralvagonzavod and Omsktransmash. The latter went bankrupt and was absorbed by UVZ in 2004. Of the other two, Kharkiv's Malyshev Plant remained Ukraine's main tank producer, while Kirov Plant exited tank production and refocused toward civilian and heavy engineering activities.²⁸

Today, Uralvagonzavod comprises more than 40 industrial companies, research institutes, and design bureaus, producing a wide range of products, including metallurgical goods, railcars, diesel engines, armored vehicles, engineering equipment, and protective gear.²⁹ UVZ is generally considered a vertically integrated manufacturer of tanks and armored vehicles, but some critical components—like main gun barrels and gunner's sights—are manufactured outside the concern.³⁰

Uralvagonzavod's key production facilities are clustered in Rubtsovsk, Volchansk, Nizhny Tagil, Omsk, and Chelyabinsk. Rubtsovsk is home to the 163rd Armored Repair Plant (BTRZ), which overhauls BMP-2 infantry fighting vehicles.³¹ Volchansk is where UVZ produces the Tucha grenade-launching system, which is used to create a protective smoke screen to mask armored vehicles.³² The plant in Nizhny Tagil, the main UVZ production site, remains the core of Russia's tank production and modernization, being effectively the only facility capable of producing new MBTs (T-90Ms) and conducting large-scale upgrades (for instance, for the T-72 series).³³ Omsktransmash modernizes the T-80 series, but reserves are nearly exhausted (see Table 1), and the

factory has proved unable to revive long-dormant T-80 manufacturing lines.³⁴ Chelyabinsk Tractor Plant-Uraltrac (ChTZ-Uraltrac) manufactures V-92S2 diesel engines for T-90Ms and T-72B3s.³⁵ Other armored tank repair plants (BTRZs 103, 61, and 81) focus on refurbishing older vehicles and operate at lower technological and production capacity, though they contribute meaningfully to overall output.³⁶

In the post-invasion period, UVZ has undertaken efforts to modernize its Nizhny Tagil facilities, as reflected in at least 183 visible tenders reviewed by CSIS, including major investments in upgrading armored hull production infrastructure and acquiring new industrial equipment (e.g., shot-blasting systems).³⁷ While UVZ's continued issuance of multimillion-dollar tenders suggests ongoing expansion and modernization of production capacity, a more substantial increase in new tank output would still require much larger investments in new assembly lines and significantly greater acquisition of advanced machinery.³⁸ UVZ claimed in August 2025 to have introduced more than 500 pieces of modern manufacturing equipment since 2022, but as Dara Massicot and Richard Connolly conclude, "to build more quickly, Russia would either need to build or convert new factories, take existing factories temporarily offline to retool them, or import armored equipment from abroad."³⁹

In 2023, Rostec transferred four enterprises (Uraltransmash, Plant No. 9, Central Research Institute of Metallurgy and Materials, and Central Research Institute Burevestnik) out of Uralvagonzavod to NPK Techmash (under JSC Technodynamika) to consolidate self-propelled artillery production.⁴⁰ The transfer created a vertically integrated structure, with Technodynamika controlling the full artillery production cycle from barrels to munitions, while refocusing UVZ on armored vehicle production.⁴¹

POST-2022 PERFORMANCE

Since 2022, production has increased significantly, though production estimates vary; manufacture of new T-90M MBTs alone has reportedly increased by 200-400 percent compared to prewar levels, while thousands of older models from reserve stores have been refurbished (see below).⁴² Prime Minister Mikhail Mishustin's 2023 claim that tank production had tripled since early 2022, alongside Rostec CEO Sergei Chemezov's assertion of a sevenfold increase, have been linked to UVZ's transition to a three-shift, 24/7 work schedule in late 2022.⁴³ According to official reports (though these claims are difficult to independently verify), UVZ received a state order for 400 tanks "shortly after the Ukraine War started," and tank production lines had a "full load of work" up to 2024.⁴⁴

In 2022, UVZ's main plant in Nizhny Tagil shifted its capacities toward military output. Procurement data analyzed by the authors provide limited but suggestive evidence of continued industrial activity at NPK Tagil following the invasion. Visible spending on metal inputs remained substantial in 2022 and was heavily concentrated at the company's principal tank-production facility. Visible procurement focused on basic iron and steel, rolled metal, forgings, stampings, blanks, and cast iron, commonly used in tank hulls, turrets, and armor production.

According to some estimates, the volume of finished products intended for military or defense industrial base customers shipped from Nizhny Tagil more than tripled between 2021 and 2023, from 12,000 to 37,000 tons, and has remained relatively steady since. The share of finished products intended for military or obscured customers increased between 2021 and 2024 from 21 percent to 66 percent. Both the absolute volume of finished products delivered to frontline recipients and the share of total throughput rose from 2022 to 2023 while volumes sent to repair facilities remained constant, suggesting that repair facilities may have been operating at maximum capacity even early in the conflict.⁴⁵ It is possible that some repair capacities were created at or near storage sites in order to expedite replacement of armored losses and “ship functional equipment directly to the front” during this period, but in 2024 shipments to legacy repair facilities and to front-adjacent clusters decreased (to 36 and 46 percent, respectively) in conjunction with depletion of reserves.⁴⁶

A decree by President Putin issued in 2017 set an ambitious target for Rostec to increase the share of dual-use and civilian goods output to 50 percent by 2025.⁴⁷ The intent behind this decision was to diversify Rostec’s, as well as its subsidiaries’, peacetime portfolio and increase their revenue streams. By early 2022, the conglomerate nearly met this goal, reaching 45 percent; however, following the post-2022 wartime shift, the share decreased to 35 percent by 2024.⁴⁸ For example, UVZ freight car output declined by 47.8 percent in 2022, linked to UVZ’s state defense order load.⁴⁹ While some reports have claimed that the company has introduced “more than 500 units of new equipment” for civil and special-purpose production since 2022, UVZ’s civilian production has clearly suffered. By 2025, UVZ freight car production fell to 8,200 units (15.6 percent market share and overall fourth place among rolling stock producers), down from over 24,000 annually in 2011.⁵⁰

Despite reports of sharp decreases of Russian arms exports (\$14.6 billion in 2021 to \$3 billion in 2023), Uralvagonzavod has exhibited its products at international arms expos throughout the Middle East and Southeast Asia. In April 2026, Uralvagonzavod publicly displayed footage of an April 2000 mobility test of the T-90S in the jungles of Malaysia for the first time, boasting the tank’s performance despite outside air temperatures exceeding 40 degrees Celsius (104 degrees Fahrenheit).⁵¹ This came as UVZ announced its readiness to offer Malaysia a flexible cooperation agreement to include assembly and full service support of the T-90MS (an export variant of the T-90M).⁵² The offer is part of broader efforts to increase exports and reinforce cooperation with Southeast Asian partners.⁵³

Production

TANKS

Tanks played a significant role on the battlefield early on in Russia’s full-scale invasion of Ukraine.⁵⁴ As of 2026, Russia continues to deploy tanks when Ukraine’s drone defenses are degraded, but their battlefield presence is greatly reduced.⁵⁵ Many tanks are being used as supplemental artillery rather than for mobile armored assault.⁵⁶

Despite claims by Russian high-ranking officials regarding multifold increases in tank production, most tanks deployed in Ukraine since 2022 have been reactivated.

Despite claims by Russian high-ranking officials regarding multifold increases in tank production, most tanks deployed in Ukraine since 2022 have been reactivated (i.e., either deployed to units or sent for refurbishment) from reserve stockpiles of older Soviet-era platforms rather than newly built.⁵⁷ As a result, since 2022, tank reserves, maintained across at least nine storage facilities, have notably declined.⁵⁸ By October 2025, approximately 4,800 of 7,342 prewar tanks had reportedly been reactivated.⁵⁹ Although this drawdown does not directly match battlefield losses (estimated at above 4,300 by 2026), combined with production data it serves as a useful proxy for Russia's capacity to sustain armored forces.⁶⁰ Table 1 summarizes the reduction in Russia's visible reserves.

Table 1: Comparison of Russia's Prewar and Current Visible Main Battle Tank Reserves

Designator	Prewar Stocks	January 2026 Stocks	Net Change
T-55	313	112	201
T-62	1,897	784	1,113
T-64	752	449	303
T-72/T-72A	1,142	452	690
T-72B	1,478	188	1,290
T-80	1,648	141	1,507
T-90	112	0	112
Total	7,342	2,126	5,216

Source: David Axe, "Russia Is Running Low On Tanks. So Why Are A Thousand First-Generation T-72s Still Sitting In Storage?," *Forbes*, July 7, 2024, <https://www.forbes.com/sites/davidaxe/2024/07/07/russia-is-running-low-on-tanks-so-why-are-a-thousand-first-generation-t-72s-still-sitting-in-storage>; Dmytro Shumlianskyi, "Russia Has Depleted Its Tank Stocks: The Industry Is Not Covering Combat Losses," *Militarnyi*, March 30, 2025, <https://militarnyi.com/en/news/russia-has-depleted-its-tank-stocks-the-industry-is-not-covering-combat-losses/>; and; Covert Cabal, "The Last Remaining 'Large' Stock of Tanks - T-62: The Last Hope," YouTube video, January 23, 2026, https://www.youtube.com/watch?v=wCeAW_KWcWQ; and Mukhina, "Only 35% of Russia's Strategic Tank Reserves Remain."

The tanks that remain in storage—many over 50 years old, exposed to decades of harsh conditions and, thus, often requiring significant technological upgrades and expensive refurbishment—are in varying states of disrepair.⁶¹ Higher-quality and more modern vehicles have largely already been drawn down, forcing reliance on older, harder-to-modernize stocks. As accessible reserves are depleted or degraded, refurbishment is becoming increasingly complex and costly.⁶²

Estimates of prewar tanks in active units range from 2,840 to 3,200.⁶³ While Table 1 does not capture the ratio of newly produced versus reactivated tanks deployed in Ukraine, it illustrates that Russia has drawn extensively on reactivated T-72, T-80, and T-90 variants to replenish battlefield

losses over the course of the war, sometimes supplemented by even older tanks such as the T-55 and T-62.⁶⁴

T-55: Serial production of the T-55, which is based on the T-54, began in 1958, and over the course of 21 years, Soviet factories produced more than 23,000 T-55s of all variants.⁶⁵ Today, 70-year-old T-55 MBTs from storage are refurbished and modernized at Omsktransmash.⁶⁶ As shown in Table 1, only 112 T-55 MBTs are estimated to remain in storage, meaning that these tanks will likely not play any significant role in Russia's future conflicts.

T-64: The T-64 was introduced to service in the Red Army in 1967. The T-64 and its variants were almost exclusively produced at the Malyshev Factory in Kharkiv, Ukraine. Russia retained approximately 4,000 T-64 MBTs, of which 752 survived in 2022 in various states of disrepair. Today, Ukraine continues to update and employ T-64s, but Russia is not able to refurbish and modernize most of its remaining stock due to extensive overhaul requirements and lack of access to spare parts.⁶⁷ The T-64 will effectively play no role in Russia's future conflicts.

T-62s: The T-62M, introduced in 1983, is an upgraded version of the second-generation T-62—originally fielded in 1961 as an evolution of the T-55.⁶⁸ It is reportedly refurbished and upgraded at the 103rd BTRZ in Atamanovka, an UVZ subsidiary.⁶⁹ Reports in October 2022 indicated that the BTRZ received a contract to refurbish and modernize 800 T-62 tanks over three years, making it the primary facility for T-62 modernization.⁷⁰ Estimates from September 2023 suggest an output of roughly 7-17 tanks per month—equivalent to 252-612 over three years—indicating the plant was unlikely to fulfill the contract on schedule.⁷¹

T-72s: UVZ has not manufactured T-72-series tanks from scratch since 1992, but has refurbished and modernized existing T-72s, T-72As, and T-72Bs.⁷² Between February 2022 and February 2026, 1,980 T-72s were visually confirmed as removed from storage for refurbishment and delivery to active units.⁷³ As many as 200 T-72B3M units (a modernized variant featuring upgraded optics, engine, and armor, introduced in 2014) were refurbished in 2024 alone.⁷⁴ By early 2026, UVZ reportedly began drawing down remaining T-72 reserves, including 452 of the older T-72 “Ural” model.⁷⁵ Around the same time, it shifted toward modernizing older T-72A hulls (manufactured between 1981 and 1985 and mostly stored in open-air lots), a more complex process requiring substantial upgrades to electronics, chassis, autoloader, and protection systems; partially modernized variants were already observed in service in 2024.⁷⁶ Intercepted documents further suggest, albeit with lower confidence, that Russia plans to overhaul and modernize over 800 T-72 MBTs into the T-72B3M configuration by 2036.⁷⁷

T-80s: The T-80BVM, the most advanced variant of the third-generation T-80, was developed in the 2010s and first appeared during the 2017 Zapad exercise.⁷⁸ Despite a 2023 announcement by UVZ General Director Aleksandr Potapov that Omsktransmash would resume production of new T-80 tanks, the plant remains focused on modernization, and efforts to restart serial production in Omsk have stalled since then.⁷⁹ Since 2017, Omsktransmash has been overhauling older variants of the T-80 from storage to the T-80BVM standard.⁸⁰ Upgrades include an improved main gun, autoloader, reactive armor, fuel economy, gunsights and protection against FPV drones.⁸¹ Estimates of modernized T-80 output vary widely. On the high end, Omsktransmash may have

increased annual output of T-80BVM units (mostly modernized T-80BV and T-80U) from 40 in 2022 to as high as 400 in 2024.⁸² On the low end, Omsktransmash may have produced only 150 T-80BVM units in 2024.⁸³ Regardless, approximately 1,507 T-80 series tanks have been withdrawn from reserve bases since 2022.



Russian T-90M tanks displayed during a rehearsal for the Victory Day parade in St. Petersburg on May 3, 2025.

Photo: Olga Maltseva/AFP via Getty Images

Team suggested that Russia manufactured about 20-30 new tanks in 2024, while the IISS estimates total T-90M output at 60-70 in 2023.⁸⁹ More recent assessments indicate a significant expansion in production. IISS reports estimate an increase of 500 T-90Ms in Russia's arsenal between 2024 and 2026, coming out to 250 T-90Ms per year. Ukraine's Defense Intelligence estimates that Russia could produce up to 250 newly built T-90M hulls annually by late 2025, while Janes assesses current production at approximately 150-200 new tanks per year.⁹⁰

Leaked Uralvagonzavod planning documents indicate targets of over 400 T-90M/T-90M2 units annually by 2028-2029 and 1,783 units overall between 2026 and 2036, though the precise status of the "T-90M2" designation remains unclear.⁹¹ In June 2026, Rostec announced further upgrades to the T-90M based on battlefield feedback from Ukraine, including enhanced EW capabilities and additional protective features.⁹²

T-14: The T-14 was originally conceived as a highly automated, next-generation (often described as fourth-generation) main battle tank designed for network-centric warfare.⁹³ UVZ also produced a small pre-series batch of roughly 20 T-14 Armata tanks between 2015 and 2018 out of an initially planned 2,300, none of which have fully demonstrated the platform's intended capabilities.⁹⁴ T-14s have been virtually absent from the front lines in Ukraine, with Rostec CEO Chemezov claiming that the system is "too valuable" to lose. However, the Kremlin-affiliated media outlet TASS has reported on the very brief, experimental deployment of Armata on the battlefield, alleging that the vehicle

T-90s: As of March 2026, the T-90M is the only main battle tank Russia is producing from scratch.⁸⁴ First introduced in 2017, the T-90M is a deeply modernized variant of the T-90 (itself a third-generation design derived from the Soviet-era T-72), featuring an upgraded turret, fire-control system, sights, armor, and engine, and benefiting from mature production infrastructure and the reuse of existing hulls.⁸⁵ Russia entered the war in Ukraine with about 65-85 T-90M tanks as well as approximately 112 T-90 and 270 T-90A MBTs.⁸⁶ All prewar stores of T-90 and T-90A were sent either to active units or to Nizhny Tagil for modernization by June 2025.⁸⁷ Annual production of new and refurbished T-90M MBTs has increased since 2022, though estimates vary widely.⁸⁸ Earlier estimates by Conflict Intelligence

has been “finalized” as a result of this experimental use.⁹⁵ UVZ’s inability to manufacture T-14s in higher quantities may change once the war is over. Yet, considering the concern’s limited capacity when it comes to producing older tank versions from scratch, it is unlikely that the T-14 production will reach the intended levels of several thousands in the years to come.

ARMORED VEHICLES

BMP-T Terminator: Besides MBTs, Uralvagonzavod produces low quantities of BMP-T Terminator and BMPT-72 Terminator II tank support vehicles on the T-72 and T-90 chassis. The Terminator was designed in response to heavy losses of armored units in Chechnya and features anti-tank guided missiles (ATGMs), a 30 mm autocannon, a grenade launcher, and a coaxial 7.62 machine gun, giving it greater lethality.⁹⁶ The Terminator was first delivered to the Russian army in 2018 and is claimed to incorporate unspecified technologies from the T-14 Armata.⁹⁷ By 2022, only 10 of the vehicles had been delivered to active units, and by 2025 a total of 19 BMP-T vehicles had entered active service.⁹⁸ The Terminator suffers from supply chain issues (see below). Altogether, it appears that Uralvagonzavod prioritizes MBTs and other vehicles over the BMP-T.

TOS-1A: The TOS-1A Solntsepek is an upgraded version of the TOS-1 Buratino heavy flamethrower built on the T-72/T-90 chassis by Omsktransmash. Introduced in 2001, it is equipped with 24 launchers for its 220 mm thermobaric rockets, which can engage targets from 400 m to 6 km.⁹⁹ In 2023, it was reported that 50 TOS-1A and TOS-2 (a 2020 successor to the TOS-1A built on a three-axle truck chassis in unknown quantities) heavy flamethrowers were present in active units.¹⁰⁰ By 2024, reports estimated that 55 TOS-1A units were active in the Russian army.¹⁰¹ In April 2024, during an official visit by Sergei Shoigu, Uralvagonzavod officials announced that production of the TOS-1A had increased 250 percent over the previous year.¹⁰²

UBIM: The first delivery of Uralvagonzavod’s Universal Armored Engineering Vehicles (UBIM) was announced in March 2026.¹⁰³ The vehicle is based on the T-90M and is “equipped with a bulldozer blade, a crane boom with a maximum lifting capacity of 7500 kg, [and] an excavator bucket or a hydraulic hammer.”¹⁰⁴ The UBIM “combines the functions of three specialized vehicles: BREM (armored repair and evacuation vehicle), IMR (engineering clearance vehicle), and BMR (armored demining vehicle).”¹⁰⁵ It is designed for recovery, obstacle clearing, and anti-mine operations in combat conditions. Production numbers are unknown.

UNMANNED ARMORED VEHICLES

UVZ also appears to be investing in its robotic land warfare capabilities. At the 2018 Azerbaijan International Defence Exhibition, Aleksandr Potapov announced that design work for a new robotic assault complex based on the T-72B3 chassis had begun.¹⁰⁶

In July 2025, UVZ published on social media a video of its optionally crewed tank, dubbed the T-72 Shturm, along with its command vehicle.¹⁰⁷ The video ostensibly depicts the first demonstration of the Shturm complex, alternatively known as the Heavy Assault Robotic System, in its full configuration. The command vehicle appears similar to the BMO-T heavy tracked armored personnel carrier and is designed to remotely operate a platoon of Shturm tanks in fortified urban environments and other high-risk operations.¹⁰⁸ It is estimated to be capable of controlling

a platoon of three robotic tanks at distances of up to three kilometers.¹⁰⁹ Whether the combat and command vehicle prototypes are fully operational in remote mode is unknown, as the 2025 demonstration included at least one crewed Shturm vehicle. The complex has not yet been tested in combat conditions.

Challenges

LABOR SHORTAGES

Since 2021, Uralvagonzavod has expanded recruitment and implemented multiple wage hikes, including a 12 percent increase in May 2023 followed by a reported 28 percent increase in August 2024, exceeding the national average nominal wage growth of roughly 22 percent.¹¹⁰ In 2021, Uralvagonzavod employed around 20,000 workers in Nizhny Tagil, adding over 5,000 employees in both 2023 and 2024. A 2026 release by OSINT Varta estimates the workforce at 38,685 in Nizhny Tagil, with 8,836 at Omsktransmash and 724 at the 103rd BTRZ.¹¹¹

Yet, despite an increased workforce, labor shortages persist, suggesting structural constraints rather than simple supply deficits. During a February 2024 visit to Nizhny Tagil, Putin acknowledged workforce shortages and training bottlenecks at UVZ, which faces a shortfall of nearly 1,500 skilled workers.¹¹² Official vacancy data show 256 open positions as of April 2026, many of them long-standing, with similar shortages across other armored vehicle plants such as Omsktransmash and Kurganmashzavod.¹¹³

To address this problem, in 2023, the Sverdlovsk regional government signed an agreement to bring more than 10 colleges and technical schools into Uralvagonzavod's workforce pipeline, with admissions and curricula adjusted to the plant's needs; training is now conducted across 14 institutions.¹¹⁴ In 2024, Putin suggested further expanding vocational training at UVZ.¹¹⁵ Among other measures to address labor shortages, UVZ announced a major recruiting drive for critical trades like milling and welding, and even resorted to recruiting prison labor.¹¹⁶

Despite expanded recruitment pipelines and wage increases, reports of retention difficulties, equipment issues, and broader industrial constraints persist, suggesting that output remains bottlenecked by labor quality, training lags, and supply chain limitations rather than headline workforce size alone.¹¹⁷

CROWDING OUT CIVILIAN INDUSTRIES

War mobilization is crowding out civilian production not only through direct reallocation of resources into the defense sector but also through weakening demand in the civilian sector relevant to UVZ civilian production: The railcar market saw a sharp contraction through 2025 and into early 2026, driven in part by high inflation and elevated interest rates.¹¹⁸ In 2023, Uralvagonzavod was reported to have halted nonmilitary output, though other sources suggest it was reduced rather than eliminated.¹¹⁹ By October 2025, civilian shops were shifted to a four-day workweek, with workers encouraged to transfer into military production, and in November the company announced plans to cut about 10 percent of its workforce (primarily in civilian divisions) amid declining railcar demand.¹²⁰

SANCTIONS

Sanctions appear to have disrupted the manufacture of some products.¹²¹ For example, sanctions seem to have restricted Russia's access to French-made thermal imaging matrices used in the Sosna-U thermal sighting system, forcing manufacturers to install technologically inferior 1PN-96MT-02 sights in all refurbished T-80, T-72, and T-62 tanks. The 1PN-96MT-02 is manufactured by the Vologda Optical and Mechanical Plant, but the thermal imaging matrix used in the device is of unknown type and origin.¹²²

Prior to 2022, Russia imported more than half of its bearings from Europe and North America.¹²³ Sanctions reduced Russia's access to these high-quality bearings and forced changes in supply chains.¹²⁴ In particular, limited access to high-quality bearings may be restricting UVZ's capacity to manufacture tanks, engines, railcars, and other vehicles. More frequent mechanical failure of turrets, engines, transmissions, and other drivetrain components should be expected for tanks constructed with lower-quality bearings. Some evidence of such failures indeed exists, but often in conjunction with overloading of the drivetrain and turret by heavy makeshift anti-drone armor known as grills, mangals, or cope cages.¹²⁵

FOREIGN COMPONENT DEPENDENCIES

In response to sanctions-induced constraints, since 2022, UVZ has increased dependency on tooling and machines imported from China. According to Ukrainian sources, in 2024 alone, Chinese manufacturers and their intermediaries delivered machine tools or milling equipment to Russia that are being used in UVZ's tank production.¹²⁶ In mid-2023, India's Defense Ministry urged UVZ and other Russian manufacturers to partner with Indian companies to produce spare parts for Russian weapon systems locally to address some of the existing problems.¹²⁷

Russian manufacturers also remain dependent on many Western components. For example, Ukrainian sources have identified 276 pieces of Western high-tech tooling and equipment (including lathes, mills, and computer numerical control [CNC] machines) used by UVZ despite sanctions, many of which were acquired prior to the introduction of sanctions.¹²⁸ Besides, Chinese machine tools are in turn equipped with German and Japanese CNC systems, including those produced by Siemens, Heidenhain, and Fanuc.¹²⁹ This suggests that as Western machine tools are being replaced with Chinese alternatives, UVZ's dependence on Western electronics persists, since Chinese equipment still relies on advanced components produced in allied countries.

CORRUPTION

In March 2022, the Main Intelligence Directorate of Ukraine (HUR) reported that corruption had left Russia's stored armored vehicles and other equipment in "extremely unsatisfactory condition."¹³⁰ According to the report, only one in ten of Russia's mothballed tanks removed from storage was in working condition because of theft of components containing precious metals. The HUR further claimed that many of Russia's 4th Tank Division's stored tanks had been "completely dismantled" and that some were even missing engines. Items most commonly pilfered include optical devices, computers, and electronic equipment.

In 2023 it was reported that the head of the technical support department of Russia's Southern Military District had been arrested on charges relating to the theft of seven V-92C2 engines intended for installation in T-90 series tanks.¹³¹ The value of stolen engines exceeded 20.5 million rubles (\$260,000 at that time).¹³²

Corruption in Russia's domestic ball-bearing industry appears to be problematic as well, potentially impacting tank production. For instance, more recently, Russia has nationalized the holding company KIMP, which controls three ball-bearing plants: IO-GPZ, OK-Loza, and GPZ-2 Tver.¹³³ The crackdown and nationalization of these factories may suggest that the level of corruption was intolerable and has interfered with defense production.

OTHER ISSUES

Open-source intelligence (OSINT) and social media reports of uneven production quality point to possible manufacturing constraints, including material issues and broader degradation of the post-Soviet tank manufacturing base. Reports of unexpected material failure, like fractured T-90M turret hulls and separation of armor plating, suggest manufacturing defects perhaps due to the use of unskilled labor, corruption, or a lack of access to proper tools.¹³⁴ Another failure mode of the T-90M is a condition known as "disco head," which is characterized by uncontrolled rotation of the turret after being struck by enemy fire. Experts assert that the peculiar failure mode is a result of poor crew training and unsophisticated fire-control electronics, which may be exacerbated by Western sanctions.¹³⁵

Almaz-Antey Concern

Synopsis

Almaz-Antey was the first major defense holding established in post-Soviet Russia, created in the early 2000s by consolidating decaying Russian enterprises in the air defense sector with the dual goal of monopolizing the domestic market and gaining a competitive edge over international rivals. Over time, it evolved into one of the Kremlin's most strategically important defense industrial holdings, spanning air defense, missile production, radar systems, and aerospace defense technologies, consistently ranking among the world's top arms producers and maintaining strong domestic and foreign demand. State-backed investments before 2022 expanded production capacity at key facilities, including the Obukhov, Avitek, and Nizhny Novgorod plants, which later became important for Russia's wartime air defense production.

In the post-2022 period, the concern sought to expand production capacity to meet wartime demand, including through infrastructure development projects at the Obukhov plant identified by CSIS. However, the war-driven production expansion likely came at the expense of its arms exports. The company has further improved the performance of its surface-to-air missile (SAM) systems through combat experience and continued the development of its most advanced systems (albeit, most likely, at limited capacity). However, intensified Ukrainian drone attacks on Russian territory have demonstrated that improved effectiveness against individual precision weapons does not always translate into resilience against large-scale saturation attacks. Since 2022, the concern has expanded into unmanned systems, from combat drones to ground-based UAV surveillance infrastructure for both defense and civilian customers. Looking ahead, Russia's

increased production of long-range systems and related equipment, combined with the battlefield proliferation of cheaper drones that are gradually displacing more expensive munitions, could allow the Kremlin to build air defense stockpiles beyond immediate war needs.¹³⁶ Almaz-Antey and its subsidiaries will play a central role in such an effort.

At the same time, labor shortages, sanctions pressure, dependence on foreign electronics, and growing Ukrainian strikes against Russia's defense industrial infrastructure may increasingly constrain further expansion of Almaz-Antey.

Background

Joint Stock Company Almaz-Antey Air Defense Concern (also known as JSC Concern PVO "Almaz-Antey," with "PVO" denoting "air defense" in Russian) was established by President Putin in April 2002, following a merger of two core defense firms and other related entities: (1) Almaz, focusing on mostly long-range SAM systems; and (2) Antey, specializing in short-range and troop air defenses. Overall, 46 enterprises, including design bureaus, R&D institutes, and production plants, were originally incorporated into the concern.¹³⁷

Almaz-Antey became the first major holding company created under the federal target program "Reformation and Development of Defense Industrial Complex (2002-2006)." The program was initiated in 2001 and aimed to reduce the 1,700 firms then making up Russia's defense industrial complex by two-thirds to address issues with military production stemming from chronic underinvestment and underemployment at those enterprises. The reform envisaged amalgamating the remaining entities into major "system-building integrated structures" (i.e., holdings). In the case of Almaz-Antey, the goal behind the merger was to monopolize the domestic air defense market and attain a competitive edge over international rivals.¹³⁸

The company further expanded in the years that followed and today comprises over 60 entities across 17 regions, employing around 130,000 to 140,000 people.¹³⁹ It produces a broad range of military hardware, including integrated air and missile defense systems, SAMs, air defense radars, ground surveillance radars, and command and control systems, as well as equipment for GPS and GLONASS, Russia's satellite navigation system.¹⁴⁰ It also supplies the Russian government with radio equipment and software for air traffic control and works with Roscosmos, Russia's space agency, on military space programs.¹⁴¹

The creation of Almaz-Antey has been widely regarded as one of the Kremlin's most effective strategic decisions. Almaz-Antey's air defense systems consistently enjoyed strong demand both from the Russian government, which started prioritizing purchases of new anti-aircraft defense systems amid deteriorating relations with the West, and from foreign customers, who were drawn to its advanced and competitively priced systems.¹⁴² By 2008, the concern became the largest Russian supplier of military products, with its revenue from core activities reaching 88.8 billion rubles (roughly \$3.3 billion in 2008).¹⁴³ By 2011, the company's existing portfolio reached around \$6 billion, and further increased to \$8.5 billion in 2013.¹⁴⁴

In 2014, the concern was first sanctioned for supplying pro-Russian groups in eastern Ukraine with missiles.¹⁴⁵ Due to the joint effect of the sanctions and falling oil prices, Almaz-Antey's financial performance declined.¹⁴⁶ In 2014, the concern reported consolidated revenue of over 209 billion rubles (\$5.5 billion in 2014).¹⁴⁷ In 2016, the company's revenue constituted around 212.4 billion rubles (\$3.17 billion at that time), while its debt burden, already in an unstable state years prior, reached the peak of long-term debt.¹⁴⁸ Nonetheless, arms deliveries continued: By 2016, the MOD had received five segments of the S-400 long-range SAM system, as well as the Buk-M2 and Buk-M3 medium-range SAM systems and the Tor-M2 short-range SAM system, along with various radar stations.¹⁴⁹

In 2014, Putin also made a decision (finalized in February 2015) to change Almaz-Antey's name from JSC Concern PVO "Almaz-Antey" to JSC Concern VKO "Almaz-Antey," with "VKO" standing for "aerospace defense" in Russian. This move symbolized the company's increased role within Russia's defense industrial base, covering not only air but also space defense systems.¹⁵⁰ This decision was driven in part by the Kremlin's thinking that the United States and its NATO allies increasingly viewed near-Earth space as a possible theater of military operations against Russia, especially as the 2014 Ukrainian crisis unfolded and concomitant Western sanctions against Almaz-Antey were introduced.¹⁵¹ As a result of the reform, several additional research institutes and factories (particularly in satellite navigation and space-based reconnaissance) were incorporated into the concern.¹⁵²

In 2017, Almaz-Antey's revenue rebounded, and the Stockholm International Peace Research Institute (SIPRI) ranked it 10th among the top 100 arms-producing and military services companies globally, generating \$8.6 billion.¹ This was the first year a non-Western company ranked in the top 10. Almaz-Antey moved to ninth place in 2018, with its arms sales rising to \$9.6 billion, accounting for 27 percent of the total arms sales of Russian companies included in SIPRI's top 100.¹⁵³ The S-400 long-range SAM system was central to Almaz-Antey's post-2014 increase in arms sales. China became the first international buyer of the S-400 after it signed a contract in late 2014 and received deliveries in 2018; it was soon followed by Turkey (discussions began in 2016 and the delivery took place in 2019) and India (whose multibillion-dollar purchase was approved in 2018).¹⁵⁴ Overall, between 2009 and 2018, Almaz-Antey's position in SIPRI's top 100 changed from 24th to 9th place.

However, in 2020, the company experienced a decline in arms sales, earning \$7.6 billion in revenue, partly due to decreased state arms procurement induced by low oil prices and delays in arms export deliveries caused by the Covid-19 pandemic.¹⁵⁵ Given that 95 percent of Almaz-Antey's total revenue had traditionally come from its military sales, reduced state demand and delayed arms export shipments resulted in the company losing its position in the top 10 and moving to 17th place.¹⁵⁶ From

I Note that SIPRI calculates company revenues differently from standard company financial reporting, focusing not on total revenues but specifically on arms revenues, the latter covering both domestic procurement and foreign exports. Hence, Almaz-Antey's revenue numbers as reported by SIPRI might be different from the revenue numbers reported by the concern itself in a particular year. See Aude Fleurant, Alexandra Kuimova, Diego Lopes da Silva, Nan Tian, and Pieter D. Wezeman, "The SIPRI Top 100 Arms-Producing and Military Services Companies, 2017," SIPRI Fact Sheet, December 2018, https://www.sipri.org/sites/default/files/2018-12/fs_arms_industry_2017_0.pdf.

2021 onward, the concern stopped providing data to SIPRI, while claiming rising revenues, to avoid additional sanctions pressure.¹⁵⁷

Before 2022, as part of its expansion, Almaz-Antey also managed to complete three large-scale projects, constructing the Nizhny Novgorod Machine-Building Plant and carrying out large-scale modernization efforts at its Avitek and Obukhov plants (described below). According to the concern's general director, Yan Novikov, Almaz-Antey invested 107 billion rubles of its own funds into these projects and borrowed the rest, although the exact amount of funding that went into these three projects remains unknown.¹⁵⁸ These investments have proved to be effective and strategically important. These modernized plants were reportedly capable of large-scale production of SAM systems from around 2016 and, since February 2022, have played an important role in Russia's air defense campaign against Ukraine, supplying the Russian forces with the S-300 and S-400 systems.¹⁵⁹ Overall, between 2002 and 2022, Almaz-Antey invested 550 billion rubles in modernizing its facilities, of which 378 billion rubles were its own funds.¹⁶⁰

Organizational Structure

Almaz-Antey's subsidiaries fall into three categories: (1) design bureaus, responsible for the design, prototyping, and testing of SAM systems, as well as SAM system components and missiles; (2) research and production institutes, responsible for developing highly technical subsystems from radar and navigation technologies to military electronics; and (3) production plants, responsible for serial production of SAM systems and related equipment.

While many of the concern's major enterprises are concentrated in Moscow and the Moscow region, Almaz-Antey's industrial footprint is geographically dispersed, with a significant presence in St. Petersburg (where its Obukhov Plant is located) and across eastern, northeastern, central, and western parts of Russia. Based on estimates from the KSE Institute, approximately 22 percent of Almaz-Antey's supplier contracts involve internal transactions, illustrating a moderate level of vertical integration.¹⁶¹ The concern's leadership exercises tight control over its subsidiaries, overseeing production timelines and, whenever needed, consolidating entities to boost output.¹⁶²

Table 2 lists Almaz-Antey's key subsidiaries across the three categories, along with the main products they develop and/or produce. These entities have been identified through open-source reporting and the authors' conversations with different defense and military experts.^{II}

II Note that Table 2 does not provide an exhaustive list of Almaz-Antey's subsidiaries and may exclude companies significant to the concern's operations. The table should thus be used for illustrative purposes, showcasing connection between design bureaus, research institutes, and production plants within the Almaz-Antey network.

Table 2: Overview of Almaz-Antey's Key Subsidiaries and Products and Services Offered

Category	Subsidiary Name	Location	Key Products Developed and/or Produced
Design bureaus (designing, prototyping, and testing SAM systems and their parts)	Public Joint Stock Company "Scientific and Production Association 'Almaz'; named after academician A.A. Raspletin" (NPO Almaz)	Moscow	• A lead developer of the S-300 and S-400 long-range SAM systems • Develops radars, including the 92N6 Gravestone radar for the S-400 system and the 96L6 Cheese Board radar for the S-400 and S-500 systems • Develops command centers, including the 55K6E mobile command post for the S-400 system¹⁶³
	Open Joint Stock Company "Scientific-Research Institute of Instrument Design"; named after V. Tikhomirov (NIIP)	Greater Moscow region	• A lead developer of the Buk medium-range SAM systems • Develops radar systems for fighter aircraft • Claims to be the only enterprise within Russia's defense industrial complex, besides Almaz-Antey and Rostec, whose 10 different developments are being used in Ukraine today, including the Buk-M1, Buk-M1-2, Buk-M2, and Buk-M3 SAM systems and radar systems for the MiG-31BM, Su-27SM, Su-30SM, Su-35S, and Su-57 fighter aircraft¹⁶⁴
	Machine-Building Design Bureau "Fakel" (Fakel)	Greater Moscow region	• Develops SAMs used in the long-range systems such as the S-300 and S-400, Tor short-range missile system family, A-135 anti-ballistic missile systems deployed around the Moscow industrial region, and the Rif and Rif-M naval air defense systems • Develops the 40N6 and 48N6 missiles and interceptors for the S-400 complex¹⁶⁵
	Experimental Design Bureau "Novator" (Novator)	Yekaterinburg	• Develops Russia's Kalibr cruise missile and its export variant, "Club" • Develops the 9M727 cruise missile, which is part of the Iskander-K operational-tactical missile system used by Russia for precision strikes against Ukrainian military infrastructure¹⁶⁶
Research and production institutes (developing highly technical subsystems)	Radiofizika	Moscow	• Develops advanced radar systems, using modern antenna technology, which are capable of working across different frequency ranges for both long-distance detection and precise targeting • Manufactures and supplies onboard transponders and radar modules for Russia's Orion UAV's piloting radio equipment; Orion drones, which close the reconnaissance and strike loop, have been used by Russia in Ukraine to both search for and destroy targets¹⁶⁷
	Russian Scientific Research Institute of Radio Equipment (VNIIRA)	St. Petersburg	• Develops surveillance and landing radars • Has some experience with developing multifunctional, lightweight UAVs built mostly with domestic components, yet specific characteristics of these drones remain unknown¹⁶⁸

Category	Subsidiary Name	Location	Key Products Developed and/or Produced
Production plants (building SAM systems and subsystems)	Joint Stock Company “Moscow Machine-Building Plant ‘Avangard’” (MMZ Avangard)	Moscow	Produces all types of missiles for Russia’s S-300 and S-400 long-range SAM systems, including the 40N6 and 48N6 missiles for the S-400 system¹⁶⁹
	Obukhov Plant	St. Petersburg	- Produces SAM systems, including the S-300, S-400, and S-350 complexes - Located within St. Petersburg’s Northwestern Regional Center, created to unify Almaz-Antey’s St. Petersburg-based subsidiaries into a larger entity¹⁷⁰
	Joint Stock Company “Vyatka Machine-Building Enterprise Avitek” (Avitek)	Kirov	- Produces the S-400 SAM system - Produces SAMs, including for the Tor and Kinzhal systems¹⁷¹
	Nizhny Novgorod Machine-Building Plant	Nizhny Novgorod	- Produces the S-350, S-400, and S-500 systems - Produces the Nebo-M and Nioby radar complexes¹⁷²
	Izhversk Electromechanical Plant “Kupol” (IEMZ Kupol)	Izhversk	- Produces the Tor short-range SAM systems, including the Tor-M2 - Produces Garpiya drones, which are based on the Iranian Shahed-136 design and heavily used by Russian forces in Ukraine¹⁷³
	Ulyanovsk Mechanical Plant	Ulyanovsk region	- Produces the Buk medium-range SAM systems, including the Buk-M1, Buk-M2, and Buk-M3 variants¹⁷⁴ - Produces the Pantsir-S1 short-to-medium range air defense missile-gun system. The Pantsir-S1 is designed by the KBP Instrument Design Bureau, a Rostec subsidiary, yet its serial production takes place at the Ulyanovsk plant. The Pantsir-S1 is stationed around Moscow together with the Tor, S-300, and S-400 systems to protect the city from Ukrainian attacks¹⁷⁵

Post-2022 Performance

Open-source reporting points to significant Russian air defense losses, likely numbering in the hundreds since the start of the war. However, in many cases it is not possible to determine whether complete batteries or only individual launchers, radars, or other components were damaged or destroyed.^{III} Based on Oryx data, as of May 18, 2026, at least 416 Russian SAM system components have been destroyed, damaged, abandoned, or captured by Ukrainian forces.^{IV} Ukrainian official and

III Note that a SAM battery is the complete tactical unit, consisting of necessary equipment (radars, launchers, etc.) and personnel for detecting, tracking, and engaging aerial targets.

