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Disassembling the Russian War Machine: Logistics, Chokepoints, and Dependencies

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Executive Summary

A close look at the logistics of the Russian military-industrial complex (MIC) reveals a variety of unsanctioned chokepoints, depleted stockpiles, and foreign dependencies. The centralized, top-heavy MIC relies heavily on ostensibly civilian firms to fuel the Russian war machine, which is now operating at full tilt. In a previous publication in this series—***Disassembling the Russian War Machine: Key Players and Nodes***—we documented the MIC's transformation and centralization, which enable dramatic scaling of production but also hinder innovation. Despite large state investments designed to meet the needs—particularly munitions and materiel—of Russia's full-scale war against Ukraine, Soviet-era stockpiles are rapidly dwindling. This has created the need for China and North Korea to step in as critical external suppliers, sustaining Russia's military production through shipments of key inputs and finished armaments.

In this report, we aim to disassemble Russia's war machine by focusing on its logistics channels and chokepoints. ***Section I*** examines supplies to the army, shipments of tanks, armored vehicles, and artillery from storage facilities, Russia's reliance on China and North Korea, and the critical role of machinery and components imports. ***Section II*** isolates chokepoints in supply chains across several areas such as construction materials, explosives, minerals, energy, and logistics. ***Section III*** analyzes sector- and product-level manufacturing dynamics, focusing on the weapons industry and some of its most important outputs, as well as aviation and naval spheres. Finally, ***Section IV*** concludes with takeaways and policy recommendations.

- **The backbone of the Russian military-industrial complex is the country's vast transport network, whose logistics are centralized and increasingly oriented toward the frontline.** Supplies to the military itself are highly concentrated; three quarters of the total volume of cargo movements are organized at the strategic command level. Shipments to the frontline have boomed since the full-scale invasion, with volumes nearly tripling between 2021 and 2023, particularly in staples like oil products and explosives. Nonetheless, a series of challenges still face the continued expansion of the military's supply chains.
- **Shipments from storage bases reveal dwindling stocks of tanks, armored vehicles, and artillery systems.** The volume of military equipment shipments from storage bases declined by more than 25% in 2024, and early 2025 data suggests that these numbers will continue to slide. Russia's stockpile of Soviet-era equipment—including some materiel that is ready for the battlefield and some that must be repaired—has been irreversibly depleted. Russia is also increasingly shipping equipment directly to the frontline instead of repair facilities, indicating the creation of restoration capacities near its storage bases and frontline.
- **Hundreds of thousands of tons of explosives have been shipped from North Korea to Russian ammunition storage bases, though somewhat lower volumes this year suggest a peak in 2024.** Shipments of explosive materials suspected to be from North Korea accounted for 52% of all explosives transported to known arsenal locations in 2024. This flow of munitions has propped up Russia's war of aggression in the face of significant battlefield needs and the MIC's capacity expansion challenges. A stable, albeit smaller, inflow of explosives arrives via the Caspian Sea, potentially from Iran.
- **The Russian economy's pivot to the East has left the MIC dependent on Chinese imports, with only a handful of large logistics companies facilitating the connections.** MIC-affiliated logistics companies have consolidated control of Chinese shipping routes, now accounting for nearly half of cargo shipments from the border. Consequently, large volumes of cargo from China are concentrated at a

limited number of strategic hubs, most of which are in and around Moscow. Growth in machinery and automotive imports underscores the trade reorientation in response to Western sanctions.

- **Numerous near-monopolistic suppliers across a wide range of inputs create critical chokepoints for Russia's MIC; many of these chokepoints have not been sanctioned.** From raw materials and reinforced concrete to explosives, single entities account for the majority of the entire MIC's supply of certain products. Many of these entities are heavily reliant on their MIC clients' business, yet their nominally civilian statuses have shielded them from the sanctioning coalition. Supplies of components—particularly those that are imported—are more frequently dominated by logistics firms.
- **Sector-level analyses reveal that the MIC's production expansion has underlying vulnerabilities.** Russia has dedicated immense resources to its military-industrial manufacturing base since the full-scale invasion, rescuing many enterprises from bankruptcy or decline. Russia's military industry has significantly expanded weapons refurbishment and production, despite persistent dependencies on imported critical materials. The military aviation sector has adapted impressively but remains vulnerable due to reliance on foreign machinery and materials. Naval priorities extend beyond the invasion of Ukraine, with a strategic focus on submarine and Arctic-capable vessel production to assert dominance in the High North.
- **Product-level analyses show Russia's priorities in resource allocation to specific weapon systems.** Missile production remains sustained, supporting both frontline operations and strikes on Ukraine's civilian infrastructure. Artillery manufacturing is expanding, particularly regarding shells and guided bombs, but faces serious input constraints; Russia compensates for insufficient manufacturing capacity by importing large quantities of munitions, most importantly from North Korea. Despite official claims of engine production growth, most facilities show no corresponding rise in industrial activity.
- **Sanctions on critical MIC chokepoints would reduce Russia's capacity to wage war on Ukraine and threaten NATO.** Quasi-civilian companies with sizable MIC market share should not enjoy access to Western financial or export markets, and sanctioning them would hinder their ability to fuel the Russian war machine. Similarly, sanctions—and the credible threat of secondary sanctions—on companies facilitating critical machinery and components imports for the MIC could create significant bottlenecks to Russia's import-dependent supply chains. Finally, all scientific and commercial ties with Russian companies, institutions, and individuals should be stopped as they inadvertently strengthen Moscow's military capacity.
- **Lifting sanctions on Russia would be a strategic mistake.** Despite a surge in funding since the full-scale invasion, the Russian MIC remains deeply constrained by structural inefficiencies, dependence on critical imported inputs, and depletion of restorable reserves. Existing sanctions have exacerbated these weaknesses and exposed Russia's difficulties in scaling technological modernization. Nonetheless, Russia's activity in the naval sector points to ambitions beyond Ukraine. Any sanctions relief at this point would strengthen a system that presents a direct threat to European security.

I. Russia's Military Industry: Key Logistics Channels

Cargo traffic is the backbone of Russia's military-industrial complex and, thus, its war of aggression against Ukraine. In this section, we investigate key logistics channels. First, we analyze the supply lines of the Russian military, including its centralized logistics, the rising importance of frontline destinations, and developments with regard to important products such as fuel, construction materials, and explosives. Second, we take a closer look at the movement of stored military equipment—tanks, armored vehicles, and artillery systems—documenting important developments that demonstrate the concerted effort Russia has undertaken to reactivate older equipment and illustrate the increasing depletion of its stocks. Third, we focus on Russia's pivot to imports from partners in the east, finding an increasing reliance on supplies from China as well as concealed imports of explosives from North Korea and Iran. Finally, we delve into a specific category of goods that are critical for the Russian MIC—machinery and components—and for which important structural vulnerabilities exist.

Supply Lines of the Russian Military

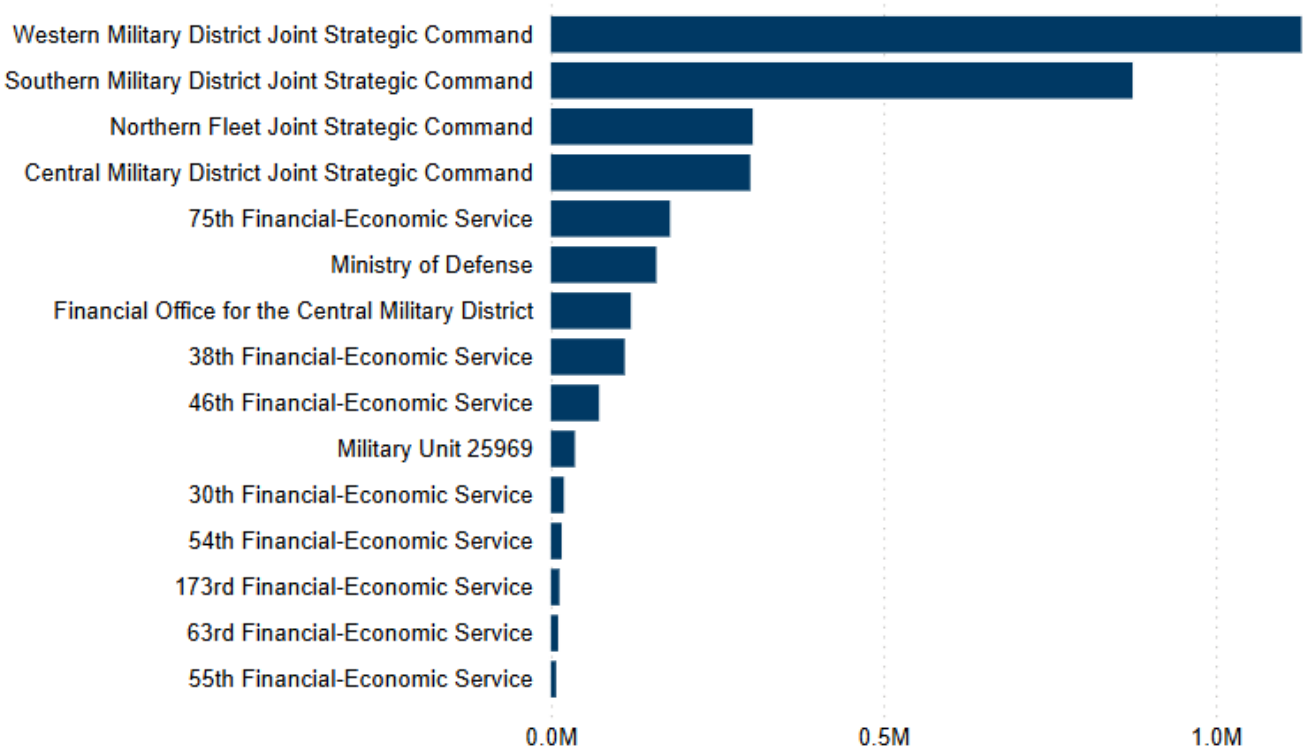
We examine the logistics of Russian army entities, focusing on the critical role of the country's transportation network in sustaining wartime supply flows. The fact that the coordination of these movements is centralized at the strategic command level and that shipments to frontline destinations have risen markedly in recent years illustrates the extent to which logistics lies at the heart of Russia's war of aggression. Our analysis reveals several mounting vulnerabilities, including how fuel deliveries to the armed forces are increasingly dependent on a shrinking pool of suppliers and facilities, and supplies of construction materials rely on a single source. Furthermore, Russia's growing reliance on imported explosives underscores the fragility of its munitions supply chain and the limitations of its domestic production capacity. Finally, a look at what unnamed cargo—i.e., flows where important details are concealed—can tell us about the Russian military's supply routes.

Centralized Logistics

The Russian military logistics system encompasses several levels: the Ministry of Defense (MoD), the Unified Strategic Command (OSK) units for the Western, Southern, and Central Military Districts, and the North Sea Fleet strategic command; Financial-Economic Service[1] (FES) units; and, lastly, individual local military units. Shipments involving army entities are administratively organized at the top strategic command level, which account for 75% of their cargo tonnage (see Figure 1). Oil products, such as diesel, gasoline, and jet fuel, make up most of the cargo volume, with only three main departure points playing a critical role in the supply of such products to the military. Outside of fuel shipments, an extreme bottleneck exists in construction materials procurement, with 90% of materials sourced from one company, Barrikada (see *Construction Materials: Barrikada*). Another narrow set of locations handles a disproportionate share of the military's supplies: eastern border stations.

[1] In Russia's Ministry of Defense, the FES units are responsible for overseeing and supporting the budgeting and execution of state contracts for goods, services, and works procured for the MoD's needs.

Figure 1: Railway cargo in 2021-24 by top 15 army entities, in metric tons



Source: KSE Institute

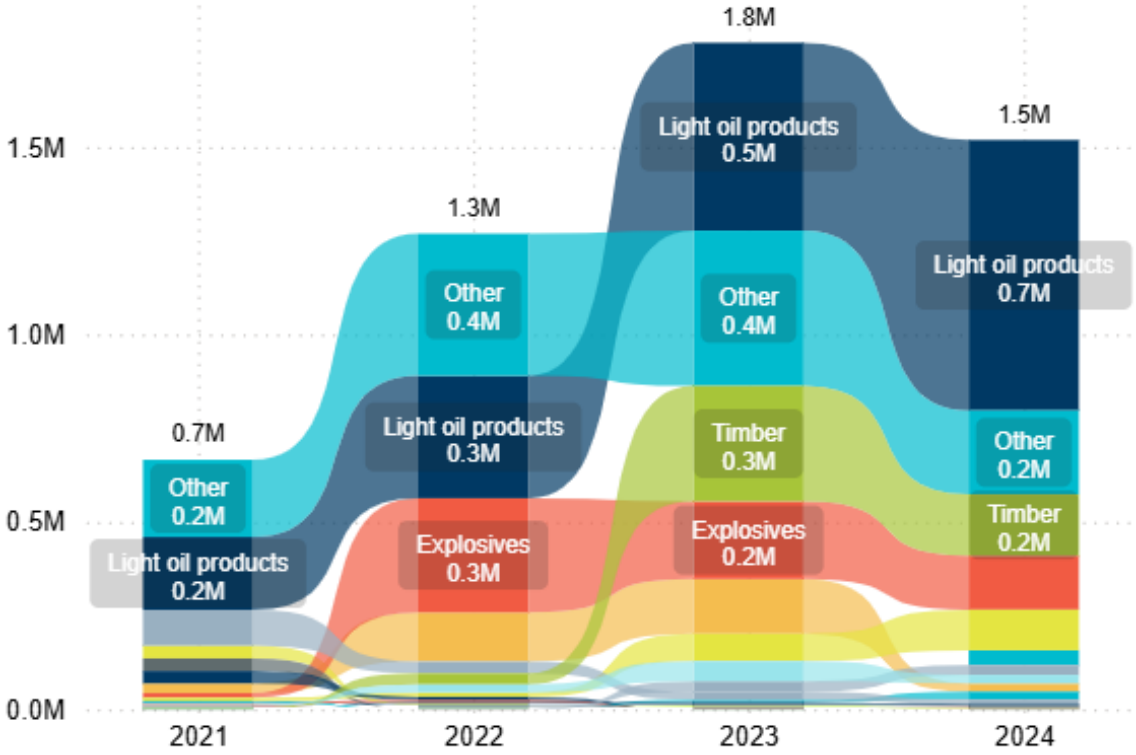
Frontline Destinations

Rather unsurprisingly, shipments to the frontline have boomed since the full-scale invasion. In the first year of the full-scale war, materials headed to frontline destinations doubled from 600 thousand to 1.3 million tons. Then, as the war dragged on and the Russian army dug in, they increased by another 38% in 2023. Decreasing in 2024 to 1.5 million tons, it appears that supply chains have largely reached their capacity (see Figure 2).

The top cargo categories supplied to the frontlines by volume are consistent with the needs of the army. Oil products made up over half of the 2024 total, for example. 'Other unnamed cargo,' which we can reasonably presume to be military equipment, peaked in 2023 and decreased by 46% in 2024, corroborating the exhaustion of materiel restored from conservation fields (see *Movements of Stored Military Equipment*). Explosive materials, timber,[2] and foodstuffs round out the top five categories, each supplying the invading forces.

[2] Timber supplies originate in a handful of sources in Tver, Arkhangelsk, and Leningrad oblasts.

Figure 2: Shipments to frontline destinations of army entities or obscured consignees by cargo classification, in metric tons



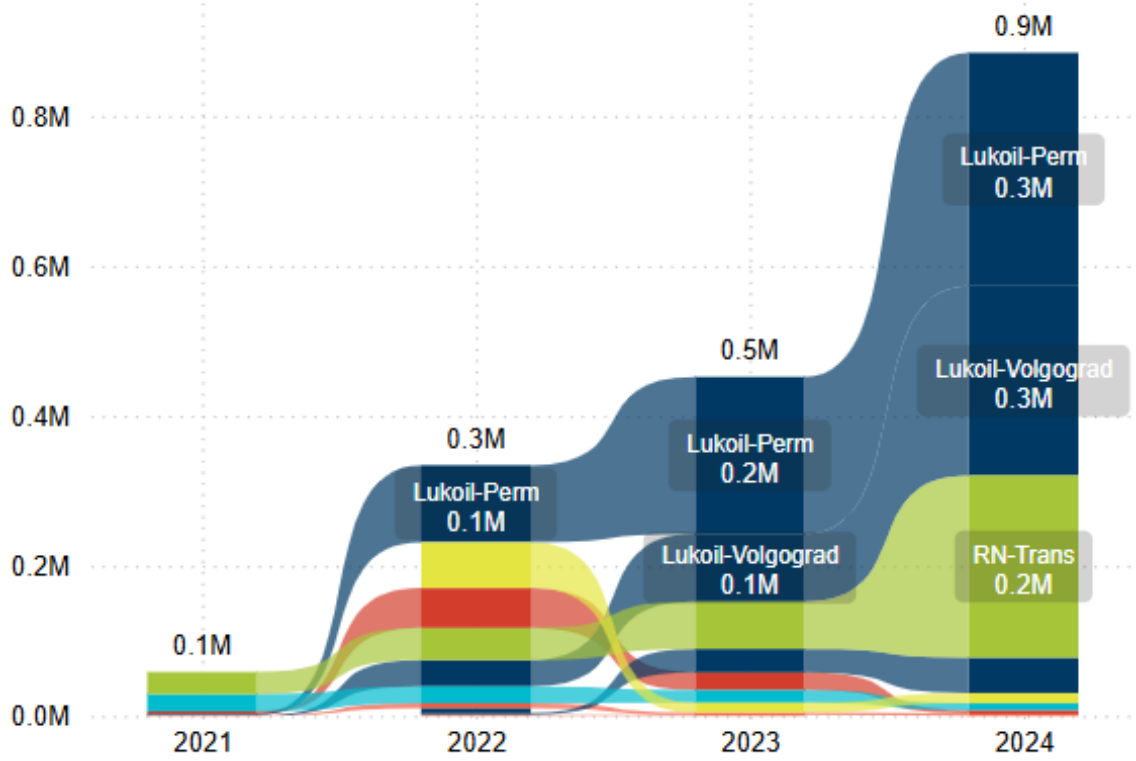
Source: KSE Institute

Oil Products

While most oil and gas is moved by pipeline, oil products—like diesel—are frequently shipped by rail. The volume of oil products shipped via rail to army entities has risen sharply during the full-scale invasion—from 0.04 million tons in 2021 to 0.3 million tons in 2022, 0.5 million tons in 2023, and 0.9 million tons in 2024 (see Figure 3). In addition to skyrocketing volumes, it has shifted structurally: Gazpromneft and Slavneft have been sidelined, while Lukoil and Rosneft have captured greater market shares. Lukoil provides 70% of fuel shipments, and RN-Trans, a subsidiary of Rosneft, handles 25%. Departure points are in the Perm, Volgograd, and Samara oblasts.

The declines of Gazpromneft and Slavneft are also evident in the geography of shipping patterns. Omsk oblast's Kombinatskaya station, for example, shows how Gazpromneft has reduced its supplies to army entities; GPN-Logistika, the company's logistics subsidiary, ships more than 80% of its total cargo from Kombinatskaya, and is responsible for nearly all of the station's fossil fuel shipments. Kombinatskaya's outgoing volumes to army entities more than halved in 2023, then declined by another two-thirds in 2024. Slavneft, operating out of Yaroslavl, also significantly reduced its supplies to army entities—from 61 thousand tons in 2022 to 13 thousand tons in 2023 and 26 thousand tons in 2024.

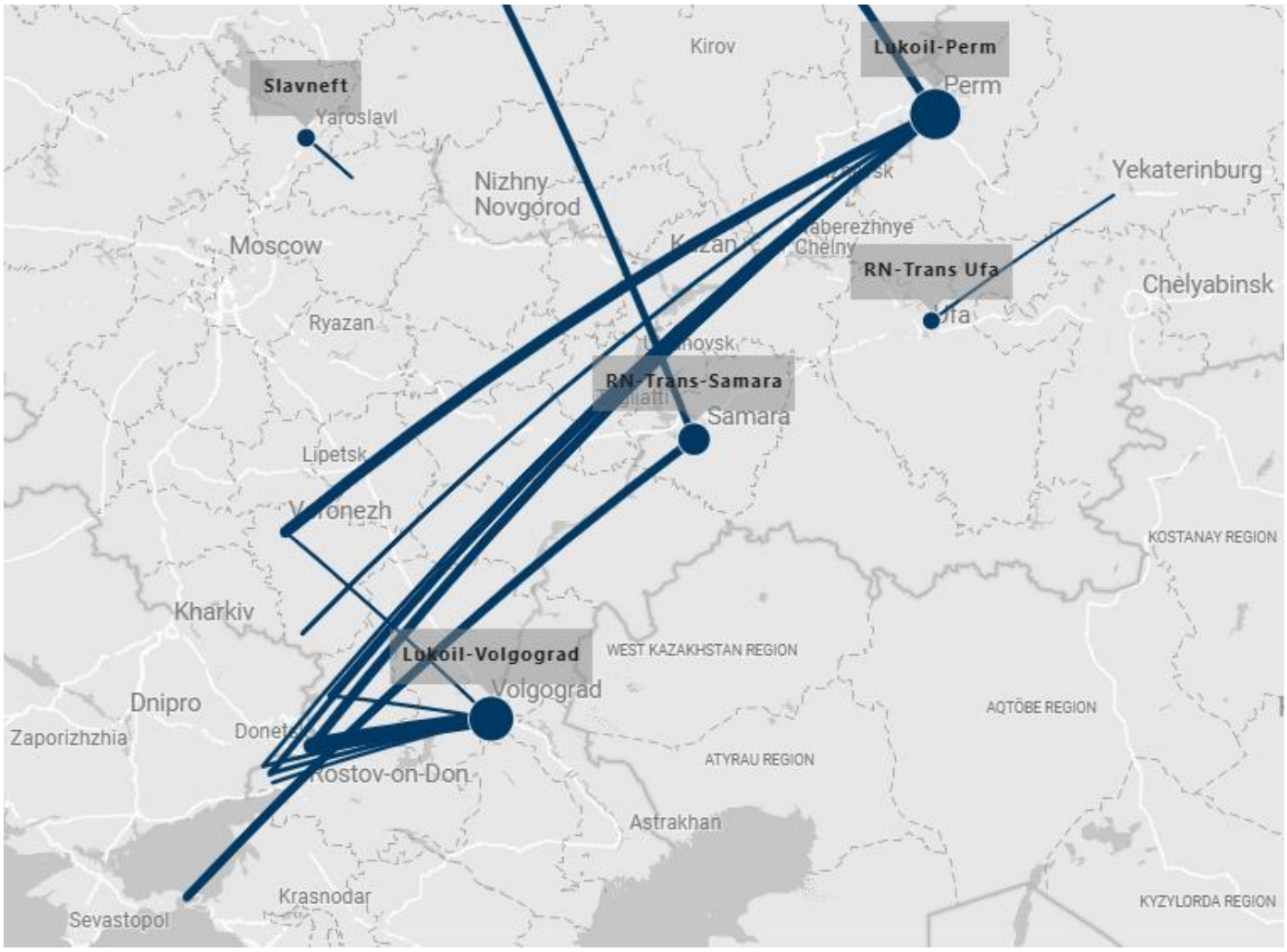
Figure 3: Railway shipments of oil products to army entities by supplier, in metric tons



Source: KSE Institute

On the other end of the supply chain, destination points of oil products reveal strategic military logistics priorities (see Figure 4). Destinations near the Ukrainian border—including Gukovo, Matveev Kurgan, Neklinovka and the Crimean ferry hub—have seen substantial shipment increases, particularly in 2023 and 2024. Gukovo (Rostov oblast), near the border with Ukraine's Luhansk oblast, experienced an 86% increase in volumes received in 2023, and doubled again in 2024, likely supporting the invading forces' operations in eastern Ukraine. Voronezh, which has airfields and military bases, has received 61 thousand tons of oil products in 2023, which increased by 88% in 2024. Matveev Kurgan, also in Rostov oblast near the Ukrainian border, similarly spiked from 11 to 96 thousand tons between 2023 and 2024. The Crimean ferry hub, a crucial logistics point supporting Russia's military aggression that is located on the Chushka Spit in the Taman Bay, received 41 thousand tons of oil products in 2023, which increased to 63 thousand tons in 2024.

Figure 4: Destinations of oil products shipments sent to army entities by volume

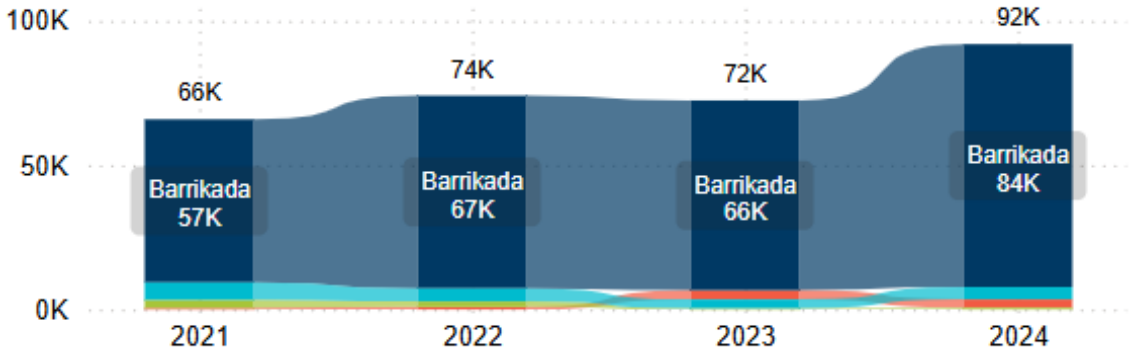


Source: KSE Institute
Note: bubbles represent origin points

Construction Materials

Construction materials show a concentrated sourcing pattern, with 90% of cargo delivered to army entities coming from Gatchina near St Petersburg and supplied by AO Barrikada company (see *Construction Materials: Barrikada* for a deeper investigation). Shipments of construction materials to army entities increased substantially by 27% in 2024 (see Figure 5). The growth is predominantly due to deliveries to Angarsk (Irkutsk oblast), which is co-located with the Belaya airbase and missile storages, and Voronezh oblast, coinciding with the Buturlinovka airbase. Shifts of construction materials destinations to those further from the frontline may indicate an expansion of capacity at already-existing production sites.

Figure 5: Shipments of constructions materials to army entities by supplier, in metric tons



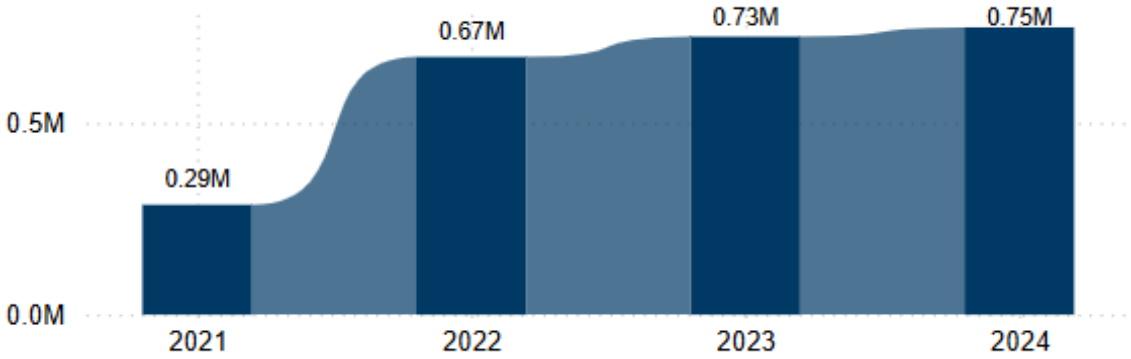
Source: KSE Institute

Explosive Materials

Shipments of explosive materials to and from army or obscured entities more than doubled in 2022 to 0.67 million tons, and have been steadily increasing in 2023 (+8%) and 2024 (+3%) (see Figure 6). Far more than in other cargo categories, the corporate supply chains of explosives are hidden—counterparties are obscured in 94% of the shipping by volume. Geographically, however, certain patterns emerge. 129 thousand tons, or 18% of 2023 tonnage, originated in the Nakhodka region in the far east, pointing to possible import flows from North Korea. In 2024, Nakhodka doubled its supply to 244 thousand tons, or 52% of the annual explosives volume received by arsenals, in a sign of an increasing dependence on imports. A deeper investigation into explosives from North Korea can be found in a later section (see *North Korean and Iranian Explosives*).

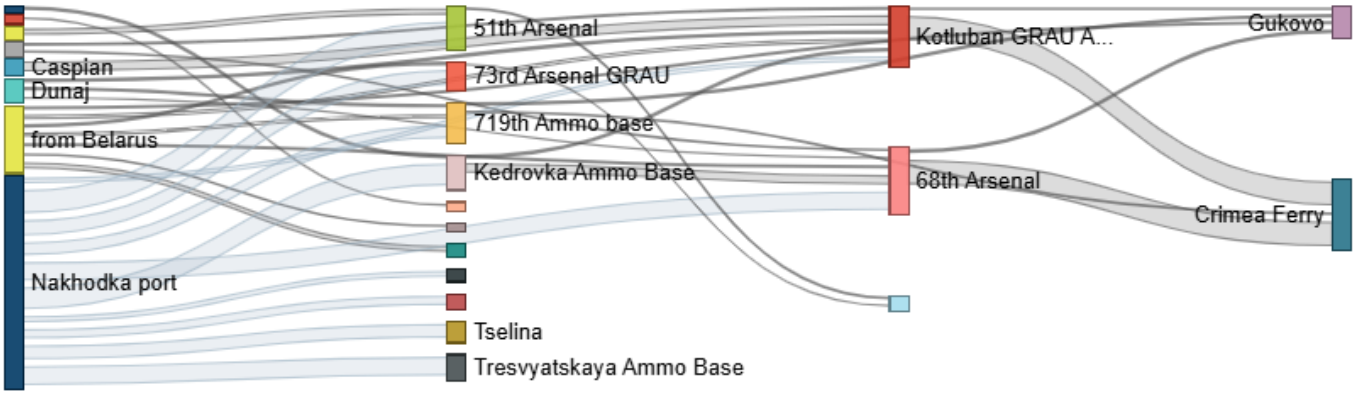
Destination points vary by volumes and their place in military supply chains. Arsenals and ammo depots serve as distribution hubs: they receive high volume flows from origin points like Nakhodka, then redistribute them to frontline staging points like Gukovo and the Crimea ferry hub. A few stand out: the 68th Arsenal (army unit 30184), located near the Mozdok airbase in the Vladikavkaz region (North Caucasus); the 719th ammunition base, near Tikhoretsk in Krasnodar oblast; Kedrovka, an ammunitions storage (army unit 92922) near Yekaterinburg; and the 51st Arsenal of the GRAU (Russia's Main Missile and Artillery Directorate) in the Vladimir oblast (see Figure 7 and Figure 8).

Figure 6: Shipments of explosive materials to/from army or obscured entities, in metric tons



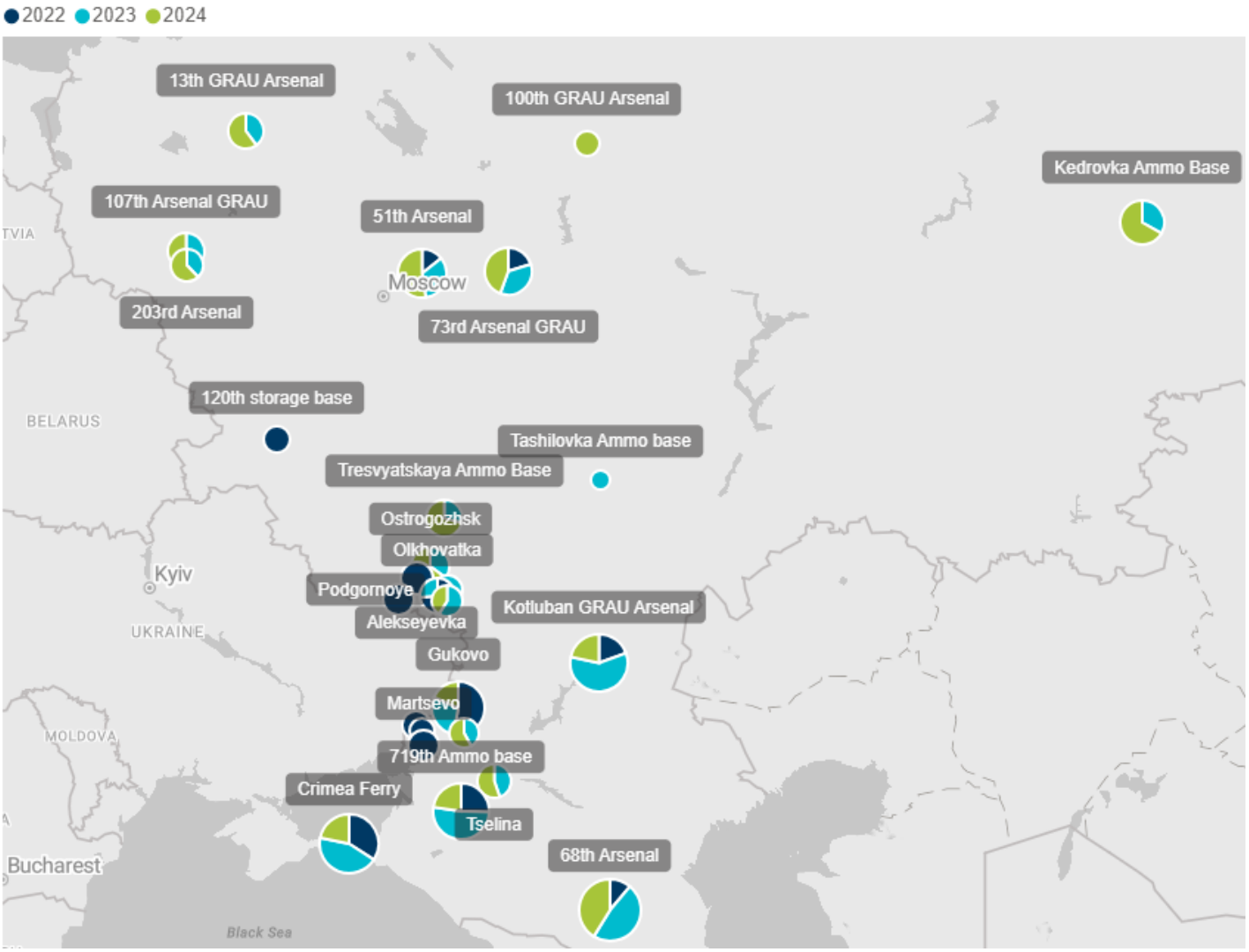
Source: KSE Institute

Figure 7: Explosive materials cargo flows



Source: KSE Institute

Figure 8: Explosive materials destinations by volume and year

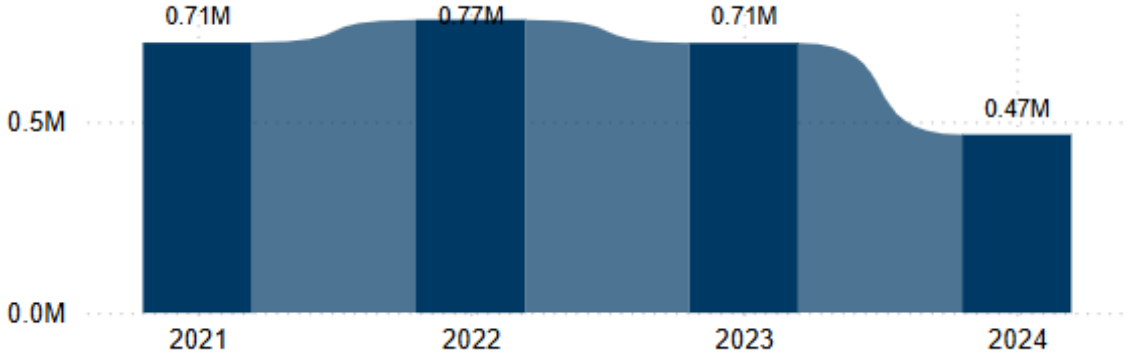


Source: KSE Institute

Unnamed Cargo

Shipments categorized as 'other unnamed cargo' are suspected to have military significance, and not just because they are overwhelmingly redacted or military-related—94% of this cargo type is shipped by obscured or military industry counterparties. The volume shipped to and from army or obscured entities increased with the full-scale war, increasing from 710 to 770 thousand tons between 2021 and 2022. Most of this is attributable to a single departure point bordering Belarus. Shipments of unnamed cargo declined in 2023 (710 thousand tons) and 2024 (470 thousand tons), which is explained by changing frontline priorities. In 2024, traffic to destinations in Rostov, Krasnodar, and Voronezh oblasts decreased by 39%, 72%, and 80% respectively, while shipments to Kursk oblast increased from 14 to 40 thousand tons, making it the second largest destination by tonnage (see Figure 9).

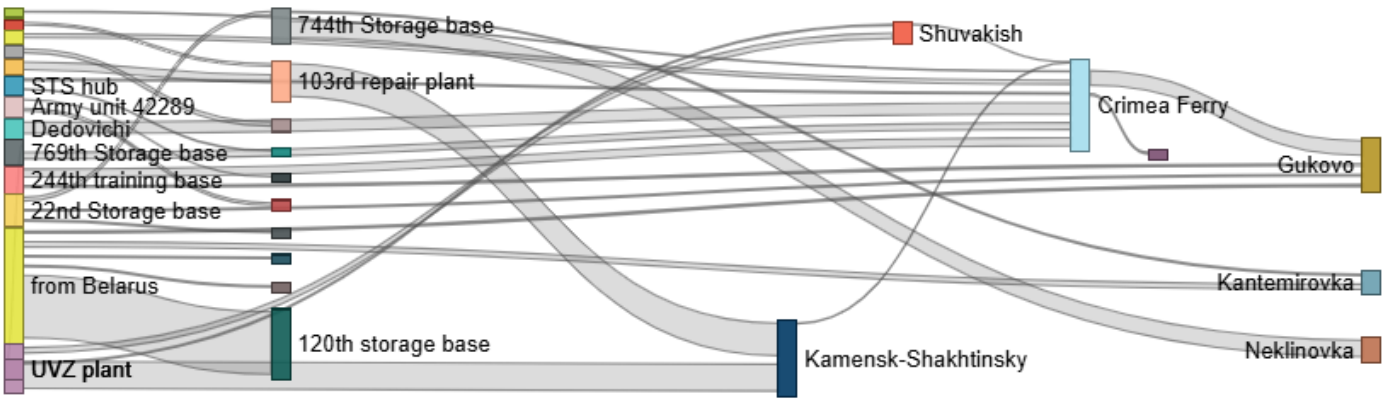
Figure 9: Shipments of unnamed cargo to/from army or obscure entities, in metric tons



Source: KSE Institute

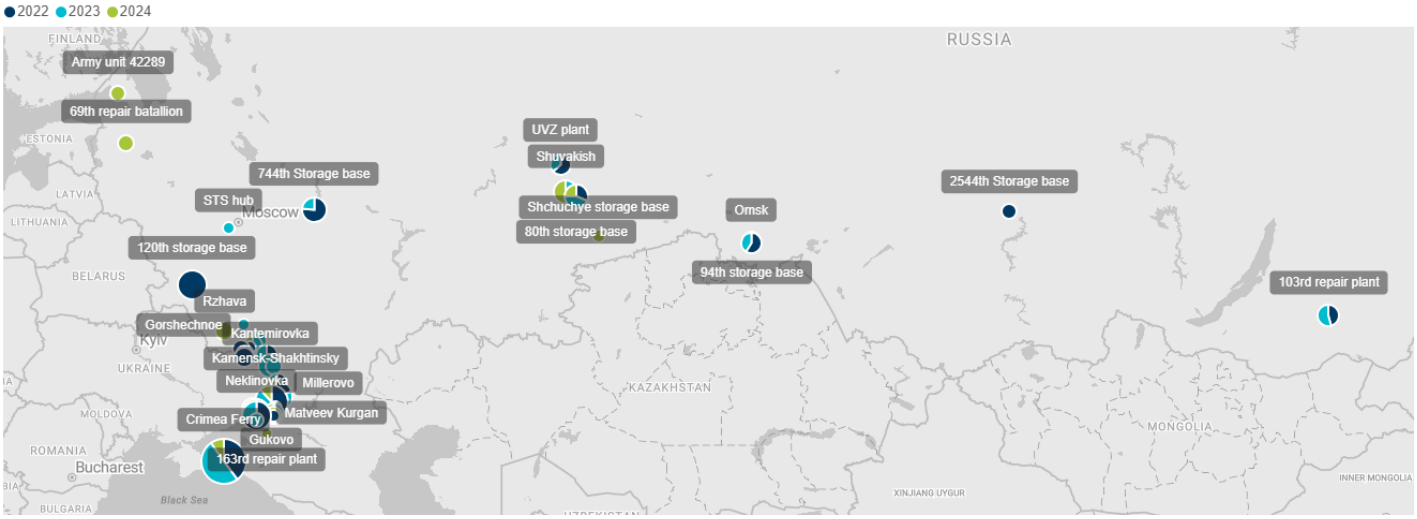
Greater confidence in the military nature of the unnamed cargo comes from an analysis of the shipments' geography. These flows of unnamed cargo strongly suggest that the goods in question are made up of tanks, armored vehicles, and other military systems and equipment. Generally, this cargo moves from locations around military storage bases and reserve fields to the frontline, or first to the repair plants and facilities and then to frontline points. The most notable of these destinations are Kamensk-Shakhtinsky and Gukovo in Rostov oblast. There are also redistribution flows, such as from Belarus to Bryansk, or from the Crimea ferry to Gukovo (see Figure 10 and Figure 11). For a closer look at shipments from storage field, see *Movements of Stored Military Equipment*.

Figure 10: Flows of unnamed cargo, in metric tons



Source: KSE Institute

Figure 11: Destinations of unnamed cargo by volume and year

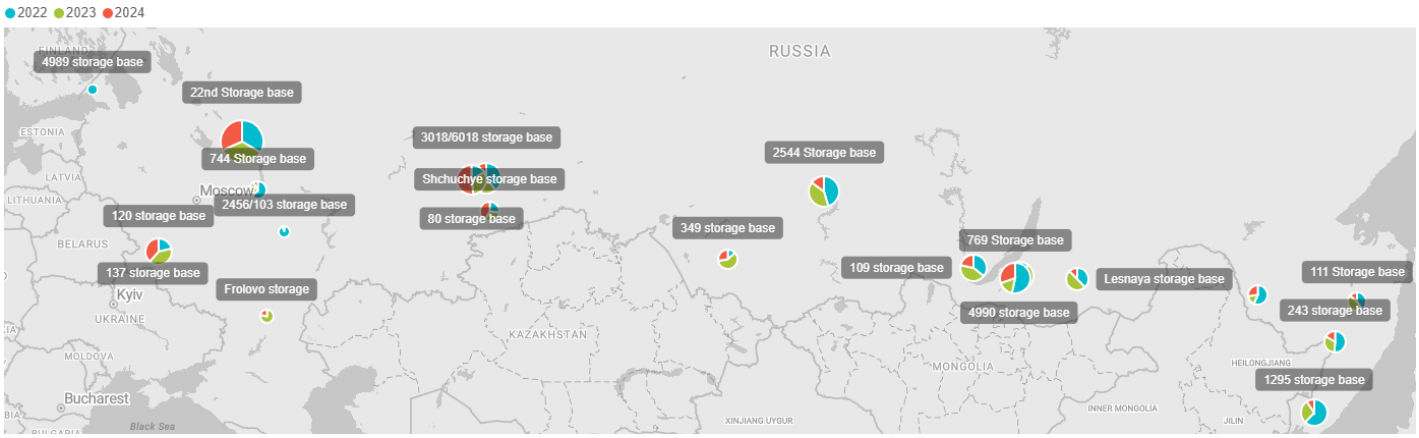


Source: KSE Institute

Movements of Stored Military Equipment

Data on railway shipments from Russia's tank, AFV, artillery, and MLRS storage bases provide insight into the broader trajectory of its reserve mobilization and repair strategy. Following a large increase in 2022, overall shipment volumes plateaued in 2023 and dropped markedly in 2024, indicating a diminishing pool of restorable assets.[3] In parallel, the focus has shifted from internal redistributions toward repair activities and direct deployment to the frontline. The increase in frontline-directed shipments observed in 2023, coupled with stable volumes to traditional repair centers, supports the hypothesis that field-based repair capabilities have been established or expanded. This adaptation allows for expedited equipment reactivation near reserve sites, streamlining the mobilization-to-deployment cycle.

Figure 12: Russian storage facilities for heavy military equipment by outgoing volume and year



Source: KSE Institute

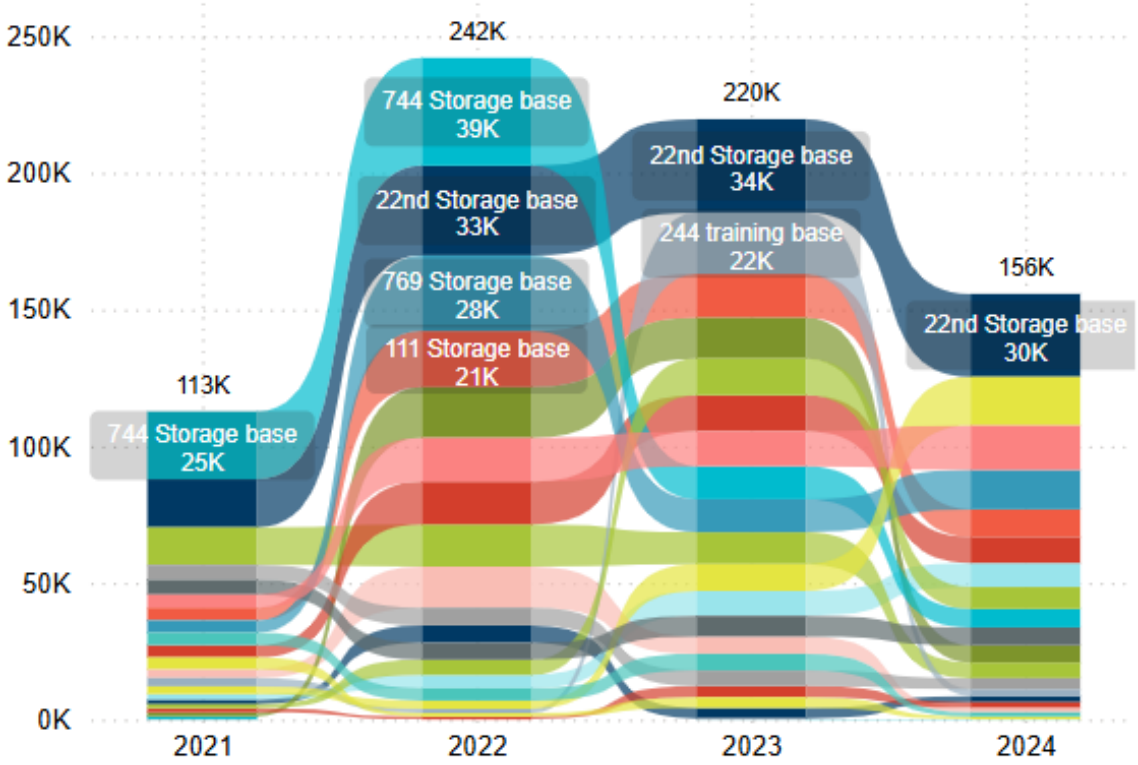
[3] This is corroborated by OSINT investigations, see "Covert Cabal" on YouTube

Origins: Storage Facilities

Our analysis identified 30 railway stations situated in proximity to Russia's principal storage fields for heavy military equipment and the associated repair depots (see Figure 12). These installations account for approximately 96% of the country's total pre-war tank storage, along with an estimated 80% of the pre-war inventory of armored fighting vehicles (AFVs), and 90% of artillery and multiple launch rocket system (MLRS) platforms. Our analysis focuses on rail cargo designated as "other," as this category encompasses most of the relevant military equipment.

A marked surge in shipments from these stations has been observed since the start of the full-scale invasion. In 2021, outbound shipments from storage fields totaled 113 thousand tons (see Figure 13). The volume more than doubled in 2022 to 242 thousand tons, reflecting the urgency of large-scale equipment mobilization, but declined in 2023 to 220 thousand tons (-9%). Shipments fell again in 2024 to 156 thousand tons (-29%). This supports the hypothesis that there has been a gradual depletion of serviceable reserves that can be restored or mobilized from storage. Annualized data from January-April 2025 would suggest a further 24% decline to 119 thousand tons.

Figure 13: Shipments from storage facilities by origin, in metric tons



Source: KSE Institute

The origins of military equipment shipments are concentrated among a limited number of strategic nodes. The 22nd storage base (Buy in Kostroma oblast) accounted for 16% of all observed outbound cargo, followed by base 744 (Ilino) with 11%, and base 769 (Ulan-Ude) with 8%. This concentration of Russia's storage fields in just a handful of locations scattered allows researchers to track the extent to which the Russian military is exhausting its Soviet reserves of heavy equipment—reserves that cannot be replenished overnight, or sometimes at all.[4]

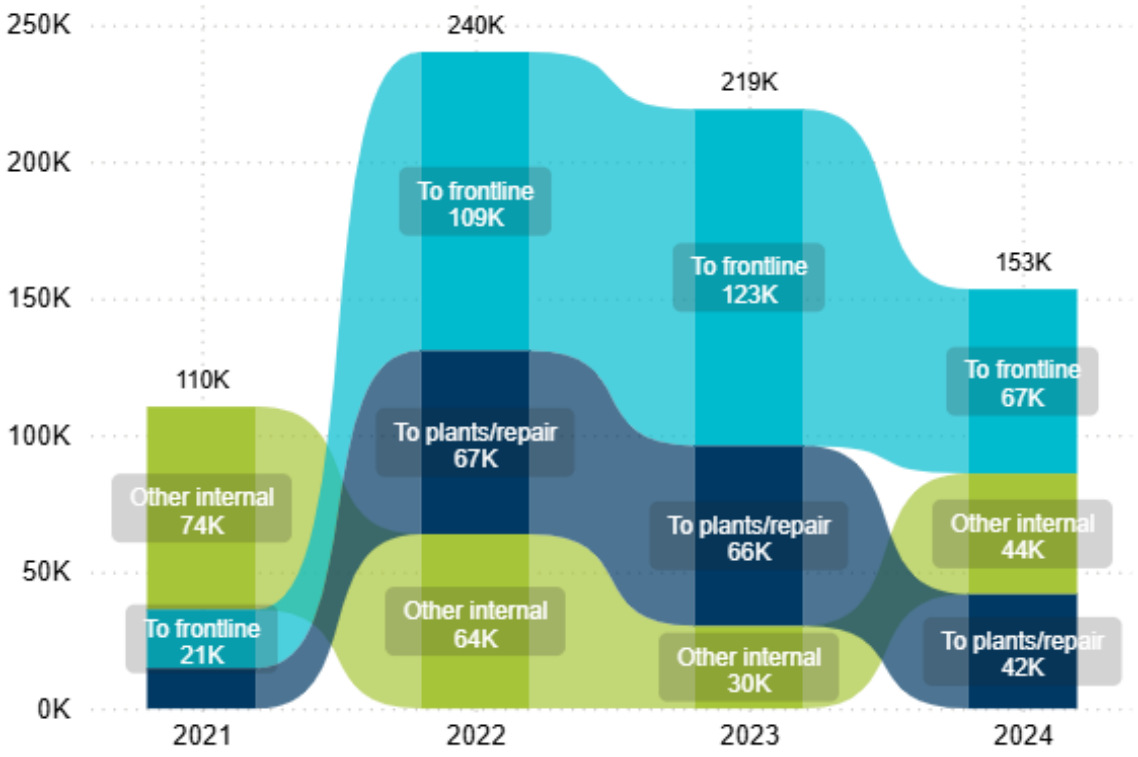
[4] See "Covert Cabal" on YouTube

Destinations: Repair Plants and Frontline Locations

The destinations of shipments of heavy military equipment from stations near reserve fields have undergone a significant transformation over the course of the full-scale war. For analytical clarity, destinations are categorized into three functional groups: (i) repair facilities, including both large plants and regional maintenance bases; (ii) frontline destinations, defined as locations in close proximity to active combat zones; and (iii) other destinations indicating internal redistributions, i.e., movements not directly associated with repair or deployment operations.

In 2021, prior to the large-scale activation of reserve stocks, approximately two thirds of shipments fell under the internal redistribution category (see Figure 14). These movements likely reflected routine reallocation activities within the broader military supply chain. A notable shift then took place in 2022, coinciding with elevated equipment losses on the battlefield and the commencement of a comprehensive repair initiative. That year, there was a clear pivot toward accelerated force regeneration and forward deployment: 28% of total outbound volumes were directed toward repair facilities, while 45% were routed to frontline-adjacent locations. The primary repair destinations included: Nizhny Tagil, home to Uralvagonzavod, Russia's primary battle tank manufacturer; Omsk, which houses Omsktransmash, a critical heavy vehicle refurbishment center; and the 103rd military repair depot in Chita.

Figure 14: Shipments from storage facilities by destination, in metric tons

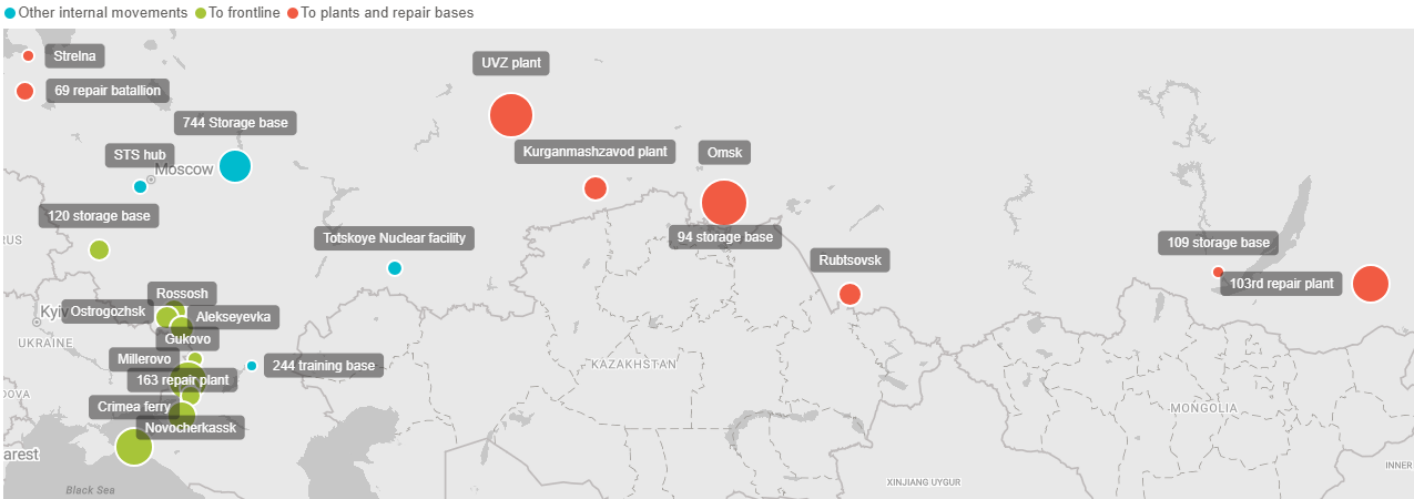


Source: KSE Institute

Frontline-oriented shipments were sent to areas that function as staging points for equipment deployment in Ukraine, including the Crimean ferry hub and logistics hubs in Rostov and Krasnoyarsk (see Figure 15 and Figure 16). In 2023, shipments to frontline areas increased both in absolute volume and as a proportion of total throughput, rising from 45% in 2022 to 56%. At the same time, the volume sent to repair facilities remained flat. This could reflect an increased capacity to conduct repair and reactivation directly at or near the storage facilities themselves, or a network of plants and repair bases that was already operating at capacity in 2022. In either

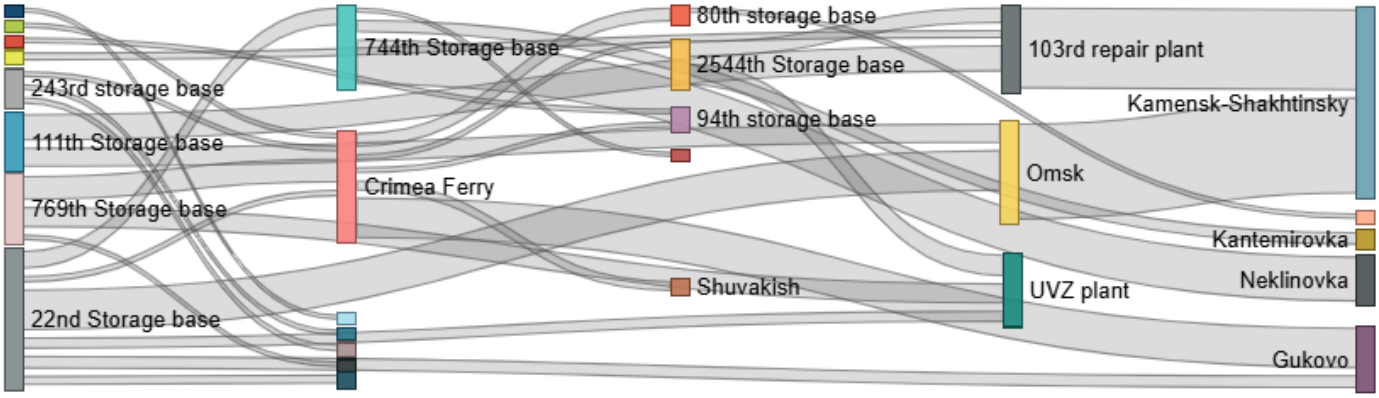
case, the Russian military's logistics have continued to adapt to deploy heavy equipment to the front and replace sustained losses. By enabling on-site or nearby restoration, the Russian military's logistics chains were likely able to bypass traditional repair nodes and ship fully functional equipment directly to the front. But in 2024, both frontline and repair facilities shipments declined—by 46% and 36% respectively—indicating reserve depletion.