IV These include roughly 143 Buk-series launcher vehicles (Transporter Erector Launcher [TEL] and Transporter Erector Launcher and Radar [TELAR] units); 85 Tor-series TLAR (Transporter, Launcher, and Radar) units; 13 launchers and associated components used in the S-300; 29 S-400 launchers; and one S-350 launcher. See Jakub Janovsky, Naalsio, Aloha, Dan, Kemal, and Alexander Black, “Attack on Europe: Documenting Russian Equipment Losses During the

expert estimates place Russian air defense losses far above visually confirmed counts, claiming more than 840 systems destroyed or damaged since the start of the war, including S-300, S-400, Buk, and Tor systems.¹⁷⁶ More recently, President Zelensky announced that Ukrainian forces had struck 274 Russian air defense systems and radar stations in that month alone—a record for the war.¹⁷⁷ These losses are compounded by the rapid expenditure of interceptor missiles. RUSI's December 2025 report argues that Russian air defense interceptors are currently being fired faster than they can be produced, although this is overwhelmingly concentrated among older or obsolete platforms such as the 9K33 Osa.¹⁷⁸

To offset these losses, Russia has reportedly redeployed substantial numbers of S-300 and S-400 systems from other military districts (including the Leningrad Military District, the Finnish border, and, to a lesser extent, Kaliningrad) to reinforce air defenses supporting operations in Ukraine.¹⁷⁹ At the same time, these losses should not be overstated. Some Western experts, including the Royal United Service Institute's Justin Bronk, believe that, despite Ukraine having destroyed numerous Russian air defense systems with weaponry like drones, artillery, and missiles, Russia still maintains a large arsenal—likely several hundred batteries still in service—and keeps producing its most powerful systems (see below).¹⁸⁰

As per analyzed sources, the recent performance of Russian air defense systems has improved compared to the first years of the war. Russian SAMs are now believed to be more effective at shooting down Ukrainian aircraft and drones, missiles such as the U.S.-origin AGM-88 HARM (High-Speed Anti-Radiation Missile), and the GMLRS (Guided Multiple Launch Rocket System) rocket artillery rounds. This improvement likely reflects several factors, including an increase in SAM system operators' combat experience, more frequent coordination between Russia's long-range SAM systems and fighter aircraft operating near the front line, software updates that have improved the performance of radars, and improved resistance to EW.¹⁸¹ Some Western commentators even argued that the adeptness of Russian SAM systems such as the S-400 has reduced the effectiveness of Western long-range strike weapons, which Ukraine has employed on the battlefield to shift the war's dynamics.¹⁸²

Despite Ukraine having destroyed numerous Russian air defense systems with weaponry like drones, artillery, and missiles, Russia still maintains a large arsenal—likely several hundred batteries still in service—and keeps producing its most powerful systems.

Yet the May 17, 2026, Ukrainian drone strike against the Moscow region has demonstrated that improved performance of Russian air defense systems against individual precision weapons does not necessarily translate into immunity against mass saturation. Ukraine employed hundreds of domestically developed deep-strike drones, navigating gaps in the layered network of the S-400,

Russian Invasion of Ukraine,” Oryx, February 24, 2022, <https://www.oryxspioenkop.com/2022/02/attack-on-europe-documenting-equipment.html>.

S-300, Panstir-S1, and Tor systems stationed around the capital and striking Russian military and energy infrastructure.¹⁸³ Russian authorities have claimed that Russian air defenses intercepted the majority of these drones, but the attack has demonstrated that Almaz-Antey's products remain vulnerable to mass saturation by lower-cost Ukrainian drones when combined with what Ukrainians have called "intelligence for identifying blind spots, route planning, and appropriate tactics."¹⁸⁴

Overall, in the post-2022 period, Almaz-Antey's air defense systems have provided significant protection to the Russian army and military infrastructure, even if Ukrainian strikes on Russian territory have demonstrated that these systems are hardly impenetrable. Moscow has also exercised restraint with some of the more advanced elements of its air defense inventory, either largely avoiding their use (as in the case of the 40N6 long-range air defense missiles designed for its S-400 and S-500 missile systems) or deploying them only sparingly (as with the 48N6 missiles primarily used by the S-400 and late-model S-300 systems).¹⁸⁵ While NATO's air forces have acquired significantly more detailed information about the strengths, weaknesses, and technical characteristics of the concern's SAM systems than they had prior to the full-scale invasion, the weaponry and tactics for countering these systems do not yet exist in sufficient numbers in European NATO states.¹⁸⁶

Production

LONG-RANGE SYSTEMS

Among the long-range SAM systems developed by the concern are the S-300, S-400, and S-500 systems.

The S-300 SAM system has been in service since 1978. It is designed to protect military and civilian infrastructure from aircraft, cruise missiles, and limited ballistic missile threats, with its different variants, including the S-300P and S-300V, serving air force and army air defense roles, respectively.¹⁸⁷ The S-300 uses phased-array radar systems capable of tracking dozens of simultaneous targets and can engage multiple threats at altitudes reaching 27 km and ranges of up to 150 km, depending on the missile type. Information regarding the exact numbers of the S-300 system and its variants in Russia's pre-2022 inventory is hard to glean from open sources, but it has been estimated that the deployment of the system peaked in 2000, with Russian air defense forces fielding around 1,900 S-300P launchers at that time. The number of active launchers reportedly dropped to 800 by 2017.¹⁸⁸

Both Russia and Ukraine have used the S-300 systems, including the S-300P and S-300V series, in the current war.¹⁸⁹ Presumed numbers of the S-300 complexes in Russia's arsenal have varied during this time but have nonetheless remained in the several hundreds: By 2023, it was estimated that Russia possessed over 500 S-300 launchers and 8,000 interceptor missiles.¹⁹⁰ In May 2024, President Zelensky argued that Russia had accumulated 10,000 S-300 missiles.¹⁹¹

The S-400 "Triumf" is a successor to the S-300 and has been in service since 2007. It is designed to counter stealth aircraft, drones, cruise missiles, and short- to medium-range ballistic missiles, with its mission set and capabilities being roughly comparable to those of the U.S. Patriot system.



Russia's S-400s ride through Red Square during the Victory Day military parade in Moscow on May 9, 2018.

Photo: Kirill Kudryavtsev/AFP via Getty Images

The S-400's maximum engagement range is 400 km depending on the missile type deployed, while its radar suite can reportedly detect targets at up to 600 km and track up to 300 aerial objects simultaneously. Triumph has been used by Russia in the current war, including to strike targets in Ukraine.¹⁹²

Prior to the full-scale invasion, some sources suggested that Russia had around 56 full S-400 systems deployed by the early 2020s.¹⁹³ Following the invasion, various sources assessed that at least a dozen have been damaged and destroyed in the conflict.¹⁹⁴ Yet, given Russian reports in September 2025 about doubling S-400 production, including related missiles and technical equipment, Russia likely still retains dozens of complete S-400

systems.¹⁹⁵ Overall, analysts note that Moscow's procurement of the S-400 over recent decades has outstripped its spending on fighter aircraft, with the upgrades to the Obukhov Plant, Avitek, and the Nizhny Novgorod Machine-Building Plant enabling the current manufacturing.¹⁹⁶

Putin has also alluded to Russia's productive capacity for its long-range SAM systems: During his January 2023 visit to the Obukhov Plant, which manufactures the S-300 and S-400 complexes, Putin highlighted that Russia's productive capacity was approaching that of the rest of the world combined, and exceeded that of the United States by threefold.¹⁹⁷ CSIS was able to identify activities signaling purported production expansion at the Obukhov Plant (see Figures 1a and 1b). A comparison of satellite imagery from August 23, 2022, and March 15, 2026, shows that several notable infrastructure development projects took place at the plant. The first was the construction of an approximately 7,000 square meter assembly and production building in the northeast section of the Obukhov complex, undertaken sometime between July 2023 and April 2024. Furthermore, in the north central section of the complex, two open-air storage yards were constructed: The first one was built between July 2023 and April 2024 and used as a storage facility for shipping containers, while the second one was built between September 2025 and February 2026 for storage of air defense systems. The March 15, 2026, image shows that approximately 22 military vehicles are present in the paved storage yard, with some likely to be the S-300 systems and their support vehicles (although the resolution of the imagery is not sufficient to make more positive identifications).

Figure 1a: Site of Future Infrastructure Developments, Obukhov Plant, 2022



Copyright © 2026 Vantor. Image may not be republished without permission. Please contact imagery@csis.org.

Figure 1b: New Infrastructure Developments, Obukhov Plant, 2026



Copyright © 2026 Vantor. Image may not be republished without permission. Please contact imagery@csis.org.

Finally, the S-500 “Prometheus” is designed to engage various long-range (reportedly, up to 600 km) and high-altitude (up to 200 km) targets, including fifth-generation aircraft, low-orbit satellites, and ballistic and cruise missiles, while its radar network can reportedly detect and track hypersonic weapons and intercontinental ballistic missiles.¹⁹⁸ The S-500 entered combat duty as a full regiment only recently, in December 2025.¹⁹⁹ Prior to that, it allegedly first appeared in Crimea in June 2024 in what Ukrainian sources described as the “experimental application,” aimed at strengthening Russian air defenses over the occupied peninsula.²⁰⁰

MEDIUM-RANGE SYSTEMS

Among Almaz-Antey’s key medium-range SAM systems are the Buk missile system family and the S-350 “Vityaz.”

Buk variants, including the Buk-M1, Buk-M1-2, Buk-M2, and Buk-M3, have been widely deployed by Russian forces in Ukraine.²⁰¹ The Buk-M3 is designed to intercept various aerial threats, including aircraft and cruise missiles, at distances of up to 70 km and altitudes of up to 35 km, and is believed by some to even outperform the S-300P long-range SAM system.²⁰² In 2022, Almaz-Antey’s general director, Novikov, referred to the Buk-M3 as the company’s “calling card,” saying that it would unequivocally occupy a prominent place in the concern’s product lineup in the years to come.²⁰³ While specific pre-2022 inventory totals for the Buk missile system family are difficult to provide, in 2025, some military commentators claimed that Russia had produced over 600 launcher units of the Buk system in various versions over the years, including export variants, and that Russia had approximately 380 launcher units in service, including 100 units of the Buk-M3 by 2025.²⁰⁴ The latter estimate is also echoed in the 2025–2026 IISS analyses, which claim that Russia has around 390 Buk systems, including over 70 Buk-M3s, in its arsenal.²⁰⁵

Almaz-Antey reportedly began expediting deliveries of the Buk medium-range SAM systems to the Russian armed forces in 2023, placing a special emphasis on the delivery of the Buk-M3 complexes produced by the Ulyanovsk Mechanical Plant (UMP).²⁰⁶ According to the state defense order, in 2023, UMP was tasked with delivering two divisions of the Buk-M3 to the Russian military.²⁰⁷ In December 2025, Russian military sources reported that a batch of the Buk-M3, manufactured under the 2025 state defense order, was delivered to the troops ahead of schedule.²⁰⁸ In January 2026, Russian sources on Telegram further alleged that Almaz-Antey was increasing the manufacturing of the 9M317M medium-range SAMs for the Buk-M3 complexes, with one such installation being capable of carrying an ammunition of six missiles. This, according to online commentators, would more effectively repel the Ukrainian attacks.²⁰⁹

Finally, the S-350 “Vityaz,” which Novikov has also singled out as a product that will be prioritized by the concern in the coming years, alongside the Buk-M3, was introduced in 2020. It is designed to counter cruise missiles, low-flying aircraft, drones, and short-range ballistic missiles, with the maximum engagement range reaching 120 km and an altitude of 30 km, depending on the missile variant used.²¹⁰ Overall, Russia is estimated to have around 38 S-350 systems (although the 2025–2026 IISS analyses list only six S-350 systems in Russia’s arsenal). Additionally, in 2020, it was reported that Almaz-Antey would deliver 12 S-350 batteries (totaling 144 launchers), to the Russian military by 2027.²¹¹ Since 2022, Almaz-Antey has also claimed to have increased production of the S-350. In

this regard, in 2024, Nizhny Novgorod's machine-building cluster—home to the Nizhny Novgorod Machine-Building Plant, which produces the S-350, among other air defense systems—reportedly recorded 4.2 percent industrial growth.²¹² In 2025, the concern claimed that it more than doubled S-350 production.²¹³ However, Russia has very rarely deployed this system against Ukraine, and Ukrainian sources claim to have destroyed the first deployment of the S-350 launcher in February 2025 and struck its multifunction radar, 50N6E, in January 2026.²¹⁴

SHORT-RANGE SYSTEMS

Among the concern's short-range SAM systems is the Tor missile system family, including the Tor-M1 and Tor-M2 variants. The Tor-M1 entered service in the early 1990s and has since been used to counter precision-guided munitions, aircraft, helicopters, cruise missiles, and drones at distances of around 12 km, as well as intercept targets at altitudes of around 6 km.²¹⁵ The Tor-M2, an upgraded version of the Tor-M1 variant, was introduced in 2010. It is designed to intercept a wide range of threats, including fixed-wing aircraft, helicopters, drones, precision-guided munitions, and cruise missiles. The system has an engagement range of up to 15–20 km and altitude coverage up to 10 km, and is able to track and engage multiple targets simultaneously.²¹⁶ Both Tor-M1 and Tor-M2 variants have been widely used by Russia to protect troop positions and chief rear facilities on the battlefield in Ukraine.²¹⁷ While the exact scale of Russia's Tor missile system family arsenal is unknown, some open-source analysis has pointed to 200 active Tor-M1 systems in Russia's possession.²¹⁸ The 2025–2026 IISS analyses, however, point to a smaller estimate—roughly 129 Tor systems in Russia's arsenal.²¹⁹ For systems have been repeatedly targeted by Ukrainian drone attacks; OSINT researchers have estimated that over 80 Tor-class systems have been destroyed as of January 2026.²²⁰

IEMZ Kupol, a key producer of these systems, has also alleged that it has increased production numbers and product modernization efforts since the invasion. General director of the plant Fanil Ziyatdinov described the recent dynamics as “unprecedented,” stating that both 2024 and 2025 were record years for Kupol, with output in 2025 two and a half times higher than in 2024. Since the start of the war, Kupol has reportedly become the largest enterprise in Russia's Udmurt Republic in terms of its output, providing a tenth of its industrial production. Ziyatdinov also stated that the company developed the Tor-M2KM combat module, based on the latest Tor-M2 variant, to help the Russian troops cover important facilities on the front lines and in the rear.²²¹

UNMANNED SYSTEMS

Since 2022, IEMZ Kupol has also increased its drone manufacturing capability.²²² Reportedly, the plant has been building new one-way attack (OWA) UAVs based on the Iranian Shahed 136 design, but using a Chinese copy of the Limbach 550 engine instead of the Iranian original.²²³ Ukrainian sources have claimed that these OWA-UAVs, known under the names of Garpiya and Geran-2 in Russia, are the main reason behind Russia's ability to intensify drone attacks against Ukraine throughout 2025.²²⁴ In July 2025, Reuters reported that Kupol had allegedly signed a contract with the Russian MOD to build more than 6,000 Garpiya drones throughout the year, up from 2,000 in 2024, with over 1,500 units already delivered by April 2025.²²⁵

Beyond drone production, Almaz-Antey has also been working on the ground-based infrastructure for UAV surveillance and monitoring. In February 2024, the company announced the creation of

a multi-position drone surveillance system able to determine drone coordinates and analyze the detected UAVs.²²⁶ CSIS analysis of the post-2022 Russian procurement data shows that, between 2024 and 2025, the State Air Traffic Management Corporation—Russia’s primary civilian air navigation service provider—signed at least 33 contracts worth over 18.9 billion rubles (\$227 million in 2025) with the concern. Over 97 percent of these contracts explicitly mention UAVs in their subject text, covering multi-position drone surveillance, digital aeronautical-information systems, and components of the unified UAV air traffic management system.

More recently, Almaz-Antey announced the development of specialized droneports—automated base stations that house, launch, and service UAV interceptors, aimed at protecting critical infrastructure from drone attacks with minimal human intervention.²²⁷

Taken together, these developments illustrate that, while Almaz-Antey primarily remains a defense manufacturer, it also has dual-use commercial ambitions, with some of its UAV-related systems developed post-2022 also catering to civilian customers.

Challenges

FOREIGN COMPONENT DEPENDENCIES

Prior to the full-scale invasion, Almaz-Antey relied heavily on foreign components, including Western CNC machine tools for precision manufacturing.²²⁸ This dependence on foreign-sourced components has seemingly not changed since 2022.

For instance, the S-400 system uses Russia’s Elbrus-90 micro computing system for data processing and target tracking. The latter is believed to rely on microprocessors manufactured at Taiwan’s TSMC, official access to which has been constrained following the 2022 export control restrictions. While Russia has sought to localize production of these microprocessors, the Russian company tasked with fulfilling the state defense order has reportedly failed to do so.²²⁹ In another instance, MMZ Avangard, a major manufacturer of missiles for the S-300 and S-400 complexes, used U.S. computer hardware for its IT systems.²³⁰ Similarly, IEMZ Kupol, which since 2022 has taken on new drone production, has reportedly been able to increase the manufacturing of Garpya-A1 attack drones using Chinese-made L550E engines, the latter shipped to Kupol via front companies and labeled as “industrial refrigeration units.”²³¹

Finally, since 2024, reports have been emerging about India becoming one of the suppliers of electronics to Russia.²³² Customs data from 2022 to 2025, reviewed by CSIS, show that Almaz-Antey received at least 375 transactions from India within this time period, classified as aircraft avionics and control systems.^v

These cases demonstrate the extent of Almaz-Antey’s and its subsidiaries’ dependence on foreign-sourced components and equipment, but they also illustrate Almaz-Antey’s ability to

V Please note that one transaction can contain multiple items.

circumvent sanctions through the help of China and other willing third countries, even at extra cost and resources.²³³

LABOR SHORTAGES

Almaz-Antey's struggle to attract and retain a qualified workforce predates the 2022 invasion but has intensified due to the current war-related production demands.²³⁴ In this regard, the case of Nizhny Novgorod's machine-building cluster, which houses Almaz-Antey's Nizhny-Novgorod Machine-Building Plant, is illuminating. While investment in this industrial cluster is flowing in, with 18-22 billion rubles (\$237-240 million) in sectoral investment expected in 2026, it lacks the qualified personnel to convert the capital into output at the required quality and pace. Around 38 percent of the skilled machine operators in this cluster are over 55 years of age, and while vacancy rates for CNC operators and toolmakers are projected to increase by 15-20 percent throughout 2026, there are fewer applicants than open positions. As a result, precision machine shops tied to the Nizhny-Novgorod Machine-Building Plant are so busy fulfilling defense orders under workforce constraints that their schedules are fully booked 18-24 months in advance.²³⁵

Although in January 2022 Almaz-Antey's leadership claimed that the concern worked with other conglomerates on staff exchanges, including temporarily transferring employees between firms to meet urgent production needs, such a practice is likely far more limited today, given the widespread shortage of qualified personnel within Russia's defense industrial complex.²³⁶

In the past, the company had tried to attract and retain a young workforce by creating a corporate training system, including establishing a continuous "school-university-concern" model spanning from early education to postgraduate training. At the production plant level, for instance, UMP has claimed that it begins training future specialists during their school years through career guidance programs, engineering-focused classes, and its own "School of Radio Engineering." UMP also collaborates with universities by recruiting student interns and is licensed to carry out around 100 educational programs to support production needs and workforce skill development.²³⁷ Yet it remains unclear if these programs have yielded the intended results during wartime.

UKRAINIAN ATTACKS

As Ukraine has been more actively targeting Russian military infrastructure—including air defenses—on Russian territory since 2022, Almaz-Antey and companies linked to the concern have increasingly become targets of these Ukrainian drone and missile attacks.

For instance, in July 2022, Kyiv successfully struck IEMZ Kupol with drones, leading to a partial roof collapse and temporarily halting the plant's drone production line.²³⁸ In March 2023, missiles struck the Kremniy El defense plant, which produces 1,000-1,500 types of electronic components, with Almaz-Antey being one of its main customers, including for its S-300 and S-400 systems. Since 2022, Kremniy El has been attacked six times, by both missiles and drones.²³⁹ In the same month, Ukrainian UAVs hit the Granit Innovation Center in Sevastopol in occupied Crimea. The center is an Almaz-Antey facility that focuses on the maintenance and repair of the concern's air defense systems, including the S-300, S-400, Buk, and Tor systems, as well as the 92N6E and 96L6E radar stations. The Ukrainian MOD has claimed that the facility will no longer be able to

repair these systems; however, details regarding the extent of damage are not fully known to outside observers.²⁴⁰

Besides direct attacks, as Ukrainian reconnaissance drones and capabilities continue to develop, so does Kyiv's ability to conduct reconnaissance operations of Russian defense plants. For instance, in May 2025, a Ukrainian resistance group reportedly reconnoitered the Obukhov plant, gathering important details about the plant's operations and logistics and passing the data to the Ukrainian armed forces.²⁴¹ These Ukrainian strikes and reconnaissance activities have the ability to disrupt Almaz-Antey's operations and impact production numbers.

DECREASED ARMS EXPORTS

While Almaz-Antey's arms exports have become significantly more difficult to track since 2022, increased state defense orders consuming production capacity, intensified labor shortages, and Western sanctions complicating payment channels suggest that the concern's foreign arms sales have declined substantially during this period.

The company's general director, Novikov, indicated as much in an April 2022 interview, stating that the concern's "unconditional priority" would remain the fulfillment of the state defense orders. In the same interview, however, Novikov claimed that Almaz-Antey's portfolio of export orders for military products exceeded \$7 billion at the beginning of 2022.²⁴² This suggests that deliveries, maintenance, and modernization services under preexisting contracts likely continued in the post-2022 period (even as the new export activity slowed), with India being the most notable example. Reportedly, India is preparing to receive the fourth squadron of the S-400 under the 2018 contract in 2026.²⁴³

Despite the absence of confirmed new export contracts, Almaz-Antey has been actively marketing its systems internationally, including at arms shows in the United Arab Emirates in 2023 and Egypt in 2025, showcasing the S-400, S-350, the Tor-M2 family, and the Antey 4000 (an export-oriented variant of the S-300V4 line).²⁴⁴

Concern Radio-Electronic Technologies (KRET)

Synopsis

KRET was established as part of Rostec in 2009, with the goal of vertically integrating and modernizing the ecosystem of Russian defense firms producing EW systems, including avionics, radar, and other platforms tied to electromagnetic spectrum operations (EMSO). Over the course of the 2010s, KRET's consolidation drive benefited from Russia's post-2014 military buildup and efforts at import substitution, which expanded the company's access to defense contracts, in addition to orders for dual-use and civilian production.

Since the launch of Russia's full-scale invasion of Ukraine in 2022, EMSO has remained a core feature of the war, thereby raising the profile of and demand for KRET's land and air systems—like the Krasukha, Vitebsk, Khibiny, and Sapphire—particularly in the context of increasingly intensive Ukrainian UAV operations. KRET appears to have expanded production, and it is adapting systems to operate in the shifting conditions of the battlefield. Importantly, the realities of drone warfare have incentivized Russia's push toward smaller, more mobile, distributed EW systems needed for jamming enemy platforms, and it is likely that as new players offering these systems emerge in the Russian EW space, they will be merged into KRET's existing corporate structure.

However, EW production does face real constraints. A shortage of skilled laborers, plus the ongoing reality of sanctions-induced supply chain costs, both remain challenges. That being said, for now Russia's EW sector appears able to deliver for troops at the front and integrate increasingly prevalent autonomous technologies.

Background

Russia's use of EW tactics dates back to the Russo-Japanese War, when Russian forces used radio interference to disrupt Japanese naval operations.²⁴⁵ The Soviet Union made significant advances after 1945, developing EW capabilities as part of its broader scientific and technological competition with the United States.²⁴⁶ During that period, much of the industrial output connected to EW was overseen by the Ministry of Radio Industry, which was in charge of work connected to military radar systems, in addition to missile defense, space research, and the production of consumer goods.²⁴⁷ In the post-Soviet period, the ministry's successor, Corporation Radiocomplex, was transformed into a private joint stock company, serving a coordinating role for Russia's radioelectronics sector, with key firms (including state-owned ones) as its founders and shareholders.²⁴⁸

Following the post-Soviet transition, Russian military planners realized investing in the country's expertise in the radio frequency spectrum could help Russia compensate in areas where it lagged Western technology. Russian military planners came to understand that the air, land, sea, and space domains were going to become increasingly dependent on the spectrum, with EW specifically playing a critical role.²⁴⁹ In the air domain, in part due to a lack of advanced machine tools that allowed the kind of precision metalwork that provides certain Western-made aircraft with anti-radar detection capacity, Russian military aircraft producers conceded they could not match Western stealth capabilities.²⁵⁰ They instead prioritized EW systems to protect Russia's more detectable aircraft by jamming enemy sensors.²⁵¹ Russia has relied on EW as a core element of an asymmetrical response to emerging U.S. airborne and space-based systems targeting command, control, intelligence, surveillance, and reconnaissance (ISR) networks.²⁵² This positioned Russia among a small cohort of states with substantial EW capabilities and a clearly defined doctrinal role for their use.²⁵³

Russia has invested in the production of both offensive EW systems, which are designed to attack an enemy's successful use of the electromagnetic spectrum, and self-protection systems, used to defend a platform like an aircraft or a tank from either enemy projectiles or offensive EW systems. Offensive EW systems can be more modular and less bespoke than self-protection systems, which need to be more sophisticated due to the space, weight, and energy constraints caused by their positioning on specific platforms. In the post-2022 period, Russia has also turned to the production of distributed EW systems, which are smaller offensive EW systems that need less power to function, are more mobile than traditional systems, and are being produced by new companies in the EW space.²⁵⁴

The EW production ecosystem is relatively concentrated. KRET, a Rostec subsidiary, controls an estimated 60 percent of the domestic market.¹ Formed by a February 2009 decision, KRET consolidated firms and design bureaus involved in EW, avionics, and radar under a single umbrella,

I A distant second behind KRET is Sozvezdie Concern, with roughly 20 percent, while the remaining top five producers each control no more than 10 percent of the market. Vladimir Teslenko, "Научные принципы радиоэлектронной борьбы" [Scientific principles of electronic warfare], *Kommersant*, February 24, 2017, <https://www.kommersant.ru/doc/3211081>.

creating a highly vertically integrated structure in support of EMSO.²⁵⁵ While some capabilities remain outside KRET (like the Scientific-Research Institute for Radio Engineering [TsNIRTI], which is part of Almaz-Antey and provides EW systems for MiG aircraft), the KRET ecosystem integrates the core of airborne EW development and production. Unlike its Soviet predecessors, KRET aimed to produce both military and civilian products and to compete commercially.²⁵⁶

Established in the wake of Russia's 2008 war with Georgia, KRET expanded alongside Russia's post-2014 military buildup and import substitution policies. Its success in securing domestic contracts stemmed in part from developing substitutes for Western and Ukrainian electronic components restricted by sanctions.²⁵⁷ As reliance on state defense orders grew, KRET systems were deployed during Russia's recent conflicts. For example, Russian-backed militias in eastern Ukraine employed advanced signal jamming and GPS spoofing capabilities, including systems linked to KRET.²⁵⁸ KRET systems also supported the Russian Air Force's expeditionary group in Syria in 2015, where the offensive Krasukha and the self-protection Khibiny-M systems at Khmeimim airbase in Latakia enabled operations by the Su-24M, Su-25SM, Su-30, and Su-34 aircraft.²⁵⁹ Around Russia's deployment to Syria, KRET representatives claimed that Russian EW jamming and electronic countermeasures could reportedly reduce tactical aircraft losses to enemy fire by 20-30 times.²⁶⁰ KRET revenues rose accordingly, from a purported 65.5 billion rubles in 2011 (\$2.2 billion at that time) to 200 billion by 2020 (\$2.76 billion in 2020), an increase of more than 200 percent in nominal ruble terms.²⁶¹ By the mid-2010s, avionics accounted for the majority of its revenue (around 64 percent), while EW systems made up roughly 14 percent.²⁶²

Available data indicate expanded EW output in the late 2010s and early 2020s, predominantly in offensive EW systems, coinciding with the Russian military's renewed emphasis on EMSO. This pattern aligns with Russia's 2010s decision to embrace scaling EW capabilities through quantity, rather than necessarily competing head-to-head with NATO in the realm of innovation.²⁶³ According to Pavel Luzin, between 2013 and 2017, EW forces in the Russian military received over 600 new and upgraded EW systems.²⁶⁴ KRET in particular reportedly provided 62 high-end EW systems in 2017, with a drop in deliveries recorded in 2018. By early 2021, Russian military-aligned outlets reported that over the previous three years, the Russian military received 1,000 units of different types of EW systems, including 19 of the most advanced models.²⁶⁵

KRET also significantly expanded its civilian output between 2009 and 2021, increasing it more than 20-fold (from 2.3 to 47.4 billion rubles), and coinciding with the boom in the commercialization of computer and digital communications technology.²⁶⁶ This fits into a broader effort by the Kremlin to encourage growth in the production of civilian radio electronics by Russian defense firms, with Putin in 2016 calling for a 3.7 times increase in the production of these devices by 2020.²⁶⁷ For example, procurement data shows that in 2020, KRET completed 73 contracts for OKPD2 32.5 (medical and dental instruments) totaling 13.2 billion rubles. The largest of this batch, worth 7.5 billion rubles (\$100 million at the time) and signed on April 15, 2020, was a contract with Russia's Ministry of Industry and Trade for ventilators and oxygenation devices, reflecting a state-directed pandemic conversion. This episode demonstrates the ability for civilian production at scale. However, reporting on the utility of the rapidly produced ventilators confirmed that some started

hospital fires leading to patient deaths, raising serious questions about the reliability of some of KRET's civilian products.²⁶⁸

The push for diversification continued into the early 2020s; in 2021, Signal, a major KRET subsidiary, announced plans to raise civilian output 30 percent by 2025, with a particular focus on providing electrical goods to oil, gas, and construction-related industries—all of which have played significant roles in supporting Russia's post-2022 war machine. However, the achievement of that metric remains unverified.²⁶⁹ Also in line with this broader diversification strategy, in 2026, KRET subsidiary Electropribor in Tambov began construction of a large industrial complex to produce free-inertial navigation systems for civilian aircraft.²⁷⁰

Organizational Structure

As of 2015, KRET's umbrella of subsidiaries comprised 97 separate entities, but more recent estimates put the figure at about 70, consistent with Rostec's 2024 description and KRET's efforts to streamline operations in the 2010s.²⁷¹ Together, the different KRET enterprises produce EW systems for Russian aircraft, naval vessels, and ground forces. Given this level of vertical and horizontal integration, Russia has built a conglomerate that, like some of its Western peers, can in theory provide the Russian military with a promising platform for full spectrum integration, enabling greater coordination between Russian military systems across the EMSO portfolio. This process of vertical integration fits into a broader pattern visible across much of the Russian defense industry and is a stated priority of the country's defense leadership.²⁷²

Like other major defense firms, the KRET holding structure comprises design bureaus, research institutes, and manufacturing plants that churn out physical systems. KRET has significant holdings across the Russian defense industry, including subsidiaries such as Tekpribor, Radiopribor, the Moscow Institute of Electromechanics and Automatics, and Compass MKB, among others (see below).²⁷³ A key pillar of the conglomerate is the Kaluga Scientific Research Institute for Radio Engineering (KNIRTI), KRET's primary provider of EW systems for Sukhoi aircraft.²⁷⁴ Some of the other firms within the KRET ecosystem focused on either design, production, or a combination of the two include the Ryazan Instrument Plant, Ekran Research Institute, NIIAO (an avionics integrator), Avionika Concern, Elektropribor, Fazotron-NIIR Corporation, Aerospace Equipment Corporation, VNII Gradient, OKB Elektroavtomatika, V.V. Tarasov Aviaavtomatika, and Aeropribor-Voskhod.²⁷⁵

The Signal plant in Stavropol plays a key role within KRET's broader organizational structure. Founded in 1971, the plant is one of the largest defense enterprises in the North Caucasus.²⁷⁶ By 1988, the plant had distinguished itself within the broader late-Soviet economy with the construction of an impressive microelectronics complex, which at the time was unmatched domestically, enabling its continued growth through state contracts.²⁷⁷ Today, variants of Signal's Khibiny EW system are deployed on the Su-34 and Su-35 aircraft as a means of executing self-protection EW in the face of Ukrainian jamming; the Su-34 in particular is actively conducting strike missions in Ukraine.²⁷⁸

Beginning in 2002, Signal intensified collaboration with TsNIRTI and KNIRTI (likely as part of a refurbishment effort begun in 1999), and in 2012 it was formally subsumed into the KRET infrastructure as part of the conglomerate's broader consolidation.²⁷⁹ As of 2023, Signal's authorized capital was reportedly 263 million rubles (\$3.1 million at that time), with net assets valued at 7 billion rubles (\$82.60 million), and 2022 revenue reaching 7.5 billion rubles (\$111 million in 2022).²⁸⁰ Less than a year before the launch of the full-scale invasion, a state-aligned outlet claimed that Signal was experiencing annual production growth of around 60 percent.²⁸¹

In the post-invasion period, 2025 was reportedly a record year for Signal, which saw a 62 percent increase in production, along with a 36 percent increase over 2024's standard hours worked. The firm also claimed to have hired roughly 800 people that year alone (an increase equivalent to nearly half of its 2021 workforce of about 1,700), underlining efforts to expand output for the war in Ukraine.²⁸²

Post-2022 Performance

In terms of wartime production of specific EW systems, Russian government-aligned sources paint an imprecise, yet optimistic picture. One challenge of interpreting potential output of EW systems is a lack of consistency when it comes to terminology: Is output measured in units of EW systems, integrated systems, more portable systems, or larger EW complexes combining different systems? The 2026 IISS annual *Military Balance* reports that the Russian military fields five EW brigades (combat support for the Russian army), eight Mi-8 Hip J helicopters, three Il-22PP Mute aircraft, and roughly sixteen Mi-8MTPR-1 helicopters. Additionally, the Russian military districts—including Moscow, Central, Southern, and Eastern—maintain their own EW brigades in peacetime. At full strength, these formations likely comprise hundreds of personnel and operate major EW systems, such as the Krasukha, Leer, Moskva, or Murmansk complexes, while smaller EW companies attached to maneuver brigades typically consist of roughly 100 personnel operating lighter systems.²⁸³ However, while estimates like IISS's are useful, self-protection EW systems are embedded across a wide range of Russian air and naval assets, including those not primarily designed for EMSO. For this reason, Russia's overall EW capacity should be much larger than the number of high-end systems employed by dedicated EW units.

Official assessments of total EW systems output differ. According to a statement from Putin, production of communications and EW equipment increased 12.5-fold between 2022 and 2025.²⁸⁴ Meanwhile, visually confirmed losses of Russian EW systems in Ukraine between February 2022 and March 1, 2026, included around 119 radar systems and 95 jamming and electronic deception systems, according to Oryx.²⁸⁵ The OSINT site identifies six destroyed or damaged Mi-8MTPR-1 helicopters (Rychag), one captured Krasukha-4 complex, and one destroyed Rtut-BM system.²⁸⁶ Furthermore, the 172 destroyed, damaged, or captured Russian helicopters, along with 184 destroyed or damaged fixed-wing aircraft, were all likely armed with their own EW defenses.²⁸⁷ Losses, reconstitution, and the growing importance of EW on the battlefield incentivize Russia to increase its levels of production.

At the high end of production assessments is a December 2025 statement from Defense Minister Belousov, in which he reported that in 2025 alone, over 130,000 EW systems had been delivered to the front lines—6.5 times more than in 2024.²⁸⁸ Belousov’s statement included a specific reference to so-called “trench” EW systems—smaller, more mobile EW systems that can be operated and transported far more easily than the larger, more powerful, legacy land and air systems that have earned KRET its reputation.²⁸⁹ This shift reflects a purportedly broader dynamic emerging across contemporary militaries, where EW systems are becoming smaller, more portable, and more distributed across ground and naval forces.²⁹⁰ While the relationship between KRET and the firms producing these systems remains unclear, given the conglomerate’s dominance of the Russian EW market, it is likely there is a degree of overlap between these smaller firms and some of KRET’s own subsidiaries, perhaps as subcontractors. It remains to be seen whether these smaller producers will ultimately be subsumed into KRET’s existing holdings.

Since 2022, KRET has engaged in technical iteration in response to battlefield needs. In March 2024, Rostec announced that the Signal plant, based on the request of frontline soldiers, had upgraded a remote-controlled platform armed with a 7.62 mm tank machine gun. The same press release noted that the Signal plant had developed this prototype within two months of completing customer consultations and had delivered several systems to the front in coordination with the Union of Machinebuilders of Russia (see below).²⁹¹ The question remains as to whether these innovations can be produced at scale. So far, despite battlefield adaptation, neither Russia nor Ukraine has achieved electromagnetic dominance over four years of war.²⁹²

With UAVs now among the most critical offensive systems for both militaries, expanding EW capabilities to detect, jam, and disable them has become paramount.²⁹³ Russian leadership has publicly identified the replenishment and modernization of EW assets as a priority of its broader military reconstitution effort, while Lithuanian intelligence has recently confirmed continued Russian efforts to improve EW capability, particularly in terms of drone detection and active jamming based on battlefield lessons.²⁹⁴ In response, a growing range of counter-UAV systems have emerged. Ukrainian sources report that some Russian drones are now being outfitted with their own jamming technology to detect and scramble the video feeds of Ukrainian interceptor drones.²⁹⁵

In 2023, KRET premiered a new modernized version of its 2020 Sapphire EW system, a larger complex designed specifically to jam the frequencies used by Ukrainian drones.²⁹⁶ KRET subsidiary Gradient also released the Multik, a helicopter-based EW system that is similarly designed to defend assets from drone swarms.²⁹⁷ Another KRET subsidiary, Kvant, has expanded its offering of products designed to defend armored vehicles, such as the tank-mounted Saniya system.²⁹⁸ It is possible that as the war in Ukraine and Russia’s ongoing reconstitution efforts progress, the country’s military may prioritize the production of these newer, often smaller, systems over higher-end legacy complexes that have come to define Russia’s EW profile, at least among land-based systems. This could reflect a new emphasis on using distributed offensive EW systems to protect territory, rather than individual weapons platforms.