Figure 15: Destinations of shipments of equipment from storage facilities by volume and purpose



Source: KSE Institute

Figure 16: Flows of military equipment from storage facilities



Source: KSE Institute

Involved Entities: Army Units and MIC Companies

A significant portion—approximately 88%—of railway shipments originating from Russia's storage fields have been conducted between obscured parties. Among the identifiable consignors and consignees, however, two military units stand out as prominent consignors. Army Unit 42713, stationed in Buy (Kostroma oblast), is responsible for dispatching cargo from the storage facility to major military-industrial centers including Omsk, Nizhny Tagil, and Kurgan. Similarly, Army Unit 54630, based in Kozulka (Krasnoyarsk territory, in Siberia), has been involved in sending equipment from the storage field to both the Omsk and Nizhny Tagil repair facilities.

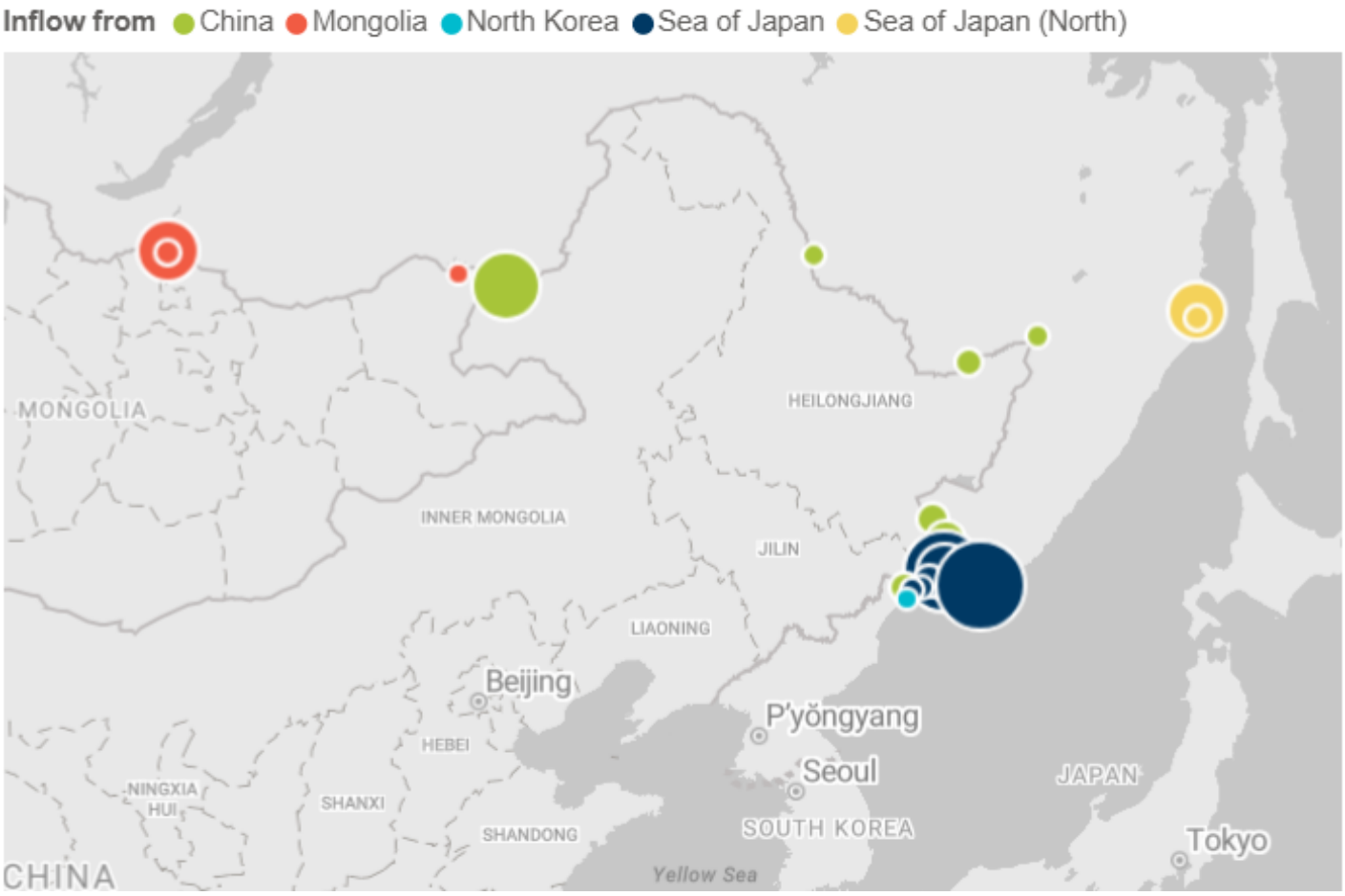
On the consignee side, entities such as Omsktransmash and Uralvagonzavod—Russia's primary armored vehicle production and repair companies—are heavily involved, alongside various state and regional repair

bases. These entities appear to be central nodes in the reactivation and redistribution of armored assets, as well as supplies of new equipment. For instance, during 2022-24 the UVZ plant received 34 thousand tons of equipment from the storage bases, while the volume of shipments from UVZ to a frontline base—Kamensk-Shakhtinsky—is much higher (59 thousand tons). After restoration, the military equipment is deployed to the frontline points, including Kamensk-Shakhtinsky and Gukovo (see Figure 16).

China and North Korea: Russia's Pivot to the East

This subsection explores the structure of railway cargo flows, revealing a deepening reliance on imports from China across both military production and the broader economy. Chinese logistics channels are increasingly dominated by a small number of military-affiliated operators who control key distribution hubs—primarily in Moscow. The sharp rise in machinery and vehicle imports further illustrates Russia's accelerated trade reorientation in response to Western sanctions. Imports from North Korea, on the other hand, are more focused on military-related cargo.

Figure 17: Railway stations on Russia's eastern border



Source: KSE Institute

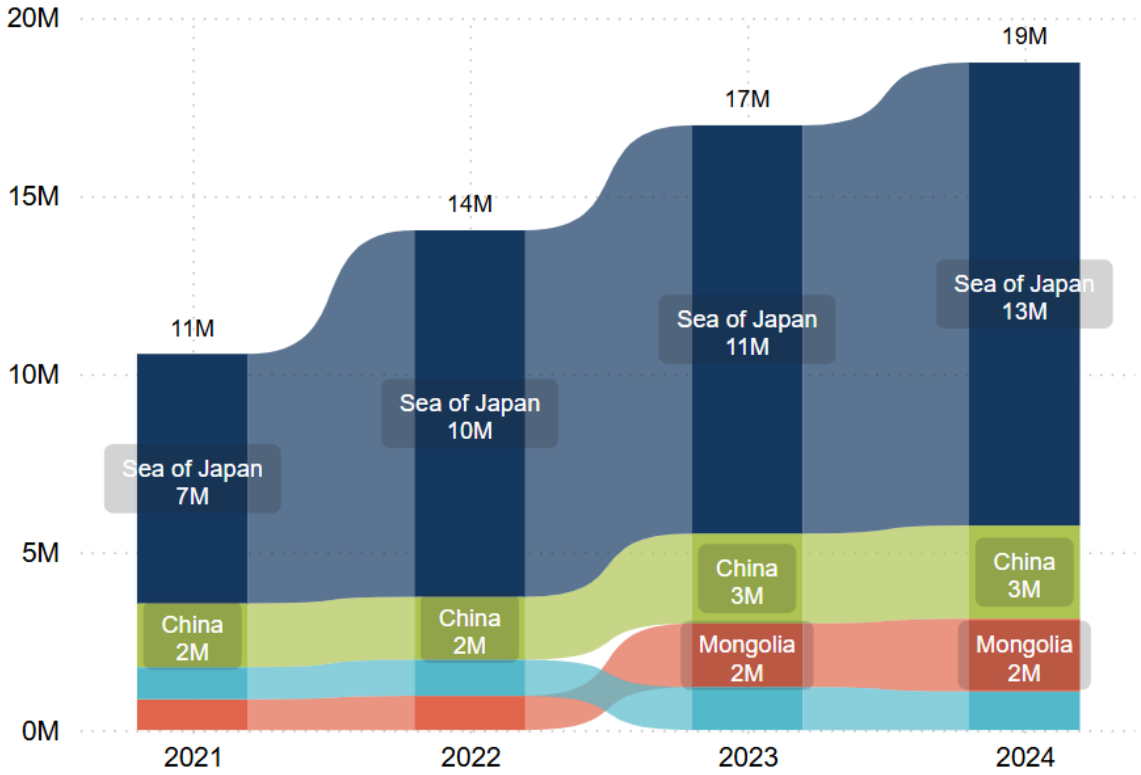
Import Dynamics

To understand the role of imports from partners in the East for the Russian MIC, we first look at cargo flows through a network of 34 railway stations—located along the Chinese, Mongolian, and North Korean borders, as well as in

ports in the Vladivostok and Nakhodka regions and the Northern Sea of Japan (see Figure 17). These stations, which are identified as border crossings, currently serve as an important import corridor for military-relevant cargo into Russia. For almost all import shipments, the data contains the country of origin. The following findings are based on the assumption that this information is not being falsified to a significant extent. We consider the alternative—where shipments are purposefully misclassified—in a later section (see *North Korean and Iranian Explosives*).

Since the start of the full-scale war, these stations have experienced substantial growth in throughput. Total rail cargo volumes at these stations increased from 7 million tons in 2021 to 10 million tons in 2022 (+48%), 12 million tons in 2023 (+21%), and 14 million tons in 2024 (+19%). The surge in volume is driven by Chinese imports, which rose sharply in 2022 and have remained high thereafter (see Figure 18). Cargo flows from North Korea through these border stations are negligible; however, there is more to the North Korean story than initially meets the eye.

Figure 18: Cargo flows from Russia's eastern border, in metric tons



Source: KSE Institute

Facilitators

Around 40% of the incoming tonnage from this network of stations is received by only a handful of logistics operators. The most important of them are OTT, Logoper, STS Logistics, Ekodor, in addition to CIT, FIT, PKT, TES, TransContainer, and T1. The sanctions coalition has already opened the door to punishing these logistics firms for their roles in facilitating Russian aggression.

OTT (*OblTransTerminal*), which operates a large rail container terminal near Moscow, was sanctioned by the US for its role in Russia's war logistics.[5] The State Department noted it as an intermediary funneling sanctioned industrial goods to Russian military manufacturers (e.g., facilitating shipments to the Kolomensky Zavod engine plant).[6] Among these industrial goods distributed to the military sector are imported CNC machine tools, which fall under the sanctions coalition's Common High Priority Items List (CHPL) due to their importance to the Russian war effort.[7] OTT climbed to the top of the market of firms shipping cargo from the border in 2022, with processed cargo volume rising from 0.63 million tons in 2021 to 1.58 million tons, and stayed on top thereafter. The share of imports coming from eastern border stations transported by OTT doubled from 6% in 2021 to 13% in 2023. In 2023, their tonnage further increased by 39% to 2.2 million tons, but contracted to 1.8 million in 2024, likely because the company is now subject to US sanctions.

LKS, one of the top providers by volume, is a part of the **Logoper** group owned by a former Russian Railways executive, Aleksandr Kakhidze. His other logistics company, RB Group, was sanctioned by Ukraine. Two more operators from Logoper group—NTT and TsT—began handling cargo flows in the Elektrougli hub in 2024 after OTT was sanctioned. Logoper group's volume of shipments from the eastern border comprised ~1.4 million tons per year in 2021-2023 but increased to 2.1 million in 2024 (+47%), overtaking OTT as the primary operator handling these import flows.

STS Logistics (CJSC Special Transportation Services) is another important player in Russia's freight and third-party logistics sector that has been sanctioned by the US for its role in supporting military supply chains.[8] The company is also active in Russia's export logistics, including oil and strategic goods transport. Following the introduction of EU sanctions on Russian shipping, media reports noted that European waters would be effectively closed to STS Logistics, constraining its ability to move Russian export cargoes abroad.[9] Nonetheless, the company quickly pivoted towards Asian routes. With the onset of the full-scale invasion, it ramped up its imports from the eastern border: volumes surged 2.7-fold in 2022 (to 400k tons), again by 2.8 times in 2023 (to 1.26 million tons), and by another 22% in 2024 (to 1.5 million tons). By 2024, STS Logistics had become the third-largest operator in this space—from 2% to 8% market share between 2021 and 2024.

Ekodor is a Moscow-based rail and trucking logistics firm that handles container shipments and operates a freight terminal in Podolsk (south of Moscow).[10] In June 2024, OFAC sanctioned Ekodor for contributing to Russia's domestic war economy.[11] Ekodor's import shipping volumes have hovered around its pre-invasion levels (1.1-1.2 million tons) during the full-scale war. Ekodor is examined in greater detail in the next section (see *Logistics: Port of Vladivostok and Ekodor*).

CIT Terminal, located in Yekaterinburg, operates under the *Oboronsnabsbyt* group—a logistics and real estate conglomerate with roots in the Soviet military's supply infrastructure. Originally established to support the MoD's logistics units, the group has retained a focus on military-relevant freight.[12] CIT Terminal itself is one of the Urals'

[5] See "On second anniversary of Russia's further invasion of Ukraine and following the death of Aleksey Navalny, Treasury sanctions hundreds of targets in Russia and globally," US Treasury; "Sanctions List Search," OFAC
[6] See "New measures targeting third-country enablers supporting Russia's military-industrial base," US Department of State
[7] See "Third-best option: China's rising role in Russian access to critical industrial equipment," Economic Security Council of Ukraine
[8] STS Logistics was sanctioned by OFAC in February 2024. See "Russia-related designations," US Treasury
[9] See "Russian oil logistics in chaos ahead of looming sanctions," Bloomberg
[10] See "Record numbers for OOO Firm Ekodor," Maxima Logistic [ru]
[11] See "As Russia completes transition to a full war economy, Treasury takes sweeping aim at foundational financial infrastructure and access to third country support," US Treasury
[12] See "Oboronsnabsbyt changed its name," CIT [ru]

biggest freight nodes, operating a large inland container and customs terminal adjacent to the Koltsovo rail hub. Its infrastructure—featuring bonded customs storage, on-site armed guards, and canine units—caters to the handling of sensitive and dual-use goods.[13] Historically, the terminal has played a role in managing freight flows tied to the military sector in the region. With the expansion of wartime trade channels, CIT's imports from the eastern border rose steadily: from 330 thousand tons in 2021 to 380 thousand tons in 2022 (+16%), 452 thousand tons in 2023 (+18%), and declined to 387 thousand tons in 2024 (-14%).

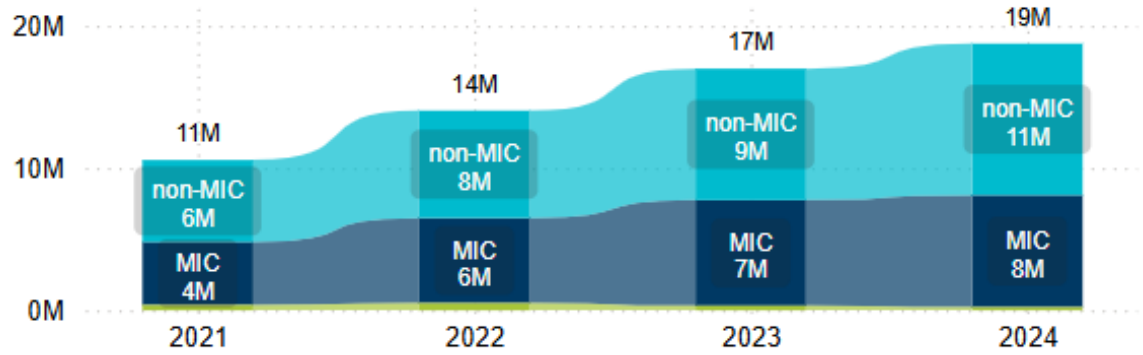
FIT LLC serves as the transport subsidiary of FESCO, one of Russia's largest integrated logistics conglomerates, with control over the port of Vladivostok as well as a sizable fleet of ships, railcars, and containers. In May 2023, the UK government sanctioned FESCO Group (Far-Eastern Shipping Company) as part of a broader effort to disrupt the enablers of Russia's war economy.[14] The designation—issued alongside those of state-linked financial institutions and military firms—highlighted FESCO's strategic role in sustaining military logistics through its control of maritime and port infrastructure. FESCO vessels have been linked to shadow fleet oil shipments, and in 2024, one of its container ships was reportedly denied refueling in Asia amid mounting sanctions pressure.[15] FIT handled relatively small volumes from the eastern border—from 306 thousand tons in 2021 to 239 thousand tons in 2024.

TransContainer is Russia's largest intermodal rail container operator, and it has been explicitly linked to military logistics. According to the U.S. Treasury, TransContainer "offers military transportation services to the Russian armed forces" and has actively assisted in the illicit shipment of North Korean munitions and weapons systems into Russia for use in the war against Ukraine.[16] The company, formerly part of Russian Railways, is now majority-owned by Delo Group (with reported involvement of Rosatom).[17] Beyond moving foreign munitions, TransContainer operates special military rail terminals and has long carried MoD cargo under contracts. It also opened a new rail terminal at the Alabuga special economic zone for military-related industry, and its executives were part of a Russian delegation to Iran in 2023, likely to secure military-industrial cooperation.[18] TransContainer's processing of shipments from the eastern border has increased over time: from 93 thousand tons in 2021 to 135 thousand tons in 2022 (46% increase), to 188 thousand tons in 2023 (40% increase), and 236 thousand tons in 2024 (25% increase).

Not only has the reliance on imports from the eastern border almost doubled from 2021 to 2024, but the control of these import flows was consolidated in the hands of logistics providers associated with the Russian military: OTT, Logoper, STS, Ekodor, CIT, FIT, and TransContainer. Together MIC-affiliated consignees received 43% of shipments from the eastern border in 2024 (see Figure 19). Of course, it is rare for MIC companies to receive cargo directly from a foreign supplier without it going through a logistics provider first. But there are cases illustrating the deepening dependence: Alabuga Exim started directly importing spare parts, synthetic resins, wheels, absorbents, and plastic parts, with volumes increasing tenfold from 2023 to 2024.

[13] See "About the group of companies," OSS [ru]
[14] See "Great Britain sanctioned 86 Russian individuals and companies, including the transport group FESCO," Trans.ru [ru]
[15] See "FESCO told about the refusal of the container ship Moskva in China," Forbes [ru]
[16] See "On second anniversary of Russia's further invasion of Ukraine and following the death of Aleksey Navalny, Treasury sanctions hundreds of targets in Russia and globally," US Treasury
[17] See "Rosatom buys into Delo as $7bn shipping push continues," Trade Winds
[18] See "On second anniversary of Russia's further invasion of Ukraine and following the death of Aleksey Navalny, Treasury sanctions hundreds of targets in Russia and globally," US Treasury

Figure 19: Shipments from Russia's eastern border by consignee affiliation, in metric tons



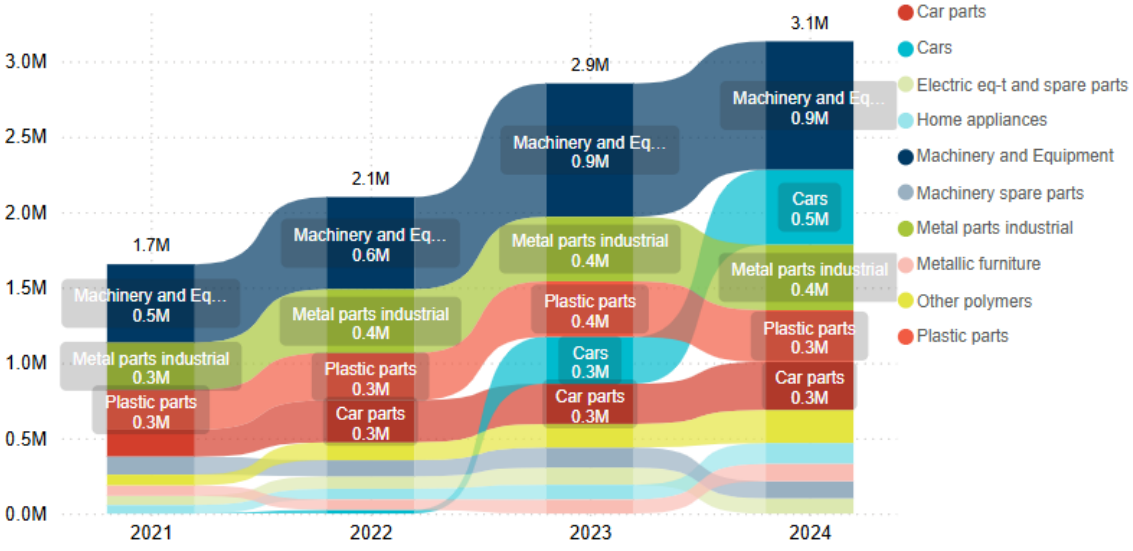
Source: KSE Institute

Products

Shipments from the eastern border have grown dramatically since 2021, thanks to increasing demand from both the civilian economy and military-industrial complex (see Figure 19). The cargo most imported by the MIC is machinery and equipment (see Figure 20). It grew consistently from 520 thousand tons in 2021 to 612 thousand tons in 2022, 885 thousand tons in 2023, and 851 thousand tons in 2024 (+63% over 2021-2024).

Another large portion of imports is related to vehicles—cars, car parts, and tires are among the top 10 cargo types. Shipments of cars skyrocketed from zero in 2021 to 312 thousand tons in 2023, continuing to grow in 2024 to 499 thousand tons. The flood of Chinese vehicles entering the Russian consumer market has been covered extensively in the media and has even led Moscow to impose fees to prevent a Chinese takeover of the Russian market.[19]

Figure 20: Shipments from Russia's eastern border to MIC-affiliated consignees, top 10 cargo types, in metric tons

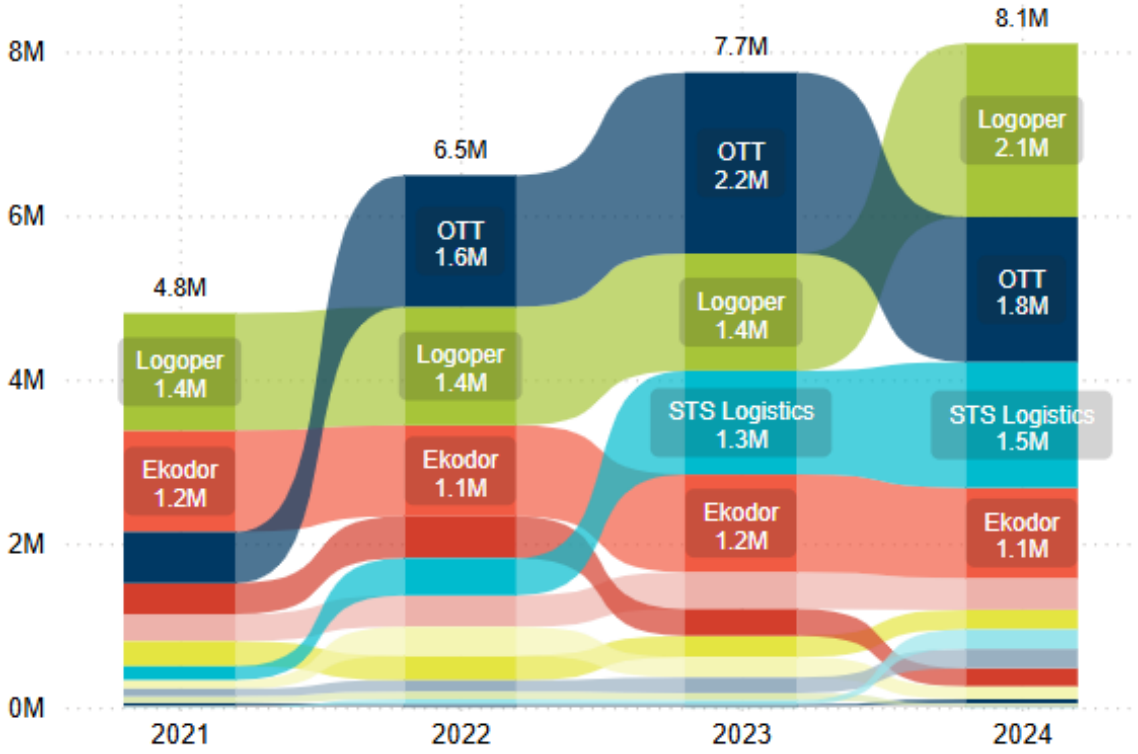


Source: KSE Institute

[19] See "Russian sales of Chinese cars surge after western sanctions hit," Financial Times; "Russia imposes fees to stem flood of low-cost Chinese cars," Financial Times

Plastic parts, on the other hand, made up a substantial portion of imports even before the full-scale invasion. In 2021 it was the third most imported cargo with 265 thousand tons, which grew to 312, 386 and 343 thousand tons in 2022-2024, respectively (see Figure 20). Whether it is in machinery or plastic parts, flows of industrial goods from the eastern border—overwhelmingly from China—were an important part of Russia's manufacturing sector before the full-scale invasion but became a defining feature during the war. Just a handful of logistics companies serve to keep this lifeline moving (see Figure 21).

Figure 21: Shipments from Russia's eastern border to MIC consignees, in metric tons



Source: KSE Institute

Destinations

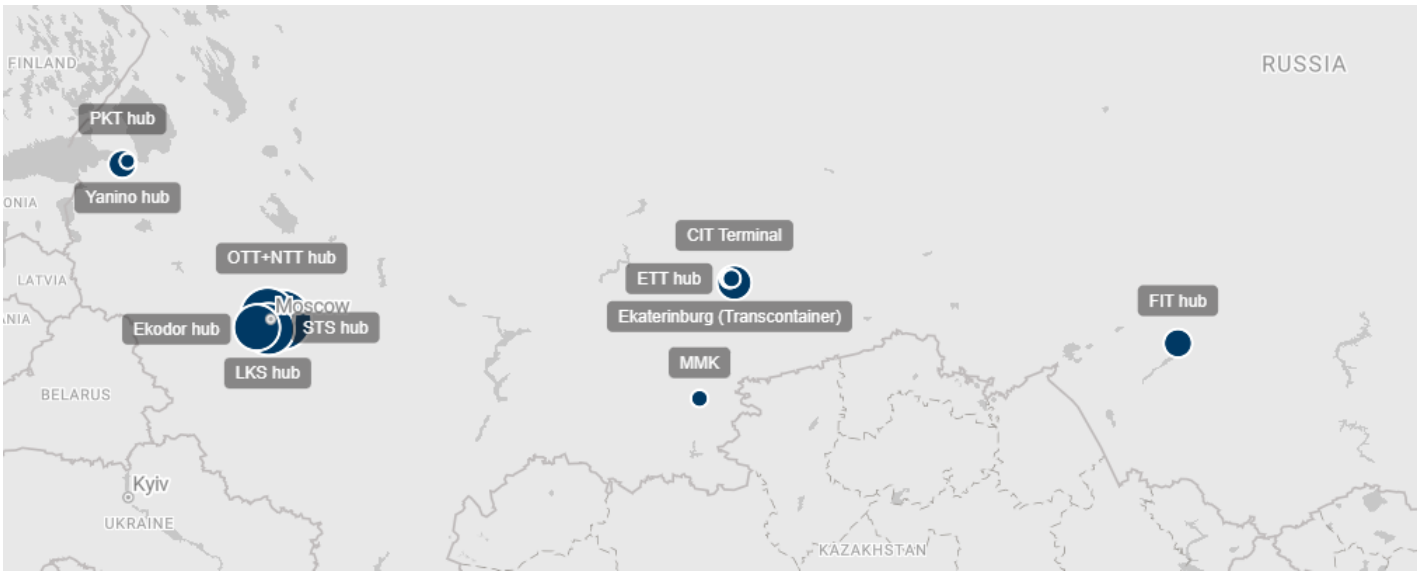
The import distribution network is heavily concentrated around a limited number of strategic hubs, including Elektrougli, Selyatino, Silikatnaya, and Koltsovo (see Figure 22). Of these, only Silikatnaya and Koltsovo handled significant volumes from the eastern border prior to 2022, which is indicative of Russia's strategic development of new supply chains during its full-scale war. Furthermore, the concentration of these hubs in and around Moscow highlights the central role that the capital plays in the movement of goods around the country, even as the supply chains stretch from the Chinese to the Ukrainian borders.