Over the course of tactical operations, the Russian military needs to continually disrupt Ukrainian drone assets while avoiding the fratricidal jamming of its own systems—a known challenge dating back to operations in Donbas in 2014, when efforts to jam Ukrainian systems also impaired Russian equipment.²⁹⁹ With Ukraine facing the same quandary, what emerges is a contest across the electromagnetic spectrum, where both sides continually shift frequencies to protect their own systems’ navigation and communications, while trying to disrupt those of the opponent.³⁰⁰ The ongoing effort to further integrate existing automation technologies and artificial intelligence into EW systems could further accelerate the pace and complexity of this high-frequency contest, with the potential for a significant battlefield edge accruing to the party able to master them.³⁰¹ While falling behind in the frontier AI race, Russia is well positioned to leverage available technologies (often imported from China) for targeted military applications.³⁰² Already in the spring of 2022, Lieutenant General Yuri Lastochkin, chief of the Electronic Warfare Troops of the Russian Armed Forces, emphasized the need to integrate more autonomous systems into Russia’s EW arsenal.³⁰³

The drones EW systems are targeting are making their own advances in autonomy. Autonomous drones are designed to operate without direct communication with a pilot, eliminating the vulnerable radioelectronic link that EW seeks to sever.³⁰⁴ If this technological capacity becomes widespread on the battlefield, it could create greater challenges for the tactical execution of electronic attack—at least in terms of anti-drone defense. That being said, autonomous systems will still rely on jammable sensors to guide their decisionmaking, meaning they are unlikely to be entirely invulnerable to EW.³⁰⁵

In the post-invasion period, KRET’s EW and air defense systems, including Vitebsk (L-370)/President-S, have continued to be featured at international venues such as the World Defense Show 2024 in Riyadh.³⁰⁶ Since 2023, KRET has also marketed the aforementioned updated anti-drone Sapphire complex at defense forums highlighting Russian systems.³⁰⁷ At the same time, Russia has historically been hesitant to export its most advanced EW systems for fear of technological leakage and reverse engineering. Nevertheless, Russia has made exceptions for China and other critical partners, such as in the case of the KNITRI LOO5S Sorbsiya suite designed for certain models of Sukhoi aircraft.³⁰⁸ Chinese analysts are already studying and publishing lessons learned from the implementation of EW in Ukraine.³⁰⁹ Going forward, Chinese defense firms could seek partnerships or supplier relationships with Russian EW producers, offering investment and access to critical components sourced by China or transshipped from Western suppliers.

Going forward, Chinese defense firms could seek partnerships or supplier relationships with Russian EW producers, offering investment and access to critical components sourced by China or transshipped from Western suppliers.

Production

The following EW systems produced by KRET have all been deployed in Ukraine since the launch of the full-scale invasion in 2022, where they have been used by Russian forces—alongside other systems—for EMSO.

LAND-BASED SYSTEMS

The Krasukha family of offensive EW systems is one of the most prominent and advanced within the Russian military, first deployed in 2014 and critical to the Russian war effort in Ukraine.³¹⁰ Work on the Krasukha-2 and Krasukha-4 systems began in the 1990s, with delivery to the Russian military beginning in 2014.³¹¹ Krasukha-4 is a land-based system mounted on a four-axle KAMAZ-6910-022 vehicle and produced by the KRET subsidiary Bryansk Electromechanical Plant.³¹² The system



The Krakushka-2 EW system.

Photo: Vitaly V. Kuzmin/Wikipedia

requires four operators and consumes 30 kilowatts of power, and KRET claims it can continuously operate for 24 hours.³¹³ The complex's antenna effectively jam an opposing enemy system, such as a plane, UAV, or even a low-orbit satellite, and the system's range can extend up to a reported 250 km, supposedly providing it with the capacity to make whole sections of airspace off-limits to enemy aircraft.³¹⁴ As the space domain becomes increasingly militarized, the Krasukha's capacity to target low-orbit satellite installations could increase in tactical utility.

The Rtut-BM offensive EW system is mounted on a two-track mobility system like a battle tank, but is designed to jam the navigation and

targeting systems of incoming rockets and artillery.³¹⁵ Two service personnel are required to operate the system, and its continuous operation time is advertised as at least 24 hours.³¹⁶ The Rtut-BM was deployed to Donbas before the full-scale invasion.³¹⁷

The Moskva-1 is designed for electronic reconnaissance and the coordination of multiple EW systems across wide swaths of territory.³¹⁸ Purportedly, the system can track up to 80 different air routes and process up to 60 airborne radio sources.³¹⁹ By triangulating off of existing radio signals in a given area, the system provides electronic support by tracking enemy systems that can then be eliminated by complementary Russian forces.³²⁰ The Moskva-1 is mounted on a KAMAZ-6350 vehicle and requires four service personnel to operate it.³²¹

AIRBORNE SYSTEMS

The Khibiny system is one of the main EW self-protection systems that defends Russia's fighter jets, including the Su-34 and Su-35 models, against both anti-aircraft and air-to-air missiles.³²² Designed by KNIRTI and produced by Signal, the system consists of two modules, one for each wing of an

aircraft, in addition to a central module carried on the aircraft.³²³ One module receives the incoming signal from an enemy weapon system, communicates that signal to the central module, and then the other module transmits a distorted version of these signals back at the enemy, thereby jamming and confusing its targeting capacity.³²⁴

Russian military helicopters also have been outfitted with offensive EW systems used to attack Ukrainian electromagnetic defenses. The Mi-8MTPR-1 is Russia's primary operational EW helicopter, integrating the Rychag-AV electronic warfare suite developed by KNIRTI into the Mi-8 platform produced by Kazan Helicopters.³²⁵ The Rychag system was preceded by an older variant, the Smalta, which is produced by the Signal plant and still in use on Russian aircraft.³²⁶ Also known as the Rychag-AV, the system is built into a modified version of the Mi-8MTV-5-1 helicopter produced by the Kazan Helicopters plant, armed with a KRET-produced LI87AE jamming system. KRET claims that the system only requires a single operator and can simultaneously suppress up to eight different enemy electronic systems.³²⁷ The operator, sitting outside the helicopter's cabin, has access to an intuitive graphic interface at the control panel that assists the operator to make adjustments to the system's settings in real time.³²⁸ Social media footage confirms the deployment of these aircraft in Ukraine since 2022, where they reportedly fly at an altitude of over 10,000 feet to avoid being hit by enemy ground fire, while still suppressing Ukrainian SAMs by jamming their radar controls.³²⁹ The helicopters can also defend Russian ground troops by scrambling the radars of Ukrainian aircraft.³³⁰

Another KRET product installed on Russian military helicopters is the self-protection Vitebsk system, which can also be found on fixed-wing aircraft and whose export variant is known as the President-S.³³¹ They are designed to defend against the Western missile systems, like the Stinger, that NATO states have delivered to Ukraine.³³² The President-S originally debuted at the Aero India exhibition in 2015, where its laser technology and radar and heat decoy deployment system were highlighted, and was sold to Belarus, Algeria, and Egypt.³³³ The President-S/Vitebsk system is purportedly produced by the KRET subsidiary Ekran Research Institute, based in Samara.³³⁴ Russian military video footage purports to show helicopters equipped with this EW system participating in the Russian assault on Kyiv's Hostomel airport in the early days of the 2022 invasion.³³⁵ Modifications and improvements to the Vitebsk system were informed by lessons from Russian operations in Syria in the 2010s.³³⁶

Challenges

LABOR SHORTAGES

EW producers are affected by existing manpower shortages, as the sector depends on highly skilled radio electronics engineers and operators whose training is both specialized and time intensive.

Demand for the skilled engineers needed to produce these systems remains high. Battlefield reports suggest that operator error stemming from insufficient training and experience has directly contributed to Russian troop and aircraft losses, further aggravating skilled manpower shortages.³³⁷

In response, Russia has expanded investment in EW training and research institutions. For example, in 2025 Rostec Academy included Signal in its corporate training educational modules and

site visits designed to cultivate the next generation of Russian defense industrial specialists.³³⁸ Signal also operates its own training center in partnership with the North Caucasus Federal University to prepare production workers for high-demand machine-building jobs across the Stavropol region, with capacity to produce about 500 trainees annually.³³⁹ However, it remains unclear whether these institutions can effectively integrate frontline combat experience and sustain rapid innovation cycles.

UKRAINIAN STRIKES

In July 2025, the Signal plant was targeted by Ukrainian long-range drone strikes, with two facilities reportedly hit and stockpiles of critical inputs, including CNC machine tools, potentially affected.³⁴⁰ However, the extent of the damage is unclear: While OSINT imagery confirms the strike, a September 2025 CSIS assessment shows only limited rooftop damage and evidence of firefighting, suggesting either modest impact or rapid repairs.^{II}

SANCTIONS

KRET has been under U.S. sanctions since 2014, with many of the companies under its control also having been sanctioned over time, including KNIRTI in 2019 and Signal in 2022.³⁴¹ Although sanctions have constrained direct access, KRET has seemingly adapted by restructuring its supply chains to import components that are critical for systems widely used in Ukraine like Khibiny, Vitebsk, and Krasukha. Media investigations expose KRET's reliance on a complex supply network of intermediaries to import restricted Western microelectronics via third countries such as mainland China, Hong Kong, and Turkey.³⁴²

II A CSIS review of relevant satellite imagery between December 11, 2022, and July 28, 2025, shows a very small potential hole on the roof of one of the Signal plant's buildings. If this damage was the result of a UAV strike, the UAV must have carried a very small warhead that produced, at most, only minor damage.

Kalashnikov

Synopsis

Kalashnikov, which emerged from the merger of the Soviet-era Izhevsk Machine-Building and Izhevsk Mechanical plants, struggled after the Soviet Union's collapse under heavy debt, fragmented corporate structures, and underutilized production capacity before being restructured in the 2010s under Rostec into a vertically integrated defense conglomerate spanning small arms, precision-guided munitions, optics, machine tools, and battlefield equipment. As part of this diversification, in the mid-2010s, Kalashnikov expanded into UAVs through acquisitions of companies such as ZALA Aero.

Since 2022, Kalashnikov has undergone rapid wartime expansion, with military output reportedly rising by 40-50 percent annually across key production categories, including assault rifles and guided artillery shells. The concern significantly expanded UAV production through new facilities and the repurposing of commercial retail space into drone manufacturing sites, accompanied by infrastructure growth and workforce expansion. Kalashnikov's partnerships with grassroots initiatives such as Ushkuynik and Project Archangel also illustrate the process of consolidation of Russia's wartime drone ecosystem under the oversight of a major state defense contractor. Battlefield adaptation drove repeated redesigns of systems such as the AK-12 assault rifle and the Lancet drone, alongside growing integration of AI-enabled targeting into UAVs as part of efforts to develop integrated "kill chains." Civilian production and dual-use activities created a mutually reinforcing dynamic, where commercial production bolstered manufacturing capacity, engineering expertise, experimentation, and operational learning. Kalashnikov further adapted its export

strategy by shifting marketing toward combat-tested UAVs, loitering munitions, and precision-strike systems aimed primarily at Global South countries.

However, major weaknesses remain, namely labor shortages, corruption, and persistent dependence on Western-made components. While Kalashnikov has adapted by building networks of intermediary suppliers operating through third countries, sanctions continue to complicate production and supply chain stability. In the coming years, Kalashnikov will likely continue to expand loitering munitions and ISR UAV output, while integrating AI-enabled targeting into reconnaissance-strike systems.

Background

Kalashnikov is an old, established defense firm with a worldwide reputation for producing assault rifles and other small arms. The modern Kalashnikov Concern was established on the basis of the Izhevsk Machine-Building Plant (Izhmash) in 2013. Located in the capital of modern Russia's Udmurt Republic and founded by decree of Tsar Alexander I in the early nineteenth century, Izhmash became particularly known in the Soviet era as the largest firearms producer. During World War II, its output was vital to Soviet defense: Izhmash produced 11.3 million rifles and carbines, allegedly more than all German factories combined (10.3 million).³⁴³

Similar to many other Russian defense manufacturers, Izhmash was significantly affected by the collapse of the Soviet Union and was unable to fully recover. By the early 2010s, Izhmash was heavily indebted and operating at a loss, burdened by a fragmented structure of 32 legal entities that generated high overhead and duplication. By 2010, net losses reached 1.7 billion rubles (\$55.93 million in 2010), and by 2011, financial liabilities rose to about 19 billion rubles (\$647.9 million in 2011), with just 20 percent of Izhmash's Soviet-era equipment being utilized.³⁴⁴ Rostec then initiated restructuring, culminating in the August 2013 merger of Izhmash and Izhevsk Mechanical Plant (Izhmekh) into Kalashnikov. Izhmash constitutes Kalashnikov's legal and industrial core, as the Soviet assault-rifle production site and the primary manufacturer of AK-series rifles, sniper rifles, and military small arms. Izhmekh is a mechanical plant that specializes in the production of precision components, machining, and metallurgy.³⁴⁵

Following restructuring under Rostec, Kalashnikov's output and financial performance improved rapidly, with some small arms exported to the United States prior to the tightening of sanctions.³⁴⁶ From 2014 to 2019, the concern's revenues expanded more than 10-fold, reaching nearly 36 billion rubles (\$556 million) by 2019, reflecting rapid expansion.³⁴⁷ In 2020, the last year for which full revenues are available in open sources, revenue declined to 30 billion rubles (\$417 million), likely impacted by the Covid-19 pandemic.³⁴⁸ Following a series of post-2022 state regulations restricting the publication of sanctions-sensitive information, Kalashnikov significantly reduced the scope of its financial disclosure.³⁴⁹

Organizational Structure

While Kalashnikov used to be primarily associated with small arms, its production recently expanded to include a multi-sector element of the Russian military industrial complex, including

missiles, UAVs, and guided-artillery munitions.³⁵⁰ Today, Kalashnikov Concern employs over 18,000 people and spans nearly 40 companies, encompassing major weapons producers alongside a set of smaller firms, including component suppliers, production support, and defense distribution and logistics providers.³⁵¹ The structure also includes the Kalashnikov Industrial Cluster, a specialized organizational vehicle designed to bring together contractors, suppliers, and tech developers in a coordinated industrial network.³⁵² Through vertical integration that unraveled over the years, Kalashnikov's structure came to mirror the three-tiered Soviet military industrial system: (1) design bureaus, responsible for concept development, prototyping, and testing (e.g., ZALA Aero in unmanned systems, the newer "G.K. Tikhiiye Krylia" specializing in vertical take-off and landing platforms, and KB LUGGAR in advanced optical systems); (2) research and engineering institutes focused on subsystem development and system integration (e.g., TsNIITochMash and NII Stali); and (3) production plants responsible for serial manufacturing (e.g., NPO IzhBS, Izhmash, the Mytishchi Machine-Building Plant, Vympel Shipyard, and the Nobel Brothers Shipyard). Selected subsidiaries are discussed below.

In February 2015, Kalashnikov acquired ZALA Aero Group ("ZALA") to expand into the UAV sector. ZALA, which is also headquartered in Izhevsk, focuses on drone design, while the Scientific and Production Association Izhevsk Unmanned Systems (NPO IzhBS) enables scaling through production.³⁵³ Together, they broadened Kalashnikov's portfolio to include civilian monitoring systems, reconnaissance drones, ISR systems, and loitering munitions.³⁵⁴ Today, ZALA is one of the leading companies in Russia's defense industry producing AI-enabled systems. Its key advantage is a dual-use model: By securing contracts across both military and civilian agencies, including the defense ministry (enabled by its integration into Kalashnikov), transportation and infrastructure, emergency situations, and law enforcement ministries, ZALA's drones have been deployed both on the battlefield and in civilian roles, such as monitoring critical infrastructure (e.g., oil pipelines). This process has generated large, diverse datasets across varied environments, strengthening software performance, accelerating innovation, and improving transferability to combat settings.³⁵⁵ For example, the AI supporting ZALA's military drones appears to rely on the same software architecture used in its civilian drones.³⁵⁶ With ZALA Aero Group and NPO IzhBS located in Izhevsk, UAV production has expanded within the city's broader defense industrial base, which over time has developed into a drone hub alongside other major enterprises such as the Almaz-Antey-owned Kupol discussed above.³⁵⁷

In 2016, Kalashnikov acquired Mytishchi Machine-Building Plant, a legacy Soviet plant focusing on transport engineering and tracked platforms. Tracked and wheeled chassis manufactured by the plant are used in major Russian weapons systems like the Almaz-Antey-produced Buk-M3 and Tor-M2 air defense missile systems and the S-300V4 SAM system.³⁵⁸ This signals a degree of codependency between different Russian defense conglomerates, with disruptions to production in one company potentially impacting production at another company.

Kalashnikov's diversification extends beyond weapons into the broader battlefield equipment ecosystem. In 2018, the concern integrated Triada-TKO (formerly Group 99) as a subsidiary specializing in tactical clothing, body armor, and combat gear.³⁵⁹ It produces soldier equipment

systems, like the Strelak combat gear set, VKPO 3.0 all-season uniforms (the recent iteration of the Russian military's modular layered clothing system), and modular load-bearing systems, which are supplied directly to the MOD.³⁶⁰ In 2024, Kalashnikov delivered about 400,000 sets of VKPO 3.0 uniforms.³⁶¹

Kalashnikov is among the major defense companies expanding cooperation with grassroots initiatives and private enterprises. Under its CEO Alan Lushnikov, Kalashnikov has invested in "People's VPK," a Russian volunteer movement focused on developing and supplying weapons for the Ukraine war to harness rapid, frontline-driven innovation. In 2025, it signed a cooperation deal with Ushkuynik, the producer of the KVN fiber-optic drone and other UAVs (see below), and with Project Archangel, a major volunteer drone training organization founded in 2022 by entrepreneur Mikhail Filippov. Project Archangel has grown into a nationwide network with training centers across 20 Russian cities and occupied Ukrainian territories, preparing thousands of servicemen and civilians for MOD contracts through two- to three-month courses.³⁶² Beyond supplementing state training, Project Archangel creates parallel pipelines that rapidly absorb battlefield lessons and translate them into technological adaptation and structured instruction.³⁶³ The partnership tasks Kalashnikov with identifying systems developed and tested by Project Archangel to scale up their production and support operator and instructor preparation.³⁶⁴ Both parties also plan to launch joint training programs for drone operators and instructors, covering systems produced by Kalashnikov and other manufacturers.³⁶⁵ Such arrangements reflect the MOD's effort to bring key Peoples' VPK initiatives under state oversight to avoid the emergence of independent weapons production outside formal control.

Post-2022 Performance

Since 2022, Kalashnikov has rapidly expanded production: Output reportedly rose about 40 percent in 2022 (described as a 20-year record high) and 45 percent in 2023 in military categories, followed by roughly 50 percent year-on-year growth in the first half of 2024 alongside production line modernization.³⁶⁶ Growth continued into 2025, with combined military and civilian output increasing by about 50 percent year-on-year in the first half of the year.³⁶⁷ Financial indicators mirror this trend: Revenue in the first 10 months of 2024 exceeded total 2023 revenue by nearly 15 percent and rose by 52 percent year-on-year in the first half of 2025.³⁶⁸ One of the key subsidiaries, Izhmekh, reported a 58 percent revenue increase in the first half of 2025.³⁶⁹

Civilian small arms production expanded alongside military output. As of 2022, civilian products accounted for 21 percent of company revenue, helping support liquidity and balance sheet stability.³⁷⁰ Civilian arms output reportedly grew by 50 percent in 2024, while the concern reportedly exceeded its planned civilian small arms shipments and reported record revenues from military and civilian small arms sales, surpassing levels seen over the previous decade.³⁷¹ This civilian production also reinforces military manufacturing: Just as ZALA's dual-use model leverages broad operational datasets from commercial infrastructure to improve military drone systems like Lancet, Kalashnikov's civilian and military rifle production relies on overlapping platforms and shared manufacturing infrastructure.³⁷²

This trajectory has translated into spatial and organizational expansion. In May 2023, Kalashnikov established a dedicated division for the production of loitering munitions and related systems at its primary production site in Izhevsk, aiming to achieve a 10-fold increase in drone production by 2024.³⁷³ Regional reporting from September 2025 also indicated plans to launch up to eight large-scale investment projects at its Izhevsk production site.³⁷⁴

To explore these developments, CSIS tracked indicators of potential production expansion at Kalashnikov's production site in Izhevsk (see Figures 2a, 2b, and 2c). By comparing satellite imagery from July 21, 2022, and April 5, 2026, CSIS identified areas of new construction absent in the 2022 baseline imagery (see area overlaid in white, Figure 2a). For instance, in the central-west section of the facility, there is an approximately 1,100 square meter building, consistent with a specialized workshop or engineering support function, along with approximately 1.7 square kilometers of grading and the addition of roughly 10 small buildings (none exceeding 1,440 square meters), consistent with distributed light manufacturing or modular assembly use (see Figure 2b).³⁷⁵ Immediately south of these developments are an approximately 22,500 square meter dirt parking area and sand pit, which are graded but have not yet been further developed. And finally, in the southwest section of the facility, there is an approximately 1.4 square kilometer developed area where construction was completed on a large, approximately 14,270 square meter warehouse and shipping building and four smaller buildings, which could be used as a final assembly and distribution hub (see Figure 2c).

Figure 2a: Infrastructure Developments at Kalashnikov Zavod, 2026



Copyright © 2026 CNES. Image may not be republished without permission. Please contact imagery@csis.org.

Figure 2b: Infrastructure Developments at Kalashnikov Zavod, 2026



Copyright © 2026 CNES. Image may not be republished without permission. Please contact imagery@csis.org.

Figure 2c: Infrastructure Developments at Kalashnikov Zavod, 2026



Copyright © 2026 CNES. Image may not be republished without permission. Please contact imagery@csis.org.

Besides its Izhevsk production site, Kalashnikov has expanded UAV production in part by repurposing commercial retail space into manufacturing facilities. For instance, in Izhevsk, at least three shopping malls were repurposed by firms linked to the Kalashnikov-ZALA ecosystem: In 2023, ZALA Aero Group repurposed the Italmas shopping mall into a drone production facility (including for Lancet loitering munitions); a ZALA-linked firm, Aeroscan, acquired the city's Stolitsa mall for similar purposes; and later that year, NPO IzhBS took over another retail site (Novy Dom) to support UAV assembly, reportedly including Granat-type systems.³⁷⁶ Similar practices have spread geographically: By 2024-2025, affiliated UAV producers (e.g., Supercam within the Unmanned Systems group) began converting retail space in other regions, such as Ryazan.³⁷⁷

Along with repurposing commercial retail space, Kalashnikov has also pursued purpose-built expansion. For example, in April 2025, it opened a new high-tech production complex covering 34,000 square meters in Moscow's Technopolis Special Economic Zone (Pechatniki); the complex is focused on electronics and advanced manufacturing and is expected to create roughly 1,000 high-tech jobs.³⁷⁸

Production

SMALL ARMS

Kalashnikov accounts for around 95 percent of Russia's output of machine guns, sniper rifles, pistols, and other handheld firearms, making it the backbone of the country's weapons supply.³⁷⁹ In terms of total production size, in 2014, Kalashnikov reported doubling production to 120,000-150,000 units.³⁸⁰ In 2019, the MOD signed a three-year contract with Kalashnikov for the delivery of 150,000 AK-12 and AK-15 assault rifles.³⁸¹ Although official production figures have not been publicly disclosed since 2022, available indicators suggest significant expansion. For example, Kalashnikov reportedly increased small arms production by 40 percent in 2022.³⁸² According to military analyst Pavel Luzin, while the company continues to produce large volumes of machine guns, Russia already possesses sufficient stockpiles for decades. For this reason, he argues that tracking exact output is of limited analytical value.³⁸³

The war in Ukraine has enabled faster feedback loops between frontline units and manufacturers. The Russian army continues to rely heavily on legacy AK-74 rifles while the AK-12 remains in production.³⁸⁴ In the post-2022 period, Kalashnikov has continuously updated and redesigned its AK-12 assault rifle based on combat feedback, including finding ways to speed up firing and give soldiers more control over firing modes.³⁸⁵ In early 2026, Kalashnikov shipped the first batch of its AK-12K (5.45 mm) carbine and the 9 mm PPK-20 submachine gun, both modified based on combat experience from the war in Ukraine.³⁸⁶

LOITERING MUNITIONS AND ACCOMPANYING SYSTEMS

Besides traditional small arms, Kalashnikov foresaw the growing role of unmanned systems earlier than many competitors and now fields one of Russia's most effective drone-based strike complexes, combining ZALA's reconnaissance UAVs and its Lancet loitering munitions. Its development began



Kalashnikov's presentation of a new variant of the AK-12 assault rifle family at the Patriot Park in Kubinka, Russia, in August 2020.

Photo: Mikhail Svetlov/Getty Images

in the early 2010s, with key systems entering production around 2019, a few years after Kalashnikov's acquisition of ZALA.³⁸⁷

Kalashnikov occupies a niche position within Russia's drone ecosystem: While the company leads in producing higher-end loitering munitions and has expanded into first-person view (FPV) drone production, it accounts for a relatively small share of total drone output dominated by cheap mass-produced FPV and Shahed-type systems. ZALA-developed platforms span several UAV categories within a reconnaissance-strike architecture that combines real-time surveillance with precision targeting. At its core are ISR drones like the Supercam family (e.g., S350 and 350M) and the SKAT-350M, the Granat series used for

artillery spotting, and the portable Tachyon system for frontline surveillance, which identify and track targets and then cue loitering munitions, such as Lancet and KUB, to strike.³⁸⁸

More advanced systems continue to emerge. In February 2026, Kalashnikov presented updated KUB-10ME loitering munitions with an extended range (over 100 km) and improved resistance to EW and air defenses, alongside onboard targeting capabilities.³⁸⁹ Other systems, such as the Rus-PE loitering munition, reportedly incorporate AI-assisted target recognition, although the extent of autonomy is unclear.³⁹⁰ The Lancet also underwent multiple upgrades, including enhanced sensors, imaging, target detection, and lock-on in poor visibility and adverse weather. Its neural networks appear to have been retrained on larger, higher-quality datasets. These improvements enable more precise target recognition and refined terminal guidance.³⁹¹ Kalashnikov's CEO Alan Lushnikov's appointment in late 2025 as chairman of the Digitalization Committee at the League for Support to Defense Enterprises, where he is involved in advancing digitalization initiatives across the defense sector, further signals Kalashnikov's focus on applied AI and integration into Russia's wartime industrial coordination and may also reflect its growing role in linking with the People's VPK (see below).

The ultimate goal appears to be an integrated "kill chain," where Kalashnikov-linked platforms cover reconnaissance, targeting, and strike functions.³⁹² Already, ISR drones like the SKAT-350M and Supercam pair with loitering munitions, including the Lancet and KUB series, which combine target detection and strike. Kalashnikov has expanded this segment by scaling production and adding manufacturing capacity.³⁹³

Despite expanded production capacity (a reported 10-fold increase in the production of Granat-4 and KUB drones in 2024), Kalashnikov's drone output remains modest relative to mass-produced systems like Shahed-type drones, which are expected to reach 60,000 units at maximum capacity



Ukraine presents the remains of the ZALA Lancet UAV during the exhibition “Evidence of Crimes” in front of the European Parliament in Brussels, Belgium, in March 2024.

Photo: Thierry Monasse/Getty Images

by 2026.³⁹⁴ The discrepancy in scale of production is likely due to unit cost, which in the case of the Lancet allegedly nears about 3 million rubles (\$30,000 as of early 2025).³⁹⁵ For example, verified OSINT data confirms 2,500 Lancet strikes as of November 2024, reaching 3,000 by early 2025.³⁹⁶ This surge aligns with reporting from the *Kyiv Independent*, which found that ZALA earned nearly \$90 million in the first quarter of 2024 alone in supplies sold to the Russian army and other armed formations.³⁹⁷ According to the Ukrainian Air Force, Russia had used around 7,000 Lancet drones against Ukraine by early November 2024; separately, LostArmour had visually documented more than 4,800 Lancet strikes by July 2026.³⁹⁸ According to defense researcher Federico Borsari, by the end of

2026 this figure could potentially double to 10,000–15,000.³⁹⁹

In parallel, Kalashnikov has expanded into FPV drones, developing lower-cost, operator-guided strike systems that complement more advanced loitering munitions. In September 2025, it showcased the Arbalet FPV drone equipped with a Kalashnikov AKS-74U assault rifle and a 30-round magazine.⁴⁰⁰ Other tactical drones include the Goliath 2.0 and Karakurt 2.0 quadcopters, designed for reconnaissance and target acquisition; following their presentation in early 2026, Kalashnikov reported transitioning to serial production.⁴⁰¹

Since 2022, Kalashnikov’s displays at international exhibits . . . have increasingly emphasized UAVs and loitering munitions, reflecting a shift in its product mix and market demand.

Since 2022, Kalashnikov’s displays at international exhibits (in Azerbaijan, Malaysia, Saudi Arabia, South Africa, the United Arab Emirates, and Vietnam) have increasingly emphasized UAVs and loitering munitions, reflecting a shift in its product mix and market demand.⁴⁰² Kalashnikov has showcased systems such as the KUB and Lancet series and reconnaissance platforms like the SKAT-350M. That these systems are repeatedly featured in Global South exhibits suggests that local customers are prioritizing cost-effective precision strike and reconnaissance capabilities, shaped by lessons from Ukraine. In May 2026, reports emerged that Russia expects to sign contracts with several African and Middle Eastern countries to supply the Lancet-E loitering munition by late 2026.⁴⁰³ In June 2026, Kalashnikov also announced that it was in advanced negotiations with an Indian partner

to supply anti-drone cartridges and eventually localize their production in India, while promoting its battlefield-tested anti-drone shotguns, and signed a contract to supply Karakurt civilian copter-type UAVs to an Indian partner.⁴⁰⁴ Kalashnikov also reportedly plans to compete for India's military UAV procurement program with its Garuda (SKAT 350M) reconnaissance drone, including the localization of production in partnership with an Indian company.⁴⁰⁵

In parallel, Kalashnikov has experimented with counter-UAV solutions, such as ZALA-linked anti-drone rifle concepts, and adaptations of the MP-155 semi-automatic shotgun platform for short-range drone defenses.⁴⁰⁶ Those were reportedly supplied to Russian units operating at the front, reflecting the growing demand for low-cost, short-range anti-drone solutions. In April 2026, Kalashnikov also announced preliminary trials of Krona, a short-range anti-aircraft missile system for territorial air defense.⁴⁰⁷

Beyond UAVs, Kalashnikov has expanded into high-precision weapons. It now produces guided-artillery shells like the 122 mm Kitolov-2M.⁴⁰⁸ The company also manufactures SAMs, including the 9M333 “fire-and-forget” missiles, engineered for the Strela-10 system to intercept low-flying aircraft, cruise missiles, and drones, and recently ramped up production of helicopter-launched anti-tank missiles Vikhr-1.⁴⁰⁹

COMPONENTS

Kalashnikov's recent expansion reflects a broader push for vertical integration to reduce dependence on foreign suppliers and accelerate wartime manufacturing. It has expanded into new domains such as machine tools and optics, extending control across multiple stages of development and manufacturing.

In the post-2022 period, Kalashnikov moved to expand domestic machine tool capacity within its own facilities to limit reliance on foreign equipment. Its output includes conventional and high-precision CNC lathes used to produce components for systems such as guided munitions and UAV support equipment, including the 250ITVM series (a high-precision turning center for metalworking applications in defense and industrial production).⁴¹⁰ In 2023, Kalashnikov produced 126 total machine tools, including 48 units of 250ITVM.⁴¹¹ Output of the 250ITVM increased in 2024 and rose by a further 10 percent in 2025, likely resulting in 55-75 units produced annually (for reference, Russia manufactured over 11,000 machine tools in 2024).⁴¹² In 2025, Kalashnikov also presented the IZH VMC650CNC vertical machining center and the IZH Caliber 20 Swiss-type CNC lathe (a high-precision longitudinal turning machine), positioning them as a domestic alternative to sanctioned Western precision machinery.⁴¹³ Both models were listed as “available for pre-order” in Kalashnikov's catalog, suggesting they remain in a market validation phase rather than full-scale serial production.⁴¹⁴ To date, Kalashnikov's machine tools show no evidence of large-scale deployment, and CNC output remains limited relative to leading Swiss-type (sliding-headstock) manufacturers that produce thousands of units annually.⁴¹⁵

Since 2022, Kalashnikov has sought to localize key components; this has included attempts to produce high-precision spindles to replace imports from Italy and equipping its machines with domestically built numerical control systems.⁴¹⁶ It also manufactures components for military products, including elements used in KUB loitering munition ground-launch systems.⁴¹⁷ Kalashnikov

has also expanded into optical and electro-optical technologies. To address Russia's continuing dependence on imported thermal imaging devices and components, in 2024 it integrated LOMO (Leningrad Optical-Mechanical Association), which specializes in precision optics, electro-optical systems, and night-vision equipment.⁴¹⁸

Challenges

LABOR SHORTAGES

In 2023, Kalashnikov reported an ambitious five-year plan to attract 20,000 additional employees, including 2,000 employees that year alone.⁴¹⁹ Between 2024 and early 2025, around 1,000 new jobs were created through the commissioning of a missile and ammunition manufacturing cluster and a separate high-precision-guided weapons facility on the Izhevsk production site.⁴²⁰ However, in 2024, Managing Director Andrey Baryshnikov flagged that the half-year production plan was met “under partial staff deficit.”⁴²¹ Regional reporting and hiring websites show hundreds of open positions.⁴²²

Labor shortages are forcing Kalashnikov to resort to unconventional recruitment strategies to sustain output. These include hiring personnel from Russia's other regions; recruiting schoolchildren for summer jobs in factory training programs offering stipends of roughly \$300 per month (including for roles such as milling machine operators, locksmiths, and foundry workers); and conducting targeted hiring campaigns aimed at war veterans and their families.⁴²³ Kalashnikov reports that more than 1,800 people have been trained in blue-collar professions through its Industrial Training School since its launch between 2023 and early 2025.⁴²⁴

Kalashnikov also supports youth engineering competitions, drone development programs, and external innovation initiatives, reflecting its growing emphasis on UAVs and advanced technologies.⁴²⁵ In September 2019, the concern established the Kalashnikov Academy Youth Technopark in Izhevsk, a specialized training center providing advanced engineering education to students aged 14-18; the opening ceremony was attended by Vladimir Putin.⁴²⁶ The academy focuses on several core high-tech tracks: robotics, neurotechnology and AI, UAV design and piloting, IT, satellite and space systems, and industrial design (including 3D modeling and prototyping). It aims to cultivate a pipeline of engineers and developers for Russia's military industrial complex.⁴²⁷ In 2025, the academy reported that over 500 teenagers had completed training across multiple tracks, while a similar number enrolled for the new academic year.⁴²⁸

CORRUPTION

Corruption, which remains among the key factors undermining production standards, is apparently so pervasive that Kalashnikov set up a direct hotline to report signs of embezzlement and corruption.⁴²⁹

Recent years have seen a rise in corruption prosecutions of senior and mid-level managers. For example, in February 2026, a Moscow court arrested Ksenia Grashchenkova, the company's former director of procurement and logistics, on embezzlement charges; the following month, her former deputy director for procurement and logistics was detained on related charges.⁴³⁰ According to the case, contractors allegedly replaced high-quality Russian components with cheaper and

lower-quality Chinese equivalents, which were reportedly smuggled into Russia disguised as ordinary hardware, directly jeopardizing the quality of modernized AK-12 rifles.⁴³¹ Separate but related proceedings against former Kalashnikov employees for large-scale fraud and commercial bribery in supply contracts for the defense ministry are also ongoing.⁴³²

FOREIGN COMPONENT DEPENDENCIES

Dependencies on foreign components remain pronounced. For example, Kalashnikov operates foreign-produced CNC machine tools, including Japanese (Okuma) and German (INDEX) systems identified at its facilities.⁴³³ Russia's machine tools used to manufacture Russian CNC equipment are themselves relying on components sourced from the United States, Europe, Japan, and Taiwan.⁴³⁴ For example, Kalashnikov uses components produced by CNC Sinumerik (Siemens) and FlexKraft (KraftPowercon) that are critical for automating machine tools used to produce high-precision components across defense manufacturing, including aerospace-grade and weapons-related systems.⁴³⁵

The same issue applies to UAVs. In 2025, ZALA proudly reported that its “cascade principle” (coordinating across a network of actors without fully owning them) enabled nearly 95 percent localization.⁴³⁶ In practice, however, this model often relies on shell companies or third-party distributors (often via platforms like Alibaba) to access dual-use Western electronics while bypassing traditional bottlenecks.⁴³⁷ Once incorporated into higher-level assemblies, these components are reclassified as part of a “localized” Russian-made module, allowing ZALA to report them as Russian-made. Indeed, open-source investigations of its Lancet loitering munitions show that they rely on at least 50-60 individual Western-made components, particularly in flight control, AI-driven targeting, and navigation (including NVIDIA Jetson modules for AI, Xilinx/AMD chips for processing, and u-blox navigation components) from companies headquartered in the United States, Switzerland, and the Czech Republic.⁴³⁸ These components enable the Lancet-3's advanced targeting and guidance capabilities that it would not otherwise have.⁴³⁹ Import data further indicate that ZALA-linked firms have sourced motors, microelectronics, carbon fiber products, aluminum components, and navigation modules, worth millions of dollars altogether, through Chinese and Hong Kong suppliers.⁴⁴⁰ These components are typically acquired through intermediary networks and are often purchased using cryptocurrency to circumvent sanctions.⁴⁴¹

SANCTIONS

Nevertheless, sanctions are constraining Kalashnikov's production. Leaked reporting indicates that, in 2023, a UAV manufacturer linked to NPO IzhBS failed to fulfill an MOD contract for Granat-4 systems, reportedly due to the impact of European sanctions and shortages of critical components.⁴⁴²

However, a 2026 Ukrainian intelligence investigation discovered that nearly half of Kalashnikov's enterprises were still unsanctioned by any member of the sanctions coalition, despite their critical role in military production. These include LLC KB “Luggar,” a developer of thermal imaging sights and laser rangefinders, and the Kalashnikov Industrial Cluster, which produces small arms, special-purpose equipment, and gear for special forces.⁴⁴³

Ushkuynik

Synopsis

Ushkuynik represents one of the most successful transitions from a self-initiated effort born outside of the typical domestic defense industrial complex into a full-fledged government-backed start-up with direct MOD and government support. Emerging from the broader “People’s VPK” ecosystem of volunteer groups, start-ups, and grassroots military innovators, Ushkuynik is a hybrid organization combining decentralized battlefield-driven innovation with formal state support and oversight. Ushkuynik’s growing cooperation with Kalashnikov reflects the incorporation of volunteer-driven wartime innovation into Russia’s formal defense industrial structure.

Following battlefield adaptation in heavily jammed environments such as Kursk, the company significantly expanded production of fiber-optic first-person view (FPV) drones and integrated training, testing, and deployment into a more centralized wartime support system. The Russian MOD appears satisfied with Ushkuynik’s role as a controlled platform through which domestic start-ups can present their solutions for potential scaling under the oversight of the MOD and the Kremlin-backed investors and coordinators. Over the next several years, Ushkuynik is poised to continue the development of relatively cheap tactical and operational-level unmanned solutions to augment the growing Russian military UAV lineup, along with rapidly designing and testing other technologies like unmanned ground vehicles and unmanned surface vehicles for military needs. However, Ushkuynik may eventually remain an exception in Russia’s “bottom-up” innovation ecosystem, as many smaller volunteer and start-up efforts launched after 2022 are likely to be

absorbed by the MOD and the larger defense industrial complex amid the state’s push for large-scale production and tighter control over how tactical weapons are designed, tested, and fielded.

At the same time, Ushkuynik still suffers from many of the same problems that haunt the rest of the industry. In particular, dependence on imported microelectronics and optics through the use of intermediary supply chains remains significant despite ongoing localization efforts.

Background

In October 2023, Russian pro-war volunteer networks moved to institutionalize cooperation within the so-called “People’s VPK,” an ecosystem of small-scale start-ups, mid-tier manufacturers, volunteer groups, and affiliated teams developing UAV, counter-UAV, and related technologies. They envisioned a technology accelerator that would help early-stage developers rapidly prototype and test systems for the Russian MOD evaluation, while also facilitating access to military customers and navigating bureaucratic procedures related to development, testing, and procurement. This effort led to the creation of the Ushkuynik Scientific and Production Center (“Ushkuynik”). The name draws on Novgorod’s historical “ushkuyniks,” river raiders active between the twelfth and fifteenth centuries, evoking a tradition of decentralized, mobile warfare.⁴⁴⁴ The concept allegedly emerged from “Dronnitsa,” an annual gathering organized by the Coordination Center for Assisting Novorossiia (KCPN) and the government of the Novgorod region, which convenes UAV operators, engineers, volunteer groups, technical start-ups, and, increasingly, state-linked defense actors.¹

Ushkuynik is part of a broader state-supported ecosystem of research and production centers focused on unmanned systems development, testing, and evaluation.⁴⁴⁵ It operates as both a production enterprise and a technology accelerator, linking small-scale innovators (the so-called “residents”) with state programs by translating bureaucratic requirements into engineering tasks and facilitating access to federal support.⁴⁴⁶ As of mid-2025, Ushkuynik reported supporting over 40 resident teams from across Russia, overseeing dozens of UAV-related projects, and receiving more than 663 million rubles (approximately \$8.5 million in 2025) in federal and regional funding for 2024-2025.⁴⁴⁷

Ushkuynik is a state-backed institution, established by the Novgorod regional government and the federal National Technology Initiative (NTI) under Russia’s broader national project on unmanned

I The first Dronnitsa meeting in 2022 focused on establishing systematic UAV training, while the 2023 event shifted toward developing domestically produced drone and counter-drone systems for military use, after which the Ushkuynik concept reportedly took shape. By 2024, the Dronnitsa emphasis moved toward coordination between developers, state institutions, and the MOD’s end users. The fourth meeting, held on September 6-7, 2025, and organized by KCPN and Ushkuynik, reportedly drew 1,500-2,000 attendees, with discussions centered on addressing shortcomings in the volunteer and start-up ecosystem to improve the Russian war effort. See Alexander Timokhin, “Dronnitsa-2025: War and Victory in the Dead Zone,” *Military Review*, September 28, 2025, <https://en.topwar.ru/271559-dronnitsa-2025-vojna-i-pobeda-v-mertvoj-zone.html>; Alexey Chadaev, Telegram post, July 25, 2025, <https://t.me/chadaevru/3972>; ДРОННИЦА [Dronnitsa], Telegram post, September 3, 2025, <https://t.me/dronnitsa/531>; ДРОННИЦА [Dronnitsa], Telegram post, September 8, 2025, <https://t.me/dronnitsa/554>; Chadaev, Telegram post, July 25, 2025; and Alexander Timokhin, “Dronnitsa-2025: War and Victory in the Dead Zone,” *Military Review*, September 28, 2025, <https://en.topwar.ru/271559-dronnitsa-2025-vojna-i-pobeda-v-mertvoj-zone.html>.

systems.⁴⁴⁸ It also receives formal support from the Skolkovo Foundation, another state-backed innovation vehicle. Functioning partly as venture capital firms, these organizations have provided early-stage investment for Ushkuynik (though the scale remains unclear) while also offering access to the political networks associated with such sponsorship. In July 2024, Ushkuynik became the first scientific and production center of its kind to receive official accreditation from Russia's Ministry of Industry and Trade. This status provides formal state oversight, access to grants, and routine inspections by multiple security and audit bodies, enabling it to tap government resources and deepen ties with industry and government.⁴⁴⁹ From that point on, Ushkuynik became less of a "People's VPK" project, as it began, and more of a hybrid entity that combined both the start-up culture of a smaller development enterprise and the key contacts of the larger Russian state defense and procurement ecosystem, allegedly without the worst habits and excesses of both systems.

Rather than operating as an independent entity, Ushkuynik's drone production is tightly integrated into Russia's state-controlled research, development, testing, and evaluation (RDT&E) ecosystem. Ushkuynik helped create a special experimental legal regime for testing anti-UAV technologies, securing authorization from several Russian security and law enforcement agencies (including the MOD, FSB, FSO, Ministry of Internal Affairs, and National Guard) to provide security for its facilities and field testing operations. For example, procurement data indicate that in November 2024, the Novgorod Region Department for Civil Defense, Emergencies, and Fire Safety procured 50 KVN drone sets from Ushkuynik for 4.3 million rubles (roughly \$46,000 in 2024), implying an average cost of about 85,000 rubles (\$915 in 2024) per set. A follow-on contract signed in December 2025 expanded the scope to include both UAVs and associated control stations "for the needs of the special military operation and special tasks related to state defense and security" for 3.11 million rubles (\$37,320 in 2025). Applying the same per-unit cost would imply roughly 37 sets, although the actual number was likely lower given the inclusion of ground control infrastructure. Resident firms supplying the MOD operate under military acceptance procedures, with each drone assigned a unique inventory number. Ushkuynik also developed a digital tracking system that reportedly allows the Russian military to monitor drones even after delivery.⁴⁵⁰ Nonetheless, Chadaev insists on portraying the center as producing "civilian" UAVs rather than weapons, arguing that drones remain civilian products until the MOD independently equips them with munitions, and denies any involvement in manufacturing explosives or warheads.⁴⁵¹

As of December 31, 2025, Ushkuynik's total assets amounted to 1.1 billion rubles (\$13.2 million), an increase of 1.05 billion rubles (89.3 times) over the previous year, while net assets stood at 950 million rubles (\$12.4 million).⁴⁵² This surge likely reflects a low initial base, the transfer of state assets, and Ushkuynik's production scaling and infrastructure growth, fueled by intensive government support.

Organizational Structure

Officially, Ushkuynik was established at the initiative of the government of the Novgorod Region, using the INTTS "Intelligent Electronics–Valdai" organizational and industrial platform. According to public documents, the center's founders consist of four legal entities: ANO "NTI Platform,"

ANO CSASD (Center for the Promotion of Autonomous Systems and Drone Development), JSC “Management Company INTTS ‘Intelligent Electronics–Valdai,’” and the Ministry of Industry and Trade of the Novgorod Region, with Alexey Chadaev as the general director. Chadaev, a prominent advocate of the People’s VPK model, has been a central figure behind the organization’s creation and development. His career has spanned various roles in Russian regional and federal politics, and he likely leveraged contacts and relationships built during that time to help facilitate Ushkuynik’s transition from an idea into a full-fledged, financially backed organization.

Chadaev’s Ushkuynik model may offer a way forward for Russia’s People’s VPK as this ecosystem continues to design, field, and test unmanned aerial systems (UAS), counter-UAS, unmanned ground vehicles, and related technologies for the front, and as it seeks to better cooperate and possibly integrate with the Russian state enterprises. People’s VPK efforts have speed and flexibility on their side, including rapid technological development and its adaptation to frontline requirements; responsiveness to specific battlefield requests via direct communications with frontline forces; avoidance of bureaucratic procedures at various stages of self-initiated and self-financed technology R&D; decentralization of production, and experimentation with nonstandard solutions that large enterprises can sometimes ignore or are incapable of implementing given their emphasis on mid- to long-term RDT&E dedicated to legacy systems.⁴⁵³ Overall, such efforts allow the military to address critical battlefield needs more rapidly and improve combat effectiveness.⁴⁵⁴

The People’s VPK ecosystem is an unusual development in Russia, which has historically maintained a top-down approach to weapons development, and where the state has had a virtual monopoly on the entire weapons production cycle. As the invasion of Ukraine stretches into the fifth year, many People’s VPK projects and individual volunteers, who initially supported the Russian military with great enthusiasm, are showing signs of strain and fatigue, driven by the need to commit substantial personal time and resources, as well as mounting difficulties in coordinating daily activities amid government efforts to restrict access to the internet and messaging platforms such as Telegram, which are widely used for communication and coordination.⁴⁵⁵

At the same time, the Russian state and the MOD appear intent on incorporating successful volunteer and start-up initiatives, proven battlefield technologies, and capable entrepreneurs into the formal defense industrial complex. Therefore, it was not surprising that Ushkuynik signed a strategic agreement with Kalashnikov Concern in June 2025 to establish a joint venture.⁴⁵⁶ The Ushkuynik-Kalashnikov partnership represents a new model of coordination between the People’s VPK and the traditional defense sector. It combines Kalashnikov’s established ties to the state customer and experience navigating procurement processes with Ushkuynik’s capabilities in tactical UAV development, effectively linking grassroots innovation to institutionalized defense production.⁴⁵⁷ Kalashnikov’s CEO Alan Lushnikov attributed the KVN drone’s success to the collaborative environment within Ushkuynik’s research and production center, which brings together formal research institutions; civilian science initiatives; “garage”-based, DIY developers; and technical “enthusiasts,” ultimately fostering a strong development community.⁴⁵⁸ As of late March 2026, neither the Russian media nor the country’s numerous military bloggers and commentators have provided additional context for how such partnership is evolving and what

specific technologies are of interest to Kalashnikov at this point in the war, though more information may emerge as Ushkuynik's products approach participation in major international military forums and exhibitions.

The Ushkuynik-Kalashnikov partnership represents a new model of coordination between the People's VPK and the traditional defense sector. It combines Kalashnikov's established ties to the state customer and experience navigating procurement processes with Ushkuynik's capabilities in tactical UAV development, effectively linking grassroots innovation to institutionalized defense production.

Production

According to Ushkuynik and state media coverage of its activities, by June 2024, after eight months of development, the initial Ushkuynik fiber-optic drone, named "Prince Vandal Novgorodsky" (Knyaz Vandal Novgorodsky or KVN), was operating with basic reliability as a brand new drone supporting attempts to push back Ukrainian advances.⁴⁵⁹ Ushkuynik's production capabilities at the time were limited—by August 2024, it had managed to produce an initial batch of only around 200 units, well short of its original plan for at least 1,200 drones.⁴⁶⁰ However, once Ukrainian forces invaded Russia's Kursk region in the summer of 2024 and intense Ukrainian EW in the Kursk sector disabled Russian UAVs and forced rapid battlefield adaptation, Ushkuynik made a "political decision" to dispatch every KVN drone to test in that combat.⁴⁶¹ According to Chadaev, the entire initial batch of roughly 200 drones was deployed out of necessity, and the rollout was premature, with limited impact due to insufficient production scale.⁴⁶²

KVNs were effective in targeting Ukrainian forces given their resistance to EW, enabled by fiber-optic control, while widely circulated recorded footage provided proof of battlefield effectiveness that accelerated operator learning and tactical adaptation, and ultimately broader military adoption and scaling of the system. By August 2025, Ushkuynik reported that KVN drones had inflicted over \$2.08 billion in damage on Ukrainian forces.⁴⁶³ Following initial field trials in the Kursk region, Ushkuynik refined the KVN drone and scaled production. By July 2025, 18,900 video-verified launches were reported, with actual use likely higher, and monthly output in the tens of thousands.⁴⁶⁴ By late 2025, the system had undergone upgrades enabling ambush use, including extended range (50–65 km) and a dual detonation mechanism.⁴⁶⁵ Production, according to state media interviews with Chadaev, reached approximately 50,000 units per month across multiple enterprises spread out across the country.⁴⁶⁶ This drone is utilized by Russia's best UAV units and formations, including the elite Rubicon Center for Unmanned Systems.⁴⁶⁷

A key turning point, in Chadaev's account, was the August 2024 establishment of a training and technical support system for MOD operators using KVN UAVs, which enabled deployment at scale.⁴⁶⁸ He indicates that KVN systems were supplied only to units whose operators had been trained and certified by Ushkuynik, creating a controlled pipeline linking training to procurement.⁴⁶⁹ By late 2025, training had become partly decentralized: Whereas Ushkuynik had previously been the exclusive provider of KVN training for the Russian military, some branches of the armed forces (especially within the emerging Unmanned Systems Forces) began to conduct instruction internally, while Ushkuynik increasingly focused on training personnel on newer systems.⁴⁷⁰

In November 2025, Chadaev introduced a new Ushkuynik-developed reconnaissance drone, "Prince Oleg the Prophet" (Knyaz Veschi Oleg, or KVO), which is already in combat use. This particular drone is similar in design to Ukraine's Valkyrie and Fury ISR drones. The KVO has a reported range of 45 km and a high survivability rate so far, "as the Ukrainians confuse it with their own drones, though this works both ways," with Russian soldiers apparently targeting the UAV, thinking it is Ukrainian.⁴⁷¹ Ushkuynik reportedly developed the KVOs in response to heavy Ukrainian attrition of more expensive Russian ISR drones, such as those produced by ZALA Aero, aiming to create a cheaper mass-produced system with comparable performance.⁴⁷² In January 2026, upgrades to KVO were announced, including extended flight endurance of up to three and a half hours and the ability to detect and evade Ukrainian interceptor drones.⁴⁷³

In January 2026, Ushkuynik announced the development of a loitering munition with a range of over 50 km and the ability to operate in tandem with the KVN, including by relaying communications through it.⁴⁷⁴ This functionality is similar to Kalashnikov's Lancet drone, which operates in tandem with the ZALA ISR UAV.⁴⁷⁵

In March 2026, Ushkuynik unveiled a new "Knyaz Vladimir Svyatoslavich" (KVS) tactical quadcopter featuring a ring-shaped wing design. KVS's estimated range is up to 50 km with a warhead weighing up to 3 kg.⁴⁷⁶ According to numerous public sources that discussed this technical development, the ring-shaped, or closed-loop, wing design eliminates traditional wingtips and reduces the intensity of wingtip vortices, improving the drone's overall aerodynamic efficiency.⁴⁷⁷

In October 2025, Ushkuynik reported that it had allegedly tested an unmanned surface vehicle (USV)—vessels that operate autonomously or remotely on the water's surface—developed by its resident firms during the recent Dronnitsa meeting, and in December that same year the company announced its intentions to deliver fiber-optic surface and subsurface drones to the front lines in 2026.⁴⁷⁸

Still, Ushkuynik's ambitions spread further. In July 2025, Chadaev claimed that one resident company affiliated with Ushkuynik was working on an unmanned ferry designed to traverse water obstacles, a "cargo platform capable of navigating independently—moving from beacon to beacon, or from shore to shore" that is "controlled remotely via a console or external device, requiring no onboard driver."⁴⁷⁹ Another affiliated firm was working on aerostats—tethered balloons equipped with specialized instrumentation to detect long-range drones entering Russian territory "the

moment they cross the border, rather than only when they are already closing in on Moscow.”⁴⁸⁰ In February 2026, that company, Aerodrommash, launched its “Barrage” airship as a quick way to replicate part of the now-unavailable Starlink coverage. The concept was codeveloped with Bauman Moscow State Technical University under the auspices of the Foundation for Advanced Research, an organization similar to the United States’ Defense Advanced Research Projects Agency.⁴⁸¹ Barrage can potentially distribute the internet from the stratosphere, or 15-40 km above ground.⁴⁸² According to developers, Barrage can offer 5G compatibility with less customization required than for satellites.⁴⁸³

Challenges

LABOR AND SCALING CONSTRAINTS

Despite some of the Ushkuynik achievements outlined above, labor and organizational bottlenecks may still constrain future scaling and adaptation as battlefield drone use evolves.

Chadaev has recently publicly acknowledged that Russia risks falling behind Ukraine in key areas such as drone R&D and communications, calling for changes at the tactical level and in the top echelons of the MOD and the Russian government.⁴⁸⁴ Chadaev often points to the larger problems in the Russian UAV and unmanned systems R&D ecosystem, perhaps using his growing reach on different platforms such as Telegram, Youtube, and RuTube as a sounding board for topics that cannot get sufficient coverage by others who may think along the same lines. For example, in March 2026, Chadaev took to his Telegram channel to question whether Russia’s Unmanned Systems Forces are developing in the right direction, given the current challenges in Ukraine combat.⁴⁸⁵

In response to some of these challenges, Ushkuynik has expanded training around fiber-optic-controlled UAVs, such as KVN, with operator training embedded in deployment and scaling. Some reporting points to courses cosponsored with volunteer groups such as “Home Front 53” (Тыл 53), a volunteer effort that fundraises for and purchases supplies and equipment for the Russian military, and claims that roughly 100 FO-FPV crews had been trained by early 2025.⁴⁸⁶ Ushkuynik also claims to have expanded its KVN and other drone production across Russia’s regions, indicating that its efforts are adequately staffed to enable growing drone numbers, though neither Chadaev nor state media have offered additional explanation or details about the staffing and resourcing needed for such a scale.⁴⁸⁷

REGIONAL DISTRIBUTION

Ushkuynik’s production is organized based on a “franchise” model, establishing standardized assembly shops using the latest commercial and dual-use technology, including 3D printing, across multiple enterprises in at least three Russian regions to reduce vulnerability to Ukrainian strikes. Such decentralization is usually associated with coordination, management, and quality control challenges.⁴⁸⁸ However, there is less information about this particular enterprise than about some of the entities described in this report; this opaqueness is likely owed both to the novelty of Ushkuynik as an organization and to certain security measures undertaken by the enterprise and the MOD to protect key information about drone and unmanned systems development and production efforts.

FOREIGN COMPONENT DEPENDENCIES

A key issue for Russian domestic drone development and manufacturing writ large is the industry's overall dependence on imported components from the United States, the European Union, China, and other countries. Ushkuynik continues to actively source Western-produced components for its drones through intermediary supply chains, including Chinese optics and Western microelectronics used in drones such as the KVO.⁴⁸⁹ Ukrainian military intelligence recently identified thirty-three U.S. and five Swiss components in one of Ushkuynik's drones.⁴⁹⁰

Despite this reality, in January 2026, Chadaev informed TASS that imported components for KVN would be replaced by Russian-made analogs.⁴⁹¹ This may be a tall order considering that neither the quality nor volume of Russian parts and components compares to what can be sourced from China or the larger international community.

SANCTIONS

As of April 2026, Ushkuynik has been sanctioned by Ukraine, the European Union, and Switzerland, but other significant sanctions jurisdictions, including the United States, the United Kingdom, Canada, and Japan, have yet to impose similar measures.⁴⁹² Chadaev relishes the company's sanctioned status, pointing to a growing significance of his enterprise in the eyes of the “collective West” supporting Ukraine. Chadaev himself has been sanctioned by the European Union and Switzerland as of late April 2026, but he does not appear on the U.S. Office of Foreign Assets Control's Specially Designated Nationals and Blocked Persons list.⁴⁹³ Despite Chadaev's optimistic rhetoric, continued sanctions, if enforced consistently, could constrain production growth, as some Ushkuynik systems remain dependent on imported components.

Conclusion

Takeaways and Implications

Main Insights

Russia's overarching objective is to sustain its defense industry as a cornerstone of military power, national strength, and economic stability.⁴⁹⁴ Taken together, the cases of Uralvagonzavod, Almaz-Antey, KRET, Kalashnikov, and Ushkuynik—while not fully representative of the broader Russian defense industrial complex—suggest a defense industry in which wartime pressures have accelerated existing trends toward greater consolidation around major state-backed conglomerates; expanded production and its specialized workforce; and an export portfolio increasingly shifted toward newer, combat-tested equipment, especially unmanned systems. As a result, despite battlefield strain, consistent labor shortages, corruption, persistent dependence on imported components, and sanctions-induced elevated costs to acquire them, Russia is likely to sustain a high production tempo in selected categories of weapons systems while gradually rebuilding its strategic reserves.

High production tempo has been, and will likely continue to be, most pronounced for UAVs, with Russia's drone output reaching several hundreds of thousands per month, according to industry experts.⁴⁹⁵ Ukrainian Commander-in-Chief Oleksandr Syrskyi seemed to confirm this assessment in a recent statement, in which he claimed that Russia plans to build 7.3 million FPV drones alone in 2026.⁴⁹⁶ Ushkuynik's reported ability to scale manufacturing to up to 50,000 drones per month suggests that relatively modest R&D investments can generate significant battlefield effects in this sector. While Kalashnikov's production scaling remains more limited, its ZALA-designed drones illustrate the emergence of UAV-driven innovation, particularly through applied AI for more

precise target recognition and improved terminal guidance. Russia also continues to adapt on the battlefield, as evidenced by, for example, the increased use of harder-to-intercept jet-powered drones, particularly Geran variants, in 2026.⁴⁹⁷

More broadly, the Kalashnikov example could serve as a road map for other major producers, demonstrating an emerging model in which large producers retain legacy systems R&D while selectively integrating technologies developed by smaller firms and technical start-ups that appeared after 2022. Legacy Soviet firms may eventually fully absorb initiatives such as Ushkuynik and Project Archangel in one form or another, integrating more flexible approaches into the broader defense industrial complex and expanding their unmanned systems' R&D and testing roles. Whether that actually happens for Ushkuynik in particular will depend both on the course of the war and on its leadership's ability to manage relations with the broader Russian military industrial sector. Overall, while this model provides a significant scaling boost, its implications for start-up culture and responsiveness to warfighter needs are uncertain.⁴⁹⁸ Some initiatives may eventually evolve into state-backed hubs for dual-use and military innovation, particularly if the war winds down and the MOD seeks to institutionalize wartime experimentation, while others are likely to disappear.

In terms of other notable weapons systems, EW remains a strategic priority, evident in official statements, purported increases of production, ongoing battlefield adaptation—such as new systems specifically designed to jam drones—and the greater integration of automated technologies that can more efficiently scan and eliminate threats operating across the electromagnetic spectrum. These developments are closely aligned with advances in drone warfare, creating increasingly integrated and overlapping capabilities across EW and unmanned systems.

Russia's production of air defense systems also seems to have expanded since 2022. While precise numbers are not available through open-source analysis, and official Russian statements need to be treated with caution, Putin has alluded that Almaz-Antey and its subsidiaries are capable of building more SAM systems than any other country in the world.⁴⁹⁹ Western military observers and Ukrainian intelligence have also signaled that despite significant battlefield losses, Russia maintains a large arsenal of air defense systems and related equipment while continuing to produce advanced SAM systems, including Kalibr cruise and Iskander ballistic missiles.⁵⁰⁰ Performance of Russian SAM systems has also improved compared to the early stages of the war, with greater effectiveness against aircraft, drones, and Western-supplied munitions. This adaptation reflects increased operator experience, better coordination with aviation, software upgrades, and stronger EW resilience. Meanwhile, Russia has allegedly only sparingly used some of its most capable air defense systems and components (such as the S-350 missile system and more advanced missiles for the S-400 systems) in Ukraine, likely preserving them for other conflict scenarios, including with NATO.⁵⁰¹

Similar to some of its air defenses, Russia has limited frontline use of its most advanced tanks, suggesting possible contingency planning vis-à-vis NATO. However, despite a sharp workforce increase, UZV has struggled to resume new T-80 production, and its civilian output has deteriorated. The company has faced numerous lawsuits over nonpayment, shifted some

artillery production elsewhere, and showed no clear signs of major new construction at its core facilities. Taken together with battlefield lessons, this suggests that tanks are declining in priority (though Russia will likely continue to maintain strategic supplies of its more advanced MBTs and employ unmanned systems during the MBT deployment for better battlefield awareness and target spotting).⁵⁰²

Implications for NATO

Russia's defense industrial capacity creates new challenges for NATO. While Russia is intensely focused on the war in Ukraine, should the war end or fighting subside, Russia would shift its focus to reconstituting its military forces.⁵⁰³ Russian reconstitution efforts could focus on two broad scenarios: one aimed at rebuilding forces for a renewed offensive in Ukraine, and another oriented toward a possible future confrontation with NATO. Most assessments agree that Russia's current production tempo is sufficient to sustain its war effort in Ukraine but insufficient to generate the combat power needed for a broader regional challenge to NATO.⁵⁰⁴ However, if the war in Ukraine were to conclude, Russia could rebuild some of its lost capacity within a relatively short time frame, and in the longer term, according to multiple intelligence assessments, it could, for instance, launch a military action against the Baltic NATO states, potentially gaining "regional superiority at least in the initial stages of the war."⁵⁰⁵ In June 2026, a joint investigation by Norwegian, Swedish, Danish, and Estonian news outlets revealed that Russia had been building new barracks, military towns, warehouses, and equipment depots near the borders of Norway, Finland, and the Baltic states. Once completed, this will enable Moscow to station up to 115,000 troops in the northwestern direction, nearly six times more than before the 2022 war.⁵⁰⁶

The central dilemma for Western defense planners is the asymmetry of production: Russia's defense industrial base is likely to remain on a wartime footing even if the fighting in Ukraine subsides, whereas Western defense industries are unlikely to mobilize comparably until a major conflict is already underway.

In a potential escalation with NATO, Russia would likely seek not to defeat the alliance militarily, but to divide it through limited territorial gains.⁵⁰⁷ While NATO significantly surpasses Russia in many conventional capabilities, including tanks, naval power, and, arguably, logistics (i.e., the ability to supply, maintain, move, and service personnel and equipment), Russia's experience over the past four years points to a model of warfare built on mass attrition, reduced reliance on armored vehicles, large-scale use of low-cost systems (especially drones), and extensive EW use to jam NATO communications while protecting its own forces from guided strikes.⁵⁰⁸ Moreover, Russia's ability to sustain casualties differs from that of democratic societies, where military losses create serious political costs. This approach would also likely be backed by layered air defense systems. As

illustrated by the examples of Ushkuynik, Kalashnikov, and Almaz-Antey, Russia's capacity to scale and deploy inexpensive FPVs and one-way attack drones could expose real vulnerabilities for NATO.

The central dilemma for Western defense planners is the asymmetry of production: Russia's defense industrial base is likely to remain on a wartime footing even if the fighting in Ukraine subsides, whereas Western defense industries are unlikely to mobilize comparably until a major conflict is already underway.⁵⁰⁹ That creates a dilemma for the West, as Russia may believe it has a conventional advantage in the short term, given its wartime defense industrial capacity and its ability to absorb casualties. Russia could calculate that, in a conventional conflict with Europe, it would incur heavy initial losses but eventually gain the advantage once Western stockpiles are depleted and before Western defense industries can significantly expand production.

In addition, Western air defense has traditionally been optimized to protect military forces and critical infrastructure, not civilian targets at scale. Ukraine's experience suggests difficulties defending against such threats. While Russia has gained experience countering Western systems, NATO forces currently lack comparable experience and capabilities to effectively counter Russia's evolving strengths (even if their knowledge of Russian air defenses, missiles, and drones has increased significantly since 2022). With the proliferation of unmanned systems, one-way attack drones, and loitering munitions, the threat has become acute for European military forces, including maneuver elements, making counter-UAVs a priority across all echelons. While not decisive on their own, they could pose even greater challenges for militaries lacking direct experience with large-scale drone warfare.

About the Authors and Contributors

Maria Snegovaya is a senior fellow for Russia and Eurasia with the Europe, Russia, and Eurasia Program at the Center for Strategic and International Studies (CSIS) and a postdoctoral fellow in Georgetown University's Walsh School of Foreign Service. She studies Russia's domestic and foreign policy, as well as democratic backsliding in post-communist Europe and the tactics used by Russian actors and proxies who exploit these dynamics in the region. Her analysis has been published in multiple policy and peer-reviewed journals. Her research and commentary have appeared in a number of publications such as *The New York Times*, *The Wall Street Journal*, Bloomberg, *The Economist*, and *Foreign Policy*. Throughout her career she has collaborated with multiple U.S. research centers and think tanks such as the Center for a New American Security and Center for European Policy Analysis. Snegovaya holds a PhD in political science from Columbia University.

Tina Dolbaia is an associate fellow with the Europe, Russia, and Eurasia Program at CSIS, where she examines political, economic, and military developments in Russia and Eurasia, as well as Russia's defense-security relations with Global South countries. She is particularly interested in Russia's evolving military industrial production capabilities and how it leverages its diplomatic and defense ties in the Global South. Previously, Tina worked in the international development sector, including Chemonics International and the Center for International Private Enterprise. She holds an MA in Eurasian, Russian, and East European studies from Georgetown University's Walsh School of Foreign Service, where she also worked as a graduate fellow, examining the intersection of the Russian defense and technology sectors, as well as great power competition in Eurasia. Tina is originally from Tbilisi, Georgia, where she obtained her bachelor of science in sociology.

Nicholas Fenton is an associate director and associate fellow with the Europe, Russia, and Eurasia Program at CSIS, where he focuses on Russian foreign policy, the war in Ukraine, and changes in the Russian economy since 2022. Before joining CSIS, Nicholas completed a Fulbright grant working as an English teacher in Omsk, Russia. Nicholas holds a master's degree in European and Russian studies from Yale University, where his research focused on the intellectual history of Soviet foreign policy during the interwar period. Nicholas earned his bachelor's degree at the University of Virginia, where he double majored in political and social thought and Russian and eastern European studies.

Max Bergmann is the director of the Europe, Russia, and Eurasia Program and the Stuart Center in Euro-Atlantic and Northern European Studies at CSIS. Prior to joining CSIS he was a senior fellow at the Center for American Progress, where he focused on Europe, Russia, and U.S. security cooperation. From 2011 to 2017, he served in the U.S. Department of State in a number of different positions, including as a member of the secretary of state's policy planning staff, where he focused on political-military affairs and nonproliferation; special assistant to the undersecretary for arms control and international security; speechwriter to then secretary of state John Kerry; and senior adviser to the assistant secretary of state for political-military affairs. Before serving in the State Department, Bergmann worked at the Center for American Progress as a military and nonproliferation policy analyst and at the National Security Network as the deputy policy director. Bergmann holds a master's degree in comparative politics from the London School of Economics and Political Science and a bachelor's degree in political science from Bates College.

Samuel Bendett is a non-resident senior associate with the Europe, Russia, and Eurasia Program at CSIS. He is also an adviser with CNA's Strategy, Policy, Plans and Programs Division, where he is a member of the Russia Studies Program. His work involves research on Russian military technology developments; uncrewed, robotic, and autonomous military systems; and artificial intelligence. He is an honorary "mad scientist" with the U.S. Army Training and Doctrine Command's Mad Scientist Initiative and a Russian military autonomy and artificial intelligence subject matter expert for the Department of Defense's Defense Systems Information Analysis Center. Mr. Bendett's prior employment includes the National Defense University, where he worked on emerging and disruptive technologies for government response in crisis situations. His previous experience includes working for the U.S. Congress, the private sector, and nonprofit organizations on foreign policy, international conflict resolution, and defense and security issues. Mr. Bendett's analyses, views, and commentary on Russian military robotics and artificial intelligence capabilities appear in major domestic and international news and media outlets. He received an MA in law and diplomacy from the Fletcher School at Tufts University.

Cory Woodall is a graduate student pursuing a master of arts degree in Eurasian, Russian, and East European Studies at Georgetown University in Washington, DC. He additionally holds bachelor's degrees in Russian Studies and Aerospace Engineering from the University of Pittsburgh and the University of Virginia, respectively. Cory is a veteran Naval Aviator who served from 2012 to 2020.

About CSIS

The Center for Strategic and International Studies (CSIS) is a bipartisan, nonprofit policy research organization dedicated to advancing practical ideas to address the world's greatest challenges.

Founded in 1962, CSIS is led by General Joseph F. Dunford, who was appointed chief executive officer in 2026, succeeding John J. Hamre. The CSIS Board of Trustees is chaired by Thomas J. Pritzker, who has held the position since 2015.

CSIS brings together more than 275 full-time staff and a global network of affiliated scholars working across four core areas of public policy: defense and security, geopolitics and foreign policy, economic security and technology, and global development. Our scholars are regularly called upon by Congress, the executive branch, the media, and others to explain the day's events and offer recommendations to improve U.S. strategy.

CSIS's purpose is to define the future of national security. We are guided by a distinct set of values—non-partisanship, independent thought, innovative thinking, cross-disciplinary scholarship, integrity and professionalism, and talent development. CSIS's values work in concert toward the goal of making real-world impact.

What sets CSIS apart is not only the quality of its research but how that research is conveyed: through original data and open-source analysis; through multimedia and data visualization; and through connecting relevant analysis with key audiences at the moments that matter most. This combination of rigor, independence, and reach has made CSIS a driving force in the policy debates shaping American security and prosperity.

Endnotes

- 1 Rudy Ruitenberg, “Russia Could Be Ready for NATO Conflict Year After Ukraine, Dutch Warn,” *Defense News*, April 22, 2026, <https://www.defensenews.com/global/europe/2026/04/22/russia-could-be-ready-for-nato-conflict-year-after-ukraine-dutch-warn>; Frank Gardner and Paulin Kola, “Is Russia Preparing for War with NATO?,” BBC News, December 11, 2025, <https://www.bbc.com/news/articles/cn81x8py3j5o>; and Ian Davis, “Is Russia Really Getting Ready to Attack NATO?,” NATO Watch, January 1, 2026, <https://natowatch.org/default/2026/russia-really-getting-ready-attack-nato>.
- 2 John Baker, “Over 127,000 Join Russian Army on Contract in Early 2026,” *Military Affairs*, May 1, 2026, <https://voennoedelo.com/en/posts/id15500-over-127-000-join-russian-army-contracts-in-early-2026>; “Совещание по рассмотрению основных параметров проекта государственной программы вооружения на 2027–2036 годы” [Meeting to review the key parameters of the draft State Armament Program for 2027–2036], Kremlin.ru, December 26, 2025, <http://kremlin.ru/events/president/news/78866>; and “Россия выделила приоритетные направления развития вооружения” [Russia identified priority areas for weapons development], RBC.ru, December 26, 2025, <https://www.rbc.ru/rbcfreenews/694e92f89a794726899af23b>.
- 3 Sam Cranny-Evans, “Mapping the Expansion of Russia’s Defence Industry,” *European Security & Defence*, September 25, 2025, <https://euro-sd.com/2025/09/articles/exclusive/46685/mapping-the-expansion-of-russias-defence-industry/>.
- 4 Vitaly Shlykov, “The Russian Defense Industrial Complex after September 11,” *European Security* 12, no. 3–4 (2003): 37–51, <https://www.tandfonline.com/doi/pdf/10.1080/09662830390436506>; and Lucas Risinger, Pavlo Shkurenko, Olena Bilousova, and Elina Ribakova, *Disassembling the Russian War Machine: Key Players and Nodes* (KSE Institute, March 2025), https://sanctions.kse.ua/wp-content/uploads/2025/03/MIC_Report_1.pdf.

- 5 Rustem M. Nureev and Evgeniy G. Busygin, “Economic Sanctions as a Factor of Modernizing of Russian Defense Industry Complex,” *Journal of Slavic Military Studies* 9, no. 3 (2017): 98-188, <https://institutional.narod.ru/jis/jis9.3.pdf#page=98>.
- 6 Pavel Luzin, interview with the authors, March 17, 2026.
- 7 Max Seddon and Christopher Miller, “Russia’s Wartime Economy Faces Mounting Strains,” *Financial Times*, April 20, 2026, <https://www.ft.com/content/04a9d05d-2502-44d4-b7e0-041aaa4f83cd?syn-25a6b1a6=1>.
- 8 Maria Snegovaya, Nicholas Fenton, Tina Dolbaia, and Max Bergmann, *The Russian Wartime Economy: From Sugar High to Hangover* (CSIS, June 2025), <https://www.csis.org/analysis/russian-wartime-economy-sugar-high-hangover>; and “Foreign Intelligence Service: Moscow Is Reducing State Credit Support for Businesses,” *Odessa Journal*, April 25, 2026, <https://odessa-journal.com/foreign-intelligence-service-moscow-is-reducing-state-credit-support-for-businesses>.
- 9 Matthew Bodner, “Rostec to Swallow Russia’s Premier Battletank Maker,” *Defense News*, April 25, 2017, <https://www.defensenews.com/land/2017/04/25/rostec-to-swallow-russias-premier-battletank-maker/>.
- 10 “Expanded Meeting of the Defence Ministry Board,” Kremlin.ru, December 17, 2025, <http://www.en.special.kremlin.ru/events/president/news/78801>.
- 11 Snegovaya et al., *The Russian Wartime Economy*.
- 12 Pavel Luzin, “Russia’s Defense Industry and Its Influence on Policy: Stuck in a Redistributive Feedback Loop,” *Russia Matters*, November 3, 2021, <https://www.russiamatters.org/analysis/russias-defense-industry-and-its-influence-policy-stuck-redistributive-feedback-loop>.
- 13 “Russian Fiber-Optic FPV Drones: Operational Scale and Operator Training,” RuAvia.su, February 5, 2026, <https://ruavia.su/russian-fiber-optic-fpv-drones-operational-scale-and-operator-training/>; “Did Russia’s Defense-Sector Boom Peak in 2025?,” *Moscow Times*, December 26, 2025, <https://www.themoscowtimes.com/2025/12/26/did-russias-defense-sector-boom-peak-in-2025-a91555>; and Angelina Trefilova, “When You Fly a Drone for the First Time, It’s Cool: Drone Operation Enters Russia’s School Curriculum,” *Moscow Times*, March 3, 2026, <https://www.themoscowtimes.com/2026/03/03/when-you-fly-a-drone-for-the-first-time-its-cool-drone-operation-enters-russias-school-curriculum-a92076>.
- 14 “Did Russia’s Defense-Sector Boom Peak in 2025?,” *Moscow Times*, December 26, 2025, <https://www.themoscowtimes.com/2025/12/26/did-russias-defense-sector-boom-peak-in-2025-a91555>.
- 15 “Meeting to Discuss Use of Defence Industry Potential in High-Tech Civilian Goods Production,” Kremlin.ru, September 8, 2016, <http://en.kremlin.ru/events/president/news/52852>; and “The Nizhny Novgorod Machine-Building Paradox,” KiTalent, March 2026, last updated April 12, 2026, <https://kitalent.com/articles/article-nizhny-novgorod-machine-building-paradox/>.
- 16 “Доля импорта высокоточных станков для отечественной промышленности снизится на четверть” [Share of imports of high-precision machine tools for domestic industry to decrease by a quarter], RuAvia.su, August 23, 2023, <https://ruavia.su/the-share-of-imports-of-high-precision-machine-tools-for-the-domestic-industry-will-decrease-by-a-quarter>; and Dmitry Gorenburg et al., *Crafting the Russian War Economy: The Effects of Export Controls on Russia’s Defense Industrial Production* (CNA, October 2024), <https://www.cna.org/analyses/2024/10/crafting-the-russian-war-economy>.
- 17 Kateryna Bondar, “How Russia Is Building a Sovereign Drone Ecosystem for AI-Driven Autonomy,” CSIS, April 13, 2026, <https://www.csis.org/analysis/how-russia-building-sovereign-drone-ecosystem-ai-driven-autonomy>.

- 18 “У истоков космовидения” [At the origins of space vision], Rostec, October 7, 2020, <https://rostec.ru/media/news/u-istokov-kosmovideniya/>.
- 19 “Returning Tank Production to Soviet Era Levels: Russia Will Soon Be Building over 3000 T-80s and T-90s per Year,” *Military Watch*, July 2, 2025, <https://militarywatchmagazine.com/article/returning-tank-production-soviet-era-levels-russia-over-3000>.
- 20 “How Many T-90M Tanks Does Russia Produce? CIT Research,” Conflict Intelligence Team, June 19, 2025, https://notes.citeam.org/eng_t90.
- 21 “Why Russia Exported Almost All the Tanks It Built Until 2022: Few New T-90s or T-14s Ordered Until Ukraine War,” *Military Watch*, October 3, 2023, <https://militarywatchmagazine.com/article/russia-exports-almost-all-tanks-t90s-clients>.
- 22 Thane Gustafson, “Tanks or Trains? Russia Is Bearing Down on Both,” *The Devil’s Dance* (Substack), June 12, 2023, <https://thanegustafson.substack.com/p/tanks-or-trains-russia-is-bearing>.
- 23 “How Many T-90M Tanks,” Conflict Intelligence Team; and “A Contract for Supply of Uralvagonzavod’s T-90S Tanks to India Marks Its 25th Anniversary,” Rostec, February 13, 2026, <https://rostec.ru/en/media/news/a-contract-for-supply-of-uralvagonzavod-s-t-90s-tanks-to-india-marks-it-25th-anniversary/>.
- 24 “Uralvagonzavod to Get 64 Billion Rubles for Development - Putin,” TASS, September 9, 2011, <https://tass.com/archive/660158>; and “Tough Times at UVZ,” *Russian Defense Policy* (blog), August 15, 2016, <https://russiandefpolicy.com/2016/08/15/tough-times-at-uvz/>.
- 25 “Uralvagonzavod to Get 64 Billion,” TASS.
- 26 Janis Kluge, “Mounting Pressure on Russia’s Government Budget,” SWP-Berlin, February 8, 2019, [https://www.swp-berlin.org/10.18449/2019RP02/#::-text=from%20gas%20exports.-,6,4.6%20percent%20of%20GDP%20in](https://www.swp-berlin.org/10.18449/2019RP02/#::-text=from%20gas%20exports.-,6,4.6%20percent%20of%20GDP%20in; and “АО ‘Научно-производственная корпорация ‘Уралвагонзавод’” [JSC ‘Research and Production Corporation ‘Uralvagonzavod’], E-disclosure.ru, https://www.e-disclosure.ru/portal/files.aspx?id=19616&type=2); and “АО ‘Научно-производственная корпорация ‘Уралвагонзавод’” [JSC ‘Research and Production Corporation ‘Uralvagonzavod’], E-disclosure.ru, <https://www.e-disclosure.ru/portal/files.aspx?id=19616&type=2>.
- 27 Bodner, “Rostec to Swallow.”
- 28 “Malyshev Plant - Ukraine,” GlobalSecurity.org, <https://www.globalsecurity.org/military/world/ukraine/malyshev.htm>; and Jon Guttman, “T-80: Why Is Russia Using One of the Worst Tanks Ever in Ukraine?,” HistoryNet, September 26, 2022, <https://historynet.com/t-80-worst-tank-russia-ukraine-war/>.
- 29 “JSC NPK Uralvagonzavod imeni F.E.Dzerzhinsky,” GlobalSecurity.org, <https://www.globalsecurity.org/military/world/russia/uralvagonzavod.htm>.
- 30 Defence Intelligence of Ukraine, “Rostec,” War & Sanctions database, last updated April 15, 2026, <https://war-sanctions.gur.gov.ua/en/rostec>.
- 31 “Russia’s Ministry of Defense to Overhaul BMP-2 Infantry Fighting Vehicles 52508162,” *Army Recognition*, Global Defense News, August 25, 2016, <https://www.armyrecognition.com/focus-analysis-conflicts/army/defence-security-industry-technology/russia-s-ministry-of-defense-to-overhaul-bmp-2-infantry-fighting-vehicles-52508162>.
- 32 Defence Intelligence of Ukraine, “VMZ - BRANCH OF NPK URALVAGONZAVOD JSC,” War & Sanctions database, last updated April 15, 2026, <https://war-sanctions.gur.gov.ua/en/rostec/15606>.
- 33 David Hambling, “Convicts, Chaos and Cut-Throats: Inside Russia’s Only Tank Factory,” *Forbes*, February 3, 2026, <https://www.forbes.com/sites/davidhambling/2026/02/03/convicts-chaos-and-cut-throats-in-side-russias-only-tank-factory>.