Elektrougli, located east of Moscow, hosts one of the country's largest multimodal transport logistics centers; it is operated by OTT, and, beginning in 2024, partially by NTT. In 2023, a new technological complex at Elektrougli was completed, enabling high-volume container handling and transshipment of goods from rail to road.[20] While officially a civilian freight hub, Elektrougli's immense capacity and proximity to military industry entities makes it

[20] See Elektrougli official website, Elektrougli [ru]

a natural staging point for military cargo heading west to the front or east to factories. This hub managed 5.9 million tons of cargo from the eastern border in 2022, or 35% of all such cargo.

Figure 22: Destinations of cargo shipped from Russia's eastern border to MIC or obscured parties



Source: KSE Institute

To the southwest of Moscow, **Selyatino** features a major rail container terminal and warehousing facilities operated by STS Logistics. In August 2024, Russian Railways even launched a special expedited freight route between Selyatino and Yekaterinburg in the Urals to speed up deliveries.[21] This line directly links the Moscow logistics hub with the industrial heartland, which is particularly useful for military supply flows. The STS Selyatino hub received 3.2 million tons of cargo from the eastern border starting 2022, or 19% of all such cargo.

The **Silikatnaya** hub, located in the southern Moscow, is operated by Ekodor. Incoming cargo volumes from the eastern border remained relatively stable at 1.1 million tons annually in 2021-2024. In total, Ekodor received 3.4 million tons during 2022-24, or 20% of these flows. The **Koltsovo** hub southeast of Yekaterinburg is operated by CIT Terminal. The company's handling of shipments from the eastern border has steadily increased, accounting for 1.5 million tons during 2022-24, or 9% of the total flows.

Other important logistics hubs receiving the cargo from eastern border stations are: **Novosibirsk,** operated by FIT (854 thousand tons, or 5% of total); **Yekaterinburg,** where approximately half of incoming cargo was handled by TransContainer (347 thousand tons, or 2% of total); the **Yanino** logistical park in St Petersburg (237 thousand tons, or 1%), which has greatly expanded its volume in 2024 (19 vs 218 thousand tons); and the **Kleschikha** TransContainer terminal (117 thousand tons, or 1%).

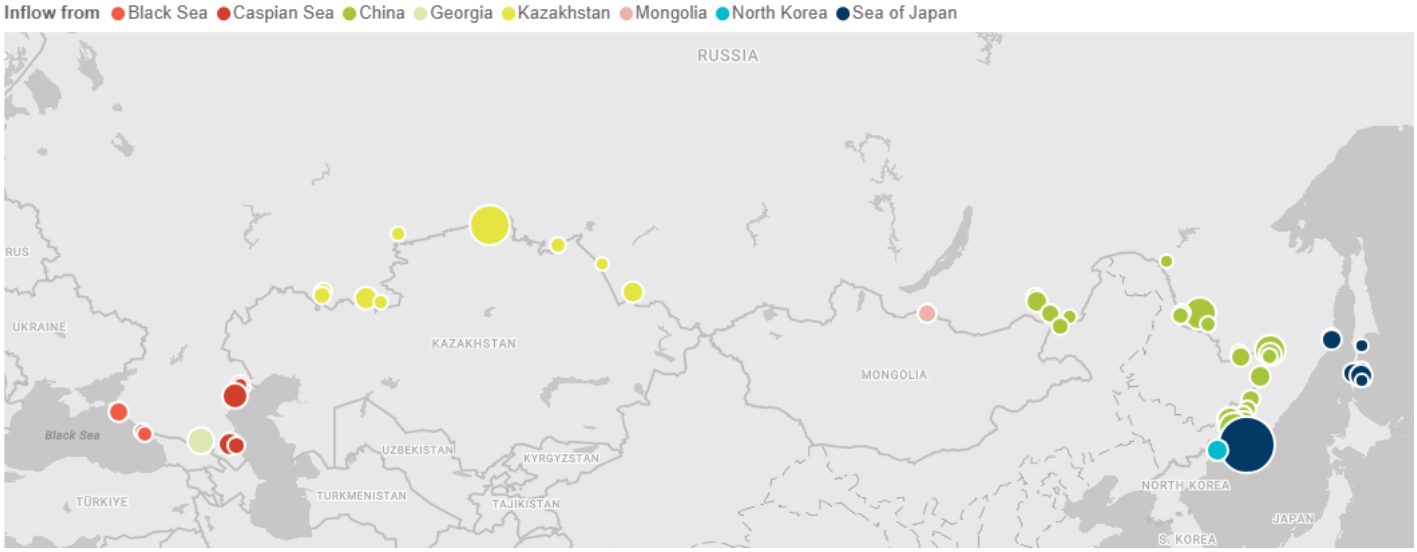
In addition to major hubs operated by MIC-affiliated transport companies, there were destinations of cargo from the eastern border connected with final users. MMK in Magnitogorsk received refractory and industrial minerals, while Irkutsk, the location of the 109th army storage facility, received wheels, containers, and machinery, likely facilitating the repair and transportation of military equipment.

[21] See "Sverdlovsk Railways developed an accelerated cargo route from the Moscow region to the Urals," Kommersant [ru]

North Korean and Iranian Explosives

The second part of our analysis focuses on specific cargo flows with 'Russia' listed as the state of origin, though this attribution is often dubious. Investigative reporting has shown that some of this cargo consists of imports of military goods—North Korean ones to be precise—which subsequently make their way to the frontlines in Ukraine.[22] We have identified stations near railway border crossings where goods are shipped from unknown or foreign consignors to unknown or MIC-affiliated consignees. This approach highlights cargo flows pertaining to army or MIC entities that very likely consist of imports. Such shipments, by design, do not have information about the country of origin; instead, we make assumptions based on the location where goods first appear (see Figure 23).

Figure 23: Stations near border crossings that could be channels for import flows



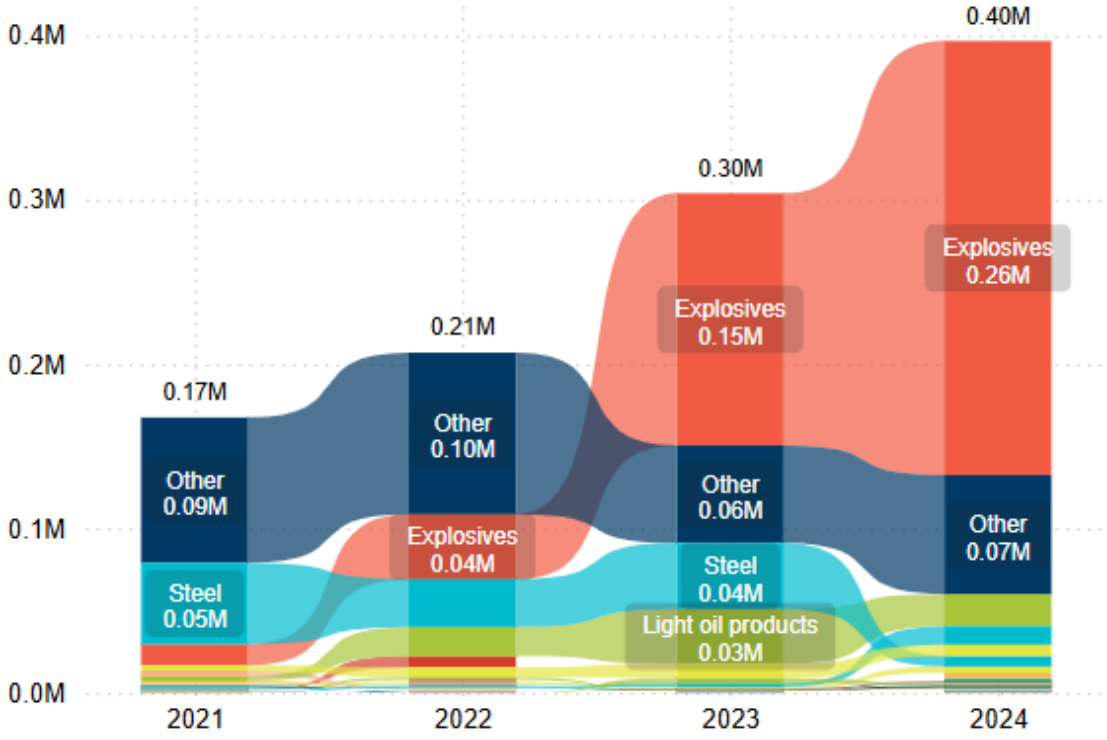
Source: KSE Institute

Note: These stations are located near railway border crossings where goods are shipped from unknown or foreign consignors to unknown or MIC-affiliated consignees.

Cargo flows through these potential import stations have been increasing in recent years due to shipments of explosives that comprised 150 thousand tons in 2023 and 260 thousand tons in 2024 (see Figure 24 and Figure 25). These findings corroborate reports that eastern ports in the Nakhodka area are used to receive shipments of military cargo from **North Korea**.[23] After arriving in Russia, the cargo then went to arsenals and ammunition bases: the 68th Arsenal in North Ossetia, 51st Arsenal in Vladimir oblast, and the Kedrovka ammo base in Sverdlovsk oblast, among others (see Figure 26). Locations like Tresvyatskaya in Voronezh oblast and Tselina in Rostov oblast receive over 80% of their explosives shipments from this North Korean channel, which means that they could be the processing and redistribution hubs of this "foreign aid." Other arsenals—such as the 51st, 73rd, 719th, and 68th—rely on North Korea for 30-40% of their inputs. The volume of explosives shipments via the Nakhodka channel dwarfs the cargo where North Korea is stated as country of origin, which comprised just 7 thousand tons over 2021-25.

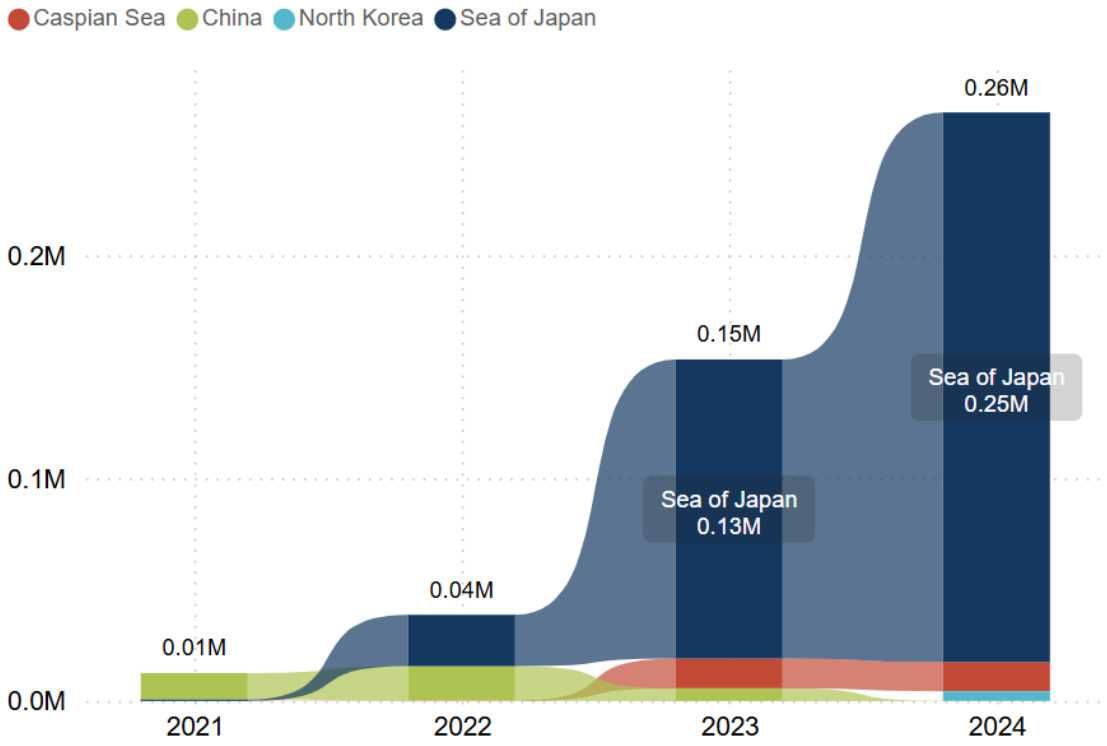
[22] See "Brothers in arms," Open Source Centre; "Inside North Korea's vast operation to help Russia's war on Ukraine," Reuters
[23] See "Brothers in arms," Open Source Centre; "Inside North Korea's vast operation to help Russia's war on Ukraine," Reuters

Figure 24: Potential import flows by cargo type, in metric tons



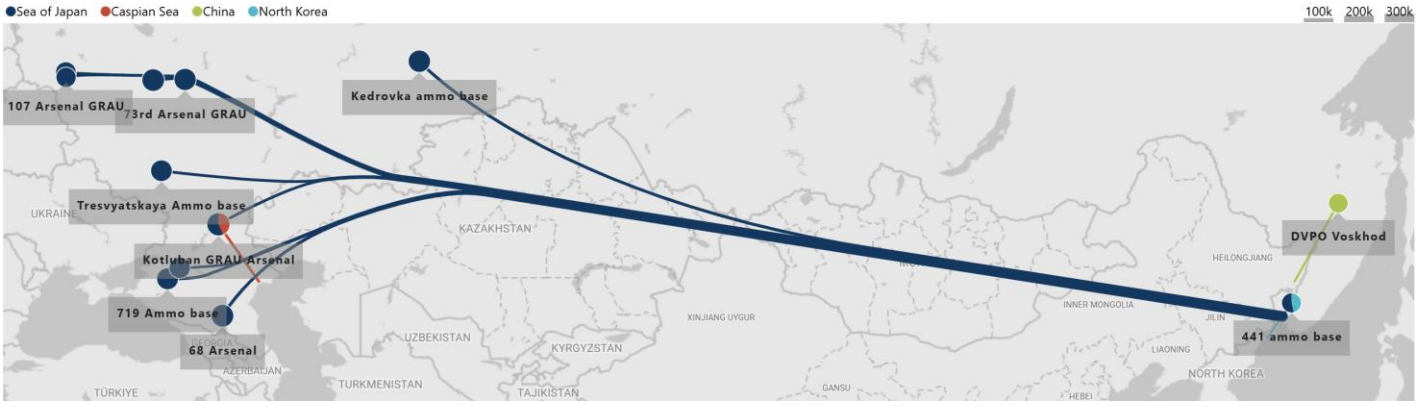
Source: KSE Institute

Figure 25: Potential import flows of explosive materials by source, in metric tons



Source: KSE Institute

Figure 26: Flows of explosive materials from potential import stations



Source: KSE Institute
Note: Bubbles represent destinations

Shipments of explosive materials from Nakhodka totaled 130 thousand tons in 2023 and grew to 244 thousand tons in 2024, accounting for 27% and 52% of the explosives volume shipped to known arsenal locations in those years, respectively. While early 2025 data suggest that North Korea's supply of munitions to Russia may have peaked in absolute terms in 2024—53 thousand tons of explosives were shipped in these supply lines in January-April—its share is still growing: this amounted to 58% of all explosives shipped to arsenals. How this has translated to the battlefield is somewhat ambiguous, as Ukrainian military intelligence claimed in July 2025 that only up to 40% of Russia's ammunition for its campaign in Ukraine is coming from North Korea.[24] In any case, recent reports that North Korea may soon send more troops to Russia[25] demonstrate that the reliance is still on the rise.

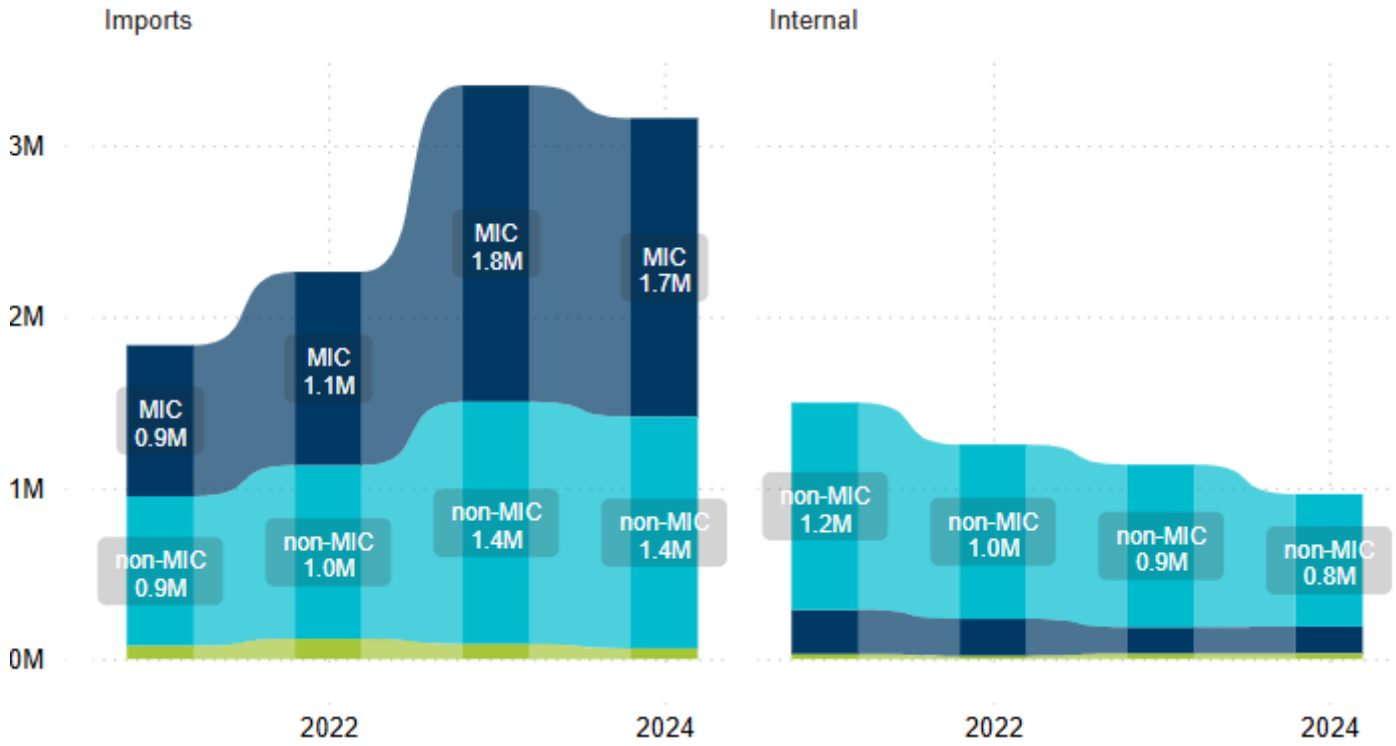
Another flow of explosive materials originates in Port Olya on the Caspian Sea, where shipments of weapons from **Iran** reportedly arrive.[26] This cargo is mainly directed to the Kotluban GRAU Arsenal in Volgograd oblast. The Kotluban GRAU Arsenal is the sole depot that receives explosives suspected to originate from both North Korea and Iran (see Figure 26). Caspian shipments are the top source of explosives coming to this arsenal—17%, with additional 12% coming from Nakhodka. Total explosives imports via the Caspian route are much smaller—13 thousand tons per year (5 thousand tons in the first four months of 2025)—but nonetheless politically significant. In addition, there are reported shipments of Iranian military equipment to Russia by airlines.[27] Non-explosives railway shipments from Iran are more substantial than their North Korean counterparts, though still limited—around 90-100 thousand tons each year—and are primarily food supplies and construction materials.

Machinery and Components

Shipments data for machinery and components reveal rising volumes, primarily linked to military-related logistics operations. For the purposes of this analysis, the following categories are included: agricultural machinery; spare parts; computers; controllers, relays, and sensors; optics; radio and communication equipment; electric devices and engineering equipment; forging and pressing equipment; other machinery; and metal forming and cutting tools.

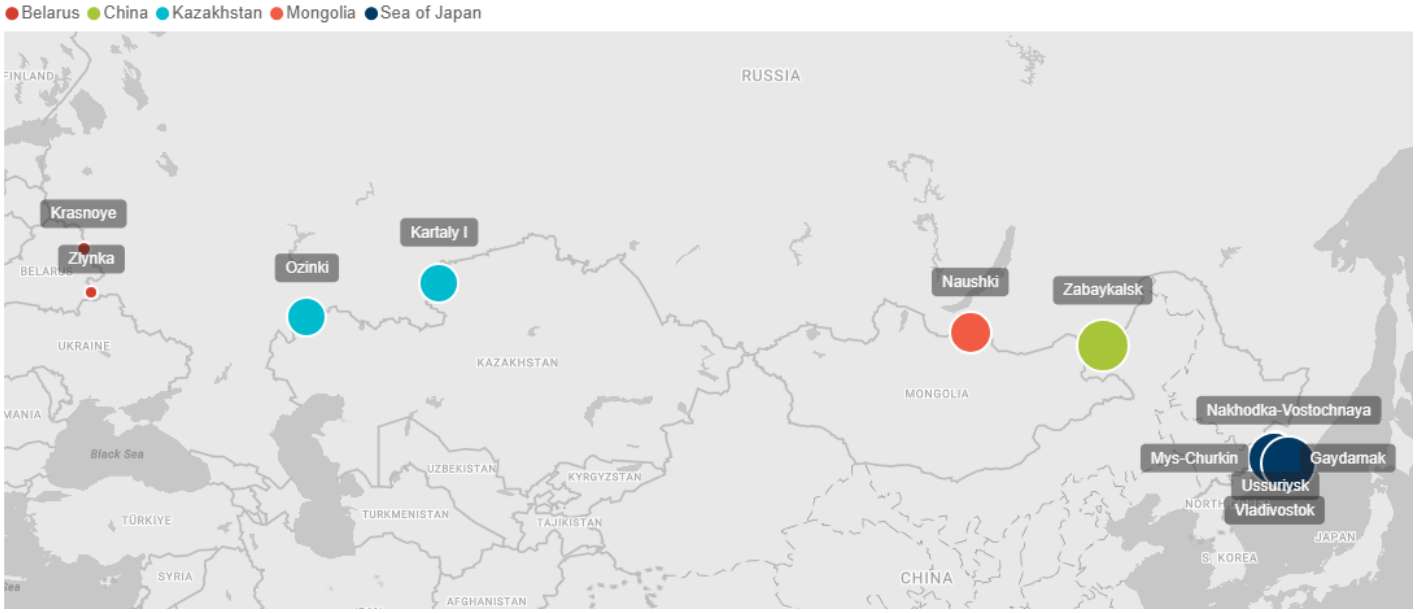
[24] See "Ukraine spy chief says 40% of Russian ammunition is North Korean," Bloomberg; Reuters and Open Source Centre reporting suggest that this is a slight decrease from earlier levels.
[25] See "North Korea may send more troops to Russia in July or August for Ukraine war, Seoul says," Reuters
[26] See "Iran oil tycoon 'Hector' plays key role in arms sales to Russia," Bloomberg
[27] See "How does Iran transport its drones to Russia?" Jerusalem Post

Figure 27: Shipments of machinery and components by origin and consignee affiliation, in metric tons



Source: KSE Institute

Figure 28: Inflow points and volumes of components and machinery imports, in metric tons



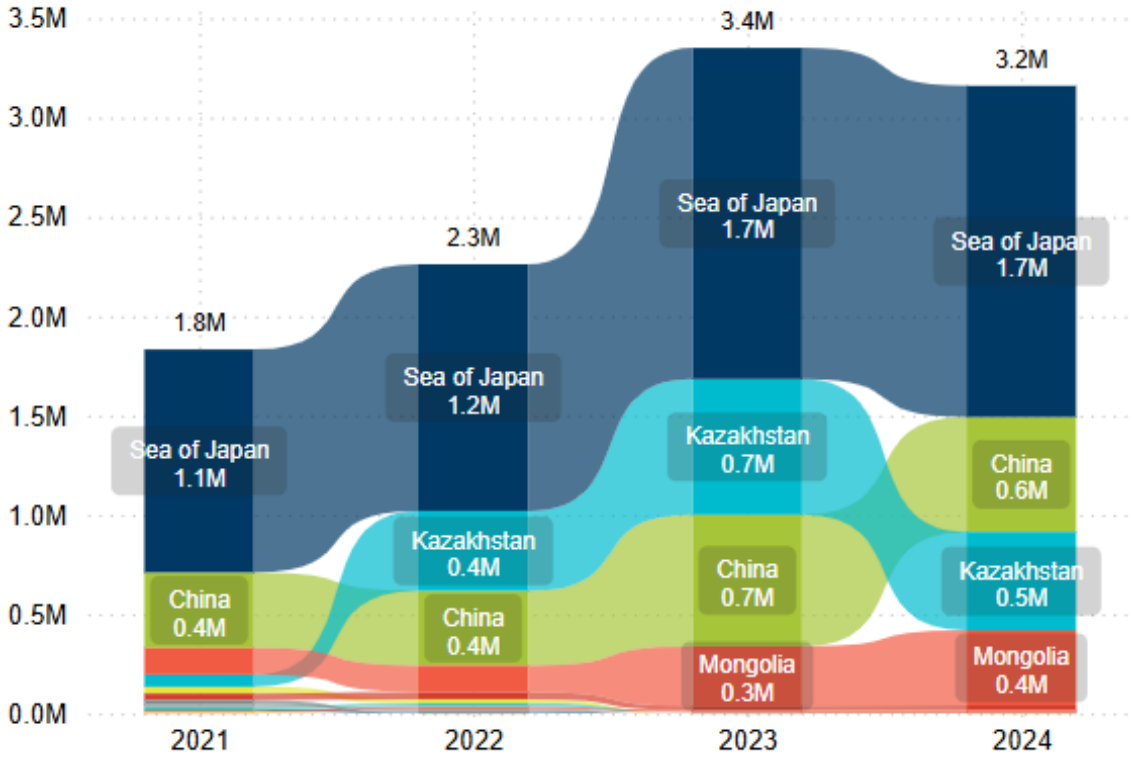
Source: KSE Institute

Imports of machinery and components increased from 1.8 million tons in 2021 to 2.3 million in 2022, then jumped to 3.4 million in 2023 and plateaued at 3.2 million in 2024 (see Figure 27). The imports are directed predominantly to military-affiliated consignees—in 2024, their share of import tonnage of components and machinery was 53%,

for example—and the overall wartime growth in imports is driven chiefly by the military-industrial complex. Internal shipments have steadily declined, which is likely an indicator of how Chinese imports have supplanted domestically produced competition, and are overwhelmingly directed to civilian entities.

The supply chain shows heavy reliance on a small number of border-crossings and overall dependence on imports (see Figure 27 and Figure 28). Import flows from points in the Far East were stable during 2021-2022 (0.38 million tons), then increased to 0.47 million tons (+23%) in 2023 and remained at the same level in 2024 (see Figure 29). Shipments from Kazakhstan became meaningful in 2022, increasing from 2 thousand to 59 thousand tons, and then tripling in 2023 to 179 thousand tons (stable in 2024).

Figure 29: Volumes of components and machinery imports by inflow point, in metric tons



Source: KSE Institute

The logistics sector is top-heavy, and the flow of machinery and components is no exception. The sector has shown increasing consolidation among the providers for these classifications of strategically important cargo, as well as noteworthy patterns of shipment destinations, with most of the hubs located around Moscow (see Figure 30). The Elektrougli hub east of Moscow is operated by **OTT.** After OTT was sanctioned, two more entities emerged that are importing components and machinery via the Elektrougli hub: NTT and TsT under **Logoper** group. Around 30% of machinery and components traffic flows through this hub. Khovrino, operated by Logoper, is handling 14%, followed by **STS** in Selyatino with 14%, and **Ekodor** in Silikatnaya with 11%.

Figure 30: Destinations of imported components and machinery

Source: KSE Institute

Russia's supply chain for machinery and components—critical to the operation and expansion of the military industry—has significant strategic vulnerabilities, despite its recent growth. It is heavily reliant on imports that are sourced through a limited number of border crossings, which can cause bottlenecks, and is facilitated by an increasingly concentrated field of logistics companies. The geographic concentration of receiving facilities, particularly in the Moscow oblast through the Elektrougli and Selyatino clusters, creates potential single points of failure. More chokepoints in the Russian MIC's operations are analyzed in detail in Section II.