- 34 David Axe, “Russia Wants 428 Tanks a Year by 2028. Its “Second Factory” Is Taking Them Apart Instead,” *Euromaidan Press*, February 24, 2026, <https://euromaidanpress.com/2026/02/24/t-80-production/>.
- 35 “Russia Got Belarusian Furnaces to Produce Engines for T-72B3 and T-90M Tanks,” *Defense Express*, February 7, 2024, https://en.defence-ua.com/industries/russia_got_belarusian_furnaces_to_produce_engines_for_t_72b3_and_t_90m_tanks-9438.html.
- 36 “How Many T-62 Tanks Can Russia Upgrade or Modernize?,” *Frontelligence Insight* (Substack), September 2, 2023, <https://frontelligence.substack.com/p/how-many-t-62-tanks-can-russia-upgrade>.
- 37 Tender search results, Rostender.info, <https://rostender.info/extsearch/advanced?query=c4b4b9f1de9431797a00919d1b1afb8b>.
- 38 “How Many T-90M Tanks,” Conflict Intelligence Team.
- 39 Massicot and Connolly, *Russian Military Reconstitution*; and “УВЗ: Сила в развитии” [UVZ: Strength in Development], Uralvagonzavod, VK post, August 22, 2025, https://m.vk.com/wall-150895226_39296.
- 40 “‘Ростех’ консолидирует в ‘Техмаше’ часть активов УВЗ” [‘Rostec’ is consolidating part of UVZ’s assets into ‘Techmash’], Interfax, June 6, 2023, <https://www.interfax.ru/business/904979>.
- 41 “Эксперты раскрыли, почему ‘Уралвагонзавод’ отказался от оборонных активов” [Experts revealed why Uralvagonzavod abandoned its defense assets], Ura.ru, April 18, 2023, <https://ura.news/news/1052642224>.
- 42 “How Many T-90M Tanks,” Conflict Intelligence Team.
- 43 “The Kremlin Wants Uralvagonzavod to Repair Tanks 24/7 But There Are Not Enough Workers,” *Defense Express*, September 21, 2022, https://en.defence-ua.com/industries/the_kremlin_wants_uralvagonzavod_to_repair_tanks_247_but_there_are_not_enough_workers-4293.html; Vladimir Kuzmin, “Мишустин заявил об увеличении выпуска танков на ‘Уралвагонзаводе’ втрое” [Mishustin announced a threefold increase in tank output at Uralvagonzavod], Rg.ru, July 18, 2023, <https://rg.ru/2023/07/18/mishustin-zaia-vil-ob-uvlichenii-vypuska-tankov-na-uralvagonzavode-vtroie.html>; “‘Ростех’ нарастил производство танков в семь раз в 2023 году,” [Rostec increased tank production sevenfold in 2023], *Izvestia*, November 1, 2023, <https://iz.ru/1598659/2023-11-01/rostezh-narastil-proizvodstvo-tankov-v-sem-raz-v-2023-godu>; and Risinger et al., *Disassembling the Russian War Machine*.
- 44 Georgy Aleksandrov, “The Barren Barrels,” *Novaya Gazeta Europe*, November 2, 2022, <https://novayagazeta.eu/articles/2022/11/02/the-barren-barrels-en>; and Risinger et al., *Disassembling the Russian War Machine*.
- 45 Risinger et al., *Disassembling the Russian War Machine*.
- 46 Ibid.
- 47 “Путин заявил, что доля гражданской продукции Ростеха достигнет 50% к 2025 году” [Putin stated that Rostec’s share of civilian products will reach 50% by 2025], TASS, December 7, 2017, <https://tass.ru/ekonomika/4792634>.
- 48 “‘Ростех’ снизил долю выпуска гражданской продукции на десять процентов” [‘Rostec’ reduced its share of civilian product output by ten percent], Nangs.org, May 3, 2024, <https://nangs.org/news/technologies/rostezh-snil-dolyu-vypuska-grazhdanskoj-produktsii-na-desyat-protsentov>.

- 49 Maria Borodaevskaya, “С рельс на гусеницы: Уралвагонзавод сокращает выпуск вагонов в пользу оборонки” [From rails to tracks: Uralvagonzavod cuts railcar production in favor of defense], *Forbes*, November 20, 2023, <https://www.forbes.ru/biznes/500543-s-rel-s-na-gusenicy-uralvagonzavod-sokra-saet-vypusk-vagonov-v-pol-zu-oboronki>.
- 50 “Фоторепортаж о производстве грузовых вагонов на ‘Уралвагонзаводе’” [Photo report on freight car production at ‘Uralvagonzavod’], *RollingStockWorld.ru*, March 20, 2026, <https://rollingstockworld.ru/gruzovye-vagony/fotoreportazh-o-proizvodstve-gruzovyh-vagonov-na-uralvagonzavode-uvz/>; and “Uralvagonzavod Has Broken the Old Soviet Record for Railroad Car Production,” *Rus Business News*, December 13, 2011, <https://www.rusbiznews.com/news/n1201.html>.
- 51 “Uralvagonzavod Shows Video of T-90S Trials in the Jungles of Malaysia for the First Time,” *www.1.ru*, April 20, 2026, <https://www1.ru/en/news/2026/04/20/uralvagonzavod-vpervye-pokazal-video-istry-tanii-t-90s-v-dzhungliakh-malaizii.html>.
- 52 Maksim Borisov, “Ростех готов продать новейшие танки Т-90МС иностранцам” [Rostec is ready to sell the latest T-90MS tanks to foreigners], *www1.ru*, April 19, 2026, <https://www1.ru/news/2026/04/19/rostekh-gotov-prodat-noveishie-tanki-t-90ms-inostrantsam.html>.
- 53 UVZ, “Готовы сотрудничать с Малайзией по новому Т-90МС” [Ready to cooperate with Malaysia on the new T-90MS], Telegram post, April 20, 2026, <https://t.me/uvznews/3683>.
- 54 Maria Snegovaya, Max Bergmann, Tina Dolbaia, Nicholas Fenton, and Samuel Bendett, *Back in Stock? The State of Russia’s Defense Industry after Two Years of the War* (CSIS, April 2024), <https://www.csis.org/analysis/back-stock-state-russias-defense-industry-after-two-years-war>.
- 55 Hans Petter Midttun, “Russia’s War Is Getting Cheaper. That’s the Worst News Europe Has Heard in Years,” *Euromaidan Press*, February 14, 2026, <https://euromaidanpress.com/2026/02/14/russias-war-is-getting-cheaper-thats-the-worst-news-europe-has-heard-in-years/>.
- 56 Jeff Hawn, “Military-Industrial Complex and Sanctions Impact,” *Riddle*, last updated May 28, 2025, <https://ridl.io/military-industrial-complex-and-sanctions-impact/>.
- 57 “Visit to Uralvagonzavod,” *Kremlin.ru*, February 15, 2024, <http://en.kremlin.ru/events/president/news/73460>; and “Медведев рассказал о росте поставок танков в зону СВО [Medvedev spoke about the growth of tank deliveries to the SMO zone],” *RIA Novosti*, November 22, 2024, <https://ria.ru/20241122/medvedev-1985263656.html>.
- 58 @@HighMarsed, “List of (probably) all Russian storage bases sorted by type,” X (formerly Twitter) post, November 5, 2023, 5:31 p.m., <https://x.com/HighMarsed/status/1721294080267710904>; and “Frontline Report: Tank Production in Crisis as Russia’s War Economy Hits the Wall,” *Euromaidan Press*, November 18, 2025, <https://euromaidanpress.com/2025/11/18/frontline-report-2025-11-17/>.
- 59 Olena Mukhina, “Only 35% of Russia’s Strategic Tank Reserves Remain After Three Years of War,” *Euromaidan Press*, October 9, 2025, <https://euromaidanpress.com/2025/10/09/only-35-of-russias-strategic-tank-reserves-remain-after-three-years-of-war/>; and Vlad Litnarovych, “From 7,342 to 92—Satellite Analysis Shows Russia’s Depot Armor Is Nearly Spent,” *United24 Media*, October 8, 2025, <https://united24media.com/latest-news/from-7342-to-92-satellite-analysis-shows-russias-depot-armor-is-nearly-spent-12298>.
- 60 “Russia Ended 2025 with Losses of More Than 13,800 Armored Vehicles in Ukraine,” *Outono.net*, January 9, 2026, <https://www.outono.net/elentir/2026/01/09/russia-ended-2025-with-losses-of-more-than-13800-armored-vehicles-in-ukraine/>; and Jakub Janovsky, Naalsio, Aloha, Dan, Kemal, and Alexander Black, “Attack on Europe: Documenting Russian Equipment Losses During the Russian Invasion of Ukraine,” *Oryx*, February 24, 2022 (continuously updated), <https://www.oryxspioenkop.com/2022/02/attack-on-europe-documenting-equipment.html>.

- 61 David Axe, “Russia Is Running Low On Tanks. So Why Are A Thousand First-Generation T-72s Still Sitting In Storage?,” *Forbes*, July 7, 2024, <https://www.forbes.com/sites/davidaxe/2024/07/07/russia-is-running-low-on-tanks-so-why-are-a-thousand-first-generation-t-72s-still-sitting-in-storage>; and Dmytro Shumlianskyi, “Russia Has Depleted Its Tank Stocks: The Industry Is Not Covering Combat Losses,” *Militarnyi*, March 30, 2025, <https://militarnyi.com/en/news/russia-has-depleted-its-tank-stocks-the-industry-is-not-covering-combat-losses/>.
- 62 Vlad Litnarovych, “Russia Just Started Tapping the T-72 Tank Stockpile It Was Saving for Last, OSINT Finds,” *United24 Media*, February 26, 2026, <https://united24media.com/latest-news/russia-just-started-tapping-the-t-72-tank-stockpile-it-was-saving-for-last-osint-finds-16307>.
- 63 Massicot and Connolly, *Russian Military Reconstitution*; and Matej Bazovský, “Future of the Russian Tank Forces,” *Adapt Institute*, March 9, 2026, <https://www.adaptinstitute.org/future-of-the-russian-tank-forces/09/03/2026/>.
- 64 Janovsky et al., “Attack on Europe”; David Axe, “The Kremlin Is Deploying Obsolete T-55 Tanks in Southern Ukraine. The Last Time It Did This, with T-62s, the Tanks Got Massacred,” *Forbes*, May 1, 2023, <https://www.forbes.com/sites/davidaxe/2023/05/01/the-kremlin-is-deploying-obsolete-t-55-tanks-in-southern-ukraine-the-last-time-it-did-this-with-t-62s-the-tanks-got-massacred/>.
- 65 Andrei Tarasenko (@@andrei_bt), “24 мая 1958 года - 60 лет танку Т-55” [May 24, 1958 - 60 years of the T-55 tank], *LiveJournal*, May 24, 2018, <https://andrei-bt.livejournal.com/841587.html>.
- 66 Daniil Irinin, “Россия модернизирует советские танки” [Russia is modernizing Soviet tanks], *Lenta.ru*, September 1, 2021, <https://lenta.ru/news/2021/09/01/t55/>.
- 67 “The World’s Largest T-64 Tank Fleet Has Been Fighting Russia for Four Years: How Has It Fared?,” *Military Watch*, January 31, 2026, <https://militarywatchmagazine.com/article/world-largest-t64-tank-fleet-fighting-russia>; Alexey Zakvasin and Elizaveta Komarova, “‘Революционная разработка’: как создание Т-64 повлияло на развитие отечественных танков” [‘A revolutionary development’: How the T-64 influenced the development of domestic tanks], *RT*, January 2, 2022, <https://russian.rt.com/russia/article/945099-t-64-sozdanie-modernizaciya-sssr-ukraina>; and “Новая жизнь танка Т-64” [New life for the T-64 tank], Central Park “Patriot” of the Ministry of Defense of the Russian Federation, October 3, 2018, <https://parkpatriot.ru/novosti/novaya-zhizn-tank-a-t-64/>.
- 68 “Russia’s New T-62 Tank Variant Built for 21st Century Engagements: Will It Be Effective in Ukraine?,” *Military Watch*, March 21, 2023, https://militarywatchmagazine.com/article/t62-variant-thermals-ukraine#google_vignette; and “T-62,” *Army Recognition*, Global Defense News, April 11, 2026, <https://www.armyrecognition.com/military-products/army/main-battle-tanks/main-battle-tanks/t-62-russia-uk>.
- 69 “Is Russia Preparing to Restore Hundreds of T-72A Tanks? What Vehicles Besides Tanks Can They Be Converted Into,” *Defense Express*, September 25, 2025, https://en.defence-ua.com/analysis/is_russia_preparing_to_restore_hundreds_of_t_72a_tanks_what_vehicles_besides_tanks_can_they_be_converted_into-15939.html.
- 70 Aleksandr Vorontsov, “Россия получит 800 модернизированных Т-62 - акт отчаяния или серьезная боевая единица” [Russia will receive 800 modernized T-62s - an act of desperation or a serious combat unit], *Voyennoye Obozreniye*, October 18, 2022, <https://topwar.ru/203438-t-62.html>.
- 71 “How Many T-62 Tanks,” *Frontelligence Insight*.
- 72 Vlad Litnarovych, “Russia Just Started Tapping the T-72 Tank Stockpile It Was Saving for Last, OSINT Finds,” *United24 Media*, February 26, 2026, <https://united24media.com/latest-news/russia-just-started-tapping-the-t-72-tank-stockpile-it-was-saving-for-last-osint-finds-16307>; “T-72,” *RuWiki*, <https://ru.ruwiki>.

- ru/wiki/%D0%A2-72; and “Танк Т-72БА” [T-72BA Tank], *Otvaga* 2004, <http://otvaga2004.ru/tanki/istoriya-sozdaniya/tank-t72ba/>.
- 73 Dylan Malyasov, “OSINT Data Shows Russia’s Tank Reserves Shrinking but Far from Exhausted,” *Defence Blog*, October 8, 2025, <https://defence-blog.com/osint-data-shows-russias-tank-reserves-shrinking-but-far-from-exhausted/>; and “Russia Has Completely Run Out Of Modern Tanks In Warehouses,” *Charter’97*, January 24, 2026, <https://charter97.org/en/news/2026/1/24/671147>.
 - 74 “T-72B3M Main Battle Tank,” *Army Technology*, <https://www.army-technology.com/projects/t-72b3m-main-battle-tank/>; Damian Ratka, “Ile nowych czołgów otrzymała Rosja?” [How many new tanks has Russia received?], *Defence24*, January 2, 2025, <https://defence24.pl/przemysl/ile-nowych-czolgow-otrzymala-rosja>; and Vadim Kushnikov, “Russia Strives to Modernize Its T-72B3 Tanks,” *Militarnyi*, November 6, 2022, <https://militarnyi.com/en/news/russia-strives-to-modernize-its-t-72b3-tanks/>.
 - 75 @@Jonpy99, “1/ Time to do another thread on Russian Armor Repair Plants (BTRZs)!,” X post, 1:52 a.m., <https://x.com/Jonpy99/status/2026913164084867489>.
 - 76 Dmytro Shumlanskyi, “Russia Switches to T-72A Modernization as T-72B Stocks Dwindle,” *Militarnyi*, February 15, 2026, <https://militarnyi.com/en/news/russia-switches-to-t-72a-modernization/>.
 - 77 Ivan Khomenko, “Russia Bets on Refurbishing 800 Aging T-72 Tanks to Replace Huge Battlefield Losses,” *United24 Media*, October 12, 2025, <https://united24media.com/latest-news/russia-bets-on-refurbishing-800-aging-t-72-tanks-to-replace-huge-battlefield-losses-12409>.
 - 78 “T-80BVM MBT Main Battle Tank,” *Army Recognition*, *Global Defense News*, April 17, 2026, <https://www.armyrecognition.com/military-products/army/main-battle-tanks/main-battle-tanks/t-80bvm-mbt-main-battle-tank-technical-data?highlight=WjYdXNzaWEiXQ%3D%3D>.
 - 79 “В России снова начнут производить танки Т-80” [Russia to resume production of T-80 tanks], *Telekanal Zvezda*, September 10, 2023, <https://tvzvezda.ru/news/2023910836-TUaTV.html>; and Axe, “Russia Wants 428 Tanks a Year.”
 - 80 Vadim Kushnikov, “The Omsktransmash Tank Plant on Fire in Russia,” *Militarnyi*, September 12, 2024, <https://militarnyi.com/en/news/the-omsktransmash-tank-plant-on-fire-in-russia/>.
 - 81 “T-80BVM,” *Weaponsystems.net*, <https://weaponsystems.net/system/835-T-80BVM>. “Russia Keeps Comprehensively Upgrading T-80BVM Main Battle Tank – Defense Firm,” July 6, 2026, <https://tass.com/defense/2156293>
 - 82 “Omsk Plant Supplies New T-80BVM Tanks to the Russian Army,” *Bulgarian Military*, July 2, 2025, <https://bulgarianmilitary.com/2025/07/02/omsk-plant-supplies-new-t-80bvm-tanks-to-the-russian-army/>.
 - 83 “Analysis: Russia Regenerates Its Tank Force,” *Janes*, October 16, 2025, <https://www.janes.com/osint-insights/defence-and-national-security-analysis/russia-regenerates-tank-force>.
 - 84 “Russia Upgrades T-90 Tank Using Troop Feedback from Battlefield – Rostec,” *TASS*, June 23, 2026, <https://tass.com/defense/2150423>.
 - 85 “Russia Uses Armata Tech to Upgrade T-90M and T-72 Fleet,” *Defense Watch*, December 17, 2025, <https://thedefensewatch.com/military-ordnance/russia-uses-armata-tech-to-upgrade-t-90m-and-t-72-fleet/>; and Sasha Epshtein, “T-90M: к чему готов самый лучший танк России” [T-90M: What Russia’s best tank is ready for], *Tech Insider*, March 2, 2022, <https://www.techinsider.ru/weapon/564174-bronya-krepka-luchshiy-rossiyskiy-tank-vstupayet-v-stroy/>.
 - 86 “How Many T-90M Tanks,” *Conflict Intelligence Team*.
 - 87 *Ibid*.

- 88 Ibid.; and Gjerstad, “Russisan T-90M Production.”
- 89 “How Many T-90M Tanks Is Russia Producing? A CIT Assessment,” Conflict Intelligence Team, accessed July 2, 2026, https://notes.citeam.org/eng_t90; and Michael Gjerstad, “Russian T-90M Production: Less Than Meets the Eye,”
- 90 Janes, “Analysis: Russia Regenerates Its Tank Force,” October 16, 2025, <https://www.janes.com/defence-intelligence-insights/defence-and-national-security-analysis/russia-regenerates-tank-force>. International Institute for Strategic Studies, *The Military Balance 2024* (London: Routledge for the International Institute for Strategic Studies, 2024), <https://www.iiss.org/publications/the-military-balance/2024/the-military-balance-2024/>. International Institute for Strategic Studies, *The Military Balance 2025* (London: Routledge for the International Institute for Strategic Studies, 2025), <https://www.iiss.org/publications/the-military-balance/2025/the-military-balance-2025/>. International Institute for Strategic Studies, *The Military Balance 2026* (London: Routledge for the International Institute for Strategic Studies, 2026), <https://www.iiss.org/publications/the-military-balance/>.
- 91 “Exclusive: Inside Russia’s 2026-2036 Tank Fleet Modernization and Buildup Plans,” *Frontelligence Insight* (Substack), October 11, 2025, <https://frontelligence.substack.com/p/exclusive-inside-russias-20262036>.
- 92 “Russia Upgrades T-90 Tank Using Troop Feedback from Battlefield – Rostec,” TASS, June 23, 2026, <https://tass.com/defense/2150423>.
- 93 “Russia’s T-14 Tank Has Introduced a Lightweight Unmanned Turret: A Revolutionary Improvement in Armoured Warfare?,” *Military Watch*, August 16, 2022, <https://militarywatchmagazine.com/article/russias-t14-turret-revolutionary-improvement>.
- 94 “T-14 (Object 149) Armata Main Battle Tank (MBT),” GlobalSecurity.org, last modified October 10, 2025, <https://www.globalsecurity.org/military/world/russia/t-14.htm>; and Isaac Seitz, “The Walls Are Closing In on Russia’s T-14 Armata Tank,” *National Security Journal*, June 11, 2025, <https://nationalecurityjournal.org/the-walls-are-closing-in-on-russias-t-14-armata-tank/>.
- 95 Maya Carlin, “Why Is Russia’s Powerful T-14 Armata Tank Not Fighting in Ukraine?,” *National Interest*, January 18, 2025, <https://nationalinterest.org/blog/buzz/why-russias-powerful-t-14-armata-tank-not-fighting-ukraine-214445>.
- 96 Kris Osborn, “Russia’s BMPT Terminator ‘Tank’ Might Have No Future,” 1945, January 11, 2025, <https://www.19fortyfive.com/2025/01/russias-bmpt-terminator-tank-might-have-no-future/>.
- 97 “First BMPT Tank Support Vehicle Delivered in 2018 to Russian Army,” *Army Recognition*, Global Defense News, January 16, 2018, <https://www.armyrecognition.com/focus-analysis-conflicts/army/defence-security-industry-technology/first-bmpt-tank-support-vehicle-delivered-in-2018-to-russian-army>.
- 98 David Axe, “The Russian Army’s Terminator Vehicles Are Heavily Armed, Highly Protected – and Far Too Few to Matter,” *Forbes*, December 10, 2022, <https://www.forbes.com/sites/davidaxe/2022/12/10/the-russian-armys-terminator-vehicles-are-heavily-armed-highly-protected--and-far-too-few-to-matter/>; and Osborn, “Russia’s BMPT Terminator.”
- 99 “Огнеметная система ТОС-1 ‘Буратино’ / ТОС-1А ‘Солнцеpek’” [Flamethrower System TOS-1 ‘Buratino’ / TOS-1A ‘Solntsepek’], Энциклопедия военной техники [Encyclopedia of Military Equipment], war-book.ru, <https://war-book.ru/rszo-tos-1/>; and “Russia Boosts Production of Destructive Rocket Launcher TOS-1A by 250% for Deployment in Ukraine,” *Army Recognition*, Global Defense News, April 19, 2024, <https://www.armyrecognition.com/archives/archives-land-defense/land-defense-2024/russia-boosts-production-of-destructive-rocket-launcher-tos-1a-by-250-for-deployment-in-ukraine>.
- 100 “Russia Boosts Production,” *Army Recognition*.

- 101 “Russians Lose Rare TOS-2 Tosochka Flamethrower System on the Battlefield for the First Time,” *Defense Express*, February 16, 2025, https://en.defence-ua.com/news/russians_lose_rare_tos_2_tosochka_flamethrower_system_on_the_battlefield_for_the_first_time-13554.html.
- 102 UVZ, “Министр обороны РФ проверил выполнение гособоронзаказа предприятием ОПК в Омской области” [Russian defence minister inspected the fulfilment of the state defence order at a defence industry enterprise in the Omsk Region], Telegram post, April 19, 2024, <https://t.me/uvznews/2659>.
- 103 UVZ, “Эксперты – о том, как УБИМ повысит мобильность подразделений” [Experts on how the UBIM will improve unit mobility], Telegram post, March 26, 2025, <https://t.me/uvznews/3646>.
- 104 “Unique UBIM Armored Vehicles Based on T-90M Tanks Have Entered Service with the Russian Military,” *www1.ru*, March 26, 2026, <https://www1.ru/en/news/2026/03/26/unikalnye-bronemasiny-ubim-na-baze-tankov-t-90m-postupili-rossiiskim-voennym.html>.
- 105 Vladislav V., “Russians Combine BREM, IMR, and BMR into a Single Engineering Vehicle - UBIM,” *Militaryni*, March 27, 2026, <https://militaryni.com/en/news/russians-brem-imr-and-bmr-into-vehicle-ubim/>.
- 106 Dmytro Shumlianskiy, “Russia Debuts Shturm Robotic Assault System,” *Militaryni*, July 28, 2025, <https://militaryni.com/en/news/russia-debuts-shturm-robotic-assault-system/>.
- 107 Fabrice Wolf, “Почему беспилотный танк Т-72 ‘Штурм’ имеет решающее значение для российских вооруженных сил?” [Why is the unmanned T-72 ‘Shturm’ tank crucial for the Russian armed forces?], *Meta-Defense*, February 24, 2026, <https://www.meta-defense.fr/ru/2026/02/24/t-72-szturm-sans-equipage-essais-et-defis-operatoires/>.
- 108 “Russia: Prototype of Unmanned ‘Shturm’ Tank Spotted,” *MILMAG*, July 28, 2025, <https://milmag.pl/en/russia-prototype-of-unmanned-shturm-tank-spotted/>.
- 109 Ivan Khomenko, “Russia’s New ‘Shturm’ Robot Tank Arrives—AI Hype, 1970s Chassis,” *United24 Media*, July 27, 2025, <https://united24media.com/latest-news/russias-new-shturm-robot-tank-arrives-ai-hype-1970s-chassis-10185>.
- 110 “В России растут зарплаты из-за сильного дефицита кадров” [Salaries are rising in Russia due to a severe labor shortage], *Vse Novosti Nizhnego Tagila* [All News of Nizhny Tagil], July 3, 2023, <https://vsenovostint.ru/2023/07/03/v-rossii-rastut-zarplaty-iz-za-silnogo-deficizita-kadrov/>; “Уралвагонзавод” повысил зарплаты работникам на 28%” [‘Uralvagonzavod’ raised employee salaries by 28%], *Interfax*, August 22, 2024, <https://www.interfax.ru/russia/977625>; and “Russian Wage Growth Hits 16-Year High in December 2024,” *Moscow Times*, March 3, 2025, <https://www.themoscowtimes.com/2025/03/03/russian-wage-growth-hits-16-year-high-in-december-2024-a88227>.
- 111 Lex Talionis and OSINT Varta, “JSC 103 BTRZ,” OSINT Varta, last updated May 7, 2026, <https://map.osint-varta.com.ua/companies/dcb35bc2-8c98-4e25-919d-ca7d608a14f5>; Lex Talionis and OSINT Varta, “JSC ‘Scientific-Production Corporation ‘Uralvagonzavod,’” OSINT Varta, last updated May 7, 2026, <https://map.osint-varta.com.ua/companies/32d2908e-4e4d-46a1-ac81-fe32f13d4824>; and Lex Talionis and OSINT Varta, “JSC ‘Omsktransmash,’” OSINT Varta, last updated May 7, 2026, <https://map.osint-varta.com.ua/companies/47b8efd1-3e7f-44fc-a116-e036187c02d2>.
- 112 “Visit to Uralvagonzavod,” President of Russia, February 15, 2024, <http://en.kremlin.ru/events/president/news/73460>; and “Vladimir Putin Directed 400 Million Rubles to Be Allocated to Sverdlovsk Technical Schools Training Personnel for Uralvagonzavod,” *Nizhny Tagil*, February 15, 2024, https://ntagil.org/news/detail.php?ELEMENT_ID=277565.
- 113 “Работа в Москве, поиск персонала и публикация вакансий” [Jobs in Moscow, staff search and job postings], *hh.ru*, <https://hh.ru/>; and “Работа России” [Work of Russia], *trudvsem.ru*, <https://trudvsem.ru/>.

- 114 Olga Glazkova, “Вуз поможет обеспечить Уралвагонзавод кадрами [University will help provide Uralvagonzavod with personnel],” Уральский федеральный университет [Ural Federal University], June 16, 2025, <https://urfu.ru/ru/news/55504/>; and “Уралвагонзавод открыл целевой набор в лучшие технические вузы” [Uralvagonzavod opened targeted enrollment at leading technical universities], СоюзМаш России [Union of Machine Builders of Russia], July 3, 2025, <https://soyuzmash.ru/news/companies-news/uralvagonzavod-otkryl-tselevoy-nabor-v-luchshie-tekhicheskie-vuzy/>.
- 115 “Владимир Путин распорядился выделить 400 миллионов рублей свердловским техникумам, готовящим кадры ‘Уралвагонзаводу’” [Vladimir Putin ordered the allocation of 400 million rubles to Sverdlovsk Technical Schools training personnel for ‘Uralvagonzavod’], Нижний Тагил [Nizhny Tagil], February 15, 2024, https://ntagil.org/news/detail.php?ELEMENT_ID=277565.
- 116 “На ‘Уралвагонзавод’ отправят работать 250 осужденных к принудительным работам” [250 convicts sentenced to forced labor will be sent to work at ‘Uralvagonzavod’], It’s My City, November 29, 2022, <https://itsmycity.net/2022-11-29/na-uralvagonzavod-otpravyat-rabotat-250-osuzhdennyh-k-prinuditelnyh-rabotam>.
- 117 “Уралвагонзавод повысил зарплаты сотрудникам на 28%” [Uralvagonzavod raised employee salaries by 28%], TASS, August 22, 2024, <https://tass.ru/ekonomika/21664901>.
- 118 Denis Morokhin, “Off the Rails: Disused Trains, Record-Low Cargo and Engine Shortages: How the War Has Impacted Russian Railways,” *Novaya Gazeta Europe*, July 4, 2025, <https://novayagazeta.eu/articles/2025/07/04/off-the-rails-en>.
- 119 “Russia’s UVZ Halts All Secondary Output, Begins Tank Mass Production,” Bulgarian Military, June 29, 2023, <https://bulgarianmilitary.com/2023/06/29/russias-uvz-halts-all-secondary-output-begins-tank-mass-production/>; and УралВагонЗавод — УВЗ [UralVagonZavod – UVZ] (Telegram channel), “Умный вагон с ИИ-психологом” [Smart wagon with an AI psychologist], Telegram, April 1, 2025, <https://t.me/uvznews/3648>.
- 120 Pavel Ivanov, “Крупнейший российский производитель танков перешел на четырехдневку” [Russia’s largest tank manufacturer switched to a four-day week], *Gazeta.ru*, October 10, 2025, <https://www.gazeta.ru/social/news/2025/10/10/26928944.shtml>; and Dariia Mykhailenko, “Orders Decline at Russia’s Uralvagonzavod Tank Factory, Forcing Major Job Cuts,” United24 Media, November 7, 2025, <https://united24media.com/latest-news/orders-decline-at-russias-uralvagonzavod-tank-factory-forcing-major-job-cuts-13197>.
- 121 Office of the Spokesperson, “Sanctions to Disrupt Russia’s Military Industrial Base and Sanctions Evasion,” U.S. Department of State, January 15, 2025, <https://2021-2025.state.gov/office-of-the-spokesperson/releases/2025/01/sanctions-to-disrupt-russias-military-industrial-base-and-sanctions-evasion/>; Oleksandr Moiseienko, “Russia Defies Sanctions, Continues to Secure Critical Bearings, Including from EU Manufacturers,” United24 Media, January 16, 2025, <https://united24media.com/war-in-ukraine/russia-defies-sanctions-continues-to-secure-critical-bearings-including-from-eu-manufacturers-5104>; and Alexander Shulepov, “Перезагрузка подшипниковой отрасли в условиях санкций: от критики — к дорожной карте” [Reboot of the bearing industry under sanctions: from criticism – to a roadmap], Ритм Машиностроения [Rhythm of Mechanical Engineering], <https://ritm-magazine.com/ru/public/perezagruzka-podshpnikovoy-otrasli-v-usloviyah-sankciy-ot-kritiki-k-dorozhnoy-karte>.
- 122 “The Ukrainian Military Seized an Extremely Valuable Russian T-80BVM Tank to Answer Where Aggressor-State Now Takes Tank Sights From,” *Defense Express*, June 13, 2023, https://en.defence-ua.com/weapon_and_tech/the_ukrainian_military_seized_an_extremely_valuable_russian_t_80bvm_tank_to_answer_where_aggressor_state_now_takes_tank_sights_from-6997.html.

- 123 Max Bergmann, Maria Snegovaya, Tina Dolbaia, and Nicholas Fenton, *Out of Stock? Assessing the Impact of Sanctions on Russia's Defense Industry* (CSIS, April 2023), https://csis-website-prod.s3.amazonaws.com/s3fs-public/2023-04/230414_Bergmann_Out_Stock.pdf?VersionId=6jfhCP0c13bbmh9bw4Yy2wbpjNnfeJi8.
- 124 David Axe, "What's Perfectly Round, Made of Metal, and Keeping Russia from Replacing the 2,000 Tanks It's Lost in Ukraine?," *Forbes*, April 19, 2023, <https://www.forbes.com/sites/davidaxe/2023/04/19/whats-perfectly-round-made-of-metal-and-keeping-russia-from-replacing-the-2000-tanks-its-lost-in-ukraine/>.
- 125 Ivan Khomenko, "Russian Tanks Are Falling Apart – Not from Ukrainian Fire, but Their Own Armor," UNITED24 Media, November 10, 2025, <https://united24media.com/latest-news/russian-tanks-are-falling-apart-not-from-ukrainian-fire-but-their-own-armor-13249>.
- 126 Defence Intelligence of Ukraine, "Інструменти війни у зброї агресора" [Instruments of war in the hand of the aggressor], War & Sanctions database, last updated April 29, 2026, https://war-sanctions.gur.gov.ua/tools?f%5Bsearch%5D=&f%5Bcountry_id%5D=&f%5Bmanufacturer_id%5D=&f%5Bcompany_id%5D=115&f%5Btitle_uk%5D=&f%5Bpt%5D=&f%5Bpd%5D=; and "Ukraine Intel: Massive Chinese, European Machine Tool Use in Russian Arms Production," *Kyiv Post*, March 26, 2025, <https://www.kyivpost.com/post/49641>.
- 127 Risinger et al., *Disassembling the Russian War Machine*.
- 128 Defence Intelligence of Ukraine, "Інструменти війни" [Instruments of war], War & Sanctions database; and Volodymyr Tunik-Fryz, "Russia Ramps Up Imports of Defence Industry Components from China, Ukrainian Intelligence Says," *Ukrainska Pravda*, March 26, 2025, <https://www.pravda.com.ua/eng/news/2025/03/26/7504602/>.
- 129 Tunik-Fryz, "Russia Ramps Up."
- 130 Michael Starr, "Corruption Hinders Russia's Attempts to Replace Losses with Old Vehicles," *Jerusalem Post*, March 27, 2022, <https://www.jpost.com/international/article-702428>.
- 131 Alia Shoaib, "A Russian Army Commander Has Been Accused of Stealing Engines from Putin's Prized T-90 Tanks, Report Says," *Business Insider*, April 29, 2023, <https://www.businessinsider.com/russian-colonel-accused-stealing-engines-prized-t-90-tanks-2023-4>.
- 132 "Какой ты, на фиг, танкист? Начальника бронетанковой службы обвинили в хищении двигателей для танков Т-90" [What kind of tank crewman are you? The head of the armored service has been accused of stealing engines for T-90 tanks], *Kommersant*, April 30, 2023, <https://www.kommersant.ru/doc/5954243>.
- 133 Игорь Глуховский, "Генпрокуратура взялась за коррупцию в шарикоподшипниковой отрасли" [The prosecutor general's office tackles corruption in the ball-bearing industry], Аргументы Недели [Arguments of the Week], December 16, 2025, <https://argumenti.ru/society/2025/12/979434>; and "Генпрокуратура добила seizure холдинга КИМП и компаний Элма, Прамо в пользу государства" [The prosecutor general's office achieved the seizure of KIMP holding and Elma and Pramo companies in favor of the state], *Kommersant*, February 20, 2026, <https://www.kommersant.ru/doc/8459718>.
- 134 Vadim Kushnikov, "The Russians Produce Defective T-90M," *Militarnyi*, June 9, 2023, <https://militarnyi.com/en/news/the-russians-produce-defective-t-90m/>.
- 135 Reuben Johnson, "Russia's Top T-90 Tank in Ukraine Has a 'Disco Head Defect,'" *National Security Journal*, June 6, 2025, <https://nationalecurityjournal.org/russias-top-t-90-tank-in-ukraine-has-a-disco-head-defect/>.
- 136 Parakilas and Shkurenko, "Russia's Military Procurement Is a Warning."

- 137 “Missile Industry,” Federation of American Scientists Intelligence Resource Program, <https://irp.fas.org/world/russia/fbis/MissileIndustry.html>; “АО ‘Концерн ВКО ‘Алмаз-Антей’” [JSC ‘Almaz-Antey Aerospace Defence Concern’], *Kommersant*, December 20, 2017, <https://www.kommersant.ru/doc/3502550/w/almaz-antey>; “ОАО ‘Концерн ПВО ‘Алмаз-Антей’. История компании” [JSC ‘Almaz-Antey Air Defence Concern’: company history], RIA Novosti, July 30, 2009, <https://ria.ru/20090730/179243873.html>; and Keir Giles, *Russian Ballistic Missile Defence: Rhetoric and Reality* (U.S. Army War College Strategic Studies Institute, June 2015), <https://apps.dtic.mil/sti/tr/pdf/ADA625224.pdf>.
- 138 “Оборонный концерн ‘Алмаз-Антей’. Досье” [Defence concern ‘Almaz-Antey’: dossier], TASS, October 13, 2015, <https://tass.ru/info/2341855>; and Shlykov, “The Russian Defense Industrial Complex.”
- 139 “Almaz-Antey Concern of East Kazakhstan Region Will Take Part in the Army-2024 Forum,” VPK.name, August 12, 2024, https://vpk.name/en/900143_almaz-antey-concern-of-east-kazakhstan-region-will-take-part-in-the-army-2024-forum.html; and “Home,” Almaz-Antey, <http://almaz-antey.ru/>.
- 140 “Продукция военного назначения” [Military production], Almaz-Antey, <http://almaz-antey.ru/catalog/produksiya-voennogo-naznacheniya/>.
- 141 Risinger et al., *Disassembling the Russian War Machine*.
- 142 Alexander Panin, “Russia’s No. 1 Military Producer Reports Growing Revenues,” *Moscow Times*, May 12, 2014, <https://www.themoscowtimes.com/archive/russias-no-1-military-producer-reports-growing-revenues>; and Andrew Radin et al., *The Future of the Russian Military: Russia’s Ground Combat Capabilities and Implications for U.S.-Russia Competition* (RAND Corporation, 2019), https://www.rand.org/content/dam/rand/pubs/research_reports/RR3000/RR3099/RAND_RR3099.pdf.
- 143 “ОАО ‘Концерн ПВО ‘Алмаз-Антей’. История компании,” RIA Novosti; and Said Aminov, “Highlights from Almaz-Antey 2008 Financial Report,” *Moscow Defense Brief* 4, no. 18 (2009), republished at Vestnik PVO, http://pvo.guns.ru/book/cast/k_pvo_annual2008_en.htm.
- 144 Vladislav V. Menshchikov, “Almaz-Antey,” *SP’s Land Forces*, February–March 2011, <https://www.spsland-forces.com/story/?id=90>; and Panin, “Russia’s No. 1 Military Producer.”
- 145 U.S. Department of the Treasury, “Announcement of Expanded Treasury Sanctions Within the Russian Financial Services, Energy and Defense or Related Materiel Sectors,” press release, September 12, 2014, <https://home.treasury.gov/news/press-releases/jl2629>; European Commission, “Almaz-Antey JSC,” EU Sanctions Tracker, <https://data.europa.eu/apps/eusanctionstracker/subjects/7439>; and Maria Domańska and Szymon Kardaś, “The Consequences of the Western Financial Sanctions on the Russian Economy,” Centre for Eastern Studies, March 24, 2016, <https://www.osw.waw.pl/en/publikacje/osw-commentary/2016-03-24/consequences-western-financial-sanctions-russian-economy>.
- 146 Domańska and Kardaś, “The Consequences of the Western Financial Sanctions.”
- 147 “Оборонный концерн ‘Алмаз-Антей’. Досье” [Defense Concern ‘Almaz-Antey.’], TASS.
- 148 Elena Gregova, Irina Tulyakova, and Victor Dengov, “The Financial Condition of Corporations of the Russian Defense-Industrial Complex, Which Are Included in the TOP Lists of the Largest Military Companies in the World,” *SHS Web of Conferences* 129, no. 5–6 (2021): 03010, <https://doi.org/10.1051/shsconf/202112903010>; and Domańska and Kardaś, “The Consequences of the Western Financial Sanctions.”
- 149 “Оборонный концерн «Алмаз-Антей». Досье” [Defense Concern ‘Almaz-Antey.’], TASS.
- 150 “History,” Almaz-Antey, <http://almaz-antey.ru/history/>.

- 151 M.B. Александров, “‘Алмаз – Антей’ стал концерном воздушно-космической обороны” [‘Almaz-Antey’ became an aerospace defense concern], Центр военно-политических исследований [Center for Military-Political Studies], MGIMO, February 17, 2015, <https://pravo.mgimo.ru/?q=node/32828>; and “Air Defense Concern ‘Almaz-Antey’ Transformed into Aerospace Defense Concern,” TASS, February 5, 2025, <https://tass.ru/armiya-i-opk/1747526>.
- 152 “‘Путин создал из ‘Алмаз-Антея’ концерн воздушно-космической обороны’” [Putin created an aerospace defense concern from Almaz-Antey], Lenta.ru, February 5, 2015, https://lenta.ru/news/2015/02/05/concern_vko/.
- 153 Aude Fleurant, Alexandra Kuimova, Nan Tian, and Pieter D. Wezeman, “The SIPRI Top 100 Arms-Producing and Military Services Companies, 2018,” SIPRI Fact Sheet, December 2019, https://www.sipri.org/sites/default/files/2019-12/1912_fs_top_100_2018.pdf.
- 154 Christopher Woody, “China Has Started Receiving Russia’s Advanced S-400 Air Defense System,” *Business Insider*, May 26, 2018, <https://www.businessinsider.com/china-has-russian-s-400-air-defense-system-2018-5>; Tom Karako, “Coups-Proofing: Making Sense of Turkey’s S-400 Decision,” CSIS, July 15, 2019, <https://www.csis.org/analysis/coup-proofing-making-sense-turkeys-s-400-decision>; and Vivek Raghuvanshi, “India Approves S-400 Buy from Russia amid Expectations for More Bilateral Deals,” *Defense News*, September 28, 2018, <https://www.defensenews.com/land/2018/09/28/india-approves-s-400-buy-from-russia-amid-expectations-for-more-bilateral-deals/>.
- 155 Alexandra Marksteiner, Lucie Béraud-Sudreau, Nan Tian, Diego Lopes da Silva, and Alexandra Kuimova, “The SIPRI Top 100 Arms-Producing and Military Services Companies, 2020,” SIPRI Fact Sheet, December 2021, https://www.sipri.org/sites/default/files/2021-12/fs_2112_top_100_2020.pdf; Lorenzo Scarazzato, Xiao Liang, Nan Tian, and Diego Lopes da Silva, “Developments in Arms Production and the Effects of the War in Ukraine,” *Defense and Peace Economics* 35, no. 6 (August 2024), <https://doi.org/10.1080/10242694.2024.2381784>; and Fenella McGerty, “Budget and Pandemic Present Challenges to Russia’s Defense Industrial Base,” *Defense News*, August 17, 2020, <https://www.defensenews.com/opinion/commentary/2020/08/17/budget-and-pandemic-present-challenges-to-russias-defense-industrial-base/>.
- 156 Gregova et al., “The Financial Condition of Corporations”; and Marksteiner et al., “The SIPRI Top 100 Arms-Producing and Military Services Companies, 2020.”
- 157 Lucie Béraud-Sudreau, Xiao Liang, Diego Lopes da Silva, Nan Tian, and Lorenzo Scarazzato, “The SIPRI Top 100 Arms-Producing and Military Services Companies, 2021,” SIPRI Fact Sheet, December 2022, https://www.sipri.org/sites/default/files/2022-12/fs_2212_top_100_2021.pdf; and “Алмаз-Антей» начнет выпускать гражданские беспилотники в 2023 году” [Almaz-Antey to start manufacturing civil drones in 2023], TASS, June 16, 2022, <https://tass.ru/ekonomika/15095385>.
- 158 “Ян Новиков, ‘Безусловный приоритет — выполнение задач государственного оборонного заказа,’” [Yan Novikov, ‘unconditional priority - fulfilling the tasks of the state defense order’], National Defense, April 25, 2022, <https://oborona.ru/product/zhurnal-nacionalnaya-oborona/bezuslovnyj-prioritet-vypolnenie-zadach-gosudarstvennogo-oboronnogo-zakaza-43621.shtml>.
- 159 “How Investment in S-400 Air Defences ‘Reindustrialised’ Russia’s Missile Sector,” *Military Watch*, May 31, 2023, <https://militarywatchmagazine.com/article/investment-s400-reindustrialised-sector>.
- 160 “‘Безусловный приоритет’” [Unconditional priority], National Defense.
- 161 Risinger et al., *Disassembling the Russian War Machine*.
- 162 “Концерн ВКО Алмаз-Антей объединит дочерние предприятия” [Concern VKO Almaz-Antey will consolidate subsidiaries], VPK.name, June 22, 2018, https://vpk.name/news/219197_koncern_vkoalmaz-antei_obedinit_dochernie_predpriyatiya.html.

- 163 “ПАО ‘НПО ‘Алмаз’” [PJSC “NPO ‘Almaz’”], Raspletin Scientific Production Association, accessed May 8, 2026, <https://raspletin.com/>; “АО ‘Концерн ВКО ‘Алмаз-Антей’” [Concern VKO Almaz-Antey], Kommersant, December 20, 2017, <https://www.kommersant.ru/doc/3502550/w/almaz-antey>; and Jack Watling et al., “Disrupting Russian Air Defence Production: Reclaiming the Sky,” Royal United Services Institute, December 2025, <https://static.rusi.org/rp-disrupting-russian-air-defence-production.pdf>.
- 164 “АО ‘НИИП имени В.В. Тихомирова’” [JSC NIIP named after V.V. Tikhomirov], MAKS Airshow Exhibitor Profile, accessed May 8, 2026, <https://airshow.ru/expo/111/anketa.htm>; “НИИП имени В.В. Тихомирова” [NIIP named after V.V. Tikhomirov], Mil.Press FlotProm, accessed May 8, 2026, <https://flotprom.ru/%D0%9D%D0%B8%>; and “НИИП имени В.В. Тихомирова отмечает 70-летие” [NIIP named after V.V. Tikhomirov marks its 70th anniversary], National Defense, March 1, 2025, <https://oborona.ru/product/zhurnal-nacionalnaya-oborona/niip-imeni-v-v-tihomirova-otmechaet-70-letie-46651.shtml>.
- 165 “ФАКЕЛ” [Fakel], Энергетика и промышленность России [Power and Industry of Russia], accessed May 8, 2026, <https://www.eprussia.ru/com/company/1422.htm>; and Watling et al., “Disrupting Russian Air Defence Production.”
- 166 “3М-14 Kalibr (SS-N-30A),” Missile Defense Advocacy Alliance, accessed May 8, 2026, <https://www.missiledefenseadvocacy.org/missile-threat-and-proliferation/todays-missile-threat/russia/ss-n-30a-kalibr/>; and Oleksandr Moiseienko, “Inside Russia’s Iskander-K: Ukraine Unmasks 41 Factories Behind the Cruise Missile,” United24 Media, January 21, 2026, <https://united24media.com/latest-news/inside-russias-iskander-k-ukraine-unmasks-41-factories-behind-the-cruise-missile-15195>.
- 167 Defence Intelligence of Ukraine, “ПАО Радиофизика” [PAO Radiofizika], War & Sanctions database, accessed May 8, 2026, <https://war-sanctions.gur.gov.ua/ru/components/companies/3325>; “ПАО ‘Радиофизика’” [PAO Radiofizika], M2data.net, accessed May 8, 2026, <https://m2data.net/en/companies/radiofizika>; and Olivia Sapwood, “Russia Engages Orion Drones to Counter Naval Drones,” *Militarnyi*, February 3, 2025, <https://militarnyi.com/en/news/russia-engages-orion-drones-to-counter-naval-drones/>.
- 168 “Концерн ВКО Алмаз-Антей” [Concern VKO Almaz-Antey], Историко-информационный портал ЕС ОрВД [Historical-Information Portal of the Unified Air Traffic Management System of Russia], <https://ovdrf.ru/page/152>; and “Новый отечественный БПЛА от концерна ВКО Алмаз-Антей” [New domestic UAV from Concern VKO Almaz-Antey], Top War, August 10, 2022, <https://en.topwar.ru/200082-novyyj-otechestvennyj-bpla-ot-koncerna-vko-almaz-antey.html>.
- 169 “АО ‘НИИП имени В.В. Тихомирова’” [JSC NIIP named after V.V. Tikhomirov], Moscow Aviation Institute (MAI), <https://mai.ru/content/org/index.php?ID=90113>; “АО ‘Концерн ВКО ‘Алмаз-Антей’” [JSC Concern VKO Almaz-Antey], Rusprofile, <https://www.rusprofile.ru/id/3125273>; and Watling et al., “Disrupting Russian Air Defence Production.”
- 170 “The Obukhov State Plant: Funded From an Engineer’s Own Pocket,” Russia Beyond (RBTH), July 20, 2015, https://www.rbth.com/defence/2015/07/20/the_obukhov_state_plant_funded_from_an_engineers_own_pocket_47901.html; “Обуховский завод — 160 лет на передовых позициях промышленного производства” [The Obukhov Plant: 160 years at the forefront of industrial production], National Defense, May 24, 2023, <https://oborona.ru/product/zhurnal-nacionalnaya-oborona/obuhovskij-zavod-160-let-na-peredovyh-pozicijah-promyshlennogo-proizvodstva-44740.shtml>; and “‘Безусловный приоритет’” [Unconditional priority], National Defense.
- 171 “Joint Stock Company Vyatka Machine-Building Enterprise ‘Avitek,’” War and Sanctions Portal, Defence Intelligence of Ukraine (HUR), <https://war-sanctions.gur.gov.ua/en/components/companies/3436>.
- 172 “Visit to Nizhny Novgorod 70th Anniversary of Victory Plant,” Kremlin.ru, March 29, 2016, <http://en.kremlin.ru/events/president/news/51592>; and “Production of Anti-Aircraft Missile Systems S-500 and S-400 Started at the Nizhny Novgorod Machine-Building Plant,” Russian Aviation, February 27, 2018,

<https://www.ruaviation.com/news/2018/2/27/10917/?h#:-:text=Production%20of%20anti%20aircraft%20missile%20systems%20S%2D500%20and,started%20at%20the%20Nizhny%20Novgorod%20machine%2Dbuilding%20plant.>

- 173 “Ижевский электромехаический завод ‘Купол’” [JSC Izhevsk Electromechanical Plant “Kupol”], Udmurt Republic Union of Industrialists and Entrepreneurs, <https://udmrsp.ru/zavod-kupol>; Defence Intelligence of Ukraine, “Серед компаній, до яких застосовані санкції: Акціонерне Товариство ‘Іжевський Електромеханічний завод ‘Купол’” [Among the sanctioned companies: Joint-Stock Company Izhevsk Electromechanical Plant “Kupol,”] War & Sanctions database, <https://war-sanctions.gur.gov.ua/ru/tools/company/3347>; and Benjamin Jensen and Yasir Atalan, “Drone Saturation: Russia’s Shahed Campaign,” CSIS, *CSIS Briefs*, May 13, 2025, <https://www.csis.org/analysis/drone-saturation-russias-shahed-campaign>.
- 174 Николай Медуницын и Владимир Капустин [Nikolai Medunitsin and Vladimir Kapustin], “55 лет АО ‘Ульяновский механический завод’ [55 years of JSC Ulyanovsk Mechanical Plant], National Defense, December 24, 2020, <https://oborona.ru/product/kapustin-vladimir/55-let-ao-ulyanovskij-mekhanicheskij-zavod-41429.shtml>; and “Ульяновский механический завод (УМЗ)” [Ulyanovsk Mechanical Plant (UMZ)], Zavody Rossii [Factories of Russia], accessed May 8, 2026, <https://xn--80aegj1b5e.xn--plai/factory/umz-0>.
- 175 “Pantsir-S1 SA-22 Greyhound,” Army Recognition Group, March 5, 2026, <https://www.armyrecognition.com/military-products/army/air-defense-systems/air-defense-vehicles/pantsir-s1-russia-uk>; and Dmytro Shumlianskyi, “Ukrainian Attack on Moscow: Analysis of Air Defense Rings Breakthrough in Russia’s Capital Region,” May 17, 2026, <https://militaryny.com/en/news/ukrainian-attack-on-moscow-analysis-of-air-defense-rings-breakthrough-in-russia-s-capital-region/>.
- 176 Sinéad Baker, “Ukraine’s Alpha Unit Dealt a \$4 Billion Hit to Russia’s Air Defenses Last Year,” *Business Insider*, January 19, 2026, <https://www.businessinsider.com/ukraine-alpha-unit-4-billion-hit-to-russian-defenses-year-2026-1>. Defence of Ukraine (@DefenceU), “June was a bad month for Russian air defense,” X post, July 1, 2024, 11:13 a.m., https://x.com/DefenceU/status/1807794540134178951?ref_src=twsrc%5Etfw%7Ctwcamp%5Etweetembed%7Ctwterm%5E1807794540134178951%7Ctwgr%5E9608d09cc8d0412aef41081fc9c53634e871981f%7Ctwcon%5Es1_&ref_url=https%3A%2F%2Fwww.businessinsider.com%2Fukraine-says-destroyed-russian-air-defense-systems-2024-7; and Chris Panella, “Ukraine Says It Has Destroyed 40 Russian Air Defense Systems in 2 Weeks,” *Business Insider*, July 1, 2024, <https://www.businessinsider.com/ukraine-says-destroyed-russian-air-defense-systems-2024-7>. Yuri Kobzar, “Скільки комплексів С-400 і С-300 осталося у Росії” [How many S-400 and S-300 SAM systems does Russia have left], UNIAN, June 11, 2024, <https://www.unian.net/weapons/skolko-zrk-s-400-i-s-300-ostalos-u-rossii>.
- 177 Olha Pokotylo, “Ukraine Hit 274 Russian Air Defense Systems in March 2026 – Zelensky,” April 5, 2026, <https://news.online.ua/en/ukraine-hit-274-russian-air-defense-systems-in-march-2026-zelensky-902864/>; and “Ukraine’s Defense Forces Hit over 151,200 Enemy Targets in March,” *Ukrinform*, April 3, 2026, <https://www.ukrinform.net/rubric-ato/4108934-ukraines-defense-forces-hit-over-151200-enemy-targets-in-march.html>.
- 178 Jack Watling, Nikolay Staykov, Maya Kalcheva, Olena Yurchenko, Bohdan Kovalenko, Olena Zhul, Oleksii Borovikov, Anastasiia Opria, Roman Rabieiev, Nadiia Reminets, and Alex Whitworth, *Disrupting Russian Air Defence Production: Reclaiming the Sky* (London: Royal United Services Institute, 2025), <https://www.rusi.org/explore-our-research/publications/research-papers/disrupting-russian-air-defence-production-reclaiming-sky>.

- 179 Donald Hill, “Russian Air Defences of 2026: Part 3,” Introduction by Tom Cooper, Sarcastosaur (Substack), April 7, 2026, <https://xxtomcooperxx.substack.com/p/russian-air-defences-of-2026-part-13c>. Donald Hill, “Russian Air Defences of 2026: Part 2,” Introduction by Tom Cooper, Sarcastosaur (Substack), April 6, 2026, <https://xxtomcooperxx.substack.com/p/russian-air-defences-of-2026-part-4a7>.
- 180 Sinéad Baker, “Russia’s War in Ukraine Has Made Its Formidable Air Defenses an Even Tougher Challenge for NATO, Airpower Analyst Warns,” *Business Insider*, February 14, 2026, <https://www.businessinsider.com/russias-air-defenses-learned-ukraine-now-bigger-threat-nato-2026-2>; and Justin Bronk, “The Evolution of Russian and Chinese Air Power Threats,” Royal United Services Institute, January 8, 2026, <https://www.rusi.org/explore-our-research/publications/insights-papers/evolution-russian-and-chinese-air-power-threats>.
- 181 Bronk, “The Evolution of Russian and Chinese Air Power Threats.”
- 182 Henry Robinson, “Missile Warfare and Air Defense in the Ukraine Conflict: Evaluating Long-Range Systems and Ukraine’s Defenses Against Russian Threats,” Onero Institute, August 8, 2025, <https://www.oneroinstitute.org/research/missile-warfare-and-air-defense-in-the-ukraine-conflict-evaluating-long-range-systems-and-ukraines-defenses-against-russian-threats>.
- 183 Shumlianskyi, “Ukrainian Attack on Moscow.”
- 184 Ibid; and Matthew Loh, “These are the 3 drones Ukraine used to pierce Moscow’s air defense gauntlet in its biggest attack yet,” *Business Insider*, May 18, 2026, <https://www.businessinsider.com/ukraine-drones-long-range-moscow-air-defenses-biggest-attack-2026-5>.
- 185 Watling et al., “Disrupting Russian Air Defence Production.”
- 186 Baker, “Russia’s War in Ukraine.”
- 187 “S-300 Air Defense System,” *Defense Watch*, <https://thedefensewatch.com/product/ukraine-secures-more-s-300-interceptors-with-norways-help/>.
- 188 Missile Defense Project, “S-300 (SA-10 Grumble),” *Missile Threat*, CSIS, last updated July 6, 2021, <https://missilethreat.csis.org/defsys/s-300/>.
- 189 Thomas Newdick, “Russia Now Firing S-300 Surface-to-Air Missiles at Land Targets in Ukraine: Official,” War Zone, July 9, 2022, <https://www.twz.com/russia-now-firing-s-300-surface-to-air-missiles-at-land-targets-in-ukraine-official>.
- 190 Ian Williams, *Putin’s Missile War: Russia’s Strike Campaign in Ukraine* (CSIS, May 2023), https://csis-website-prod.s3.amazonaws.com/s3fs-public/2023-05/230505_Williams_Putin_Missile.pdf.
- 191 “Russia Has Accumulated 10,000 S-300 Missiles, But There Are Suitable Weapons in the World to Counter Them – Zelensky,” Ukrinform, May 25, 2024, <https://www.ukrinform.net/rubric-ato/3867872-russia-has-accumulated-10000-s300-missiles-but-there-are-suitable-weapons-in-the-world-to-counter-them-zelensky.html>.
- 192 “S-400 Triumf Air Defense System,” Defense Watch, December 16, 2025, <https://thedefensewatch.com/product/s-400-triumf-air-defense-system/>; Missile Defense Project, “S-400 Triumf,” *Missile Threat*, CSIS, last updated July 6, 2021, <https://missilethreat.csis.org/defsys/s-400-triumf/>; and “Ukraine’s SOF Destroy Russian S-400 Triumf Launcher, Ammunition Depot in Crimea,” Ukrinform, November 9, 2025, <https://www.ukrinform.net/rubric-ato/4056564-ukraines-sof-destroy-russian-s400-triumf-launcher-ammunition-depot-in-crimea.html>.
- 193 “How Many S-400 Missile Systems Does Russia Have?,” *Newsweek*, May 24, 2024, <https://www.newsweek.com/how-many-s-400-missile-systems-russia-1904353>.

- 194 Ibid; “Why Ukraine Can’t Seriously Deplete Russia’s S-400 Air Defence Arsenal: Massive Production Scale Allows For Rapid Replenishment,” *Military Watch*, June 27, 2025, <https://militarywatchmagazine.com/article/why-ukraine-cant-seriously-deplete-russia-s400>; and Janovsky et al., “Attack on Europe.”
- 195 “Almaz-Antey Doubles Production of S-350 Vityaz and S-400 Triumf Air Defense Missile Systems,” Russian Aviation, September 19, 2025, <https://www.ruaviation.com/news/2025/9/19/20116/?h>; and “Russia Doubles Missile Production for S-400 Air Defence System,” *Military Watch*, September 20, 2025, <https://militarywatchmagazine.com/article/russia-doubles-missile-production-s400>.
- 196 John Baker, “Almaz-Antey Boosts Output of S-400 and S-350 Air Defense Missiles,” *Military Affairs*, September 22, 2025, <https://voennoedelo.com/en/posts/id1307-russia-doubles-s-400-and-s-350-missile-production-in-2025>. It is worth noting that the S-400 system is believed to cost much more than Russian advanced fighter aircraft such as the Su-57. The price of the S-400 is estimated at \$500 million, while the Su-57 is estimated at \$70 million. See Amanda Macias, “Russia Is Luring International Arms Buyers with a Missile System That Costs Much Less Than Models Made by American Companies,” CNBC, November 19, 2018, <https://www.cnbc.com/2018/11/19/russia-lures-buyers-as-s-400-missile-system-costs-less-than-us-models.html>; and Kushal Deb, “Why Russian Jets Are So Much Cheaper: The Shocking Truth About Russian Fighter Jets,” WION, August 2, 2025, <https://www.wionews.com/world/why-russian-jets-are-so-much-cheaper-1754142609345>.
- 197 “Russia Makes Major Investment into Production of S-400 Systems as Defence Sector Is ‘Reindustrialised,’” *Military Watch*, October 20, 2023, <https://militarywatchmagazine.com/article/investment-s400-reindustrialised-sector>.
- 198 “S-500 Prometey Air and Missile Defense System,” *Defense Watch*, <https://thedefensewatch.com/product/s-500-prometey-air-and-missile-defense-system/>.
- 199 Inder Singh Bisht, “Russia Activates First S-500 Air and Missile Defense Regiment,” *Defense Post*, December 18, 2025, <https://thedefensepost.com/2025/12/18/russia-s-500/>. “Белоусов: на боевое дежурство заступил первый полк с ЗРС С-500” [Belousov: First Regiment Equipped with the S-500 Air Defense System Has Entered Combat Duty], Kommersant, December 17, 2025, <https://www.kommersant.ru/doc/8294241>.
- 200 Inder Singh Bisht, “Russians Move S-500 Air Defense System to Crimea: Ukraine Spy Chief,” *Defense Post*, June 13, 2024, <https://thedefensepost.com/2024/06/13/russians-s-500-crimea/>; and Rachel Amran and the Kyiv Independent News Desk, “Budanov: Russia Places S-500 Air Defense Systems in Occupied Crimea,” *Kyiv Independent*, June 13, 2024, <https://kyivindependent.com/budanov-russia-places-s-500-air-defense-systems-in-occupied-crimea/>.
- 201 “NIIP imeni V. V. Tikhomirova otmechaet 70-letie” [V. V. Tikhomirov Research Institute of Instrument Engineering celebrates its 70th anniversary], National Defense, February 17, 2025, <https://oborona.ru/product/zhurnal-nacionalnaya-oborona/niip-imeni-v-v-tihomirova-otmechaet-70-letie-46651.shtml>.
- 202 “Buk-M3 Viking 9K317M SA-27 Gollum,” *Army Recognition*, Global Defense News, April 26, 2026, <https://www.armyrecognition.com/military-products/army/air-defense-systems/air-defense-vehicles/buk-m3-9k317m-medium-range-air-defense-missile-system-technical-data-sheet-specifications-11312154>; and Ivan Khomenko, “Why Was Russia’s Buk-M3 Air Defense System Seen Rolling Through Alabama?,” United24 Media, March 9, 2026, <https://www.united24media.com/latest-news/why-was-russias-buk-m3-air-defense-system-seen-rolling-through-alabama-16640>.
- 203 “‘Безусловный приоритет’” [Unconditional priority], National Defense.
- 204 Sergey Nakhimov, “Самоходный зенитный ракетный комплекс «Бук»: варианты ракет и модификации” [Self-propelled surface-to-air missile system “Buk”: missile variants and modifications], Amalnews, August 8, 2025, <https://amalantra.ru/zrk-buk/>.

- 205 “Chapter Four,” *The Military Balance*, 2025; and “Chapter Four,” *The Military Balance*, 2026.
- 206 “Almaz-Antey Speeds Up Deliveries of Buk-M3 Anti-Aircraft Systems to Russian Troops,” *Defense Mirror*, October 11, 2023, https://defensemirror.com/news/35188/Almaz_Antey_Speeds_up_Deliveries_of_Buk_M3_Anti_Aircraft_Systems_to_Russian_Troops.
- 207 Ibid.
- 208 “Ратный труд и трудовой подвиг” [Military labor and labor feat], National Defense, December 19, 2025, <https://oborona.ru/product/zhurnal-nacionalnaya-oborona/ratnyj-trud-i-trudovoj-podvig-47456.shtml>.
- 209 “Russian Defense Industry Increased Production of 9M317M Units,” *Eurasia Daily*, January 14, 2026, <https://eadaily.com/en/news/2026/01/14/russian-defense-industry-increased-production-of-9m317m-units>.
- 210 ““Безусловный приоритет”” [Unconditional priority], National Defense; and “S-350 Vityaz Missile Defense System,” *Defense Watch*, <https://thedefensewatch.com/product/s-350-vityaz-missile-defense-system/>.
- 211 “S-350,” Deagel, <https://www.deagel.com/Armies/S-350/a002482>; “Chapter Four,” *The Military Balance*, 2025; “Chapter Four,” *The Military Balance*, 2026; and “Russian Military to Receive 144 S-350 ‘Vityaz’ Air Defense Systems by 2027,” *Defense Mirror*, February 27, 2020, https://defensemirror.com/news/26424/Russian_Military_to_receive_144_S_350_Vityaz_Air_Defense_Systems_by_2027.
- 212 “Nizhny Novgorod Machine-Building in 2026: A Boom That Cannot Find the Hands to Build What It Has Promised,” KiTalent, April 12, 2026, <https://kitalent.com/articles/article-nizhny-novgorod-machine-building-paradox/>.
- 213 “Almaz-Antey Doubles Production,” Russian Aviation.
- 214 Thomas Newdick, “Ukraine Appears to Have Destroyed Its First Russian S-350 Air Defense System,” TWZ, February 17, 2025, <https://www.twz.com/land/ukraine-appears-to-have-destroyed-its-first-russian-s-350-air-defense-system>.
- 215 “Tor-M1 Air Defense System,” *Defense Watch*, <https://thedefensewatch.com/product/tor-m1-air-defense-system/>.
- 216 “SA-15D TOR-M2 TOR-M2K,” *Army Recognition*, Global Defense News, <https://www.armyrecognition.com/military-products/army/air-defense-systems/air-defense-vehicles/tor-m2-russia-uk>; <https://thedefensewatch.com/product/tor-m2-air-defense-system/>.
- 217 Maria Tril, “Ukraine’s Drone Forces Destroy 9th Tor-M1 in 9 Days in Occupied Donetsk Oblast,” *Euro-maidan Press*, April 9, 2026, <https://euromaidanpress.com/2026/04/09/ukraines-drone-forces-destroy-9th-tor-m1-in-9-days-in-occupied-donetsk-oblast/>; and Sofia Syngaivska, “Ukrainian Drone Operators Eliminate Tor-M2 System Covering Russian Positions (Video),” *Defense Express*, March 4, 2026, https://en.defence-ua.com/news/ukrainian_drone_operators_eliminate_tor_m2_system_covering_russian_positions_video-17710.html.
- 218 “Tor-M1,” Deagel, <https://www.deagel.com/Armies/Tor-M1/a000375>.
- 219 “Chapter Four,” *The Military Balance*, 2025; and “Chapter Four,” *The Military Balance*, 2026.
- 220 Sania Kozatskyi, “Ukrainian Drones Strike Latest Russian S-350 Radar and Tor and Buk Launchers,” *Militarnyi*, January 2, 2026, <https://militarnyi.com/en/news/ukrainian-drones-strike-latest-russian-s-350-radar-and-tor-and-buk-launchers>; Cyril Barabaltchouk, “Ukraine Deploys Heavy FP-2 Drones to Destroy Russian Tor Launchers in Donetsk Region,” United24 Media, March 9, 2026, <https://united24media.com/latest-news/ukraine-deploys-heavy-fp-2-drones-to-destroy-russian-tor-launchers-in-donetsk>.

- region-16636; and Jakub Janovsky, Naalsio, Aloha, Dan, Kemal, and Alexander Black, “Attack on Europe: Documenting Russian Equipment Losses During The Russian Invasion of Ukraine,” Oryx, February 24, 2022, <https://www.oryxspioenkop.com/2022/02/attack-on-europe-documenting-equipment.html>.
- 221 “IEMZ Kupol Is Constantly Upgrading Its Serial Products, Taking into Account the Experience of Their Use in Its Production Area,” VPK.name, April 30, 2025, https://vpk.name/en/1099504_iemz-kupol-is-constantly-upgrading-its-serial-products-taking-into-account-the-experience-of-their-use-in-its-production-area.html.
 - 222 Ukraine’s Defence Intelligence, “Joint-Stock Company Izhevsk Electromechanical Plant Kupol,” War & Sanctions database, accessed May 8, 2026, <https://war-sanctions.gur.gov.ua/ru/tools/company/3347>; and Jensen and Atalan, “Drone Saturation: Russia’s Shahed Campaign.”
 - 223 Matthew Bint and Fabian Hinz, “Russia Doubles Down on the Shahed,” International Institute for Strategic Studies, *Military Balance Blog*, April 14, 2025, <https://www.iiss.org/online-analysis/military-balance/2025/04/russia-doubles-down-on-the-shahed/>.
 - 224 “Russia Ramps Up Drone Infrastructure: In Addition to Alabuga, Shahed Drones Now Produced at IEMZ Kupol,” *Defense Express*, April 15, 2025, https://en.defence-ua.com/news/russia_ramps_up_drone_infrastructure_in_addition_to_alabuga_shahed_drones_now_produced_at_iemz_kupol-14191.html.
 - 225 “Exclusive: Chinese Engines, Shipped as ‘Cooling Units,’ Power Russian Drones Used in Ukraine,” Reuters, July 23, 2025, <https://www.reuters.com/business/aerospace-defense/chinese-engines-shipped-cooling-units-power-russian-drones-used-ukraine-2025-07-23/>.
 - 226 “‘Алмаз-Антей’ создал многопозиционную систему наблюдения за БПЛА” [Almaz-Antey created a multi-position UAV monitoring system], РИА Новости [RIA News], February 6, 2024, <https://ria.ru/20240206/sistema-1925588226.html>.
 - 227 “Russian Company Almaz-Antey Develops Droneports for UAV Interceptors,” TASS, May 7, 2026, <https://tass.com/defense/2127985>.
 - 228 Sam Cranny-Evans, “Mapping the Expansion of Russia’s Defence Industry,” *European Security & Defence*, September 25, 2025, <https://euro-sd.com/2025/09/articles/exclusive/46685/mapping-the-expansion-of-russias-defence-industry/>.
 - 229 Watling et al., “Disrupting Russian Air Defence Production.”
 - 230 Aram Roston and David Gauthier-Villars, “U.S. Firm Supplied Networking Tech to Maker of Russian Missiles,” Reuters, October 12, 2022, <https://www.reuters.com/technology/how-us-firm-supplied-networking-technology-maker-feared-russian-missiles-2022-10-12/>.
 - 231 “Chinese Engines,” Reuters.
 - 232 John Reed, Max Seddon, Chris Cook, and John Paul Rathbone, “Russia Built Covert Trade Channel with India, Leaks Reveal,” *Financial Times*, September 4, 2024, <https://www.ft.com/content/101afcd6-8e6f-4b5f-89b0-98f48cd5d119?syn-25a6b1a6=1>.
 - 233 Risinger et al., *Disassembling the Russian War Machine*.
 - 234 Roger McDermott, “The Generational Crisis in Russia’s Defense Industry,” *Eurasia Daily Monitor* 8, no. 100, Jamestown Foundation, May 24, 2011, <https://jamestown.org/the-generational-crisis-in-russias-defense-industry/>.
 - 235 “Nizhny Novgorod Machine-Building in 2026,” KiTalent.
 - 236 “Meeting with Almaz-Antey Corporation General Designer Pavel Sozinov,” President of Russia, January 5, 2022, <http://en.kremlin.ru/events/president/news/67555>.

- 237 ““Безусловный приоритет”” [Unconditional priority], National Defense; and “Ульяновский механический завод отметит 60-летие” [Ulyanovsk Mechanical Plant will mark its 60th anniversary], *Ulpravda*, January 29, 2026, <https://ulpravda.ru/rubrics/economics/ulianovskii-mekhanicheskii-zavod-otmetit-60letie>.
- 238 Dylan Malyasov, “Ukrainian Drones Hit Russian Air Defense Maker,” *Defence Blog*, July 1, 2025, <https://defence-blog.com/ukrainian-drones-hit-russian-air-defense-maker/>.
- 239 Taras Safronov, “Rockets Strike Russian Kremniy El Defense Plant in Bryansk,” *Militarnyi*, March 10, 2026, <https://militarnyi.com/en/news/rockets-strike-russian-kremniy-el-bryansk/>; and “A War of Attrition in the Skies: Russia Adapts Missile and Drone Strike Tactics, While Ukraine Attempts to Disrupt Russian Missile Production,” *Re:Russia*, April 22, 2026, <https://re-russia.net/analytics/0418/>.
- 240 “Beyond Repair: Ukrainian UAVs Hit the Almaz-Antey Concern’s Plant That Repairs Russian Air Defense Systems,” *Ukrainian News Agency*, March 20, 2026, <https://unn.ua/en/news/beyond-repair-ukrainian-uavs-hit-the-almaz-antey-concerns-plant-that-repairs-russian-air-defense-systems>.
- 241 “Ukrainian Partisans Conducted Reconnaissance of Russian Obukhov State Plant in St. Petersburg,” *Defense Express*, May 3, 2025, https://en.defence-ua.com/news/ukrainian_partisans_conducted_reconnaissance_of_russian_obukhov_state_plant_in_st_petersburg-14382.html.
- 242 ““Безусловный приоритет”” [Unconditional priority], National Defense.
- 243 Anmol Singla, “S-400 dispatch from Russia: Where will India’s ‘Sudarshan Chakra’ be deployed?,” *Firstpost*, May 19, 2026, <https://www.firstpost.com/explainers/s400-delivery-russia-india-this-week-sudarshan-chakra-air-defence-system-explained-14012820.html>.
- 244 “Russia to showcase S-400, Antey-4000 air defense systems at Abu Dhabi arms exhibition,” *TASS*, February 16, 2023, <https://tass.com/defense/1577209>; and “Russia’s Almaz-Antey to feature Antey-4000 air defense system at arms show in Egypt,” *TASS*, November 27, 2025, <https://tass.com/defense/2049763>.
- 245 Olga R. Chiriac and Thomas Withington, “Russian Electronic Warfare: From History to Modern Battlefield,” *Irregular Warfare Initiative*, March 21, 2024, <https://irregularwarfare.org/articles/russian-electronic-warfare-from-history-to-modern-battlefield/>.
- 246 Sergey Sukhankin, “Blind, Confuse and Demoralize: Russian Electronic Warfare Operations in Donbas,” *Jamestown Foundation*, August 27, 2021, <https://jamestown.org/blind-confuse-and-demoralize-russian-electronic-warfare-operations-in-donbas>.
- 247 “Ministry of Radio Industry (Minradioprom),” *GlobalSecurity.org*, last modified April 8, 2019, <https://www.globalsecurity.org/military/world/russia/mrp.htm>.
- 248 “Интервью с В. Шимко: Корпорация ‘Радиоконкомплекс’: ‘мини-министерство’, которое помогает, а не командует” [Interview with V. Shimko: Radiocomplex Corporation: a ‘mini-ministry’ that helps rather than commands], *Elektronika*, 1998, <https://web.archive.org/web/20140714123732/http://www.electronics.ru/journal/article/1890>.
- 249 Chatham House, interview with a senior U.S. EW expert, April 28, 2026.
- 250 Thomas Withington, “A Most Irregular War: Electronic Warfare and the Russian Invasion of Ukraine,” *Journal of Electromagnetic Dominance*, May 2024, https://www.jed-digital.com/jedm/library/item/0524_may_2024/4188404/.
- 251 *Ibid.*

- 252 Chiriac and Withington, “Russian Electronic Warfare”; and Bart Hendrickx, “Ekipazh: Russia’s top-secret nuclear-powered satellite,” *Space Review*, October 7, 2019, <https://www.thespacereview.com/article/3809/1>.
- 253 Reuben F. Johnson, “Why Today’s Russian Airborne EW Falls Short,” *Journal of Electromagnetic Dominance*, May 2024, https://www.jed-digital.com/jedm/library/item/0524_may_2024/4188404/.
- 254 Online correspondence with Bryan Clark, May 2026.
- 255 “Electronic Warfare in the Sky and on the Ground,” VPK.name, March 27, 2024, https://vpk.name/en/843461_electronic-warfare-in-the-sky-and-on-the-ground.html.
- 256 Defence Intelligence of Ukraine, “Joint-Stock Company Central Research Institute of Radio Engineering Named After Academician A.I. Berg,” War & Sanctions database, last modified May 4, 2026, <https://war-sanctions.gur.gov.ua/en/components/companies/9954>; Johnson, “Why Today’s Russian Airborne EW Falls Short”; and Sukhankin, “Blind, Confuse and Demoralize.”
- 257 Vladimir Karnozov, “KRET’s EW Systems Undergo ‘Reality Check’ in Syria,” *Aviation International News*, November 9, 2015, <https://www.ainonline.com/aviation-news/defense/2015-11-09/krets-ew-systems-undergo-reality-check-syria>.
- 258 Patrick Tucker, “Ukraine’s Drone Warriors,” Atlantic Council, March 10, 2015, <https://www.atlanticcouncil.org/blogs/natosource/ukraine-s-drone-warriors/>.
- 259 Karnozov, “KRET’s EW Systems.”
- 260 Ibid.
- 261 “Electronic Technologies (ECR),” TAdviser, last updated November 24, 2022, https://tadviser.com/index.php/Company:Electronic_Technologies_%28ECR%29; Pavel Luzin, *Electronic Warfare: Russia’s Approach* (Foreign Policy Research Institute, February 2022), <https://www.fpri.org/wp-content/uploads/2022/02/electronic-warfare-022222.pdf>; and “KRET Has Disclosed the 2017 Financial Results,” Rostec, May 24, 2018, <https://rostec.ru/en/media/news/kret-has-disclosed-the-2017-financial-results/>.
- 262 Karnozov, “KRET’s EW Systems.”
- 263 Luzin, *Electronic Warfare*.
- 264 Ibid.
- 265 Alexander Grigoryev, “РЭБ: как учатся воевать бойцы невидимого фронта импульсов” [EW: How the fighters of the invisible pulse front learn to fight], *Zvezda Weekly*, March 5, 2021, archived April 20, 2021 at the Wayback Machine, <https://web.archive.org/web/20210420131500/https://zvezdaweb.ru/news/202132922-ur08Z.html>; and Sukhankin, “Blind, Confuse and Demoralize.”
- 266 “New CEO at Russian Helicopters,” HeliHub, November 30, 2021, <http://www.helihub.com/2021/11/30/new-ceo-at-russian-helicopters/>.
- 267 “Meeting to Discuss Use of Defence Industry Potential in High-Tech Civilian Goods Production,” President of Russia, September 8, 2016, <http://en.kremlin.ru/events/president/news/52852>.
- 268 Pjotr Sauer, Jake Cordell, and Evan Gershkovich, “‘Our Equipment Is Dangerous’: Russian Doctors Expected Ventilators Tragedy,” *Moscow Times*, May 13, 2020, <https://www.themoscowtimes.com/2020/05/13/our-equipment-is-dangerous-russian-doctors-expected-ventilators-tragedy-a70253>.
- 269 Elena Berg, “Ставропольскому радиозаводу «Сигнал» - 50!” [Stavropol Radio Plant ‘Signal’ is 50!], *Komsomolskaya Pravda*, June 9, 2021, <https://www.stav.kp.ru/daily/27288/4425922/>.