II. Russia's Military Industry: Key Chokepoints

Whether it is in the name of efficiency or preventing competition, the Russian military-industrial complex is structured in a manner that creates dominant suppliers across a wide range of product categories. Often, these 'suppliers' are merely logistics companies that transport materials from the original producers to their MIC customers. In some sectors, however, we find near-monopolistic suppliers of the MIC operating without intermediaries. From construction materials to explosives, minerals, and energy, single entities are often responsible a dominant share of the MIC's entire supply—and remain unsanctioned. A small number of logistics providers also control the internal distribution of critical components.

To understand a corporation's role in supplying the military-industrial complex, we focus on two metrics: market share and exposure. To measure **market share**, we calculate the corporation's *deliveries to military-industrial complex entities as a share of all shipments received by the MIC* (in a given product category and year). For example, if all military-industrial complex entities received a combined total of 300,000 tons of explosives in 2023, and a single corporation (Company X) provided 100,000 of those tons, then its market share would be 33%. Conversely, we define **exposure** as the *share of a corporation's business that its MIC customers make up*. In the same example, if Company X shipped a total of 150,000 tons of explosives in 2023, then its exposure to the MIC would be 66% (100,000 divided by 150,000). **Between market share and exposure, we can evaluate a corporation's importance to the Russian MIC, and the importance of the Russian MIC to that corporation.**

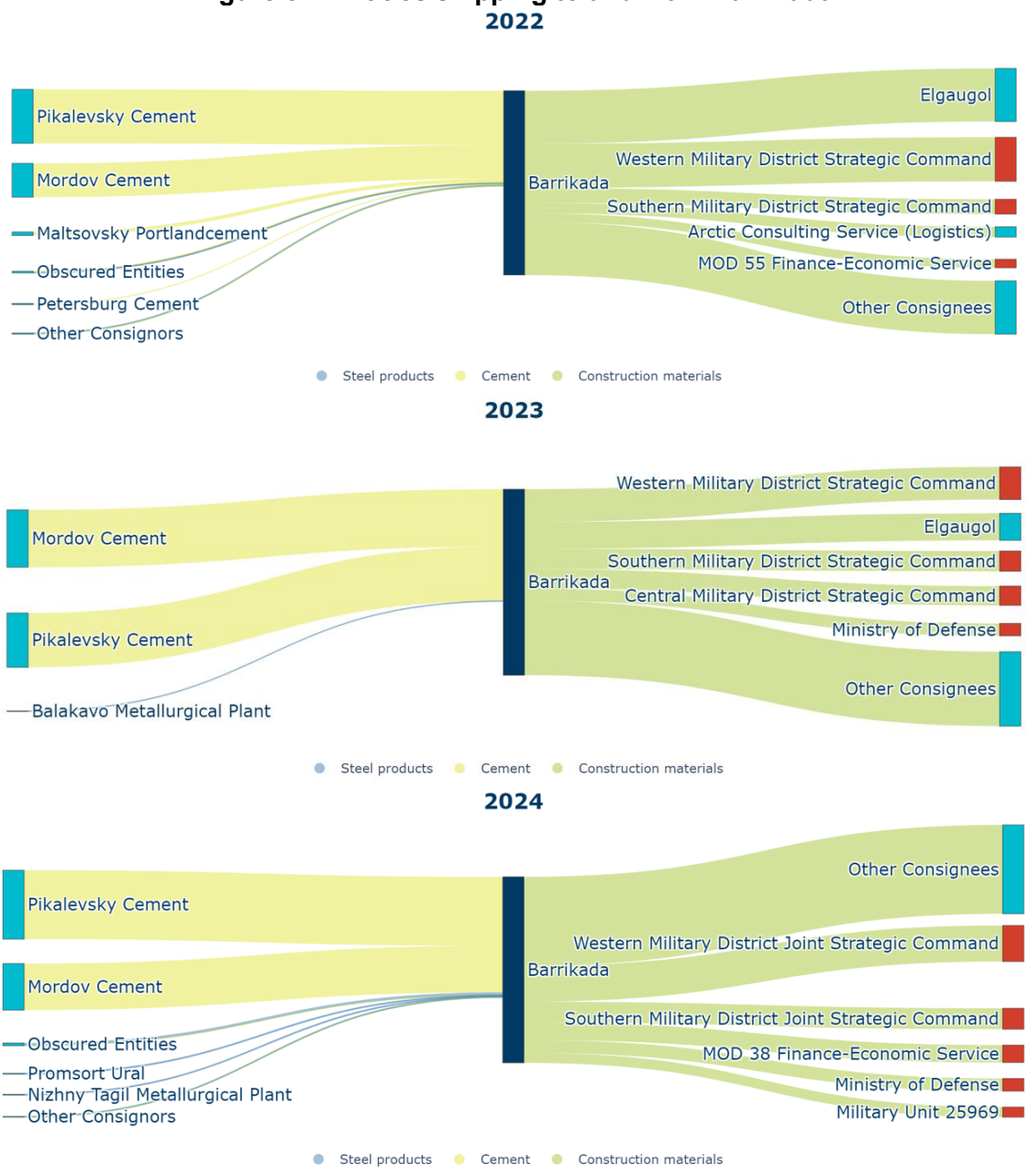
Construction Materials: Barrikada

Barrikada, a St Petersburg-based construction company that predates the October Revolution,[28] is the dominant supplier of the Russian military-industrial complex's construction material needs. In fact, since 2021, it has held approximately 20% market share in construction materials for the MIC, far exceeding its competitors in the space. It achieves this market dominance through just one cargo classification: reinforced concrete slabs. And while Barrikada is indeed one of the country's largest producers of construction materials (~15% total market share), it is particularly focused on its MIC customers: its MIC exposure has been high and is climbing higher, from around 50% in 2021-23 to 67% in 2024 and 80% in early 2025. Barrikada's chief executive claimed that military procurement contracts made up just 35% of Barrikada's business in 2020, though this number would not include contracts with the military-industrial complex that take place outside the bounds of a government contract.[29] Examining Barrikada's shipments in greater detail reveals that this figure was either never accurate or, at the very least, is no longer accurate during wartime (see Figure 31).

An early-2018 acquisition brought Barrikada into the Rostec network for the supposed purpose of expanding Rostec's civilian construction portfolio.[30] However, a November 2018 agreement made Barrikada the sole supplier of reinforced concrete aerodrome slabs (PAGs) for the Russian MoD. This entailed providing slabs for 73 military aerodromes between 2019 and 2022, according to the contract.[31] In addition to aerodrome slabs, Barrikada provides arched shelters for bombers and fighter jets, military housing, and other standardized structures for the MoD.[32] Since 2021, Barrikada has supplied around 97% of *all* reinforced concrete slabs to the Russian MIC.

[28] See Barrikada's website here [ru]
[29] See "Felix Pleskachevsky: 'The most important thing is to work together on one team,'" here [ru]
[30] See here [ru]
[31] See here [ru]. The exact details of the contract were confidential.
[32] See here [ru] and here [ru]

Figure 31: Entities shipping to and from Barrikada



Source: KSE Institute

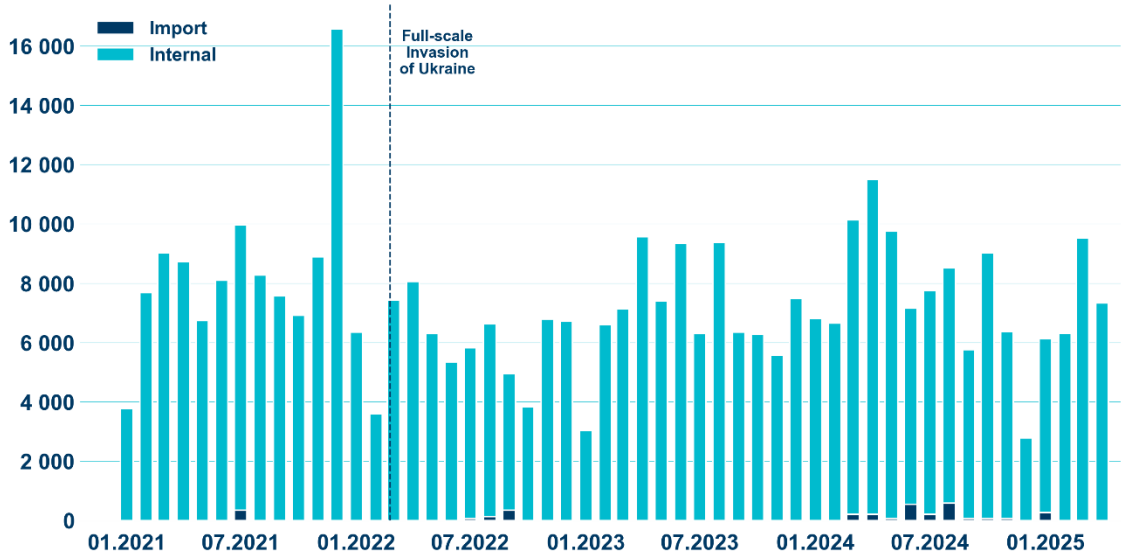
Note: Entities marked with red nodes are classified as belonging to the MIC.

Likely thanks to its ostensibly civilian nature, Barrikada has not been sanctioned by any member of the sanctioning coalition.[33] Its chief executive, Felix Pleskachovsky, is sanctioned by Ukraine, however.[34] Any sanctions applied to Barrikada would affect the company's finances far more than its supply chains, as its inputs are sourced almost exclusively from the domestic market (see Figure 32).

[33] As of mid-July 2025.

[34] See the OpenSanctions database here.

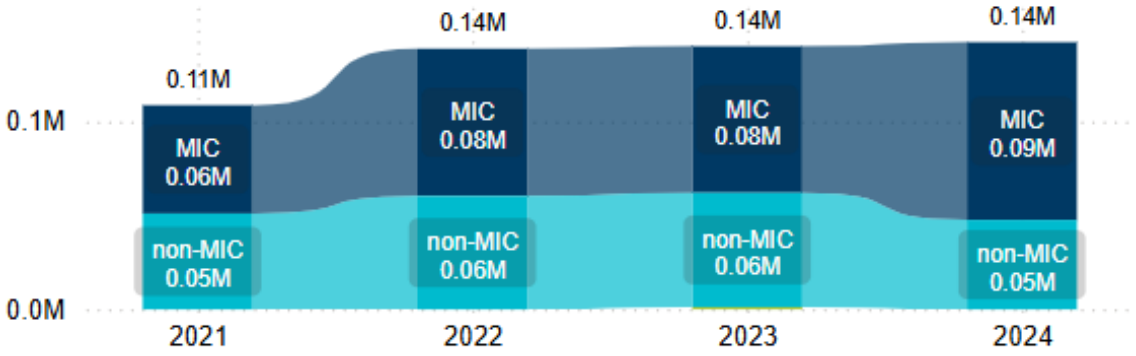
Figure 32: Sources of Barrikada's inputs, in metric tons



Source: KSE Institute

Barrikada sends and receives freight solely from Gatchina in Leningrad oblast. Its inputs primarily consist of cement and steel products, while its outputs are entirely made up of reinforced concrete slabs. While some of its outputs go to the civilian sector, much of its business is oriented around supplying not just the military-industrial complex, but the military itself (see Figure 31 and Figure 33). The Western and Southern Military District Strategic Commands are large and frequent customers of Barrikada's construction materials.

Figure 33: Consignees of Barrikada by MIC affiliation and volume, in metric tons



Source: KSE Institute

Explosives and Fertilizers: UralChem and KAO Azot

Thanks to Russia's large mining and fertilizer sectors, much of the country's explosives and dual-use chemical precursors are indeed used for civilian purposes—about 95% of shipments by volume are sent to entities that have not been linked to the military-industrial complex. The remaining 5% of shipments make up the MIC's explosives sector. **Supplies of explosives to the Russian MIC are led by two entities: UralChem Group (*OKhK Uralkhim*) and KAO Azot.**

UralChem, particularly its "Azot" subsidiary in Berezniki (Perm territory), has consistently been the leading supplier of explosives to the MIC.[35] Since 2021, the Azot branch's market share has climbed from 20% to 34%, with volumes peaking in 2024 at 110 thousand tons. While UralChem's explosives business does rely in large part on civilian customers, particularly in the mining industry, its chemicals and fertilizers business is far more exposed to the MIC. The Biysk Oleum Plant, a daughter corporation of the MIC giant Sverdlov Plant, received approximately one quarter of all inorganic chemicals shipped by UralChem's Azot in 2022-24. According to media investigations, UralChem-supplied chemicals, including nitric acid, ammonium nitrate, and aqueous ammonia, are used in the Sverdlov Plant's production of anti-tank missiles.[36] By volume, ammonium nitrate shipments are UralChem's largest explosives-related deliveries to the MIC (>100 thousand tons in 2024), while relatively low volumes (<500 tons) of sodium nitrate and niter grant the firm monopoly status for the entire MIC.

UralChem and its subsidiaries must remain at an arm's length from overt participation in Russia's war machine in order to maintain their role in global food supply chains; UralChem is among the largest producers of nitrogen fertilizers globally. As a result of its prominence on the global stage, both UralChem and the sanctioning coalition have tread carefully around sanctions involving the company. After the European Union sanctioned Dmitry Mazepin, the billionaire owner of UralChem, Mazepin reduced his holdings in the company to a 48% share, thus sparing UralChem from corresponding sanctions.[37] For its part, the European Union later eased restrictions to support fertilizer exports to developing countries—and to avoid political blowback that may push these countries closer to Moscow.[38] Recent reporting that UralChem is being used in sanctions circumvention may bring new attention to the group, however.[39]

Second only to UralChem Group is **KAO Azot**, which operates out of the Siberian city of Kemerovo. While its exposure to the MIC has hovered around 10% since 2021, its market share in the explosives sector[40] has declined from 34% to 18%. This is a result of two trends: declining total output from KAO Azot and growing demand from the MIC as a whole.

Due to their relatively limited exposure to the military-industrial complex, neither UralChem nor KAO Azot is likely dependent on their MIC ties for survival. Only around 5-10% of UralChem or KAO Azot's explosives shipments are sent to MIC firms in any given year. Their substantial market shares, however, suggest that their absence from the MIC market could seriously impede the Russian war machine's ability to source explosives and related chemicals at large scales.

Industrial Minerals: Stagdok, Achinsky Cement, and Kvarts

Three players in the industrial minerals market—none of which are sanctioned—lead the supply of military-industrial complex entities: AO Stagdok, Achinsky Cement, and Kvarts. Furthermore, the three entities almost exclusively supply the MIC.

[35] UralChem's shipments of explosives originate nearly exclusively from its Azot subsidiary in Berezniki, Perm territory.
[36] See "A guide to Russian wartime oligarchs," Proekt media [ru]
[37] See "Mazepin handed over control of UralChem to two top-managers," Forbes [ru]; "The Russian billionaires whose chemical factories fuel Russia's war machine," Reuters. UralChem is sanctioned by Ukraine.
[38] See "A guide to Russian wartime oligarchs," Proekt media [ru]; "Mazepin handed over control of UralChem to two top-managers," Forbes [ru]; "The Russian billionaires whose chemical factories fuel Russia's war machine," Reuters
[39] See "Russian explosive makers use fertilizer firms to blunt sanctions," Bloomberg
[40] The participation of KAO Azot (and affiliated entities) in the explosives sector consists entirely of ammonium nitrate shipments.

Stagdok, located in Lipetsk oblast (western Russia), is part of the vertically integrated Novolipetsk Steel (NLMK)[41] conglomerate. It has won a series of public procurement contracts related to the storage of explosive materials, most recently in late 2024.[42] It is also the near-exclusive supplier of limestone to the Lebedinsky Mining and Processing Plant in Belgorod oblast.[43] Part of billionaire Alisher Usmanov's Metalloinvest company, the Lebedinsky Plant has been sanctioned by the US and UK since April 2023. Stagdok's limestone shipment flows to the plant have declined steadily from 125 thousand tons in 2021 to 70 thousand tons in 2024, which has coincided with both reduced total output by Stagdok and reduced total demand by the Lebedinsky Plant. Stagdok's limestone is used in steel manufacturing, like at the Lebedinsky Plant or the Red October Corporation in Volgograd, and in construction.

Achinsky Cement, a large cement producer in Krasnoyarsk territory (Siberia), is the leading supplier of the military-industrial complex's cement. The firm has two primary outputs: Portland cement and clinker cement. The former is only rarely sent to MIC entities, whereas the latter is sent exclusively to the sector. In 2021-24, Achinsky Cement held between 90-100% MIC market share for clinker cement (peaking at over 240 thousand tons in 2023), with 100% MIC exposure. Despite such high exposure to the MIC, its customers are varied—no single recipient accounted for more than 15% of its cement shipments. A college in Achinsk, advertising its supply of qualified workers to local firms in the 'military-industrial complex' (*OPK,* its Russian acronym, is the Russian state apparatus' preferred term for the MIC), specifically listed Achinsky Cement as an example of a military-industrial firm.[44] Nonetheless, Achinsky Cement remains unsanctioned.

Kvarts, located in Chelyabinsk oblast (central Russia), provides molding sands, crushed stone, and gravel for construction and industrial customers. The firm, which was founded in 1935, has been supplying the steel giant MMK and the MIC (for the production of tank armor and ammunition) since the days of the second world war.[45] A large—albeit shrinking—share of Kvarts' output is sent to Russia's premier tank producer, Uralvagonzavod. In 2021, for example, Kvarts sent 61% of its molding sands (111 thousand tons) to Uralvagonzavod. Behind Uralvagonzavod were MMK and Altaivagon (a train manufacturer in Altai territory), each receiving between 10-15% of Kvarts' molding sands between 2021-24. The majority of its remaining customers are smaller firms in the military-industrial complex. Surprisingly, Kvarts seems to be more important to Uralvagonzavod and MMK's supply chains than vice versa: it accounts for more than 70% of Uralvagonzavod's molding sands supply, and 84-90% of MMK's supply. Kvarts' role in the MIC as a whole is both clear and distinct: it provided around 75% of its molding sands to the sector, claiming ~35% market share. Despite its dominant role in this industrial niche and its long history of serving the MIC, Kvarts has not been sanctioned by any member of the sanctioning coalition.

Energy: Lukoil, Rosneft, Gazprom, and NKhTK

Supplies of hydrocarbons to the military-industrial complex are most commonly carried out by the producers themselves—or their logistics subsidiaries—which makes sanctioning actions unlikely for political reasons. Lukoil and Rosneft stand out for their supplies to army entities (see *Supply Lines of the Russian Military*) but are joined by a number of other large entities and corporate groups for supplies to the military-industrial complex as a whole. Despite the breadth and depth of the Russian energy sector, however, just a handful of entities hold disproportionate market share in supplying the MIC.

[41] See "Novolipetsk Steel PJSC," Bloomberg
[42] See a list of Stagdok's procurement contracts here [ru]
[43] See "Lebedinsky Mining and Processing Plant," Metalloinvest [ru]
[44] See "Filling the staffing needs of military-industrial complex firms," Achinsky College of Transportation and Agriculture [ru]
[45] See "OOO Kvarts — 75 years of leadership in the Russian market," Southern Ural Chamber of Commerce and Industry [ru]

Oil products are supplied to the sector primarily by Rosneft, Lukoil, and, to a lesser extent, Slavneft and Gazpromneft. Vorkuta Ugol, based in the Pechora coal basin beyond the arctic circle,[46] and PAO Coke in Kemerovo (Siberia) lead coal and coke suppliers, respectively. Natural gas is less straightforward, though Gazpromtrans and NKhTK handle most rail deliveries to the MIC.

In the case of both oil and gas, supplies flow by pipeline, by highway, and by rail. Even rail shipments, the most visible of the three, are complicated by self-dealing—i.e., a logistics firm serves as both the consignor and consignee of a shipment, obscuring the true recipient from view. Nevertheless, clear trends are visible, including in the divide between Russia's civilian and military economies.

RN-Trans, a large logistics company under the Rosneft corporate umbrella, is the most prominent case of a logistics subsidiary with disproportionate market share supplying military-industrial complex. Its largest—and its most disproportionately MIC-destined—supplies are jet fuel and diesel. In 2024, for example, RN-Trans shipped nearly 340 thousand tons of jet fuel to MIC entities, which earned it nearly 75% market share. Its dominance is only challenged by Slavneft, which is particularly active in supplying jet fuel to engine manufacturers (see *Products: Engines*). RN-Trans' market share in the MIC is particularly striking compared to its shipments to the civilian sector, which claimed only 13% market share and fell behind Lukoil, Slavneft, and Gazpromneft in the same year. Furthermore, RN-Trans is more reliant on its MIC customers than its competitors, with around one third of all jet fuel deliveries going to the sector. RN-Trans has not been sanctioned by any member of the sanctioning coalition.[47]

Lukoil, operating through its subsidiaries in Perm, Volgograd, and Nizhny Novgorod oblasts, dominates supplies of diesel and gasoline to the MIC with market shares consistently above 50%. Rail shipments of diesel and gasoline have consistently risen across the MIC, and Lukoil has been a chief beneficiary of the increased demand. Unlike with jet fuel, Lukoil has relatively high exposure to the MIC, while RN-Trans is the undisputed leader in the civilian market. Thus, there is a clear product-specific specialization in the civilian and military economy: RN-Trans leads jet fuel supplies to the MIC while supplying the civilian sector with diesel and gasoline, and Lukoil supplies diesel and gasoline to the MIC while most of its remaining oil products go to the civilian sector.

Each of Lukoil's leading subsidiaries supplying the MIC have been sanctioned, though only by Ukraine.[48] The parent company, Lukoil PJSC, has been sanctioned by the US, however.[49] The EU is said to have recently scuttled plans to sanction the Dubai-based trading arm of Lukoil, partially due to Hungarian opposition.[50]

Natural gas and petrochemical shipments are handled by a variety of entities in Russia, with two clear trends. First, two entities stand out as leading suppliers of the military-industrial complex: Gazpromtrans and NKhTK.

Gazpromtrans, a logistics subsidiary of gas giant Gazprom, is the dominant supplier of liquified natural gas (LNG) on the Russian market. Thanks to the loss of much of the European export market, Russia has a glut of natural

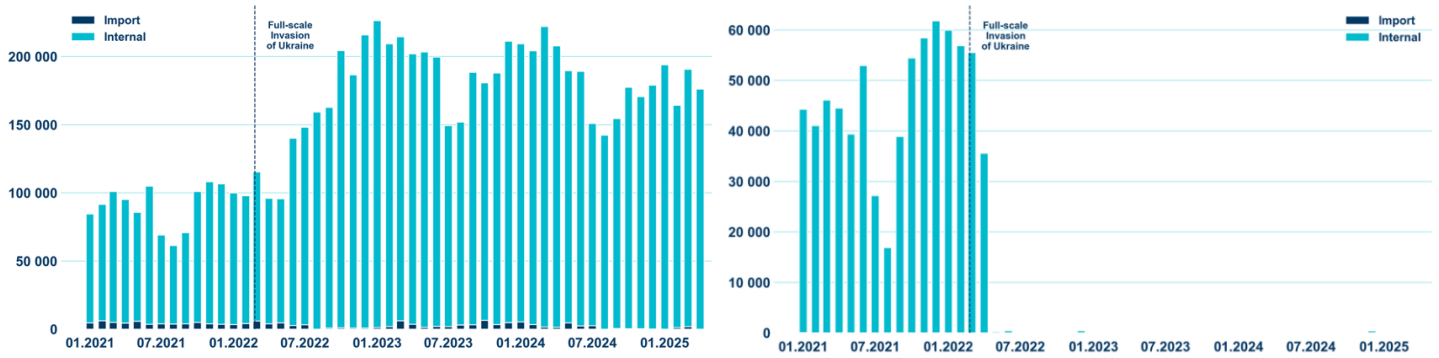
[46] See "Europe's easternmost city: Photos of life in Vorkuta, one of Russia's fastest dying cities," Meduza
[47] See "AO RN-Trans," OpenSanctions
[48] See OpenSanctions database entries for Lukoil's Perm, Volgograd, and Nizhny Novgorod subsidiaries.
[49] See "Lukoil OAO," OpenSanctions. Lukoil PJSC has also been sanctioned by Australia, Canada, Ukraine, and New Zealand.
[50] See "EU countries adopt four sets of new Russia sanctions," Reuters. For more information on the Russian Shadow Fleet, see "Assessing Russia's shadow fleet," KSE Institute, "Creating 'shadow-free' zones," KSE Institute, and "Oil spill insurance and the shadow fleet," KSE Institute

gas.[51] Rail shipments, in which Gazprom holds considerable total market share (>50%), attest to this (see Figure 34). Gazpromtrans is unsanctioned by any member of the sanctioning coalition besides Ukraine.[52]

NKhTK, a logistics firm that specializes in the transit of liquified natural gas and petrochemicals, [53] is a leading supplier of petrochemicals to the military-industrial complex. Its largest supplies to the MIC are of butanes and propane, which garnered the firm more than 70% market share in 2021 and 2022. It is unsanctioned by the sanctioning coalition,[54] though one of its parent companies, SG-Trans, has been sanctioned by Ukraine.[55]

Second, direct rail shipments to the MIC plummeted after 2022 and have not recovered. Most strikingly, shipments of LNG to the MIC fell from 50 thousand tons per month to nearly zero within two months of Russia's full-scale invasion (see Figure 34). This could signal, from most to least likely: a move to shield the sector from direct ties to the MIC, wherein firms like NKhTK effectively ship LNG to themselves (as both consignor and consignee) or each other in an effort to avoid sanctions; a sudden shift from rail-based to pipeline- or highway-based deliveries to the MIC; or a remarkable decline in demand from the MIC, exactly when overall deliveries spiked.

Figure 34: Total rail deliveries of LNG (left) and LNG deliveries to MIC consignees (right), in metric tons



Source: KSE Institute

Logistics: Port of Vladivostok and Ekodor

As KSE Institute research showed in a previous report,[56] the Russian military-industrial complex is highly dependent on imported components, particularly from China. **Whether imported or domestically produced, logistics firms play a critical role in delivering components to the MIC, with two firms dominating the space: the Commercial Sea Port of Vladivostok and Ekodor.**[57]

The **port of Vladivostok** is dominant across a wide range of product categories supplied to the military-industrial complex, from communications equipment and batteries to machinery spare parts, and rubber products. Compared to its ubiquity in MIC supply chains, it plays a smaller role in supplying the civilian economy—in no high-volume product category does it exceed 25% market share. In 2023, for example, the port of Vladivostok served as the consignor for 61% of all shipments of 'other machinery and spare parts'—a catch-all nomenclature

[51] See "Russia faces gas surplus as European exports collapse, eyes data centres," Reuters; "Inside Russia's Gazprom: can the ailing energy giant be revived?" Financial Times
[52] See "LLC Gazpromtrans", OpenSanctions
[53] See NKhTK's website here [ru]
[54] See "OOO NKhTK," OpenSanctions
[55] See "Joint-Stock Company SG-Trans," OpenSanctions
[56] See "Disassembling the Russian war machine: key players and nodes," KSE Institute
[57] See "Commercial Sea Port of Vladivostok PJSC," Bloomberg; "Firma Ekodor OOO," Bloomberg

for machinery frequently employed by both civilian and MIC firms—destined for MIC consignees, nearly six times higher than its market share in the economy as a whole. Automobile spare parts, which are similarly used by both the civilian and MIC economy, also show a particular weighting towards the military sector: just under a third of shipments were bound for MIC entities, capturing 57% MIC market share.

The port of Vladivostok handles shipments overwhelmingly from a single source: China. By volume, around 98% of its shipments are imports, and around 98% of those imports come from China.[58] Its shipment volumes from China have also increased steadily since the full-scale invasion, from 2.3M tons in 2021 to nearly 3M tons in 2024. Following Russia's full-scale invasion of Ukraine, the port of Vladivostok has been emblematic of the booming Sino-Russian economic relationship and the limits of Western sanctions.[59] Chinese cargo, particularly in high-tech and industrial categories, has flooded into Russia, largely out of reach of Western sanctions; about one quarter of all tonnage originating from the port of Vladivostok is destined for the military-industrial complex in any given year. Yet, likely thanks to its role facilitating imports to the broader economy, it remains unsanctioned.

Whereas the port of Vladivostok handles shipments, particularly imports, of all cargo categories, **Ekodor** is more specialized and accounts for slightly lower volumes of cargo. Its largest category of shipments to the MIC, for example, is food and drink (96 thousand tons, or 27% market share in 2022), including 7 thousand tons of vodka. Aside from food and drink, it primarily supplies the military sector with construction materials (~27% market share), plastics (~15%), electrical engineering equipment (~35%), and motor oil (~45%). Unlike the port of Vladivostok, Ekodor handles domestically sourced cargo.