- 270 Maksim Borisov, “Навигацию для MC-21 и «Суперджета» обеспечит Тамбов» [Navigation for the MC-21 and ‘Superjet’ will be provided by Tambov], [www1.ru](https://www1.ru/en/news/2026/02/20/navigaciiu-dlia-ms-21-i-superdzeta-obespecit-tambov.html), February 20, 2026, <https://www1.ru/en/news/2026/02/20/navigaciiu-dlia-ms-21-i-superdzeta-obespecit-tambov.html>.
- 271 “Концерн ‘Радиоэлектронные технологии’ – крупнейший российский центр приборостроения мирового уровня” [Concern ‘Radio-Electronic Technologies’ (KRET) is the largest Russian center for world-class instrumentation engineering], KRET, accessed via the Wayback Machine, May 8, 2026, <https://web.archive.org/web/20150404034554/http://kret.com/ru/about/info/>; Maria Zholobova, “The West Has Banned the Sale of Components for Weapons Production to Russia. But Russia’s Main Weapons Manufacturer, Rostec, Is Still Buying Them,” *IStories*, January 25, 2023, <https://istories.media/en/stories/2023/01/25/the-west-has-banned-the-sale-of-components-for-weapons-production-to-russia-but-russias-main-weapons-manufacturer-rostec-is-still-buying-them/>; “EW in the Sky and on the Ground,” Rostec, March 26, 2024, <https://rostec.ru/en/media/news/ew-in-the-sky-and-on-the-ground/#start>; “15 лет КРЕТ: рождение – становление – развитие” [15 years of KRET: birth - formation - development], *Aviasalon.com*, February 19, 2024, <https://aviasalon.com/o-salone/novosti/66/>; and Tatyana Korotkova, “КРЭТ консолидировал контрольный пакет акций производителя радиолокационного оборудования ‘Фазотрон-НИИР’” [KRET consolidated a controlling stake in the radar equipment manufacturer Phazotron-NIIR], *CNews*, July 7, 2014, https://www.cnews.ru/news/line/kret_konsolidiroval_kontrolnyj_paket.
- 272 “Expanded Meeting of the Defence Ministry Board,” President of Russia, December 17, 2025, <http://www.en.special.kremlin.ru/events/president/news/78801>.
- 273 “Радиоэлектронные технологии (КРЭТ)” [Radioelectronic Technologies (KRET)], *TAdviser*, https://www.tadviser.ru/index.php/%D0%9A%D0%BE%D0%BC%D0%BF%D0%B0%D0%BD%D0%B8%D1%8F:%D0%A0%D0%B0%D0%B4%D0%B8%D0%BE%D1%8D%D0%BB%D0%B5%D0%BA%D1%82%D1%80%D0%BE%D0%BD%D0%BD%D1%8B%D0%B5_%D1%82%D0%B5%D1%85%D0%BD%D0%BE%D0%BB%D0%BE%D0%B3%D0%B8%D0%B8_%28%D0%9A%D0%A0%D0%AD%D0%A2%29.
- 274 Defence Intelligence of Ukraine, “Joint Stock Company Concern Radioelectronic Technologies (KRET),” War & Sanctions database, [Война і санкції], last updated May 12, 2026, <https://war-sanctions.gur.gov.ua/en/components/companies/3513>; and Richard Scott, “Tuning in, Turning on: Russia Brings Radio-Electronic Combat to the Fore,” *Journal of Electromagnetic Dominance* 47, no. 5, May 2024, https://www.jed-digital.com/jedm/library/item/0524_may_2024/4188404/.
- 275 “KRET Concern Radioelectronic Technologies,” *GlobalSecurity.org*, March 28, 2016, <https://www.globalsecurity.org/military/world/russia/kret.htm>; “КРЭТ впервые представил бортовой комплекс обороны «Президент-С» для рынка Индии” [KRET presented the President-S airborne defense system for the first time for the Indian market], Union of Machine Builders of Russia [Союз Машиностроителей России], February 18, 2015, <https://soyuzmash.ru/news/companies-news/kret-vpervye-predstavil-bortovoy-kompleks-oborony-prezident-s-dlya-rynka-indii/>; and Wolf SVR, “Военная приемка. ‘КРЕТ’ Часть 1. /2024/” [Military acceptance. ‘KRET’ part 1. /2024/], YouTube video, December 4, 2024, <https://www.youtube.com/watch?v=KwYlbIHomb0&t=1131s>.
- 276 Reuben Johnson, “Ukraine Just Bombed Russia’s Top Electronic Warfare Factory,” *National Security Journal*, July 28, 2025, <https://nationalecurityjournal.org/ukraine-just-bombed-russias-top-electronic-warfare-factory/>.
- 277 “Снабжает оборонку и попалался на загрязнении реки: история ставропольского радиозавода ‘Сигнал’” [Supplying the defense industry and getting caught polluting the river: the history of the Stavropol Radio Plant ‘Signal’], *Блокнот Ставрополь* [Bloknot Stavropol], September 26, 2023, <https://bloknot-stavropol.ru/news/snabzhaet-oboronku-i-popadalsya-na-zagryaznenii-re-1651498>.

- 278 “Electronic Warfare in the Sky and on the Ground,” VPK.name; “Russia to Upgrade Su-34 Bomber’s EW System Based on Ukraine Combat Experience,” TASS, May 23, 2022, <https://tass.com/defense/1454493>; and Brandon J. Weichert, “Russia Just Sent Another Batch of Su-34 Fighter-Bombers into Ukraine,” *National Interest*, December 19, 2025, <https://nationalinterest.org/blog/buzz/russia-just-sent-another-batch-su-34-fighter-bombers-into-ukraine-bw-121925>.
- 279 “История предприятия” [Company history], ПАО Ставропольский радиозавод ‘Сигнал’ [PJSC Stavropol Radio Plant Signal], accessed via Wayback Machine, archived June 1, 2021, <https://web.archive.org/web/20210601100818/http://signalrp.ru/company/history>; and “Снабжает оборонку и попался на загрязнении реки” [Supplying the defense industry and getting caught polluting the river:], Блокнот Ставрополь [Bloknot Stavropol].
- 280 “Снабжает оборонку и попался на загрязнении реки” [Supplying the defense industry and getting caught polluting the river] Блокнот Ставрополь [Bloknot Stavropol].
- 281 Елена Берг [Elena Berg], “Ставропольскому радиозаводу «Сигнал»—50! [The Stavropol Radio Plant ‘Signal’ Turns 50!],” *Комсомольская правда—Ставрополь* [Komsomolskaya Pravda – Stavropol], June 9, 2021, <https://www.stav.kp.ru/daily/27288/4425922/>.
- 282 Berg, “Ставропольскому радиозаводу” [The Stavropol Radio Plant]; and “ТПП Ставропольского края: ПАО “Сигнал” — 55 лет на службе промышленности и обороны страны” [Stavropol Krai Chamber of Commerce and Industry: PAO Signal - 55 years serving the country’s industry and defense], Торгово-промышленная палата Ставропольского края [Stavropol Chamber of Commerce and Industry], February 6, 2026, <https://stavropol.tpprf.ru/ru/news/595847/>.
- 283 Bryan Clark, “The Fall and Rise of Russian Electronic Warfare,” *IEEE Spectrum*, July 30, 2022, <https://spectrum.ieee.org/the-fall-and-rise-of-russian-electronic-warfare>; Roger N. McDermott, *Russia’s Electronic Warfare Capabilities to 2025: Challenging NATO in the Electromagnetic Spectrum* (International Centre for Defence and Security, September 2017), https://icds.ee/wp-content/uploads/2018/ICDS_Report_Russias_Electronic_Warfare_to_2025.pdf; “Russia: Radio-Electronic Battle (REB) Complexes Company,” TRADOC G2 / T2COM G2 Operational Environment Enterprise, *How They Fight Series*, <https://oe.t2com.army.mil/site-content/OEE/Russia%20Landing%20Zone/Russia-Radio-Electronic-Battle-Complexes-Company.pdf>; and Clark, “The Fall and Rise.”
- 284 “Putin Notes Multiple Growth in Production of Weapons in Demand In Special Operation Zone,” TASS, December 26, 2025, <https://tass.com/defense/2065325>.
- 285 Jakub Janovsky, Naalsio, Aloha, Dan, Kemal, and Alexander Black, “Attack on Europe: Documenting Russian Equipment Losses During the Russian Invasion of Ukraine,” Oryx, February 2022, <https://www.oryxspioenkop.com/2022/02/attack-on-europe-documenting-equipment.html>.
- 286 Ibid.
- 287 Ibid.
- 288 “Expanded Meeting of the Defence Ministry Board,” President of Russia, December 17, 2025, <http://www.en.special.kremlin.ru/events/president/news/78801>.
- 289 For open-source references to some of the systems Belousov described, see “РЭБ ‘ОБЕРЕГ’ Мобильный переносной подавитель FPV-дронов” [‘OBEREG’ Electronic Warfare System Mobile Portable FPV Drone Jammer], РЭБ “ОБЕРЕГ,” <https://oberegfpv.ru/#contacts>; “‘Пероед-М’ – новый эффективный комплекс перехвата беспилотников” [Peroed-M - a new, effective drone interception system], Дзен, March 1, 2024, <https://dzen.ru/a/ZfrfPUhoYEGSwq2>; “‘Силок’ (изделие РБ-504П-Э)” [‘Silok’ (product RB-504P-E)], Рособоронекспорт, 2025, <https://roe.ru/production/protivovozdushnaya-oborona/sredstva-radioelektronnoy-borby/kompleksy-borby-s-bpla/rb-504p-e/#>; and Daniil Irinin, “Белоусов рассказал

об эффективности ‘Соседки’” [Belousov described the effectiveness of the ‘Sosedka’], Lenta.ru, December 17, 2025, <https://lenta.ru/news/2025/12/17/belousov-rasskazal-ob-effektivnosti-sosedki/>.

- 290 These smaller, more portable systems may include, for example, the Chyorny Glaz, or “Black Eye” system (a small, mobile antenna meant to protect frontline troops and assets from drone attacks), or Concern Avtomatika’s modernized handheld Pishchal anti-drone EW system. Online correspondence with Bryan Clark, May 2026; Sofia Syngaivska, “Ukrainian Border Guards Destroy Russia’s New Black Eye EW System in the South,” *Defense Express*, October 23, 2025, https://en.defence-ua.com/news/ukrainian_border_guards_destroy_russias_new_black_eye_ew_system_in_the_south-16244.html; “Носимый комплекс противодействия беспилотным летательным аппаратам Пищаль-ПРО” [Pishchal-PRO man-portable counter-drone system], Concern Avtomatika, <https://www.ao-avtomatika.ru/catalog/products/pishchal-pro/>; and “Разработчик сообщил о модернизации комплекса ‘Пищаль-Про’ для борьбы с новыми дронами” [The developer announced the modernization of the Pishchal-Pro system to combat new drones], TASS, April 14, 2023, <https://tass.ru/armiya-i-opk/17531319>.
- 291 “Ставропольский завод КРЭТ модернизировал платформу дистанционного управления пулемётом” [KRET’s Stavropol Plant upgraded the remote-control platform for a machine gun], Rostec, March 26, 2024, https://rostec.ru/media/news/stavropolskiy-zavod-kret-moderniziroval-platformu-distantsionnogo-upravleniya-pulemetom/?sphrase_id=6813366#start.
- 292 Matthew N. Slusher, “Lessons from the Ukraine Conflict: Modern Warfare in the Age of Autonomy, Information, and Resilience,” CSIS, May 2, 2025, <https://www.csis.org/analysis/lessons-ukraine-conflict-modern-warfare-age-autonomy-information-and-resilience#h2-the-rise-of-autonomous-systems-and-their-impact-on-force-architecture->.
- 293 Thomas Withington, “The Electromagnetic Battle for Ukraine,” *Journal of Electromagnetic Dominance* 47, no. 5 (May 2024), https://www.jed-digital.com/jedm/library/item/0524_may_2024/4188399.
- 294 Expanded Meeting of the Defence Ministry Board,” Kremlin.ru, December 17, 2025, <http://www.en.special.kremlin.ru/events/president/news/78801>; and Defence Intelligence and Security Service, *National Threat Assessment 2026* (State Security Department of the Republic of Lithuania, March 2026), <https://www.vsd.lt/wp-content/uploads/2026/03/2026-GR-ENG-El.pdf>.
- 295 Dmytro Shumlianskiy, “Russians Have Begun to Serially Equip Supercam Drones with Interceptor Evasion Systems,” *Militarnyi*, September 7, 2025, <https://militarnyi.com/en/news/russians-have-begun-to-serially-equip-supercam-drones-with-interceptor-evasion-systems/>; “Russian Force Generation & Technological Adaptations Update, October 9, 2025,” Institute for the Study of War, October 9, 2025, <https://understandingwar.org/research/russia-ukraine/russian-force-generation-technological-adaptations-update-october-9-2025/>; Сергій FLASH | Про технології [Serhiy FLASH | About technologies], “Противник розробив нову систему боротьби з нашими зенітними дронами.” [The enemy has developed a new system to combat our anti-aircraft drones.], Telegram post, September 6, 2025, https://t.me/serhii_flash/6188.
- 296 “The Russian Sapphire electronic warfare system has the ability to suppress all types of drones, including FPV drones,” Top War, November 14, 2023, <https://en.topwar.ru/230166-rossijskij-kompleks-rjeb-sapfir-poluchil-vozmozhnost-podavljat-vse-tipy-bespilotnikov-vkljuchaja-fpv-drony.html>; “Sapphire Electronic Warfare System Is Presented at Dubai Airshow 2023,” RuAviation, November 13, 2023, <https://ruavia.su/sapphire-electronic-warfare-system-is-presented-at-dubai-airshow-2023/>; Ayeza Ali, “Russia’s National Guard Might Acquire ‘Sapphire’ Anti-Drone Systems - Manufacturer,” Pakistan Point, 2020, <https://www.pakistanpoint.com/en/story/1012345/russias-national-guard-might-acquire-sapphire-anti-d.html>; and “Sapphire (Antidron Complex),” TAdviser, [https://tadviser.com/index.php/Product:Sapphire_\(antidron_complex\)#::-:text=2024:%20Product%20Announcement,conditions%20and%20near%20industrial%20facilities](https://tadviser.com/index.php/Product:Sapphire_(antidron_complex)#::-:text=2024:%20Product%20Announcement,conditions%20and%20near%20industrial%20facilities).

- 297 Jodesz Gavilan, "Russia Unveils 'Multik' System to Counter Ukrainian Drone Attacks," *Defense Post*, October 21, 2025, <https://thedefensepost.com/2025/10/21/russia-multik-system/>; "Рашисти злякалися збиття вертольотів українськими дронами і вже розробили комплекс протидії, який по факту комплекс РЕБ" [The Russians were afraid of the helicopters being shot down by Ukrainian drones and have already developed a countermeasure complex, which is in fact an electronic warfare complex.], *Defense Express*, October 17, 2025, https://defence-ua.com/news/rashisti_zljakalisja_zbittja_vertolotiv_ukrajinskimi_dronami_i_vzhe_rozrobili_kompleks_protidiji_jakij_po_faktu_kompleks_reb-20578.html; Dariia Mykhailenko, "Russia Deploys 'Multik' EW Pods to Shield Helicopters from \$500 Ukrainian Drones," *United24 Media*, October 17, 2025, <https://united24media.com/latest-news/russia-deploys-multik-ew-pods-to-shield-helicopters-from-500-ukrainian-drones-12588>; and "Предприятие КРЭТ ВНИИ 'Градиент' открыло кафедру радиопизики и лабораторию РЕБ в Южном федеральном университете" [KRET VNII Gradient opened a radiophysics department and an electronic warfare laboratory at Southern Federal University], *Rostec*, March 5, 2015, <https://rostec.ru/upload/iblock/b7b/b7bead32865f1eb43560775bbb39fe6.pdf>.
- 298 "Новый комплекс РЕБ «Сания» замечен на танке Т-80БВМ" [The new Saniya electronic warfare system has been spotted on a T-80BVM tank], *www1.ru*, January 16, 2024, <https://www1.ru/news/2024/01/16/novyi-kompleks-reb-saniia-pokazali-na-tanke-t-80bvm.html>; and Ростех [Rostec] "Ростех создал комплекс по борьбе с FPV-дронами" [Rostec has built a complex to fight with FPV-drones], *VK.com post*, March 5, 2024, https://vk.com/wall-47275428_309399.
- 299 Sukhankin, "Blind, Confuse, and Demoralize."
- 300 Vytis Andreika, "Russia's Changes in the Conduct of War Based on Lessons from Ukraine: Adapting Technology, Force Structures, and the Defense Industry," *Army University Press*, September-October 2025, <https://www.armyupress.army.mil/Journals/Military-Review/English-Edition-Archives/September-October-2025/Lessons-from-Ukraine/>.
- 301 Roger McDermott, "Electronic Warfare in Contemporary Russian Military Thought," *Jamestown Foundation*, June 27, 2022, <https://jamestown.org/electronic-warfare-in-contemporary-russian-military-thought/>; Andreika, "Russia's Changes in the Conduct of War"; and Kateryna Bondar, interview with the authors, April 8, 2026.
- 302 Bondar, interview, April 8, 2026.
- 303 "Эфир под нашим надёжным контролем" [The airwaves are under our secure control], *Красная Звезда* [Red Star], April 15, 2022, <http://redstar.ru/efir-pod-nashim-nadyozhnym-kontrolem>.
- 304 Bondar, interview, April 8, 2026.
- 305 Online correspondence with Bryan Clark, May 2026.
- 306 "EW in the Sky and on the Ground," *Rostec*; and "New Ilyushin IL-76MD-90AE at the WDS," *Militär Aktuell*, February 18, 2024, <https://militaeraktuell.at/en/new-ilyushin-il-76md-90ae-at-the-wds>.
- 307 "Быть на шаг впереди. Рассказываем, на что способен антидроновый комплекс 'Сапфир'" [Stay one step ahead. We explain the capabilities of the Sapphire anti-drone system], *Fabricators.ru*, <https://fabricators.ru/article/byt-na-shag-vpered-rasskazyvaem-na-cto-sposoben-antidronovyy-kompleks-sapfir>; and "КРЭТ показывает на 'Иннопроме' антидроновый комплекс 'Сапфир' и электродвигатели для беспилотников Rostec" [KRET is showcasing the Sapphire anti-drone system and electric motors for unmanned aerial vehicles at Innoprom], July 8, 2024, <https://rostec.ru/media/news/kret-pokazyvaet-na-innoprome-antidronovyy-kompleks-sapfir-i-elektrodvigateli-dlya-bespilotnikov/#start>.
- 308 Johnson, "Why Today's Russian Airborne EW Falls Short."

- 309 Andreika, “Russia’s Changes in the Conduct of War”; and Tin Pak and Yu-cheng Chen, “Weaponizing the Electromagnetic Spectrum: The PRC’s High-powered Microwave Warfare Ambitions,” *Jamestown Foundation* (Substack), <https://jamestown.substack.com/p/weaponizing-the-electromagnetic-spectrum>.
- 310 Clark, “The Fall and Rise.”
- 311 “Electronic Warfare Complexes ‘Krasukha,’” VPK.name, May 4, 2022, https://vpk.name/en/599824_electronic-warfare-complexes-krasukha.html.
- 312 “Комплекс радиоэлектронной борьбы Красуха-С4” [Krasukha-S4 electronic warfare system], KRET, https://kret.devup.cc/ru/product/krasuka_c4/about.
- 313 Ibid.
- 314 “Electronic Warfare in the Sky and on the Ground,” VPK.name.
- 315 “Комплекс радиоэлектронной борьбы Ртуть-БМ” [Rtut-BM Electronic Warfare System], KRET, https://kret.devup.cc/ru/product/rtut_bmp/about.
- 316 Ibid.
- 317 Sergey Sukhankin, “Russian Capabilities in Electronic Warfare: Plans, Achievements and Expectations,” Jamestown Foundation, July 19, 2017, <https://jamestown.org/russian-capabilities-in-electronic-warfare-plans-achievements-and-expectations/>; and “Подтверждено присутствие на Донбассе российского комплекса СПР-2М ‘Ртуть-БМ’ (фотофакт)” [The presence of the Russian SPR-2M Rtut-BM complex in Donbas has been confirmed (photo evidence)], InformNapalm, August 16, 2016, <https://informnapalm.org/25915-kompleks-rtut-na-donbasse/>.
- 318 Chiriac and Withington, “Russian Electronic Warfare.”
- 319 “Станция радиоэлектронной разведки Москва-1Э” [Moscow-1E Electronic Intelligence Station], KRET, <https://kret.devup.cc/ru/product/moscow1e/about>.
- 320 Clark, “The Fall and Rise.”
- 321 “Станция радиоэлектронной разведки Москва-1Э” [Moscow-1E Electronic Intelligence Station], KRET.
- 322 “Комплекс радиоэлектронной борьбы Хибинь-М” [Khibiny-M electronic warfare system], KRET, <https://kret.devup.cc/ru/product/hibiny/about>.
- 323 Ibid.; and “Electronic Warfare in the Sky and on the Ground,” VPK.name.
- 324 “Electronic Warfare in the Sky and on the Ground,” VPK.name
- 325 Piotr Butowski, “This Is Russia’s Electronic Warfare Helicopter Jamming in Ukraine,” War Zone, October 10, 2022, <https://www.twz.com/this-is-russias-electronic-warfare-helicopter-jamming-in-ukraine>.
- 326 “Mi-8: Russia’s Electronic Countermeasures Helicopter,” Key.Aero, <https://www.key.aero/article/mi-8-russias-electronic-countermeasures-helicopter>; and Johnson, “Ukraine Just Bombed.”
- 327 “Вертолетная станция активных помех Л187АЭ” [Helicopter active jamming station L187AE], KRET, <https://kret.devup.cc/ru/product/l187ae/about>.
- 328 А.А. Морозов [A.A. Morozov] “Конкурс «Авиастроитель года»: Вертолетный комплекс РЭБ «Рычаг-АВ-Э»: Описание конкурсной работы” [Aircraft Builder of the Year Competition: “Rychag-AV-E” Helicopter-Based Electronic Warfare System - Description of the Competition Entry] АО «Калужский научно-исследовательский радиотехнический институт» (АО «КНИРТИ») [JSC “Kaluga Scientific Research Radio Engineering Institute” (JSC KNIRTI)], https://www.aviationunion.ru/konkurs/docs/2017/7/Nom_7_KNIRTI.pdf.

- 329 Butowski, “This Is Russia’s Electronic Warfare.”
- 330 Ibid.
- 331 Ritu Sharma, “With 18 Missiles ‘Blocked’, Russia’s Vitebsk-25 Electronic Warfare System Saves the Day for Ka-52 Alligator,” *Eurasian Times*, June 13, 2023, <https://www.eurasiantimes.com/with-18-missiles-blocked-russias-vitebsk-25-ew-system/>; and Stefano D’Urso, “Let’s Talk About the Vitebsk L370, the Russian New Generation Directional IR Countermeasure (DIRCM) System,” *The Aviationist*, July 8, 2020, <https://theaviationist.com/2020/07/08/lets-talk-about-the-vitebsk-l370-the-russian-new-generation-directional-ir-countermeasure-dircm-system/>.
- 332 Sharma, “With 18 Missiles ‘Blocked.’”
- 333 “В Индии показали экспортную версию комплекса обороны ‘Президент-С’” [An export version of the President-S defense system was unveiled in India.], Lenta.ru, February 18, 2025, https://lenta.ru/news/2015/02/18/president_s/; D’Urso, “Let’s Talk About the Vitebsk L370”; and Dylan Malyasov, “Mi-17V-5 Helicopter Equipped with President-S Onboard Defence System Spotted in Egypt,” *Defence Blog*, September 12, 2017, <https://defence-blog.com/mi-17v-5-helicopter-equipped-with-president-s-onboard-defence-system-spotted-in-egypt/>.
- 334 “Бортовой комплекс обороны ‘Президент-С’” [President-S airborne defense system], KRET, https://kret.devup.cc/ru/product/prezident_s/about; and Wolf SVR, “Военная приемка. ‘КРЕТ’ Часть 1. /2024 г./” [Military acceptance. ‘KRET’ part 1. /2024/].
- 335 Wolf SVR, “Военная приемка. ‘КРЕТ’ Часть 1. /2024 г./” [Military acceptance. ‘KRET’ part 1. /2024/].
- 336 D’Urso, “Let’s Talk About the Vitebsk L370.”
- 337 Johnson, “Why Today’s Russian Airborne EW Falls Short”; and Withington, “The Electromagnetic Battle for Ukraine.”
- 338 “Ростех участвует в подготовке нового кадрового резерва для ОПК” [Rostec is participating in the preparation of a new personnel reserve for the defense industry], Союз Машиностроителей России [Union of Machine Builders of Russia], April 10, 2025, <https://soyuzmash.ru/news/tidings/roste-kh-uchastvuet-v-podgotovke-novogo-kadrovogo-rezerva-dlya-opk-hr-kadry/>.
- 339 “Natalia Beloborodova: How Rostec Forms an Ecosystem for Professionals,” VPK.name, February 14, 2024, https://vpk.name/en/825774_natalia-beloborodova-how-rostec-forms-an-ecosystem-for-professionals.html; and “КРЭТ открыл в Ставрополе центр подготовки специалистов для машиностроения” [KRET opened a training center for mechanical engineering specialists in Stavropol], Rostec, September 18, 2023, <https://rostec.ru/media/news/kret-otkryl-v-stavropole-tsentr-podgotovki-spetsialistov-dlya-mashinostroeniya/#start>.
- 340 “Ukraine Says Its Long-Range Drones Hit Electronic Warfare Plant in Russia,” Reuters, July 26, 2025, <https://www.reuters.com/business/aerospace-defense/ukraine-says-its-long-range-drones-hit-electronic-warfare-plant-russia-2025-07-26/>; and Johnson, “Ukraine Just Bombed.”
- 341 Department of Commerce Bureau of Industry and Security, “Addition of Certain Entities to the Entity List, Revision of Entries on the Entity List, and Removal of Entities From the Entity List,” Federal Register, August 14, 2019, <https://www.federalregister.gov/documents/2019/08/14/2019-17409/addition-of-certain-entities-to-the-entity-list-revision-of-entries-on-the-entity-list-and-removal>; Department of Commerce Bureau of Industry and Security, “Addition of Entities to the Entity List,” Federal Register, June 6, 2022, <https://www.federalregister.gov/documents/2022/06/06/2022-12144/additions-of-entities-to-the-entity-list>; Maria Zholobova, “The West Has Banned the Sale of Components for Weapons Production to Russia. But Russia’s Main Weapons Manufacturer, Rostec, Is Still Buying Them,” Important Stories, January 25, 2023, <https://istories.media/en/stories/2023/01/25/the-west-has-banned-the-sale-of-compo->

- nents-for-weapons-production-to-russia-but-russias-main-weapons-manufacturer-rostec-is-still-buying-them/; and “PJSC PZ ‘Signal,’” Open Sanctions, last updated May 11, 2025, <https://www.opensanctions.org/entities/NK-iBfqSJWv2cNGWBU3bngHDX/>.
- 342 Zholobova, “The West Has Banned.”
- 343 “Izhmash Group Enterprises,” Official Site of the Prime Minister of the Russian Federation, May 25, 2010, <http://archive.premier.gov.ru/eng/visits/ru/10716/info/10713/print/#:~:text=The%20Izhevsk%20plant%20managed%20to,managing%20company%20Izhmash%2DHolding>.
- 344 “About Kalashnikov,” Rostec, accessed via the Wayback Machine, captured January 21, 2018, <https://web.archive.org/web/20180121181605/http://rostec.ru/en/about/holdings/165>; Alexander Panin, “Kalashnikov Targets Costs and Inefficiency After \$50M Loss,” *Moscow Times*, February 1, 2014, <https://www.themoscowtimes.com/archive/kalashnikov-targets-costs-and-inefficiency-after-50m-loss>.
- 345 Defence Intelligence of Ukraine, “IMZ JSC,” War & Sanctions database, last updated April 15, 2026, <https://war-sanctions.gur.gov.ua/en/rostec/3330>.
- 346 “Kalashnikov Concern,” TAdviser, https://tadviser.com/index.php/Company:Kalashnikov_Concern; and Anna Sorokina, “Kalashnikov Concern Sees First Net Profit in 7 Years,” *Russia Beyond*, February 10, 2015, https://www.rbth.com/defence/2015/02/10/kalashnikov_concern_sees_first_net_profit_in_7_years_43579.html.
- 347 “Kalashnikov Makes First Profit in 7 Years Despite Russian Sanctions,” *Moscow Times*, February 8, 2015, <https://www.themoscowtimes.com/2015/02/08/kalashnikov-makes-first-profit-in-7-years-despite-russian-sanctions-a43660>; James Marson and Thomas Grove, “Kalashnikov Finds Success Even After U.S. Sanctions,” *Wall Street Journal*, last updated July 13, 2017, <https://www.wsj.com/articles/kalashnikov-finds-success-even-after-u-s-sanctions-1499943603>; and “Kalashnikov’s Revenue Up 280% in 2018,” TASS, March 21, 2019, <https://tass.com/defense/1049889>.
- 348 “Kalashnikov Concern,” TAdviser.
- 349 Sandzhi Vankaev, “Ministry of Finance and the Bank of Russia Clarify Rules of Disclosure of Sanctions-Sensitive Information by Issuers,” *Denuo*, January 13, 2025, <https://denuo.legal/en/insights/news/250113/>; and Russian Federation, “О внесении изменений в перечень сведений, отнесенных к государственной тайне, утвержденный Указом Президента Российской Федерации от 30 ноября 1995 г. № 1203” [“On Amendments to the List of Information Classified as State Secrets Approved by Decree No. 1203 of the President of the Russian Federation of November 30, 1995”], *Official Internet Portal of Legal Information* (Pravo.gov.ru), June 24, 2025, <http://publication.pravo.gov.ru/document/0001202506240053>.
- 350 “DIU Publishes Data on 39 Enterprises Belonging to the Russian Kalashnikov Concern,” *ArmyInform*, February 16, 2026, <https://armyinform.com.ua/en/2026/02/16/diu-publishes-data-on-39-enterprises-belonging-to-the-russian-kalashnikov-concern/>.
- 351 “Информация о компании” [Company information], Информационно-образовательный портал TheHRD.ru [Information and Educational Portal TheHRD.ru], https://thehrd.ru/companies/ao_kontsern_kalashnikov/.
- 352 “Kalashnikov Industrial Complex Listed on Federal Register,” Kalashnikov, December 9, 2022, <https://en.kalashnikovgroup.ru/news/kalashnikov-industrial-complex-listed-on-federal-register>.
- 353 Awad Mustafa, “Kalashnikov Expands Business to Drones, Boats,” *DefenseNews*, February 22, 2015, <https://www.defensenews.com/digital-show-dailies/index/2015/02/22/kalashnikov-expands-business-to-drones-boats>.

- 354 Bondar, *How Russia Is Building*.
- 355 Bondar, interview, April 8, 2026.
- 356 Bondar, *How Russia Is Building*.
- 357 “Kalashnikov Industrial Cluster,” Kalshnikov, <https://en.kalashnikovgroup.ru/dzo/promyshlennyi-klastern-kalashnikov>.
- 358 Defence Intelligence of Ukraine, “Joint-Stock Company Mytishchi Machine-Building Plant,” War & Sanctions database, <https://war-sanctions.gur.gov.ua/en/tools/company/4673>.
- 359 “Military Attachés of Friendly Countries Praise Kalashnikov Concern Products,” Kalashnikov, March 16, 2023, <https://en.kalashnikovgroup.ru/news/military-attach-s-of-friendly-countries-praise-kalashnikov-concern-products;%20>; and “ТРИАДА ТКО” [TKO Triad], Arsenal, <https://arsenal-bl.by/brands/gruppa-99-kalashnikov.html>.
- 360 Rosoboronexport, “Sterlok Combat Gear Kit,” YouTube video, April 11, 2025, <https://www.youtube.com/watch?v=abIHETyLIac&t=11s>; <https://youtu.be/IDcJWmam2bw?si=cfcZFcw1F8zWb4>; and “Kalashnikov Group Commences New Uniform Supply,” Kalashnikov, May 5, 2023, <https://en.kalashnikovgroup.ru/news/kalashnikov-group-commences-new-uniform-supply>.
- 361 “How Russia Fights: A Compendium of Troika Observations on Russia’s Special Military Operation,” United States Army Europe and Africa, March 2025, <https://api.army.mil/e2/c/downloads/2025/07/11/f2b1e75e/how-russia-fights-a-compendium-of-troika-observations-on-russia-s-special-military-operations.pdf>.
- 362 “Проект ‘Архангел’ будет готовить операторов БПЛА в Москве, Петербурге и Брянске” [The Archangel project will train UAV operators in Moscow, St. Petersburg, and Bryansk], TASS, April 1, 2026, <https://tass.ru/obschestvo/26957557>; and Defence Intelligence of Ukraine, “Archangel Limited Liability Company,” War & Sanctions database, <https://war-sanctions.gur.gov.ua/en/uav/companies/14297>.
- 363 Bondar, *How Russia Is Building*.
- 364 Ilya Maximov, “‘Калашников’ наладит производство дронов от народного ВПК” [Kalashnikov will establish production of drones from the national defense industry], *Российская газета* [Rossiyskaya Gazeta], August 27, 2025, <https://rg.ru/2025/08/27/kalashnikov-naladit-proizvodstvo-dronov-ot-narodnogo-vpk.html>; “Kalashnikov Is Developing Line of UAVs Based on Arkhangel Project Drones,” TASS, December 1, 2025, <https://tass.com/defense/2051543>; and Bondar, *How Russia Is Building*.
- 365 Javeria Sajid and Muhammad Mudassir, “Kalashnikov Begins Making New Archangel Drones for Russian Forces,” Global Defense Insight, August 28, 2025, <https://defensetalks.com/kalashnikov-begins-making-new-archangel-drones-for-russian-forces/>.
- 366 Accounting forms for 2020, 2022, 2023, and 2024 are not available in the Federal Tax Service database, according to Kontur. Available filings exist behind a paywall only for 2018, 2019, and 2021. This likely reflects an intentional move, as Russian defense enterprises are legally permitted to withhold financial disclosures to limit sanctions exposure. See “Постановление Правительства РФ от 16 сентября 2022 г. № 1624” [Russian Government Resolution No. 1624 of September 16, 2022], Garant.ru, September 21, 2022, <https://www.garant.ru/products/ipo/prime/doc/405207681/>; Larisa Bodrova, “Ограничение доступа к ГИР БО в 2024 году” [Restricting access to the State Register of Industrial Property in 2024], Kontur.Extern, last updated March 25, 2024, https://www.kontur-extern.ru/info/31245-ogranichenie_dostupa_k_gir_bo; “Russian Government Has Extended the Right of Companies Not to Disclose Financial Statements Until 1 July 2023,” Arbitration Journal, December 27, 2022, <https://journal.arbitration.ru/news/russian-government-has-extended-the-right-of-companies-not-to-disclose-financial-statements-until-1->; “Компаниям разрешили не раскрывать отчетность до июля 2023 года” [Companies are allowed

- to withhold financial statements until July 2023], RBC.ru, November 28, 2022, <https://www.rbc.ru/quote/news/article/638470639a794723d4dd1b01>; Stephanie Stacey, “Kalashnikov Boosted Production by 40% Last Year as the Russian Army Kept Buying Weapons to Use in Ukraine,” *Business Insider*, January 15, 2023, <https://www.businessinsider.com/kalashnikov-posts-record-sales-following-putins-invasion-of-ukraine-2023-1>; “‘Калашников’ подвел итоги 2022 года” [Kalashnikov summed up the results of 2022], Kalashnikov, January 12, 2023, https://kalashnikovgroup.ru/news/kalashnikov_podvel_itogi_2022_goda; “В 2023 году ‘Калашников’ нарастил производство спецтехники на 45%” [In 2023, Kalashnikov increased production of special equipment by 45%], Rostec, January 11, 2024, <https://rostec.ru/media/news/v-2023-godu-kalashnikov-narastil-proizvodstvo-spetstekhniki-na-45/#middle>; “‘Калашников’ увеличил выпуск военной и гражданской продукции” [Kalashnikov increased production of military and civilian products], Rostec, July 22, 2024, <https://rostec.ru/media/news/kalashnikov-uvelichil-vypusk-voennoy-i-grazhdanskoy-produktsii/#middle>; and “Kalashnikov: Output of Military and Civilian Products Grows by 50% in H1 2024,” Kalashnikov, July 22, 2024, <https://en.kalashnikovgroup.ru/news/kalashnikov-output-of-military-and-civilian-products-grows-by-50-in-h1-2024>.
- 367 “Kalashnikov Plant Increases Revenue by 58% Thanks to Rifles and Guns,” *www1.ru*, July 29, 2025, <https://www1.ru/en/news/2025/07/29/zavod-kalashnikova-uvelicil-vyrucku-na-58-blagodaria-ruziam-i-vintovkam.html>.
- 368 “Kalashnikov’s Revenue in 10 Months of 2024 Surpasses Entire 2023 Figure by 14.5%,” Kalashnikov, November 8, 2024, <https://en.kalashnikovgroup.ru/news/kalashnikov-s-revenue-in-10-months-of-2024-surpasses-entire-2023-figure-by-14-5>; and “Kalashnikov: H1 2025 Production Plan 100% Met,” Kalashnikov, August 13, 2025, <https://en.kalashnikovgroup.ru/news/kalashnikov-h1-2025-production-plan-100-met>.
- 369 “Kalashnikov Plant Increases Revenue by 58%,” *www1.ru*.
- 370 “‘Мы должны делать то, что у нас хорошо получается’” [‘We must do what we are good at.’], *Kommer-sant*, August 10, 2022, <https://www.kommersant.ru/doc/5502371>.
- 371 “Kalashnikov Increases Production Volume by 50% in Q1, 2024,” Kalashnikov, May 2, 2024, <https://en.kalashnikovgroup.ru/news/kalashnikov-increases-production-volume-by-50-in-q1-2024>; “Kalashnikov Fulfils 120% of Civilian Weapons Production Plan,” Kalashnikov, December 5, 2024, <https://en.kalashnikovgroup.ru/news/kalashnikov-fulfils-120-of-civilian-weapons-production-plan>; and “Kalashnikov Increases Revenue Under Export Contracts,” Kalashnikov, January 28, 2025, <https://en.kalashnikovgroup.ru/news/kalashnikov-increases-revenue-under-export-contracts>.
- 372 Bondar, *How Russia Is Building*; “Alan Lushnikov: Every Weapons Ban Negatively Affects Homeland Security,” Kalashnikov, March 24, 2023, <https://en.kalashnikovgroup.ru/news/alan-lushnikov-every-weapons-ban-negatively-affects-homeland-security>; and “Saiga rifles and carbines are based on the Kalashnikov assault rifle,” “Saiga Rifles,” *Izhmash*, archived February 8, 2010, via the Internet Archive Wayback Machine, <https://web.archive.org/web/20100208224350/http://www.izhmash.ru/eng/product/saiga.shtml>.
- 373 Reuters, “Russian Arms Maker Kalashnikov Launches Division for Production of Kamikaze Drones,” *Alarabiya English*, May 26, 2023, <https://english.alarabiya.net/News/world/2023/05/26/Russian-arms-maker-Kalashnikov-launches-division-for-production-of-kamikaze-drones>.
- 374 Dmitry Chernov, “Восемь новых инвестпроектов запустит в ближайшее время концерн ‘Калашников’” [The Kalashnikov concern will launch eight new investment projects in the near future.], *Udm-info*, September 18, 2025, <https://udm-info.ru/news/2025-09-18/vosem-novyh-investproektov-zapustit-v-blizhayshee-vremya-kontsern-kalashnikov-5476650>.

- 375 “Kalashnikov Launches New Precision Weapons Production Floor,” Kalashnikov, September 20, 2023, <https://en.kalashnikovgroup.ru/news/kalashnikov-launches-new-precision-weapons-production-floor>; and “Kalashnikov Completes All Contracts for Supply of High-Precision Armaments in December 2024,” Kalashnikov, January 14, 2025, <https://en.kalashnikovgroup.ru/news/kalashnikov-completes-all-contracts-for-supply-of-high-precision-armaments-in-december-2024>.
- 376 Robyn Dixon, “In Home of Kalashnikov, Russians Fight Plan to Turn Mall into Drone Factory,” *Washington Post*, January 26, 2023, <https://www.washingtonpost.com/world/2023/01/26/russia-izhevsk-drone-mall>; <https://lenta.ru/articles/2023/08/09/lantcet/>; “Shopping Malls in Central Russia Converted Into Drone Plants,” *Moscow Times*, September 15, 2023, <https://www.themoscowtimes.com/2023/09/15/shopping-malls-in-central-russia-converted-into-drone-plants-a82477>; and Dinara Khalilova, “Alleged Drone Factory Catches Fire in Russia’s Izhevsk,” *Kyiv Independent*, February 17, 2024, <https://kyivindependent.com/alleged-drone-factory-catches-fire-in-russias-izhevsk>.
- 377 “Russians Convert Another Shopping Mall into a Military UAV Factory Endangering Locals,” *Defense Express*, January 24, 2025, https://en.defence-ua.com/industries/russians_convert_another_shopping_mall_into_a_military_uav_factory_endangering_locals-13303.html.
- 378 “Kalashnikov Concern,” TAdviser.
- 379 “‘Мы должны делать то, что у нас хорошо получается’ [‘We must do what we are good at’], *Kommersant*.
- 380 “Russia’s Kalashnikov Arms Producer Sees First Net Profit in 7 Years,” TASS, February 6, 2015, <https://tass.com/economy/775857>; and “Production of Self-Loading Service Rifles” in *Global Development and Production of Self-Loading Service Rifles: 1896 to the Present*, by N. R. Jenzen-Jones (Small Arms Survey, 2017), <https://www.jstor.org/stable/resrep10728.10>.
- 381 Dylan Malyasov, “Russia Orders 150,000 Latest Kalashnikov Assault Rifles,” *Defence Blog*, April 8, 2019, <https://defence-blog.com/russia-orders-150000-latest-kalashnikov-assault-rifles/>.
- 382 “Amid Russia’s Attack on Ukraine, Iconic Arms-Maker Kalashnikov Is Churning Out a Record Number of Guns,” *Business Insider*, November 4, 2022, <https://www.businessinsider.com/russian-gunmaker-kalashnikov-churns-out-weapons-amid-war-in-ukraine-2022-11>.
- 383 Pavel Luzin, interview with the authors, March 17, 2026.
- 384 Redaktion, “Warrior: New AKs for the Russian Army,” *Spartanat*, August 5, 2019, <https://spartanat.com/en/ratnik-neue-aks-fuer-die-russische-armee>.
- 385 Stacey, “Kalashnikov Boosted Production by 40%”; and Peter Suci, “Russia Continues to Improve the AK-12 Assault Rifle,” *National Interest*, January 21, 2026, <https://nationalinterest.org/blog/buzz/russia-continues-improve-ak-12-assault-rifle-ps-012126>.
- 386 “Kalashnikov Ships 2026’s First Batch of Shortened AK-12K Rifles,” Kalashnikov, February 24, 2026, <https://en.kalashnikovgroup.ru/news/kalashnikov-ships-2026-s-first-batch-of-shortened-ak-12k-rifles>; and “Kalashnikov Begins Production of Upgraded PPK-20 Submachine Gun,” TASS, January 21, 2026, <https://tass.com/defense/2074567>.
- 387 Mustafa, “Kalashnikov Expands Business.”
- 388 “Skat-350M Russian Unmanned Aerial Vehicle (UAV),” ODIN, last updated August 20, 2025, <https://odin.tradoc.army.mil/WEG/Asset/c897596c5fdb70bd340287649fb12179>. Comparable ISR systems (e.g., Orlan-10) are reportedly produced at a rate of over 1,000 annually in the post-2022 surge era. See “Russia Increases Output of Orlan Drones Several Times,” TASS, February 15, 2024, <https://tass.com/defense/1746679>; and “‘Granat-4’, ‘Tachyon’ drones and mock-ups of Kalashnikov assault rifles were shown

- at the exhibition in Izhevsk,” *www1.ru*, February 13, 2026, <https://www1.ru/en/news/2026/02/13/bespilotniki-granat-4-taxion-i-makety-avtomatov-kalashnikova-pokazali-na-vystavke-v-izevske.html>.
- 389 Anton Kopylov, “100 километров под контролем: концерн ‘Калашников’ из Ижевска создал новый боеприпас” [100 kilometers under control: Izhevsk-based Kalashnikov Concern has created a new ammunition], *Udm-info*, February 26, 2026, <https://udm-info.ru/news/2026-02-26/100-kilometrov-pod-kontrolem-kontsern-kalashnikov-iz-izhevsk-sozdal-novyy-boeprilas-5555617>.
- 390 “Russia’s AI-powered loitering munition can independently identify targets,” TASS, February 2, 2026, <https://tass.com/defense/2080261>.
- 391 Bondar, *How Russia Is Building*.
- 392 Bondar, interview, April 8, 2026.
- 393 Anna Holishevska, “Kalashnikov Increases Production of Missiles and Ammunition Despite Sanctions,” *Trap Aggressor*, March 24, 2025, <https://trap.org.ua/en/publications/kalashnikov-increases-production-of-missiles-and-ammunition-despite-sanctions>.
- 394 “Kalashnikov Expands Spy, Kamikaze Drone Production by 10 Times,” *EFE*, December 24, 2024, <https://efe.com/latest-news/2024-12-24/kalashnikov-drone-production>; and Gregory Pearson, “Russia Drone Industry Statistics,” *WifiTalents*, February 12, 2026, <https://wifitalents.com/russia-drone-industry-statistics>. For comparison, in 2026 Russia can reportedly produce Shahed-like drones at roughly 60,000 units annually if running at maximum capacity. See Ryan Duffy, “Ships, Shaheds & Scale,” *Per Aspera*, March 6, 2026, <https://www.peraspera.us/ships-shaheds-scale>.
- 395 David Hambling, “Dangerously Smart: Russia’s Independent Attack Drone Developers,” *Forbes*, January 24, 2025, <https://www.forbes.com/sites/davidhambling/2025/01/24/dangerously-smart-russias-independent-attack-drone-developers>.
- 396 “ZALA ‘Lancet’ - October 2024,” *ZALA Aero*, November 2, 2024, <https://zala-aero.com/en/news/zala-lancet-oktjabr-2024/>; “ZALA Lancet: Top 100 Video Applications by the End of 2025,” *ZALA Aero*, January 12, 2026, <https://zala-aero.com/en/news/zala-lancet-top-100-video-primenenij-po-itogam-2025-goda>; and Nikolay Novichkov, “IDEX 2025 - Zala Aero Showcases Improved Lancet Loitering Munitions,” *European Defence Review*, February 21, 2025, <https://www.edrmagazine.eu/idx-2025-zala-aero-showcases-improved-lancet-loitering-munitions>.
- 397 Kyiv Independent, “Who Helped Russians,” YouTube.
- 398 Alisa Yurchenko, “Investigation: Who Helped Russians Increase Production of Domestic Attack Drones Despite Sanctions,” *Kyiv Independent*, November 21, 2024, <https://kyivindependent.com/investigation-who-helped-russians-increase-production-of-domestic-attack-drones-despite-sanctions>; “Overcoming Russia’s Arms Stockpile Exhaustion,” (forthcoming), Center for European Policy Analysis, 2026; and “Барражирующие боеприпасы «Ланцет»” [“Lancet” Loitering Munitions], *Lostarmour*, <https://lostarmour.info/tags/lancet>.
- 399 Authors’ email correspondence with Federico Borsari, May 5, 2026. Note that any production ramp-up largely depends on government’s contract/orders and foreign procurement.
- 400 Vlad Litnarovych, “Russia Straps Kalashnikov to FPV Drone, Claims it Can Storm Positions and Shoot Down Aircraft,” *United24 Media*, September 11, 2025, <https://united24media.com/latest-news/russia-straps-kalashnikov-to-fpv-drone-claims-it-can-storm-positions-and-shoot-down-aircraft-11574>; and Andrii Galadei, “The Enemy Has Developed an FPV Drone with a Machine Gun for Assaults and Column Protection,” *Mezha*, September 11, 2025, <https://oboronka.mezha.ua/en/v-rosiji-rozrobili-dron-z-avtomatom-304748>.

- 401 “‘Калашников’: БПЛА ‘Голиаф’ и ‘Каракурт’ научили перестраивать частоту в полете” [Kalashnikov: Goliath and Karakurt UAVs learned to change frequencies in flight], TASS, January 18, 2026, <https://tass.ru/armiya-i-opk/26181151>.
- 402 “Rosoboronexport to showcase 400+ Russian defense products at Vietnam Defense 2022 in Hanoi,” Rosoboronexport (Russian Defence Export), December 5, 2024, <https://roe.ru/en/media/posts/kategoriya-1/rosoboronexport-to-showcase-400-russian-defense-products-at-vietnam-defense-2022-in-hanoi/>; “Kalashnikov to Showcase SMO-Tested Products in Riyadh,” Kalashnikov, January 31, 2024, <https://en.kalashnikovgroup.ru/news/kalashnikov-to-showcase-smo-tested-products-in-riyadh/>; “Rosoboronexport to Exhibit Lancet-E Loitering Munition System Overseas for First Time at ADEX 2024,” Rosoboronexport (Russian Defence Export), September 23, 2024, https://roe.ru/upload/pdf/1348_post.pdf; “Rosoboronexport to Exhibit Products for Enhancing Security on the African Continent at AAD 2024,” Rostec, September 16, 2024, <https://rostec.ru/en/media/news/rosoboronexport-to-exhibit-products-for-enhancing-security-on-the-african-continent-at-aad-2024/#middle>; “ZALA ‘Lancet-E’ at the Exhibition in South-East Asia,” ZALA Aero, December 18, 2024, <https://zala-aero.com/en/news/zala-lancet-je-na-vystavke-v-jugo-vostochnoj-azii/>; “Барражирующий боеприпас ‘Калашникова’ Куб-2Э подтвердил надёжность как средство уничтожения живой силы” [The Kalashnikov Kub-2E loitering munition has proven its reliability as a means of destroying manpower], www1.ru, April 16, 2026, <https://www1.ru/news/2026/04/16/barraziruiushhii-boepripas-kalashnikova-kub-2e-podtverdil-nadeznost-kak-sredstvo-unichtozeniia-zivoi-sily.html>; and “Russia Showcases over 400 Military Products at DSA Exhibition in Kuala Lumpur,” TASS, April 23, 2026, <https://tass.com/defense/2121457>.
- 403 “Russia plans to sign contracts on Lancet-E munition with Africa, Mideast countries,” TASS, May 26, 2026, <https://tass.com/defense/2136561>.
- 404 “Kalashnikov Close to Agreement with India on Anti-Drone Cartridges,” TASS, June 24, 2026, <https://tass.com/economy/2151069>; “Kalashnikov to Start Selling the Karakurt Drone to India,” TASS, June 25, 2026, <https://tass.com/economy/2151567>.
- 405 “Kalashnikov to Participate in Tender with SKAT 350M Drone,” TASS, June 24, 2026, <https://tass.com/economy/2151073>.
- 406 “Kalashnikov Group Subsidiary ZALA Aero Develops Counter-UAV System,” UAS Weekly, August 25, 2017, <https://uasweekly.com/2017/08/25/kalashnikov-group-subsidiary-zala-aero-develops-counter-uav-system/>; and Eric B., “POTD: Russian MP-155 Setup Designed for Night & Day Drone Hunts,” *TheFireArmBlog.com*, <https://www.thefirearmblog.com/blog/potd-russian-mp-155-setup-designed-for-night-day-drone-hunts-44824537>.
- 407 “Kalashnikov’s Krona Short-Range Air Defense System Undergoing Testing,” Deagel, April 13, 2026, <https://www.deagel.com/news/n000027488>.
- 408 “Kitolov-2M,” Kalashnikov, <https://en.kalashnikovgroup.ru/catalog/raketno-artilleriyskoe-vooruzhenie/upravlyaemye-artilleriyskie-vystrely/kitolov-2m>.
- 409 “Russia Reinforces Short-Range Air Defense with New 9M333 Missile Deliveries for Strela-10 Systems,” *Army Recognition*, Global Defense News, March 10, 2026, <https://www.armyrecognition.com/news/army-news/2026/russia-reinforces-short-range-air-defense-with-new-9m333-missile-deliveries-for-strela-10-systems>.
- 410 “‘Kalashnikov’ Sharply Increased Production of Machine Tools and Loaded the Plant with Orders for 2026,” www1.ru, January 12, 2026, <https://www1.ru/en/news/2026/01/12/kalashnikov-rezko-uvelicil-vypusk-stankov-i-zagruzil-zavod-zakazami-na-2026-god.html>; “Kalashnikov Keeps Ramping Up Machine Tool Production,” Kalashnikov, April 9, 2025, <https://en.kalashnikovgroup.ru/news/kalashnikov-keeps-ramping-up-machine-tool-production/>; and Defence Intelligence of Ukraine, “Concern

Kalashnikov JSC,” War & Sanctions database, last updated April 15, 2026, <https://war-sanctions.gur.gov.ua/en/rostec/456>.

- 411 “Kalashnikov in 2023: Machine Tool Output Grew by 65%,” Kalashnikov, January 12, 2024, <https://en.kalashnikovgroup.ru/news/kalashnikov-in-2023-machine-tool-output-grew-by-65>.
- 412 “‘Калашников’ увеличил выпуск” [Kalashnikov increased production], Rotsec; “Kalashnikov Increases High-Precision Machine Tool Production by 10% in 2025,” TASS, January 12, 2026, <https://tass.com/defense/2070085>; and “Russia Talks Self-Reliance, But 98% of Its Machine Tools Bought in 2024 Are Foreign-Made,” United24 Media, April 22, 2025, <https://united24media.com/latest-news/russia-talks-self-reliance-but-98-of-its-machine-tools-bought-in-2024-are-foreign-made-7768>.
- 413 “Kalashnikov Machine Tool Building: 2,000+ Models in 95 Years,” Kalashnikov, July 28, 2025, <https://en.kalashnikovgroup.ru/news/kalashnikov-machine-tool-building-2-000-models-in-95-years>; “Updated IT-42S CNC Lathe from Kalashnikov Presented in Moscow,” *www1.ru*, May 30, 2025, <https://www1.ru/en/news/2025/05/30/obnovlenniy-tokarniy-standok-s-cpu-it-42s-ot-kalashnikova-predstavili-v-moskve.html>; and “CNC Machines,” Kalashnikov, <https://en.kalashnikovgroup.ru/catalog/neoruzhynoe-proizvodstvo/produksiya-promyshlennogo-naznacheniya/stankostroenie/tokarnye-stanki-s-chpu>.
- 414 “CNC Machines,” Kalashnikov.
- 415 “Updated IT-42S CNC Lathe from Kalashnikov Presented in Moscow,” *www1.ru*, May 30, 2025, <https://www1.ru/en/news/2025/05/30/obnovlenniy-tokarniy-standok-s-cpu-it-42s-ot-kalashnikova-predstavili-v-moskve.html>; and Julian Cooper, “The Machine Tool Industry of Russia at a Time of War and Sanctions,” *Post-Communist Economies* 36, no. 5 (2024): 527–561, <https://doi.org/10.1080/14631377.2024.2325787>.
- 416 Cooper, “The Machine Tool Industry of Russia.”
- 417 “Kalashnikov Increases High-Precision Machine Tool Production,” TASS.
- 418 “Russia Imported \$50 Million Worth of Thermal Imaging Components in 2024, Essential for Its Military and Defense Industry,” *The Insider*, February 19, 2025, <https://theins.ru/en/news/278968>; “LOMO Passes into Kalashnikov Concern’s Management,” Kalashnikov, May 16, 2024, <https://en.kalashnikovgroup.ru/news/lomo-passes-into-kalashnikov-concern-s-management>; and “LOMO,” *New Technologies*, <https://nt-rt.ru/en/brand/1576>.
- 419 “2 тысячи сотрудников дополнительно привлекут на концерн «Калашников» в Удмуртии в 2023 году” [An additional 2,000 employees will be hired at the Kalashnikov Concern in Udmurtia in 2023], *Kommersant*, June 30, 2023, <https://www.kommersant.ru/doc/6071247>.
- 420 Holishevskaya, “Kalashnikov Increases Production”; and “Kalashnikov to Open a New Precision Weapons Manufacturing Facility,” Kalashnikov, April 25, 2024, <https://en.kalashnikovgroup.ru/news/kalashnikov-to-open-a-new-precision-weapons-manufacturing-facility>.
- 421 “‘Калашников’ увеличил выпуск” [Kalashnikov increased production], Rotsec.
- 422 Open positions include 227 in the Udmurt Republic (Izhevsk, Sarapul, Votkinsk, etc); 10 in Rybinsk; 191 in Moscow Oblast (Mytishi, Moscow, Podolsk); and 91 in other regions (Chaykovsky, Agryz, Kirov, etc).
- 423 “Kalashnikov Concern and the Government of the Udmurt Republic Strengthen Cooperation,” Kalashnikov, June 29, 2023, <https://en.kalashnikovgroup.ru/news/kalashnikov-concern-and-the-government-of-the-udmurt-republic-strengthen-cooperation>; Julia Struck-Feshchenko, “Kalashnikov Arms Producer Turns to Schoolkids to Keep Russia’s War Machine Running,” *Kyiv Post*, June 19, 2025, <https://www.kyivpost.com/post/54767>; and “Участников СВО в Удмуртии будут трудоустраивать в Концерн ‘Калашников’” [SVO participants in Udmurtia will be employed by the Kalashnikov Concern], *Udm-info*,

- September 27, 2025, <https://udm-info.ru/news/2025-09-27/uchastnikov-svo-v-udmurtii-budut-trudous-traivat-v-kontsern-kalashnikov-5481781>.
- 424 “Kalashnikov Academy Sums Up Year’s Results,” Kalashnikov, December 26, 2025, <https://en.kalashnikovgroup.ru/news/kalashnikov-academy-sums-up-year-s-results>; and “Kalashnikov Trains 1,800 in New Professions,” Kalashnikov, March 13, 2025, <https://en.kalashnikovgroup.ru/news/kalashnikov-trains-1800-in-new-professions>.
- 425 “Kalashnikov Expands Russia’s UAV Arsenal with New Line Based on Archangel Drone Project,” *Army Recognition*, Global Defense News, December 1, 2025, <https://www.armyrecognition.com/news/aerospace-news/2025/kalashnikov-expands-russias-uav-arsenal-with-new-line-based-on-archangel-drone-project>.
- 426 “Kalashnikov Academy Celebrates 6th Anniversary,” Kalashnikov, September 19, 2025, <https://en.kalashnikovgroup.ru/news/kalashnikov-academy-celebrates-6th-anniversary>.
- 427 “Kalashnikov Academy Celebrates Anniversary,” Kalashnikov, September 19, 2023, <https://en.kalashnikovgroup.ru/news/kalashnikov-academy-celebrates-anniversary>.
- 428 “Kalashnikov Academy Sums Up Year’s Results,” Kalashnikov; and “New Academic Year Begins for Kalashnikov Academy Trainees,” Kalashnikov, October 1, 2025, <https://en.kalashnikovgroup.ru/news/new-academic-year-begins-for-kalashnikov-academy-trainees>.
- 429 Michael Starr, “Sanctions Hobble Russian Defense Industry Production of Tanks, Missiles, Jets - GUR,” *Jerusalem Post*, March 30, 2022, <https://www.jpost.com/international/article-702713>; and “Combating Corruption,” Kalashnikov, <https://en.kalashnikovgroup.ru/corruption>.
- 430 “Бывшего директора концерна «Калашников» поместили под арест” [Former director of the Kalashnikov concern placed under arrest], Udm-info, February 14, 2026, <https://udm-info.ru/news/2026-02-14/byvshego-direktora-kontserna-kalashnikov-pomestili-pod-arest-5550445>; and “ТАСС: экс-замдиректора ‘Калашникова’ обвинили в мошенничестве” [TASS: Former Kalashnikov deputy director accused of fraud], Kommersant, March 9, 2026, <https://www.kommersant.ru/doc/8497004>.
- 431 “Former Kalashnikov Concern Executive Arrested in Case of Abuse of Authority in the Execution of a State Defense Order,” [www1.ru](https://www1.ru/en/news/2026/02/14/eks-direktora-koncerna-kalashnikov-arestovali-po-delu-o-zloupotreblenii-polnomociami-pri-vypolnenii-gosoboronzakaza.html), February 14, 2026, <https://www1.ru/en/news/2026/02/14/eks-direktora-koncerna-kalashnikov-arestovali-po-delu-o-zloupotreblenii-polnomociami-pri-vypolnenii-gosoboronzakaza.html>; and “A TV Star Is Set to Stand Trial in Russia for Smuggling Parts for a Kalashnikov,” *UA News*, April 24, 2026, <https://ua.news/en/world/u-rosiyi-suditimut-zirku-teleshou-za-kontrabandu-detalei-dlia-kalashnikova>.
- 432 “Против экс-сотрудников концерна ‘Калашников’ возбудили дела о мошенничестве” [Fraud cases have been opened against former employees of the Kalashnikov concern], *Vedomosti*, March 8, 2026, <https://www.vedomosti.ru/society/news/2026/03/08/1181545-dela-o-moshennichestve>.
- 433 Defence Intelligence of Ukraine, “Concern Kalashnikov JSC,” War & Sanctions database, last updated April 15, 2026, <https://war-sanctions.gur.gov.ua/en/rostec/456>.
- 434 Dmitry Gorenburg, Samuel Bendett, Ken Gause, Pavel Luzin, Gabriela Iveliz Rosa-Hernandez, Paul Schwartz, and Elizabeth Wishnick, *Crafting the Russian War Economy: The Effects of Export Controls on Russia’s Defense Industrial Production* (CNA, October 2024), <https://www.cna.org/reports/2024/10/Crafting-the-Russian-War-Economy.pdf>.
- 435 “IZH H600,” Kalashnikov, accessed May 8, 2026, <https://kalashnikovgroup.ru/catalog/neoruzhey-noe-proizvodstvo/produksiya-promyshlennogo-naznacheniya/additivnye-tehnologii/izh-h600>; “How CIMtech Enhances Aerospace and Defense Manufacturing,” *CIMtech*, April 23, 2025, <https://cimtech.com/2025/04/23/how-cimtech-enhances-aerospace-and-defense-manufacturing/>.

- 436 TAdviser, “Zala Aero Zala Aero,” https://tadviser.com/index.php/Company:Zala_Aero; and “Локализация производства Zala достигла 95% в 2025 году” [Zala’s localization of production reached 95% by 2025], TASS, February 9, 2026, <https://tass.ru/ekonomika/26385401>.
- 437 Spencer Faragasso, “Russian Lancet-3 Kamikaze Drone Filled with Foreign Pats,” Institute for Science and International Security, December 18, 2023, https://isis-online.org/uploads/isis-reports/documents/Russian_Lancet-3_Kamikaze_Drone_Depends_on_Western_Parts_December_18_2023_FINAL.pdf.
- 438 Faragasso, “Russian Lancet-3 Kamikaze Drone”; “Ukraine’s Intelligence Reports Major Upgrades to Russian Lancet Drone,” *New Voice of Ukraine*, March 23, 2026, <https://english.nv.ua/nation/lancet-drone-with-artificial-intelligence-updates-western-details-and-risks-50594148.html>; “Russian Lancet Drones Striking Kyiv Contain at Least 50 Foreign-Made Components,” *New Voice of Ukraine*, March 18, 2026, <https://english.nv.ua/nation/zelenskyy-advisor-reveals-western-components-in-ai-drone-50592813.html>; Alisa Yurchenko, “Exclusive: American, European Microchips Found in Russia’s Latest Missile-Like Drone,” *Kyiv Independent*, January 22, 2026, <https://kyivindependent.com/exclusive-american-european-microchips-found-in-russias-latest-missile-like-drone>; and Vadim Kushnikov, “China Helps Lancet Drone Manufacturer Circumvent Sanctions,” *Militarnyi*, November 25, 2024, <https://militarnyi.com/en/news/china-helps-lancet-drone-manufacturer-circumvent-sanctions>.
- 439 Faragasso, “Russian Lancet-3 Kamikaze Drone.”
- 440 Kushnikov, “China Helps Lancet Drone Manufacturer”; and Faragasso, “Russian Lancet-3 Kamikaze Drone.”
- 441 Angus Berwick, “Inside the Russian Shadow Trade for Weapons Parts, Fueled by Crypto,” *Wall Street Journal*, April 1, 2024, <https://www.wsj.com/finance/currencies/crypto-fuels-russian-shadow-trade-for-weapons-parts-1bfdc1a1>.
- 442 “Европейские санкции срывают госконтракт МО РФ на поставку комплекса БПЛА ‘Гранат-4’” [European sanctions disrupt Russian Ministry of Defense state contract for supply of Granat-4 UAV system], InformNapalm, April 12, 2023, <https://informnapalm.org/52885-evropejskie-sankcii-bpla-granat4/>.
- 443 Yevheniia Hubina, “Ukrainian Intelligence Agency Names Russia’s Kalashnikov Group Companies Still Not Under Sanctions,” *Ukrainska Pravda*, February 16, 2026, <https://www.pravda.com.ua/eng/news/2026/02/16/8021230/>.
- 444 “Рывок за горизонт: КРЕТ на передовой радиоэлектронной борьбы” [A leap beyond the horizon: KRET at the forefront of electronic warfare], Dzen.ru, October 15, 2018, <https://dzen.ru/a/W8QYV74rN-QCug6d5>.
- 445 НПЦ «Ушкуйник» [NPC Ushkuynik], Telegram post, October 2, 2025, <https://t.me/nvgushkuynik/125>.
- 446 “Aleksei Chadaev, General Director, NPC ‘Ushkuynik,’” Vedomosti Events, last updated May 20, 2025, <https://events.vedomosti.ru/speakers/chadaev-aleksei-11027>; and Ekaterina Adamova, “Гендиректор НПЦ ‘Ушкуйник’: невзрачный с виду ‘Князь Ванда’ сжег примерно две армии” [General director of the ‘Ushkuynik’ Scientific and Production Center: the nondescript “Prince Vandal” burned about two armies], TASS, July 21, 2025, <https://tass.ru/interviews/24519075>.
- 447 NPC Ushkuynik, Telegram post, October 2, 2025; and “Home,” Ushkuynik, <http://nvgushkuynik.ru/>.
- 448 “About NTI,” NTI, <https://nti2035.ru/en/>; and Directive No. Pr-1907, September 21, 2023. Funding sources also include Minpromtorg, Skolkovo, and Fond Sodeystviya Innovatsiyam.
- 449 Alexey Chadaev, Telegram post, March 29, 2026, <https://t.me/chadayevru/4636>.
- 450 Alexey Chadaev, Telegram post, March 29, 2026, <https://t.me/chadayevru/4636>.

- 451 Ibid.
- 452 “АНО ‘НПЦ ‘Ушкуйник’,” Rusprofile, accessed May 8, 2026, <https://www.rusprofile.ru/id/1235300003685>; and “АНО ‘НПЦ ‘Ушкуйник’,” Audit-it.ru, accessed May 8, 2026, https://www.audit-it.ru/contragent/1235300003685_ano-npts-ushkuynik.
- 453 Samuel Bendett and Michael Kofman, “The Strange Rise and Fall of Russia’s Crowd Sourced Defense Industry,” *War on the Rocks*, April 28, 2026, <https://warontherocks.com/the-strange-rise-and-fall-of-russias-crowd-sourced-defense-industry/>.
- 454 Drone Hunters, Telegram post, July 5, 2025, <https://t.me/DroneHunters161/138>.
- 455 Dmitry Rogozin, Telegram post, August 10, 2025, https://t.me/rogozin_do/7442; Кот на связи [Cat on the Line], Telegram post, January 30, 2026, <https://t.me/kotsvzst/7684>; and Bendett and Kofman, “The Strange Rise and Fall.”
- 456 NPC Ushkuynik, Telegram post, October 2, 2025.
- 457 Adamova, “Гендиректор НПЦ ‘Ушкуйник’” [General director of the ‘Ushkuynik’ Scientific and Production Center].
- 458 ““Глава ‘Калашникова’ оценил оптоволоконный дрон ‘Князь Вандал Новгородский’” [“Kalashnikov Head Assessed the Fiber-Optic Drone ‘Knyaz Vandal Novgorodsky’”], TACC [TASS], August 10, 2025, <https://tass.ru/armiya-i-opk/24752429>
- 459 Sergey Bondarenko, “Гаражная революция: как эволюционировали российские беспилотники” [Garage revolution: how Russian drones evolved], Деловой Петербург [Business Petersburg], December 30, 2024, <https://www.dp.ru/a/2024/12/30/garazhnaja-revoljucija-kak-jevoljucionirovali>; and Adamova, “Гендиректор НПЦ ‘Ушкуйник’” [General director of the ‘Ushkuynik’ Scientific and Production Center].
- 460 Adamova, “Гендиректор НПЦ ‘Ушкуйник’” [General director of the ‘Ushkuynik’ Scientific and Production Center]. “Kalashnikov Head Gives High Marks,” TASS.
- 461 Alexey Chadaev, Telegram post, August 6, 2025, <https://t.me/chadayevru/3998>.
- 462 Ibid.
- 463 NPC Ushkuynik, Telegram post, October 2, 2025.
- 464 Adamova, “Гендиректор НПЦ ‘Ушкуйник’” [General director of the ‘Ushkuynik’ Scientific and Production Center].
- 465 Инженерия войны [War Engineering], Telegram post, Dec 25, 2025, https://t.me/binary_glasses/3430.
- 466 Ibid.
- 467 “Russia’s Rubikon Drone Unit Poses Growing Threat to Ukrainian Defenders,” *New Voice of Ukraine*, November 14, 2025, <https://english.nv.ua/nation/rubikon-russian-s-elite-unit-who-is-in-charge-what-is-its-structure-strategy-50560751.html>.
- 468 Chadaev, Telegram post, August 6, 2025, <https://t.me/chadayevru/3998>.
- 469 Ekaterina Adamova, “Алексей Чадаев: украинцы скопировали дрон ‘Князь Вандал’, но им это не помогло” [Alexei Chadaev: Ukrainians copied the ‘Prince Vandal’ drone, but it did not help them’], TASS, December 25, 2025, <https://tass.ru/interviews/25997259>.
- 470 Ibid.
- 471 WarHistory, Telegram post, November 6, 2025, <https://t.me/warhistoryalconafter/247892>. Authors’ translation.

- 472 Ibid.
- 473 “Creators of Knyaz Vandal Drone Working on Version Similar to Lancet,” TASS, January 12, 2026, <https://tass.com/defense/2070043>.
- 474 Ibid.
- 475 Ibid.
- 476 Vladislav V., “Russian KVS FPV Drone Ring-Shaped Wing,” *Militarnyi*, March 27, 2026, <https://militarnyi.com/en/news/russian-kvs-fpv-drone-ring-shaped-wing/>.
- 477 Ibid.
- 478 NPC Ushkuynik, Telegram post, October 2, 2025; “Autonomous Non-Profit Organization “Scientific and Production Center for Testing and Competence in the Field of Development of Unmanned Aircraft Systems and Means of Protection Against their Illegal Use ‘Ushkuynik,’” Open Sanctions, last updated May 11, 2026, <https://www.opensanctions.org/entities/NK-guTPEszwDpb6wPxxuHE8sV/>; John Baker, “Ushkuynik Unveils Fiber-Optic Controlled Unmanned Boat for Black Sea Trials,” *Military Affairs*, September 9, 2025, <https://voennoedelo.com/en/posts/id946-russian-npc-ushkuynik-tests-new-fiber-optic-unmanned-boat>; and Fred Turner, “Russia Develops Surface, Underwater, and Aerial Drones for 2026,” *Military Affairs*, December 25, 2025, <https://voennoedelo.com/en/posts/id8713-russia-prepares-naval-and-aerial-drones-for-2026-use>.
- 479 Adamova, “Гендиректор НПП ‘Ушкуйник’” [General director of the ‘Ushkuynik’ Scientific and Production Center]. Authors’ translation.
- 480 Ibid. Authors’ translation.
- 481 Lucas Minisini et al., “Welcome to the GRU University, Where Moscow Turns Students into Spies and Hackers,” Vsquare, May 7, 2026, <https://vsquare.org/welcome-to-the-gru-university-where-moscow-turns-students-into-spies-and-hackers-bauman-stupakov/>; and Telegram post, February 17, 2026, <https://t.me/chadayevru/4505>.
- 482 Ibid.
- 483 Alexey Chadaev, Telegram post, February 15, 2026, https://t.me/battle_technic/6708.
- 484 Alexey Chadaev, Telegram post, September 1, 2025, <https://t.me/chadayevru/4072>.
- 485 Alexey Chadaev, Telegram post, March 28, 2026, <https://t.me/chadayevru/4634>.
- 486 “В Управлении Минюста России по Новгородской области состоялась встреча с руководством ФОНДА ‘ТЫЛ 53’” [A meeting was held at the Directorate of the Russian Ministry of Justice for the Novgorod Region with the leadership of the ‘Tyl 53’ Foundation], BezFormata, accessed May 8, 2026, <https://velikiynovgorod.bezformata.com/listnews/novgorodskoy/158962368/?amp=1>; <https://t.me/chadayevru/3217>; Alexey Chadaev, Telegram post, January 12, 2025, <https://t.me/chadayevru/3511>; and “В РФ подготовили около 100 расчетов на оптоволоконных дронах ‘Князь Ванда’” [Approximately 100 crews on fiber-optic drones ‘Knyaz Vandal’ have been prepared in Russia], TASS, January 13, 2025, <https://tass.ru/armiya-i-opk/22869527>.
- 487 “В России ежемесячно производят свыше 50 тыс. дронов ‘Князь Ванда’” [Russia produces over 50,000 ‘Knyaz Vandal’ drones monthly], TASS, September 6, 2025, <https://tass.ru/armiya-i-opk/24984141>.

- 488 Ibid.; and “Decentralizing Supply Chains: How Regional Models Drive Resilience & Flexibility,” ARC Advisory Group, May 20, 2025, <https://www.arcweb.com/blog/decentralizing-supply-chains-how-regional-models-drive-resilience-flexibility>.
- 489 Sofia Syngaivska, “Ukraine Exposes Knyaz Veshchiy Oleg UAV with Chinese Optics and Western Chips,” *Defense Express*, April 13, 2026, https://en.defence-ua.com/weapon_and_tech/ukraine_exposes_knyaz_veshchiy_oleg_uav_with_chinese_optics_and_western_chips-18153.html.
- 490 Ivan Khomenko, “Sanctions Bypassed? Ukraine Finds US and Swiss Tech Inside Russia’s New Recon Drone,” United24 Media, April 13, 2026, <https://united24media.com/latest-news/sanctions-bypassed-ukraine-finds-us-and-swiss-tech-inside-russias-new-recon-drone-17856>.
- 491 “Бортовая электроника FPV-дрона ‘Князь Вандал’ стала полностью российской” [Onboard electronics of the FPV drone ‘Prince Vandal’ have become fully Russian], TASS, last updated March 27, 2026, <https://tass.ru/ekonomika/26919211>.
- 492 Defence Intelligence of Ukraine, “Company Profile: 14954,” War & Sanctions database, accessed May 8, 2026, <https://war-sanctions.gur.gov.ua/en/uav/companies/14954>.
- 493 Alexey Viktorovich Chadayev (EU-175270-212682),” Sanctions Lists (Lursoft), accessed May 8, 2026, <https://sanctions.lursoft.lv/person/alexey-viktorovich-chadayev/EU-175270-212682?pdf=1>; and “Aleksey Chadayev,” Open Sanctions, last updated May 11, 2026, <https://www.opensanctions.org/entities/Q4506685>.
- 494 Snegovaya et al., *The Russian Wartime Economy*.
- 495 Bondar, interview, April 8, 2026.
- 496 “Russia to Build 7.3 Million FPV Drones in 2026, Syrsky Warns,” *Kyiv Post*, May 8, 2026, <https://www.kyivpost.com/post/75714>.
- 497 Dylan Malyasov, “Ukraine Faces 8x More Jet-Powered Russian Drones Than Last Year,” Defence Blog, June 13, 2026, <https://defence-blog.com/ukraine-faces-8x-more-jet-powered-russian-drones-than-last-year/>.
- 498 Bendett and Kofman, “The Strange Rise and Fall.”
- 499 “Russia Makes Major Investment,” *Military Watch*.
- 500 Baker, “Russia’s War in Ukraine.”
- 501 Watling et al., “Disrupting Russian Air Defence Production.”
- 502 “Ростех рассказал, как после переходного этапа будут выглядеть танки в будущем” [Rostec Discussed What Tanks Will Look Like in the Future, Following the Current Transitional Phase], TASS, January 6, 2026, <https://tass.ru/armiya-i-opk/26096765>.
- 503 Charlie Duxbury, “Russian Threat Likely to Endure After Putin, Sweden Says,” Bloomberg, June 30, 2026, <https://www.bloomberg.com/news/articles/2026-06-30/russian-threat-likely-to-endure-after-putin-sweden-says>.
- 504 Rudy Ruitenberg, “Russia Could Be Ready for NATO Conflict Year After Ukraine, Dutch Warn,” *Defense News*, April 22, 2026, <https://www.defensenews.com/global/europe/2026/04/22/russia-could-be-ready-for-nato-conflict-year-after-ukraine-dutch-warn/>.
- 505 Defence Intelligence and Security Service, *National Threat Assessment 2026*.

- 506 Hanna Kaltyhina, “Northern Europe faces largest Russian military buildup in decades, investigation reveals,” Belsat, June 12, 2026, <https://en.belsat.eu/93769508/northern-europe-faces-largest-russian-military-buildup-in-decades-investigation-reveals>.
- 507 Ruitenbergh, “Russia Could Be Ready.”
- 508 Andriy Zagorodnyuk, “The New Revolution in Military Affairs: How Ukraine Is Driving Doctrinal Change in Modern Warfare,” Carnegie Endowment for International Peace, April 20, 2026, <https://carnegieendowment.org/research/2026/04/ukraine-russia-war-changing-warfare-practice-military-strategy>.
- 509 Snegovaya et al., *The Russian Wartime Economy*.



1616 Rhode Island Avenue NW, Washington, DC 20036
202.887.0200 | www.csis.org

FOLLOW CSIS