The military-industrial complex has accounted for a growing share of Ekodor's logistics portfolio since the full-scale invasion, now up to nearly 40% of all tonnage shipped. This exposure is markedly higher than the port of Vladivostok's, which has hovered around 25% and even declined since the full-scale invasion in 2022. Given that high-volume cargo categories regularly reveal Ekodor's MIC exposure rates between 40-50%, with MIC market share values between 25-30%, it is clear that the military-industrial complex is a dominant part of Ekodor's business model, and that Ekodor is similarly crucial for the continued functioning of the sector's logistics. Ekodor has been sanctioned by the US.[60]

[58] This trend deviates somewhat in Q1 2025, when Chinese imports make up just 87% of shipment volumes handled by the port of Vladivostok. This is primarily due to a surge in imports from South Korea—if Q1 trends continue, 2025 volumes will 2.5x the *combined* sum of 2021-24. The 2025 imports from South Korea come in a variety of categories, from machinery to rubber products to spare parts.

[59] See "Export controls and technology transfer: lessons from Russia," Elina Ribakova's testimony before US-China Economic and Security Review Commission; "Challenges of export controls enforcement," KSE Institute

[60] See "As Russia completes transition to a full war economy, Treasury takes sweeping aim at foundational financial infrastructure and access to third country support," US Treasury

III. Russia's Military Industry: Key Production Clusters

In this section, we build on KSE Institute's previous work on the Russian military-industrial complex, in particular the geographical clustering of MIC entities and logistics networks. This section analyzes the military-industrial complex's productive capacity at two levels, focusing on three industrial sectors and three product categories. Sector-level analysis—of heavy industry, aviation, and naval industries—captures broader trends, while the product-level—missiles, artillery, and engines—follows specific supply chains for products critical to Russia's war of aggression against Ukraine. Despite large investments, the Russian MIC's ability to expand production has not been universal: heavy industry, missiles, and aviation manufacturing have all increased, while artillery only began to grow in 2024, and others have reached their productive capacities. Imports, particularly from China, remain a crucial piece of most supply chains.

Mapping the Russian MIC

As part of KSE Institute's series on the Russian military-industrial complex, we have undertaken a comprehensive clustering exercise to better understand the geographic relationships between MIC companies, their branches, and the transportation points they use. The clustering approach has one crucial advantage: it ties logistical flows to areas. This is necessary because Russian MIC companies often hide their imports and shipments behind logistics companies, which makes them difficult to trace. As a result, we use 692 geographical clusters—encompassing 1,492 companies and branches, as well as 972 shipping points—as the backbone of our analysis of the MIC's logistics. For more information on the methodology of this approach and a more comprehensive overview of the Russian MIC's clusters, see KSE Institute's previous report, ***Disassembling the Russian War Machine: Key Players and Nodes***.

Sectors: Heavy Industry

Clusters

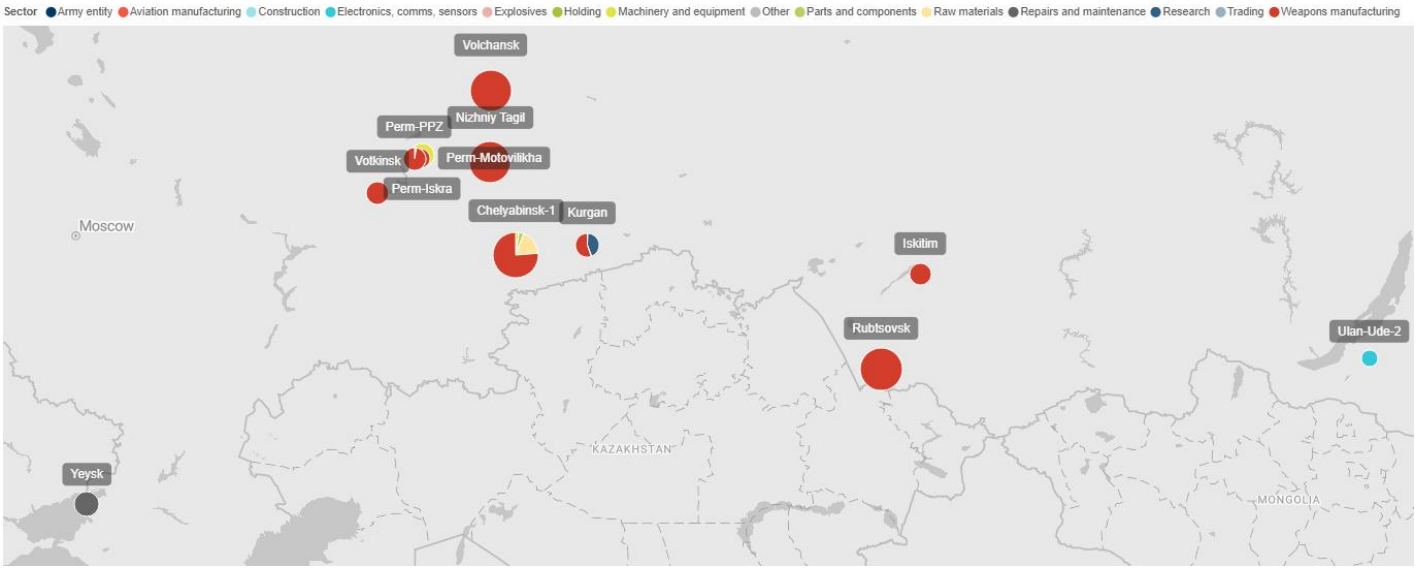
The main clusters engaged in heavy industry and repairs are concentrated far from Moscow, primarily around the Urals (see Figure 35). By the diversity of its facilities and the number of enterprises, Chelyabinsk stands out as the key node in Russia's weapons industry. Other prominent heavy industry clusters are located in Nizhny Tagil, Kurgan, Rubtsovsk, Iskitim, Perm, Votkinsk, and Yeysk. We find evidence that the major manufacturers in these clusters have ramped up production to meet the demand of the full-scale invasion in a variety of ways, including through higher volumes of cargo throughput, ever-growing salaries to recruit high-skilled workers, and local news reports touting increased shipments of equipment to the front. They are discussed in detail below.

The **Chelyabinsk** cluster represents one of the country's most diverse concentrations of military-industrial enterprises, encompassing multiple specialized facilities. These include an Uralvagonzavod (UVZ) branch, the weapons manufacturer Elektromashyna, the metallurgical complex Chelyabinsk Electrometallurgical plant (ChEMK), the engine producer SKB Turbina, the machinery enterprise Stankomash, the Chelyabinsk Smithy and Press plant (ChKPZ), and the explosives manufacturer RusVzryv. Unsurprisingly, Chelyabinsk's military-industrial sites have seen a marked surge in activity since 2022. In early 2023, the Russian MoD announced massive increases in munitions output at plants in the Chelyabinsk oblast—artillery, tank, and mortar shells production was set to grow 7–8 times by the end of 2023.[61] Moreover, the Chelyabinsk Tractor Plant (ChTZ)—part of the Uralvagonzavod group—launched a new production site in 2024 to increase tank engine output. The plant installed modern ion-

[61] See "Plants in Chelyabinsk, Kirov Regions to boost missiles, munitions production," TASS

nitriding equipment (sourced from Belarus) to harden engine parts, enabling tripled production of high-strength components.[62] According to ChTZ-Uraltrak representatives, this modernization will "multiply the production of enhanced engines for T-72B3M and T-90M 'Proryv' tanks," with the new system expected to triple engine output.

Figure 35: Heavy industry and repair clusters



Source: KSE Institute

These investments highlight a clear post-2022 ramp-up in Chelyabinsk's military production capacity—spanning both ammunition and critical tank subsystems. Notably, even civilian-oriented heavy industries in the region have been affected: changes in railway procurement briefly slowed a local railcar factory in early 2025, but it quickly rebounded to 99% capacity utilization, with the Rubtsovsk branch of Altaivagon (formerly UVZ-affiliated) reporting output growth from 6.3 billion to 17 billion rubles between 2021 and 2024.[63] This reflects how war-driven logistics and state orders have spurred broader industrial activity in Chelyabinsk and nearby areas.

The **Nizhny Tagil** cluster, 140 kilometers north of Yekaterinburg, is centered around UVZ and the Urals Science and Technology Complex (UNTK). It represents another crucial hub in the Urals region, complemented by the Volchansk UVZ branch. Together, these facilities form a significant armor and heavy military equipment manufacturing complex. For more on this critical cluster, see below.

The **Kurgan** cluster, 250 kilometers east of Chelyabinsk, combines design and manufacturing capabilities through Construction Bureau KB Shypunova's branch, Kurganmashzavod (KMZ), Kurgan Instruments plant (Kurganpribor), and Special Design Bureau of Machinery (SKBM), and is supported by a military base. Since 2022, KMZ has dramatically expanded its output and overhauled facilities to meet surging demand from the military. According to the Rostec subsidiary High-Precision Complexes (which manages KMZ), production of BMP-3 infantry fighting vehicles (IFVs) tripled during the first year of the full-scale invasion. KMZ's Deputy Director for State Defense Orders confirmed that with the war's onset, the plant implemented a series of measures to fulfill an expanded military procurement order, including additional needs for armored fighting vehicles.[64] In addition to new BMP-3s, KMZ has also devoted significant resources to repairing and upgrading

[62] See "Russia expands tank engine production with new facility at Chelyabinsk Tractor Plant," Militarnyi
[63] See "How a Rubtsovsk enterprise is growing its production volumes," Rubtsovsk Mestnoye Vremya [ru]
[64] See "Kurganmashzavod tripled output of BMP-3," Kurgan i Kurgantsy [ru]

older BMP-2s: within a few months, the factory readied an overhaul line for BMP-2 with the "Berezhok" combat module upgrade and delivered the first batch of refurbished BMP-2M to Russian troops. By September 2023, Kurganmashzavod celebrated record-high deliveries of both BMP-2M and BMP-3 vehicles for the Russian Army, signaling unprecedented volumes.[65] To support this pace, Kurgan's industrial base is also hiring aggressively. Local media and company press releases throughout 2023 highlight its recruitment efforts: for instance, Barnaultransmash (the engine supplier for BMPs) advertised dozens of positions for machinists and CNC operators at salaries of RUB70k/month, Kurganmashzavod itself sought experienced welders at up to RUB140k, and one KMZ subsidiary even offered free apartments to attract skilled workers with families.[66]

The **Rubtsovsk** cluster, near the Siberian border with Kazakhstan, combines manufacturing and military presence, housing both the Rubtsovsk Machine-Building Plant (now the Rubtsovsk branch of KMZ in Altai territory) alongside a military base. The Rubtsovsk Machine-Building Plant has similarly ramped up recruitment: it is recruiting engineers, painters, turners, and millers with promises of 6-day workweeks and pay up to RUB70k. The Rubtsovsk cluster's output (including military all-terrain vehicles and civilian machinery) reportedly grew from 54 thousand tons in 2021 to 69 thousand tons in 2024.[67]

In nearby Novosibirsk oblast, **Iskitim** hosts specialized facilities that include a branch of Splav, which creates multiple launch rocket systems (MLRS), Ganicheva, and Novosibirsk artificial fiber plant (NZIV), contributing to the Novosibirsk oblast's military production capacity. NZIV is an assembly plant for serial production of munitions—warheads, explosive charges, and rocket motors for systems like MLRS and aerial rockets.[68]

The **Perm** cluster, 300 kilometers northwest of Yekaterinburg in the Urals, specializes in propulsion and explosives, hosting branches of the Construction Bureau Iskra, the Semiconductor Machinery Institute (NIIPM), and the Perm Gunpowder plant. In a stark example of how the full-scale war has reinvigorated Russia's military-industrial base, the core enterprise of the cluster, Motovilikha Plants,[69] had been in bankruptcy since 2018 until the war's demands breathed new life into the factories. In September 2023, Motovilikha's assets were acquired by AO Remdizel, a manufacturer of military trucks and Typhoon armored vehicles in Tatarstan, for RUB 1.3 billion.[70] Almost immediately, officials announced Motovilikha's exit from bankruptcy and a state-backed expansion. Under a federal investment, Motovilikha pledged to build two new production halls, renovate its grounds, and install 200 new pieces of equipment. Construction of the new workshops was scheduled for completion by end of 2024.[71] This dramatic turnaround reflects a broader reinvigoration of the military industry: Motovilikha, once moribund, is now poised to greatly expand output of rocket artillery systems, howitzers, and related heavy weaponry.

Perm's other military facility, the Perm Gunpowder Plant—a major producer of propellants and solid rocket fuel—has likewise scaled up. Industry experts note that upgrades through 2023 enabled a roughly fourfold increase in MLRS munition production at Perm's powder works.[72] Investigative reports reveal that Russia leaned on imported cotton cellulose from Central Asia to boost domestic gunpowder output after 2022, as the Kazan and

[65] See "Kurganmashzavod set a record for BMP-2M and BMP-3 deliveries," Rossiyskaya Gazeta [ru]
[66] See "Kurganmashzavod subsidiary in Altay recruits workers for salaries up to 70 thousand," URA.RU [ru]; "At Kurganmashzavod workers with families are promised apartments," URA.RU [ru]
[67] See "How a Rubtsovsk enterprise is growing its production volumes," Rubtsovsk Mestnoye Vremya [ru]
[68] See "NZIV, AO Novosibirsk artificial fiber plant," NOZ.S [ru]
[69] See "Motovilicha Plants PJSC," Bloomberg
[70] See "Motovilicha Plants is selling property for RUB204 million," RBC Perm [ru]
[71] See "Motovilicha Plants in Perm to build two new workshops," Ekho Perm [ru]
[72] See "Military production in Russia before and after the start of the war with Ukraine," Julian Cooper in the RUSI Journal

Perm powder factories have "stepped up production since 2022 to feed Russia's war machine," which relies on huge volumes of artillery charges.[73]

The **Votkinsk** cluster, located in an industrial town in the Udmurt Republic, is another significant production center in the Volga federal district; the cluster comprises the missiles producer Votkinsk plant, a branch of Engine Corp (ODK), and a military base. Votkinsk manufactures parts for Topol-M and RS-24 Yars ICBMs, Bulava SLBMs, and the missile bodies for Iskander tactical missiles. By the end of 2023, the Votkinsk plant had published 19 new government contracts for nuclear-weapons-related components.[74]

The **Yeysk** cluster, a strategically located town 70 kilometers from Mariupol on the Sea of Azov, houses the 570th Aviation Repairs plant (ARZ) and a branch of Engine Corp (ODK), which provides military maintenance and repair capabilities in Russia's southern region. The Yeysk base hosts the 859th Naval Aviation Combat Training and Retraining Center, which operates various aircraft types. The region's proximity to the front makes it a logical hub for field repairs or depot-level maintenance.

Select Input and Output Dynamics

The growth in capacity and production of Russia's major heavy industry clusters is evident in the inputs that they receive and the outputs that they send to MIC entities. Their cargo flows have changed in volume and structure, revealing the extent to which three years of a war economy have altered the Russian military-industrial complex. Most importantly, there has been a significant expansion of refurbishment and production across heavy industry manufacturers, aided by the upstreaming of supply chains.

Metallurgical supplies—chiefly iron and steel—have increased dramatically during the full-scale war. Steel inputs to a number of clusters—Chelyabinsk, Nizhny Tagil, Kurgan, and Volchansk—show substantial growth. Steel products delivered to these clusters doubled from 0.33 million tons in 2022 to 0.75 million tons in 2024. Their suppliers of steel are MMK, Nadezhdino Metallurgical plant, Evraz, and Izhstal. The Nadezhdino plant served as the biggest contributor to growth in 2024, increasing its supplies to Chelyabinsk from 29 to 160 thousand tons. Another sizeable source of growth was imported rolled ferrous metals from Belarus, which grew from 9 thousand to 86 thousand tons between 2022 and 2024.

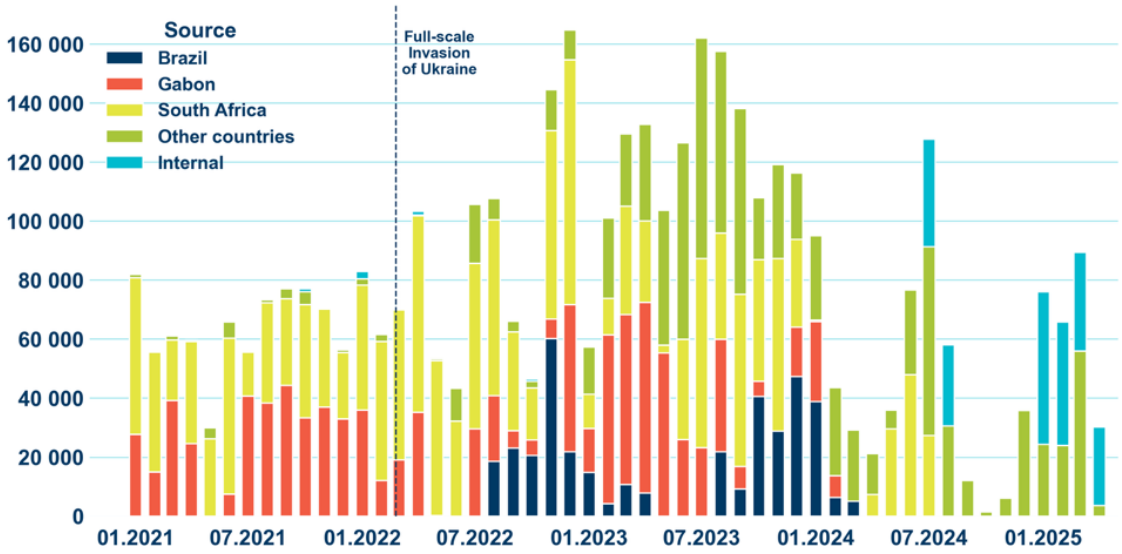
In addition to steel, the inputs of **prefabricated steel** products (e.g., beams, pipes) and cast iron have also been increasing substantially: from 36 thousand tons in 2021 to 66 thousand tons in 2022 (+85%), 95 thousand tons in 2023 (+44%), and 190 thousand tons in 2024 (+101%). The primary providers of these flows of prefabricated steel are Evraz and the Chelyabinsk Metallurgical Plant (ChMK).

Supplies of **critical minerals** are less unambiguous. Manganese materials, which are primarily consumed by the Chelyabinsk cluster, are overwhelmingly sourced from abroad (see Figure 36). Inputs of manganese ore and concentrates for heavy industry manufacturers increased dramatically from 0.75 million tons in 2021 to 1.44 million tons in 2023, before falling back near pre-invasion levels in 2024. The primary import routes are through Latvia (Skangali) and Baltic Sea ports.

[73] See "Central Asian cotton powers Russia's sanctioned gunpowder plants," Important Stories

[74] See "Massive explosion reported near Russian city that is home to missile production plant," Radio Free Europe

Figure 36: Manganese ore and concentrate inputs to heavy Industry clusters by country of origin, in metric tons



Source: KSE Institute

Inputs of **molding sands** had been declining in 2022 (-24% to 135 thousand tons) and 2023 (-17% to 112 thousand tons) but rebounded in 2024 by doubling to 233 thousand tons. The main suppliers are Kvarts in Chelyabinsk oblast (see Section II) and Balasheyka sands in Samara oblast. These supplies of molding sands are another indicator of Russia's expanded productive capacity, particularly in the heavy industry portion of the military-industrial complex.

Chemical inputs to the Perm cluster reflect increased explosives production capacity. Oleum is involved in the synthesis of chemicals used in explosives, such as nitroglycerin and TNT (trinitrotoluene). Oleum consumption in heavy industry clusters more than doubled from 3,300 tons to 8,100 tons, supplied by SUMZ, while jet fuel receipts increased by 2.5x to 1,400 tons.

Unnamed cargo, or "other uncategorized cargo," is predominantly transported by companies associated with the military industry or by concealed entities. As discussed in Section I, this cargo includes weapon platforms from storages or damaged weapons sent for repairs. Significant increases in unnamed cargo deliveries to Kurgan, Rubtsovsk, Omsk, Nizhny Tagil, and Atamanovka (home to the 103rd tank repairs plant) clusters, growing from 6 thousand tons in 2021 to 60 thousand tons in 2022 and 71 thousand tons in 2023, marked the repair and deployment of military equipment reserves; the drop-off to 54 thousand tons in 2024 shows gradual depletion of the stockpiles.

Unsurprisingly, **outputs of cargo related to military production** from heavy industry clusters have also spiked during the full-scale war. Outputs of unnamed cargo increased from 11 thousand tons in 2021 to 19 thousand tons in 2022, then to 52 thousand tons in 2023 and 71 thousand tons in 2024, with significant volumes from Kurgan and Nizhny Tagil clusters. This is likely due to refurbishment efforts, and the increase could have been larger: by late 2023, Western analysts observed that Russia's ability to refurbish damaged tanks was increasingly strained by parts shortages.[75] In mid-2023, India's Defense Ministry revealed that it urged Russian manufacturers like UVZ, Almaz-Antey, and others to partner with Indian companies to manufacture spare parts for Russian weapon systems. This came after payment issues and Russia's own wartime needs caused delays

[75] See "Russian offensive campaign assessment, February 13, 2025," ISW

in delivering spare parts to India's military.[76] By outsourcing some production of spare components, Russia could hope to free up domestic capacity for both its military and export obligations.

The growth of inputs and outputs of cargo categories coming into and out of heavy industry clusters has outstripped that of the economy writ large. This has coincided with shifts in supply chains, particularly toward the eastern border. Now three years after the initial wave of invasion-related sanctions, heavy industry manufacturers have become more reliant on Chinese and domestically produced inputs, which has allowed them to expand their production capacity to meet the needs of the war.

Deep Dive: Nizhny Tagil

Nizhny Tagil has experienced perhaps the most dramatic military-industrial surge. Located in Sverdlovsk oblast in the Urals, Nizhny Tagil is an industrial city with a population over 300 thousand. The production cluster includes two railway stations, the Uralvagonzavod plant, Urals Science-Technological Complex (UNTK), Planta Chemical plant, and Urals Construction Bureau for Carriage Building (UKBV).

Prime Minister Mikhail Mishustin noted that UVZ "has gained good momentum, increasing production more than three-fold over the last year," in remarks to the State Duma in 2023.[77] Rostec's CEO Chemezov later quantified this boom: tank output in 2023 was seven times higher than the year prior. Chemezov revealed that production of tanks had risen 7 times, light armored vehicles (BMP/BMD/APCs) 4.5 times, artillery and MLRS 2.5 times, and some types of ammunition a staggering 60 times compared to pre-war rates.[78] While likely inflated, these claims align with reports that UVZ moved to a 24/7 three-shift schedule in 2022 to meet urgent state military orders. By late 2022, UVZ's tank assembly lines were reportedly fully loaded through 2024 with an initial order for 400 tanks, and the factory was delivering batches of 5-10 tanks at a time to the army (focusing on upgraded T-72B3M and new T-90M units).[79]

This intense pace required workforce expansion and training. In January 2023, UVZ announced a large recruitment drive for "trainees" in critical trades (turners, millers, welders, etc.), inviting unemployed locals for training that would lead to jobs at the plant. The UVZ concern's other facilities also ramped up hiring—for example, Uraltransmash (a UVZ subsidiary in Yekaterinburg that produces self-propelled artillery) posted 22 new job vacancies in a single week.[80] Such recruitment efforts indicate a significant labor force expansion in Nizhny Tagil's military plants to sustain higher production levels. **UVZ and its associated factories in the Urals have been reoriented to wartime output, multiplying their production of tanks and armored vehicles, and training new skilled workers to keep assembly lines running nonstop**.

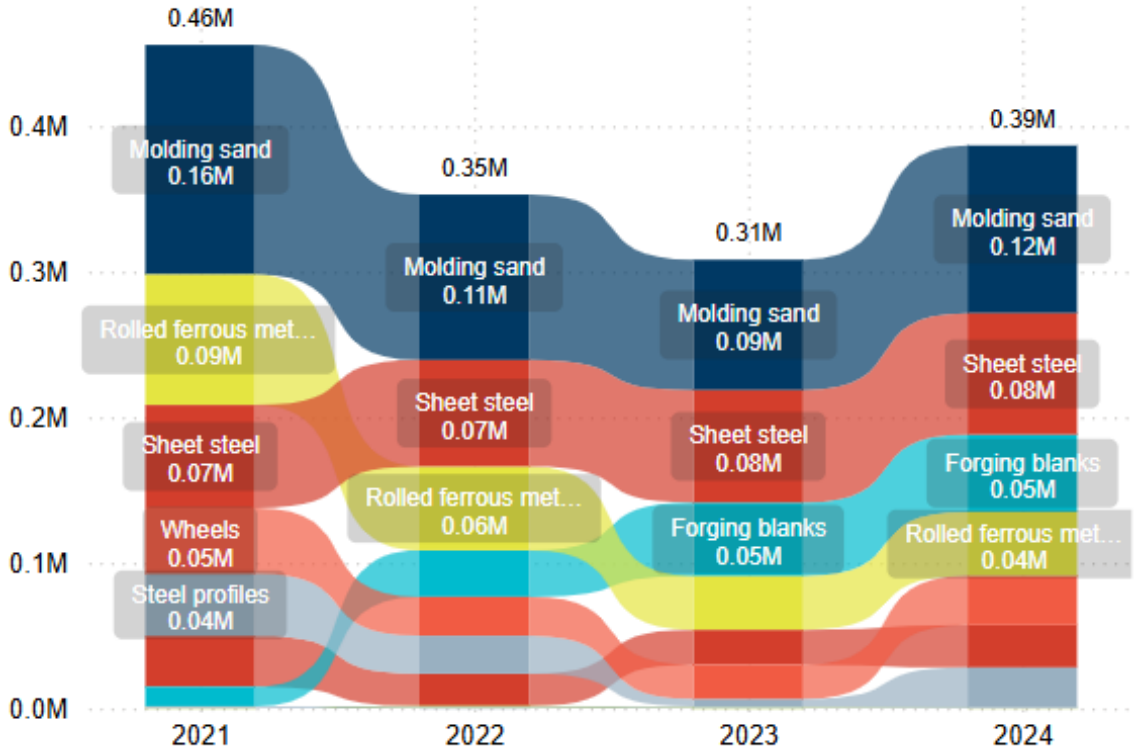
UVZ's subsidiaries that make artillery systems and components have also been reorganized under other Rostec entities to better coordinate production. In April 2023, Rostec transferred UVZ's Plant No.9 (a barrel factory), the TsNII Burevestnik design bureau, and Uraltransmash (self-propelled artillery producer) out of UVZ and into the Techmash concern—consolidating artillery systems production under one holding.[81] This suggests UVZ-proper is concentrating on core tank assembly, while upstream sub-components (guns, munitions, etc.) are handled by specialized sister companies.

[76] See "Russian OEMs consider outsourcing spares and sub-assemblies to Indian companies," Indian Defence Research Wing
[77] See "Mishustin announced a threefold increase in Uralvagonzavod tank output," Rossiyskaya Gazeta [ru]
[78] See "Rostec increased tank production sevenfold in 2023," Izvestiya [ru]
[79] See "The barren barrels," Novaya Gazeta
[80] See "The main tank factory in Russia seeks apprentices in Sverdlov," URA.RU [ru]
[81] See "Rostec consolidates artillery plants by cannon-shot system," RBC [ru]

Alongside the structural changes in the Russian economy as a whole, the Nizhny Tagil cluster underwent a significant shift in inputs in 2022. The center of the industrial cluster, the Uralvagonzavod (UVZ) plant, primarily takes in steel, industrial minerals, spirit compounds, ferroalloys, flux, and magnesium. Supplies to the cluster in 2022 moved down the supply chain—receiving preprocessed, rather than raw materials—presumably to free up production capacity for finished products.

In volume, steel deliveries (steel, steel products, cast iron) to the cluster showed a significant decline, dropping 27% from 360 thousand tons to 260 thousand tons in 2022, followed by a further decrease of 11% to 240 thousand tons in 2023, and rebounding to 295 thousand tons in 2024 (+23%). The composition of steel deliveries also underwent substantial changes. Sheet steel inputs stayed relatively constant over the years, while the changes were mostly caused by pre-processed categories, including profiles, wheels, and rolled parts. 72% of the 2024 annual steel inputs increase is attributable to prefabricated forms, while only 23% of increase is explained by unprocessed metals input (steel and iron). This shift suggests a strategic move toward preprocessed materials, possibly indicating the outsourcing of preprocessing activities (see Figure 37).

Figure 37: Top categories of inputs to Nizhny Tagil cluster, in metric tons



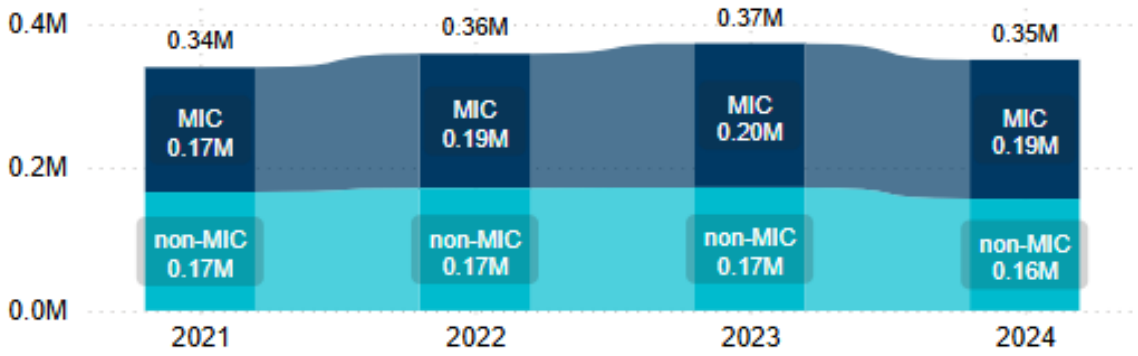
Source: KSE Institute

In the industrial minerals sector, molding sand deliveries experienced a gradual reduction, falling from 161 thousand tons in 2021 to 115 thousand tons in 2022 (-28%), 90 thousand tons in 2023 (-21%), then rebounding to 120 thousand tons in 2024 (+33%). There are two major suppliers: Kvarts (see Section II) and Balasheyka sands.

Chelyabinsk Electrometallurgical Combine (ChEMK) provides about 80% of Russia's **ferroalloys** and feeds major steel mills that supply the military industry—MMK, Evraz group, Severstal. The ChEMK group includes Serov Ferroalloys plant and Kuznetsk Ferroalloys. In 2023, the government moved to assert control over ChEMK due to its importance: prosecutors nationalized the plant (previously owned by billionaire Yury Antipov) on

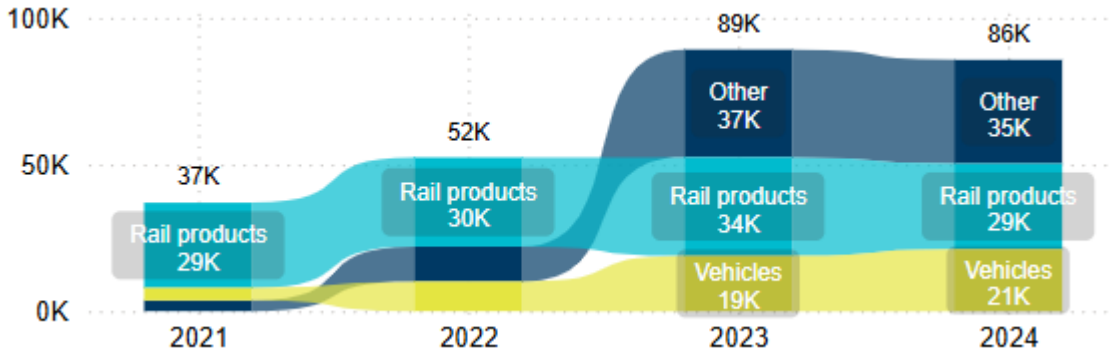
grounds that its output was crucial for national defense. Under state management, ChEMK's ferroalloy production—including ferrosilicon and ferromanganese—is being steered to ensure ample armor-grade steel is delivered to factories like Uralvagonzavod.[82] While outputs have decreased (-6% in 2024), a substantial percentage is delivered to MIC-affiliated companies—54% in 2024 (see Figure 38).

Figure 38: Ferroalloys output of ChEMK group by affiliation of consignee, in metric tons



Source: KSE Institute

Figure 39: Finished products categories delivered from Nizhny Tagil cluster, in metric tons



Source: KSE Institute

Finished products delivered from Nizhny Tagil are rail products, "other cargo", and vehicles (see Figure 39). As before, other cargo is most likely the military equipment and weapons platforms. Overall outputs have been increasing since the full-scale invasion of Ukraine, driven primarily by the output of military equipment. Its volume comprised 12 thousand tons in 2022, tripled in 2023 to 37 thousand tons, and remained stable in 2024. Rail products, such as wheel pairs, are the largest civilian category delivered to transportation enterprises, including the Murom plant Transputmash. Vehicles, which include rail car platforms and spare parts, are predominantly delivered to military industry companies, such as the Volchansk plant, or directly to the army entities, such as financial-economic services of the MoD. The percentage of output going to military or obscured parties across all finished goods categories went form 21% in 2021 to 66% in 2024.

Destinations of the finished products confirm the military vector: frontline bases, such as Kamensk-Shakhtinsky, and military platforms storages, such as the 22nd base in Buy, are among the top delivery points. The overall pattern suggests a strategic shift in the cluster's operations. This operational restructuring appears to be aimed

[82] See "Military redistribution: nationalisation of the elite, new rules of loyalty and the chaebolisation of Russia," Re:Russia

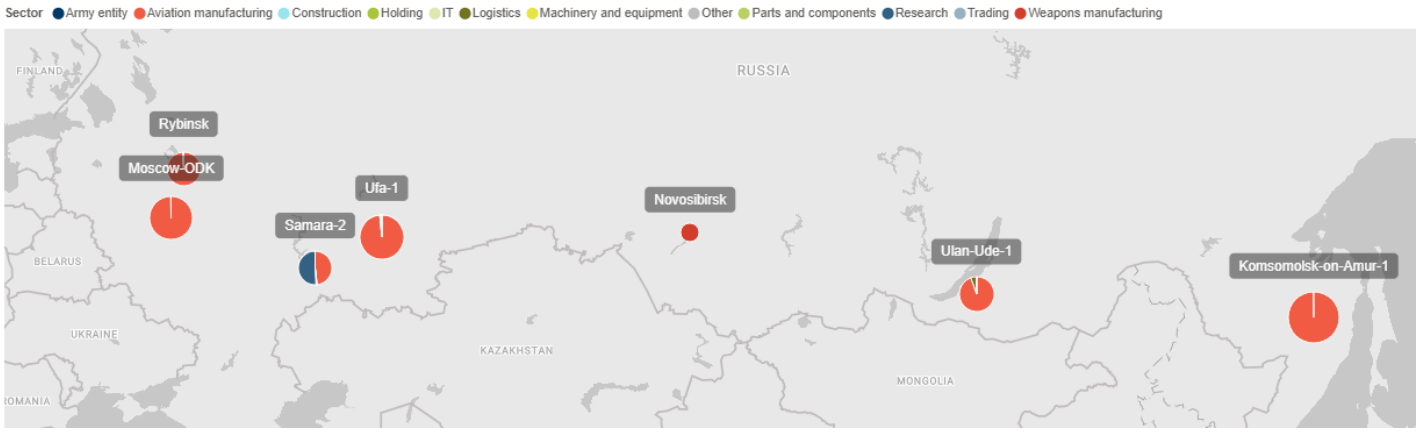
at streamlining production by receiving materials closer to their final form, which allows for a deliberate focus on final-stage production and higher-value finished goods. From 2021 to 2023, the Nizhny Tagil cluster clearly refocused its orientation toward military-industrial production, as evidenced by both its material inputs optimization and its output destination patterns.

Sectors: Aviation

Clusters

The Russian aviation manufacturing sector operates as a system of material flows across several main clusters. Ulan-Ude emerges as the primary cluster by volume, though this prominence is primarily attributed to coal shipments from the Cheremkhovo cluster rather than direct aviation manufacturing activities. The network's manufacturing entities are distributed across multiple locations (see Figure 40).

Figure 40: Aviation manufacturing clusters



Source: KSE Institute

Ulan-Ude, located 185km from the Mongolian border, hosts U-UAZ (which alone allegedly accounts for 40% of industrial output of the Republic of Buryatia,[83] U-ULZ, and Aerotech LLC, which produces Mi-8/17 series helicopters. **Ufa**, west of the Urals between Chelyabinsk and Kazan, contains an ODK engine corporation branch that creates turbofan engines for fighter jets. **Rybinsk**, a city of under 200 thousand located around 260km north of Moscow, includes ODK-Saturn and a Kronshtadt branch making turbofan engine components and conducting some UAV engine development. **Moscow** houses ODK and Salut engine plants, design bureaus (MiG, Sukhoi, Mil/Kamov), and Kronstadt UAV production in Dubna. **Samara** features an ODK-Kuznetsov branch which designs large turbofan engines (NK-32 for Tu-160 bombers, NK-25 for Tu-22M) and rocket engines. Finally, **Komsomolsk-on-Amur**, **Novosibirsk**, and **Irkutsk** are homes to plants assembling fighter aircraft.

The aviation sector has undertaken significant post-2022 expansion efforts to support the war effort. The Ulan-Ude cluster is slated to launch a new line for Ka-226 helicopters by 2025,[84] as well as complete the import-substitution project for Mi-171A3/Ka-226 parts under state funding.[85] There is also an ongoing effort to upgrade

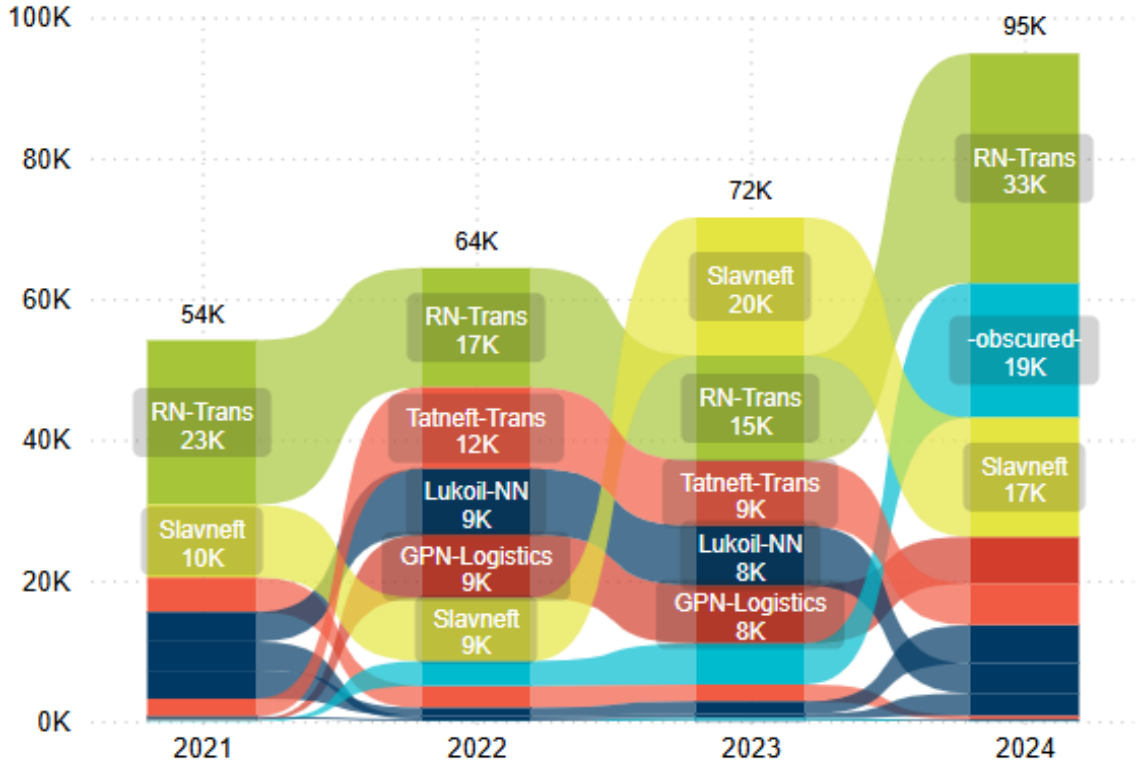
[83] See "Putin checks out Ka-226T helicopter at Ulan-Ude aviation plant," Defense Mirror
[84] See "PMEF-2023: production of Ka-226 helicopter to be launched by 2025," Mashnews [ru]
[85] See "Ulan-Ude aviation plant will produce parts for helicopters," PSB [ru]

equipment and introduce novel technologies into the manufacturing of engine parts.[86] United Aircraft Corporation (UAC) has plans to increase the annual production of the military transport carrier Il-76MD-90A to 18 units, up from six, by expanding its workforce and optimizing its supply chain.[87]

Dependence on imported components and materials was prevalent long before the full-scale invasion. Russian aviation's flagship civilian project, the MS-21 airliner, was stalled by a U.S. ban on high-grade composite resin.[88] But by 2022, Russian chemists had developed a local epoxy resin and carbon fiber, enabling the MS-21's wing to be built entirely from Russian composites.[89] Efforts to substitute Western technologies, such as turbine engine blades that require single-crystal superalloys, have been ongoing for years.[90] But even in 2025, ODK-Kuznetsov is reported to have struggled with quality control and technological obsolescence due to sanctions, leading to bottlenecks in Russia's strategic aviation programs.[91]

Much like Russian MIC's major heavy industry manufacturers, the aviation manufacturing industry has streamlined its supply chains by providing its enterprises with more prefabricated materials. There are several other significant trends in Russia's aviation manufacturing sector that have important strategic implications.

Figure 41: Oil products shipments to aviation manufacturing clusters by supplier, in metric tons



Source: KSE Institute

[86] See "World-class Russian engine manufacturing," Russian Aviation [ru]
[87] See "Russia's UAC to produce 18 new Il-76MD-90A aircraft annually," Defense Mirror
[88] See "US sanctions halt composite material supply to Russian MC-21 airliner," Defense Mirror
[89] See "MC-21-300 flies with Russian composite wing," Airframer
[90] See "In all blades: new technologies for the manufacture of aircraft engine blades," VPK News
[91] See "Engine problems: the industrial dysfunction degrading Russia's strategic bomber force," European Security and Defense

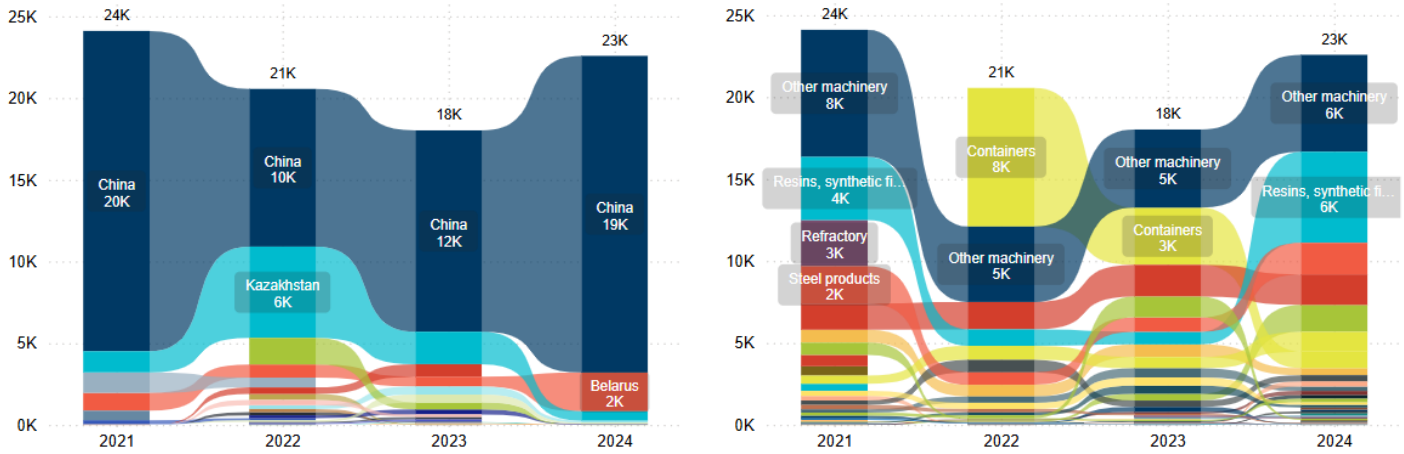
Select Input and Output Dynamics

In addition to coal and light oil products, aviation clusters receive a wide variety of inputs, including machinery, resins, synthetic fibers and plastics, rubber products, as well as various electric and electronic components.

Unsurprisingly, **jet engine fuel** shipments have increased since the full-scale invasion. Annual trends suggest, however, that it was 2024 when the demand for fuel truly lifted off. Increased consumption of jet engine producers from ODK group shows expansion of their production capacity. The primary suppliers of the fuel are RN-Trans (Rosneft), Slavneft, and Lukoil—together, they delivered around 65% of jet engine fuel and other oil products to aviation manufacturers (see Figure 41).

Coinciding with the increase in fuel receipts, aviation manufacturers made investments into their productive capacity in 2024. To do so, they have relied on **imports of machinery**, which increased to 6 thousand tons (+24%) in 2024. These deliveries were primarily directed to Ufa, with additional shipments to the Ulan-Ude and Rybinsk clusters. The majority of equipment was sourced through the Zabaikalsk hub on the Chinese border, and the imports of machinery and spare parts were predominantly declared as Chinese in origin (see Figure 42).

Figure 42: Imports to aviation manufacturing clusters by origin and cargo type, in metric tons



Source: KSE Institute

The effect of the industry's import dependence ranges from shuttering production lines to rerouting supply chains, which introduces friction and additional costs but does not ultimately cripple output. A prime example of the former case is light helicopters: in 2022, sanctions temporarily shuttered serial production of Ka-226T and Ka-62 helicopters, which previously used Western engines (Canadian Pratt & Whitney PW207 or French Turbomeca Ardiden) and other imported avionics. ODK-Klimov is reportedly fast-tracking development of replacement propulsion units: the VK-650V and VK-1600V turboshaft engines to stand in for the Western models.[92] Similarly, older Russian helicopters that historically relied on Ukrainian engines (Motor Sich's TV3-117 series) have transitioned to Klimov's VK-2500 engines over the past few years, ending a major import dependency from Ukraine.

The reliance on imports during the war was cushioned somewhat by large stockpiles and materials that Russia accumulated under pre-war contracts. In fact, the Kremlin revealed it planned to use stock intended for 2024-25 production in order to boost 2023 output, essentially burning through reserves of components ahead of schedule.[93]

[92] See "World-class Russian engine manufacturing," Russian Aviation [ru]
[93] See "The Russian army in 2023," Riddle Russia [ru]

Synthetic materials, sourced from hubs on the Chinese and Belarussian borders, increased more than six-fold in 2024 (from 900 tons in 2023 to 5.9 thousand tons). These materials—polystyrene and synthetic fibers—serve multiple purposes, including insulation and molding, while also having potential applications in explosives and UAV manufacturing. Together with rubber products, they are crucial for various aviation applications including landing gear, seals, shock absorption, vibration control, and protective coatings. While R&D institutes in Russia (e.g., under Rosatom and MoD chemistry branches) have reportedly synthesized lab-scale analogs of high-temperature polymers, mass production is not yet in place—meaning aviation manufacturers still face critical material shortages, delaying or downgrading certain subsystems.[94]

Despite the myriad challenges facing the civilian aviation industry in Russia,[95] military aviation manufacturers have rapidly expanded production capacity—in part thanks to the churn through stockpiles. They rely heavily on a combination of complex international supply chains (made all the more complex by sanctions and export controls) and concentrated domestic suppliers. While the sector shows remarkable growth and adaptation, these dependencies create potential vulnerabilities that could affect the sustainability of current production levels.

Sectors: Naval Industry

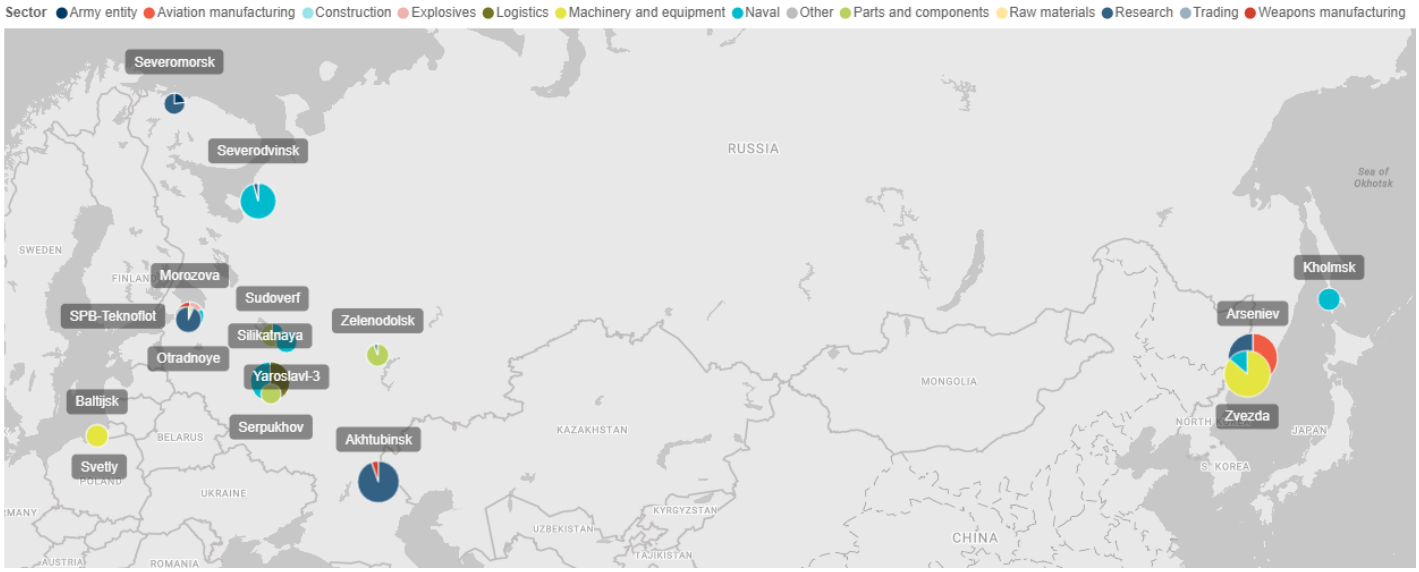
Clusters and Shipyards

Russia's naval and shipbuilding sector is composed of several vertically integrated and regionally concentrated enterprises. Many of these are embedded within large state-owned holding structures, mainly the shipbuilding corporation OSK. These entities are responsible for constructing and maintaining surface combatants, submarines, icebreakers, and auxiliary naval vessels, often working in coordination with specialized design bureaus and component suppliers. The sector is organized around a number of specialized industrial clusters that combine shipyards, repair plants, and military R&D centers. These clusters serve both the construction of new naval platforms and the maintenance of existing fleet assets, with a strong regional split between Northern, Baltic, and Far Eastern hubs (see Figure 43).

Russia's strategic arctic fleet and icebreaker construction are led by a handful of state-owned and private enterprises, Atomflot chief among them. **Atomflot** operates Russia's fleet of nuclear-powered icebreakers, which play a dual role in commercial Arctic navigation and support of Northern Fleet strategic operations. The vessels are built by the **Baltic Shipyard** (located in New Port cluster), which also receives components from ZIO-Podolsk Mechanical Engineering Plant and systems from Tekhnoflot and TsKB Aisberg, the latter being the main naval design bureau for ice-class vessels. The Baltic Shipyard's 2024 net profit reached RUB3.7 billion, compared to a RUB19 billion loss in the prior year,[96] helped by a landmark contract signed in May 2024 for a new nuclear service/support vessel (MCATO) to be delivered by 2029.[97]

[94] See "Import substitution of polymer raw materials: successes and problems," Polymer Materials [ru]
[95] See "Sanctions and aviation: how reliable are planes still in Russia?" DW [ru]
[96] See "Baltic Shipyard's profit in 2024 amounted to 3.7 billion rubles, compared to losses a year before," Port News [ru]
[97] See "The USC Baltic Shipyard laid down the Vladimir Vorobyov, a multifunctional nuclear technology maintenance vessel," Paluba News [ru]

Figure 43: Naval production and supporting clusters



Source: KSE Institute

Near the Baltic Shipyard, the **Admiralty Shipyards** launched two non-nuclear submarines in 2024.[98] OSK, the holding company of the shipyards, has laid out plans to overhaul its facilities to the tune of RUB15 billion (~$190 million) over the next several years, though much of this may be aimed at tanker production.[99] A deeper restructuring may also be in the cards for OSK's shipyards in the St Petersburg area: five shipyards (the Northern Shipyard, the Kronshtadt Marine Plant, the Baltic Shipyard, the Admiralty Shipyards, and the Sredne-Nevsky Shipyard) may be combined into a single cluster. A more comprehensive modernization and repair of the entire cluster could cost RUB200 billion (~$2.6 billion).[100]

Leningrad oblast hosts a number of other leading naval clusters, including the Morozova cluster, which includes the Nevsky Shipbuilding Plant, an explosives manufacturer, and the Morozova weapons plant, and the Otradnoye cluster, which includes Pella Shipyard and a local branch of the Kurchatov Institute. Farther north in Murmansk oblast, the Severomorsk cluster is on the coast of the Barents Sea, hosting the Northern Fleet command and affiliated army entities, and includes a division of OKB Novator.

The **Yantar Shipyard** in the Baltiysk cluster (in Kaliningrad) serves as a node for shipbuilding hubs and coordination centers. It provides production or support to the 33rd Ship Repair Plant, the Amur Shipyard, the Vyborg Shipyard, and the Baltic Shipyard. Its primary design partners include the Severnoye Design Bureau and the Central Design Bureau Almaz, which are both responsible for designing corvettes and small missile ships widely used in the Black Sea and Baltic Fleets.

The **Vyborg Shipyard (VSZ)**, northwest of St Petersburg on the Gulf of Finland, is positioned to support both military and civilian maritime needs, supplying the MoD and other state customers. Its material inputs include

[98] See "Results of the year of the shipbuilders 2024: OSK Admiralty Shipyards," Korabel [ru]
[99] See "The 15 billion ruble modernization of Admiralty Shipyards may begin in 2025," Port News [ru]; "OSK will renovate Admiralty Shipyards in the next 3-5 years," Vedomosti [ru]
[100] See "St Petersburg authorities want to create a single cluster of OSK shipyards in the city," Vedomosti [ru]

rolled steel from Severstal, and electronics from Elektroradioavtomatika. VSZ also reported a net profit of RUB783 million in 2024, a full turnaround from 2023 losses.[101]

Historically focused on patrol boats and small combatants, the **Zelenodolsk Shipyard** has supplied the State Transport Leasing Company (GTLK), Rosgvardiya, and various military units. The plant outside of Kazan has recently shifted its focus to modular fast-response vessels and small missile ships (Buyan-M class), enabling rapid construction and flexible deployment. Zelenodolsk Shipyard has launched the 5th Project 22160 patrol boat, "Victor Velikiy", and continued production of minesweepers and missile craft.[102]

The Severodvinsk cluster hosts **Sevmash** and **Zvezdochka**—Russia's premier submarine builder and naval repair facility, respectively—as well as R&D entities such as SPO Arktika, KB Rubin-Sever, and a local branch of the missile-designing MIT institute. Zvezdochka specializes in ship maintenance and overhauls, including for nuclear-powered vessels, and its facilities support both the Northern and Pacific Fleets. Sevmash, which often collaborates with Zvezdochka, is Russia's only shipyard capable of producing nuclear submarines at scale, including the Borei and Yasen classes. It also supplies components to Severnaya Verf and receives critical components from NPO Iskra and the Vladimir Plant of Precision Alloys, the latter providing specialized metallurgical products for submarine hulls and reactor compartments. Throughout 2024, there were reports of intensified commissioning of new craft across Russian yards, including Sevmash.[103]

The Zvezda cluster in the Far East is centered around the **DVZ Zvezda plant**. In 2024, two new Arctic gas tankers—'Konstantin Posyet' and 'Viktor Chernomyrdin'—were launched simultaneously from Zvezda.[104] There were plans to integrate Zvezda into OSK for deeper workload synergy but financing fell through early 2025.[105]

In addition to the core shipbuilding enterprises, Russia's naval-industrial complex includes a wide range of entities specializing in weapons systems, propulsion, communications, and electronic warfare. These companies play a central role in equipping the fleet with combat-capable platforms and advanced subsystems.

For **weapons systems and fire control**, TsNII Burevestnik (Nizhny Novgorod) is a main supplier of ship-based automated artillery systems, while NPO Pribor im. Golembiovskogo (Moscow) develops the associated ammunition. RATEP in Serpukhov (Moscow oblast) specializes in automated radar-based fire control systems for naval artillery platforms.

Several **missile and torpedo** developers contribute to the Russian Navy's strike capabilities. MKB Fakel in Khimki (Moscow oblast) manufactures missiles for ship-based launch systems. AAK Progress (Primorsk territory) and OKB Novator (Yekaterinburg) produce a range of anti-ship cruise missiles. MPO Gidropribor (St Petersburg) designs and produce ship-based missile complexes, torpedoes, and additional anti-ship weapons.

In terms of **propulsion and power systems**, ODK-Saturn (Rybinsk, Yaroslav oblast) is the primary producer of gas turbine engines for naval platforms.

Producers of **electronics, optics, and communications** equipment are more varied. Shvabe Holding, within the Rostec umbrella, develops optoelectronic systems tailored for naval use. NPO Karat designs ship-to-shore and intra-fleet communication systems, while OPK manufacturers naval satellite communications terminals. NPO Avrora (St

[101] See "The Vyborg Shipyard finished 2024 with around 784 million rubles in profit, compared to losses a year before," Port News [ru]
[102] See "Victor Velikiy the patrol boat and Typhoon the small missile ship were launched in Zelenodolsk," Port News [ru]
[103] See "Get in line: how the Russian navy was strengthened in 2024," Izvestia [ru]
[104] See "Results of the year of the shipbuilders 2024: SSK Zvezda," Korabel [ru]
[105] See "VTB declined to buy out the shipbuilding plant in Bolshoy Kamen," Vladivostok 1 [ru]

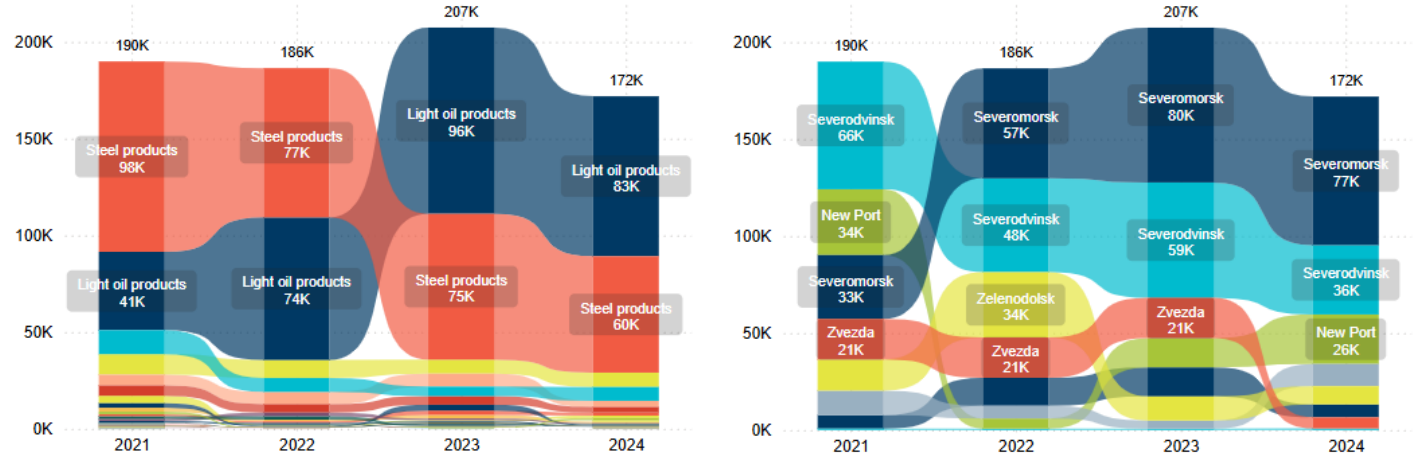
Petersburg) produces various shipboard control components, including pressure relays and integrated management systems. Granit-Elektron (St Petersburg) supplies guidance systems for high-precision naval munitions.

Cargo Flows and Inputs

Cargo traffic into these clusters reveals a **significant buildup of military-industrial activity** since 2022. Steel is one of the naval sector's primary inputs, and, together with oil, serves as a bellwether for the industry's production levels (see Figure 44). Steel consumption at specific shipyards reveals significant expansions in production: the Baltic Shipyard (+98% in 2024), Admiralty Shipyards (+10% in 2024), and Vyborg Shipyard (+93% since 2022) are among the highest increases. Their main suppliers are MMK and Severstal, with MMK serving as the principal driver of growth—while it supplied 49% of steel products to the naval industry in 2021, its market share increased to 83% by 2024.

A number of additional trends point to a **concerted effort to support the Northern Fleet's readiness**. Northern shipyards—particularly the Baltic Shipyard, Sevmash, Zvezda, and Admiral Wharfs—show clear investments in productive capacity, receiving specialized equipment from known MIC manufacturers, including Novator, ZIO-Podolsk, and the Nizhny Novgorod Machine-Building Plant. The Severomorsk cluster has also received growing volumes of diesel and jet fuel, unspecified cargo, and spare parts—mainly from obscured consignors.

Figure 44: Incoming shipments received by naval industry entities, in metric tons



Source: KSE Institute

Preparations for Future Conflict with the West

The current expansion in naval-industrial activity across Russia's shipbuilding and repair clusters reflects more than routine replenishment or maintenance. The scale of steel, explosives, and specialized equipment deliveries—coupled with multiple vessel launches, investments, and orders—**points to a deliberate capacity buildup** across multiple regions, particularly in St Petersburg.

While Russia's navy did play a significant role in the early stages of the full-scale war against Ukraine, the strategic picture has since shifted. The Black Sea Fleet suffered substantial losses and has been largely pushed out of the western Black Sea, reducing its operational relevance in the current phase of the war. With no major naval offensives underway, the ongoing industrial intensification signals preparations for a different problem set with a different set of strategic objectives.

This pattern indicates that **Russia's naval buildup is not a defensive response to losses in Ukraine but a calculated effort to expand its military footprint and prepare for future confrontations with the West**. The emphasis on submarine production, Arctic-capable vessels, and advanced weapons integration underscores an ambition to assert control over critical maritime spaces, especially in the High North. Far from signaling restraint, Russia is exploiting the current relative calm at sea to rearm and reposition its navy for long-term power projection—directed squarely at challenging NATO in the Arctic, the Baltic, and beyond.

Products: Missiles

Clusters

The Russian missile production industry comprises several specialized clusters with distinct capabilities and production focuses, together forming an integrated missile manufacturing ecosystem. The sector's primary production clusters are in **Votkinsk, Zlatoust, Yekaterinburg, Volgograd,** and **Krasnoyarsk** (see Figure 45).

Figure 45: Missile clusters

Source: KSE Institute

By spring 2024, Ukrainian military intelligence assessed that Russia was producing 115-130 long-range missiles per month (this likely includes Kh-101 air-launched cruise missiles, Kalibr sea-launched cruise missiles, Iskander ballistic and cruise missiles, and Kh-47 Kinzhal aeroballistic missiles).[106] A shortage of electronic components is consistently cited as the most critical bottleneck for modern missiles, and it remains so for Russia. In response to the first major wave of Western sanctions in 2014, Moscow launched import-substitution programs for military electronics, but the program largely failed.[107] To combat electronics shortages, Russia has leaned heavily on partners—**China** chief among them—and has likely relaxed quality controls to accept commercial-grade chips, which are easier to source. In addition to electronics, Ukraine revealed that Chinese companies had been stepping in to supply critical materials: China's Zhongfu Shenying Carbon Fiber company was accused of providing carbon fiber to Russia for missile production, specifically for the Iskander program.[108]

[106] See "Russia's seemingly endless stockpiles: how many long-range missiles does Russia have left, and how have its tactics for large-scale strikes changed?" Ukrainska Pravda
[107] See "Gosplan is to blame for everything," Kommersant [ru]
[108] See "Ukraine bans China's firms for helping Russia make missiles," Reuters

The **Votkinsk** cluster, located 400 kilometers west of Ekaterinburg in the Urals, represents a critical node in Russia's missile production capability. The cluster is centered around the Votkinsk plant, manufacturing a wide range of tactical, operational, ballistic, and intercontinental missiles that include the Temp, Pioneer, Topol, Tochka-U, and Iskander systems. The facility's production capacity appears to be expanding, as evidenced by increasing inputs of molding sand from Balasheyka sands, which had doubled their pre-invasion volumes to reach 3,125 tons in 2023, but decreased to 1,800 tons in 2024. During the 2010s, the Votkinsk plant had been scaled down—even adopting a 4-day workweek by 2020—but the war's demands reversed this trend.[109] By 2022-23, Votkinsk ramped up production—hiring thousands of new workers and moving to round-the-clock shifts—primarily to replenish Iskander missiles used against energy infrastructure and civilian targets in Ukraine. Production levels have risen substantially above pre-invasion levels, partially aided by imported components from China and Taiwan.[110]

The **Zlatoust** cluster, 115 kilometers north of the border with Kazakhstan in the city of Chelyabinsk, is home to Zlatmash, which specializes in naval missile systems and spacecraft components. Part of the strategic missile supply chain, it is believed to manufacture missile airframes and components, supporting systems like the Bulava and other ballistic missiles in cooperation with the Votkinsk plant and the Makeev Design Bureau in nearby Miass. Since the full-scale invasion, Zlatoust and other Ural-region plants (including in Miass) have seen a revival of orders that has revitalized the cluster. The Miass Machine-Building Plant, which makes hull components for submarine-launched ballistic missiles, had nearly gone bankrupt in 2021 before it received a surge of work to support new SLBM production.[111]

The **Yekaterinburg** cluster, featuring MZIK (Kalinin Machine plant), focuses on air defense missile systems, particularly for S-300 and Buk (of flight MH17 infamy[112]) platforms. MKB Novator produces missiles for the Iskander system (ground-launched cruise missiles) and is the developer of the Kalibr sea-launched cruise missiles line. This plant is part of the Almaz-Antey conglomerate and has been crucial for supplying the long-range precision strike weapons used by Russia. Early in the war, Novator's factory reportedly shifted to a 24/7 three-shift schedule (with high-level intervention to secure funding and workforce) to boost output of Kalibr and Iskander missiles.[113] Data shows increasing shipments of machinery to MZIK: up to 660 tons in 2024 from 435 tons in 2023. Newsprint paper, commonly used for packaging missiles and munitions, consumption increased from 480 to 1172 tons in 2024, providing another tangential evidence of increased manufacturing activity.

The **Krasnoyarsk** Machine-Building Plant ("Krasmash") is a major missile factory focusing on liquid-fuel strategic systems. It produces submarine-launched ballistic missiles (R-29 Sineva/Liner) and is the primary production site for the new heavy ICBM RS-28 Sarmat. In the 2021-25 period, Krasmash has been gearing up for serial production of Sarmat after its testing phase, likely with infrastructure upgrades. Equipment overhaul was reported at the plant in 2024.[114]

[109] See "Missed targets: the struggles of Russia's missile industry," CEPA
[110] See "How Russia prepares its strategic missile plant for 'eternal war,'" Kyiv Independent
[111] See "Missed targets: the struggles of Russia's missile industry," CEPA
[112] See "MH17: the open source evidence," Bellingcat
[113] See "Missed targets: the struggles of Russia's missile industry," CEPA
[114] See "Re-equipping Krasmash will allow it to produce new types of rocket and space technology," VPK News [ru]

Volgograd's Titan-Barrikady facility produces Iskander, Yars, and Topol-M missiles. In 2022, the company has received financing for digital transformation projects from Novikombank—a key bank in Rostec ecosystem.[115] Electronic activity at the factory points to a significant expansion of production since the full-scale invasion.[116]

The **Moscow** metropolitan area hosts several missile enterprises under the Tactical Missiles Corporation (KTRV) and other bureaus. This includes in Reutov (VPK NPO Mashinostroyeniya), which produces the Oniks anti-ship cruise missile and reportedly the new Zircon hypersonic cruise missile; Dubna (KB Raduga), the developer and manufacturer of air-launched cruise missiles like the Kh-55 and newer Kh-101; and Kolomna (KBM), the design bureau for Iskander and other tactical missiles (with production at Votkinsk). The Moscow oblast cluster, benefiting from proximity to research centers and higher-tier suppliers, has seen intense activity in 2022-25 as it produces many of the "high-precision" missiles used in the invasion of Ukraine (including Kh-101, Kh-59). KTRV reported a doubling of output in 2023.[117]

There are several other notable locations: **Orenburg** (Strela plant) is involved in anti-ship and anti-radar missiles (e.g. Kh-35 Uran). **St Petersburg** hosts engine makers like ODK-Klimov and NPO Saturn, which produce small turbojet engines used in cruise missiles. AAK Progress, maker of anti-ship missiles, is located in **Arseniev**. Institutions like TsNIIAG and GNPP "Region" design the software for guidance and control systems. Many of these support facilities have been drawn into the expanded production effort as sub-contractors manufacturing warheads, propulsion components, guidance systems, and explosives. Additionally, the **Smolensk** Aviation Plant (a KTRV-associated facility) produces cruise missiles and announced plans in 2023 to double its workforce from 2,000 to 4,300 employees to meet demand.[118]

Production Trends and Supply Patterns

Explosive materials outputs from producers (Novator, KBM, MZIK) show dramatic increases, rising from 60 tons in 2021 to 2.3 thousand tons in 2023, and 4.4 thousand tons shipped in 2024 (see Figure 46). Recipients include the Black and North Sea Fleet commands, and strategic commands of Western, Southern, and Central military districts. Destination points include the Crimean ferry hub, Mozdok-2 military base, and Severodvinsk North Fleet facilities.

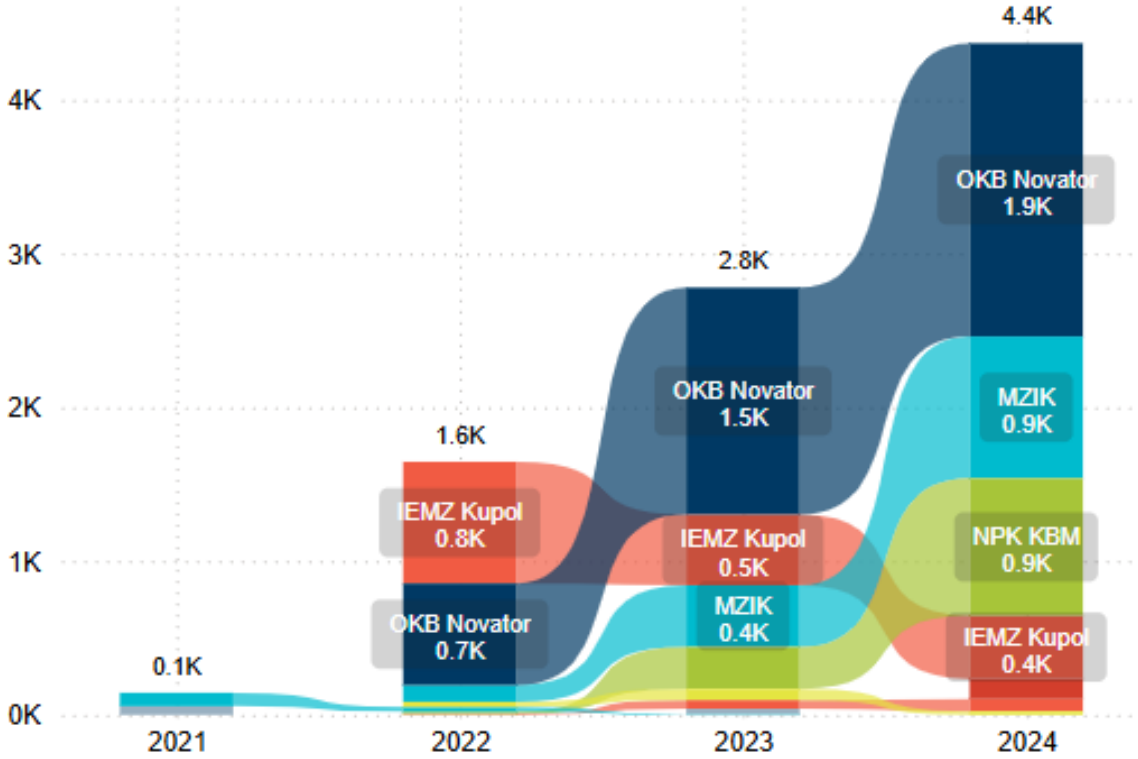
Most of this cargo flow originates in Verkhnyaya Salda in Sverdlovsk oblast, where the VSMPO-AVISMA plant is located. According to one source,[119] the fueling of missiles happens at a secret facility in the same area.

Cargo from missile clusters classified as "other" has increased significantly, particularly from the Kupol plant to Yeysk airbase on the Azov Sea, rising from 87 tons in 2021 to over 500 tons in 2022-2024.

Both input and output dynamics suggest a successful adaptation of the missile production network to wartime demands, with most facilities increasing output despite potential material constraints. Notable expansions have taken place at both Votkinsk and MZIK manufacturing facilities. The growth in explosive materials shipments and specialized cargo to military commands, in particular, indicates sustained missile production and deployment capabilities that support the invading forces and strikes against Ukraine's civilian infrastructure.

[115] See "Novikombank will finance Roscosmos projects for 3.7 billion rubles," VPK News [ru]; "Titan-Barrikady," Rhodus Intelligence
[116] See "A glimpse inside Putin's secret arms empire," The Economist
[117] See "Shoigu reported on the doubling of high-precision missile production," RBC [ru]
[118] See "Russia's military-industrial complex is gaining momentum: where does the money come from, and who helps Russia produce missiles," Ukrainska Pravda
[119] See "A secret factory in the Urals and the disappearance of an engineer: RDK published its investigation into the production of Kalibr rockets in Russia," Stopkor [ru]

Figure 46. Shipments of explosives and military equipment from missile manufacturers, in metric tons



Source: KSE Institute

Products: Artillery

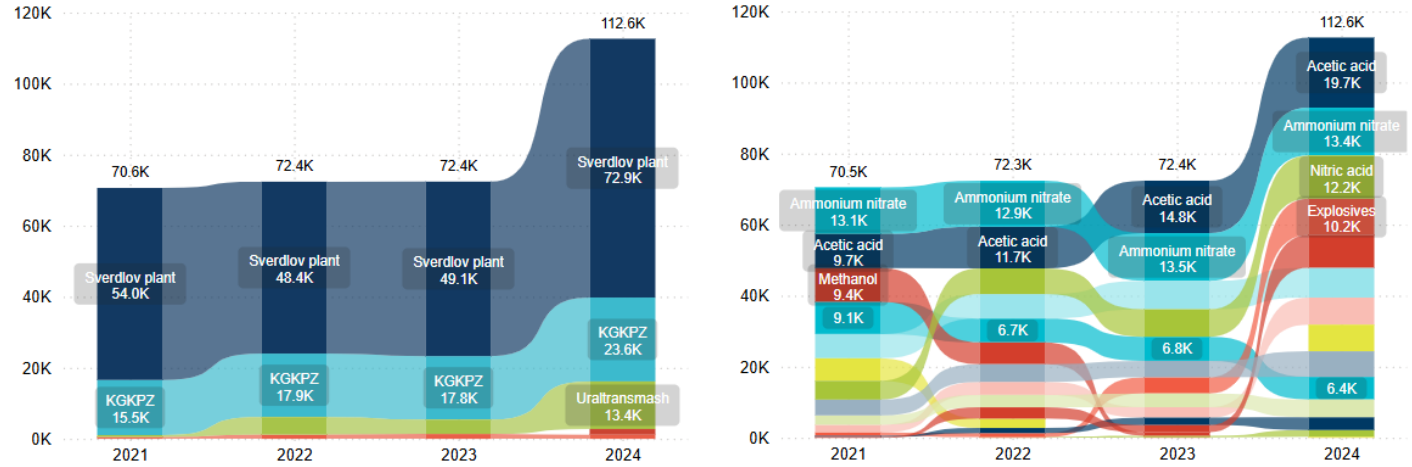
Russia's artillery supply chains show significant 2024 growth in both explosive ordnance and platform manufacturing but also expose significant vulnerabilities—especially in limited-source inputs such as chemicals, sheet steel, and molding sand (see Figure 47). The reliance on imports of North Korean munitions (see *Section I*) underscores the inadequacy of domestic supplies, however, as production cannot keep pace with elevated fire rates and dwindling stockpiles.

Clusters

The primary artillery producing clusters in Russia are **Dzerzhinsk**, **Kazan**, **Yekaterinburg**, and **Volgograd**. Dzerzhinsk's Sverdlov plant specializes in explosive ordnance for shells and guided bombs, while Yekaterinburg's Uraltransmash produces Msta-S and Akacia platforms. KGKPZ in Kazan creates charges for artillery shells, has full cycle nitrocellulose production, and is the only supplier of smokeless gunpowder, has been delivering to the MoD directly.[120] Volgograd's Titan-barrikady contributes components for Msta-S and Bereg platforms. In addition, **Biysk** is home to oleum plant, which since 2020 is a part of Sverdlov plant, and NPO Splav is making metal casings for artillery shells in **Tula**.

[120] See KGKPZ's database entry in War & Sanctions

Figure 47: Cargo delivered to artillery manufacturers, in metric tons



Source: KSE Institute

Select Input Dynamics

Artillery production facilities rely on inputs from multiple regions. Magnitogorsk serves as the primary steel supplier, while Biysk, through its oleum plant affiliated with the Sverdlov plant, provides essential explosive materials. Chemical supplies to Dzerzhinsk and Kazan flow from multiple sources, including Nevinnomyssk Azot for acetic acid, Uralchem for ammonium nitrate, nitric acid, and aqueous ammonia, Novokuybyshev oil company for denatured alcohol, SUMZ for oleum, and RN-trans for acetone. Balasheyka sands maintains a crucial role in providing molding sand to Uraltransmash.

The artillery producers' inputs reveal an overall pattern of significantly expanding production, particularly in 2024. Shipments of chemicals to Sverdlov plant increased from 49 to 73 thousand tons in 2024 alone. Similar growth can be seen at KGKPZ: from 18 thousand tons in 2023 to 24 thousand tons in 2024.

These chemicals each serve specific functions in the production of explosives. Acetic acid facilitates the production of acetate-based explosives and nitrocellulose, while ammonium nitrate serves as a primary ingredient in ANFO and composite explosives. Denatured alcohol functions as an essential solvent; nitric acid enables nitration processes for TNT and RDX production; and acetone acts as a solvent for nitro-compounds.

A 2024 investigation revealed that Russian fertilizer and petrochemical companies linked to sanctioned oligarchs have pivoted to supplying munitions plants with these chemicals.[121] For example, EuroChem delivered 43 thousand tons of nitric and acetic acid to the Sverdlov plant—enough to fill hundreds of thousands of artillery shells. UralChem (see *Explosives and Fertilizers: UralChem and KAO Azot*) likewise sent 27 thousand tons of ammonium nitrate and 6 thousand tons of acid to the same plant. Even Evraz supplied 5 thousand tons of toluene, a TNT precursor, to munitions facilities including the Biysk Oleum Plant, which ramped up output under state military contracts in 2023.[122] The plant has also received 15 billion rubles for upgrades and new equipment to

[121] See "The Russian billionaires whose chemical factories fuel Russia's war machine," Reuters

[122] See "Sanctioned Russian billionaires supplying ingredients for explosives used in Ukraine war," Novoe Russkoe Slovo

boost acid and high explosive production.[123] Satellite imagery from September 2024 shows extensive new construction and land clearing for additional production infrastructure.[124]

Uraltransmash's production trends indicate significant expansion, with incoming shipments of steel increasing from 2 thousand to 18 thousand tons, and molding sand from 2.1 thousand to 3.7 thousand tons in 2024. However, both of these inputs have single source suppliers: MMK for steel and Balasheyka sands for molding sand. Splav started receiving seamless pipes from Volzhskiy pipe plant, taking in 1.6 thousand tons in 2024, compared to only 57 tons in 2021.

Products: Engines

Clusters and Entities

The Russian engine manufacturing network centers around several enterprises within the United Propulsion Corporation (ODK) group and independent manufacturers. Entities with the largest cargo volume footprint include ODK-UMPO, ODK-Saturn, ODK-Kuznetsov, MMP Chernyshova, NPO Energomash, and ODK-Star.

ODK-UMPO is Russia's largest aviation engine manufacturer, producing turbofan engines for fighters (AL-31F, AL-41F series for Su-27/30/35 and initial Su-57 engines) and parts for helicopters. ODK-UMPO additionally makes industrial gas-turbine units (derivatives of aircraft engines for gas pipelines) and helicopter gearbox components. Their production capabilities span two locations, with the main facility in Ufa and a branch operation in Lyubertsy. The **Ufa cluster** surrounding ODK-UMPO also incorporates NPO Saturn and Berg Engineering (main trading partners for ODK-UMPO), Sputniktelecom for IT infrastructure, and Ufa Hydraulics for specialized machinery production. The Ufa cluster thus covers design, production, and support for a wide range of military turbofans and turboshafts

ODK-Saturn specializes in engine production for both conventional aircraft and UAVs, while also manufacturing energy equipment. Saturn also took on naval engine work, most notably by developing marine gas turbines to replace Ukrainian imports after 2014. Based in the **Rybinsk cluster**, ODK-Saturn is co-located with ODK-Gazovye Turbiny (ODK-GT), which builds industrial gas turbine power and compressor units. Their operations benefit from a robust industrial cluster that includes a branch of Krondshtadt aviation, NIR (New Instrumental Solutions) for component manufacturing, machinery producer Raskat, and the 190 Central Repair Plant of Communications Equipment, creating a comprehensive aviation manufacturing hub. This cluster's capabilities span aviation (fighter and transport aircraft engines), marine propulsion, and industrial turbines; it has accumulated a large share of the sector's R&D potential.

ODK-Kuznetsov demonstrates particularly advanced capabilities, producing aircraft engines, rocket engines, and gas turbine systems, with specialized expertise in laser welding and crafting. Their facility houses the Povolzhsk aviation technology institute, which provides design support. ODK-Kuznetsov produces the NK-series turbofan/turbojet engines (e.g. NK-32 for Tu-160 bombers, NK-25 for Tu-22M, NK-12 turboprops for Tu-95) and has historically designed prominent rocket engines (the NK-33 family). The **Samara cluster** also encompasses the "Motorostroitel" plant (now integrated under Kuznetsov), which handles serial production. Notably, Samara's ODK-Kuznetsov mass-produces the RD-107A/108A rocket engines used on Soyuz launch vehicles (with design support from Moscow's NPO Energomash). The Samara cluster surrounding ODK-Kuznetsov represents one of the most

[123] See "Altay explosives production plant will receive 15 billion rubles in investment," TASS [ru]
[124] See "The cost of inaction: Russia's defence industry redevelopment," Tochnyi.info

integrated manufacturing complexes, with MPP Agregat, Samara Machinery Design Bureau (SKBM), NIR's branch, and Energomash's local operation all sharing the former Kuznetsov enterprise address. The cluster's capabilities are further enhanced by the Samara ball bearings plant-9 and Aviakor aviation plant. This cluster has end-to-end engine capabilities—encompassing design, manufacturing, and testing—for both aircraft and space applications.

ODK-Star concentrates on critical engine components and systems, including fuel control apparatus, engine units, rotation frequency sensors, and oil pumps. Operating from the **Perm cluster**, their facility forms part of a specialized manufacturing cluster that includes Inkar (another ODK branch), trading company Permmetall, aviation manufacturer Reductor-PM, a gearbox maker for helicopters (under the Russian Helicopters rather than ODK corporate umbrella), and chemical producer Khimprom. The ODK-Perm Motors plant builds PS-90A turbofans (used on Il-76MD-90A transports, Tu-214 and Il-96 airliners). Its sister design bureau ODK-Aviadvigatel (Perm) develops these large engines for airliners. This arrangement creates a vertically integrated supply chain for engine components and systems.

The **Moscow metropolitan area** (including Moscow, Lyubertsky, and Khimki) hosts numerous entities in the engine supply chain. The capital region's clusters are extensive, combining production, R&D, and supply of components.

ODK-Salyut in Moscow is a production and R&D complex for gas-turbine engines (famous for AL-21F/AL-31F and now involved in PD-14 component production). Salyut has several sites—the main plant in Moscow and a branch in the region (the Voskresensk Machine-Building Plant "Salyut"), which handles fabrication and testing of engine parts. Another Moscow-based entity is MMP Chernyshova, which produces RD-33 family turbofan engines for MiG-29 fighters and small turbojets for missiles and UAVs. MMP Chernyshova is surrounded by Rostec's Center for Additive Technologies, Vympel, and parts producer KETT. Also in Moscow, "AMNTK Soyuz" is a design bureau historically responsible for small turbojets (such as for cruise missiles).

In R&D, Moscow hosts institutes like TsIAM (Central Institute of Aviation Motors) and VIAM (All-Union Institute of Aviation Materials). TsIAM provides testing facilities (including a noted test center in Lyubertsy/Lytkarino), while VIAM develops advanced alloys and composites for engines. These institutes materially support all engine clusters (for example, developing high-temperature alloys and composite fan blades).

Khimki (Moscow oblast) contains NPO Energomash, Russia's leading liquid rocket engine designer and manufacturer (under Roscosmos rather than ODK corporate umbrella), which produces engines like the RD-180 and RD-191. It collaborates with ODK-Kuznetsov, which mass-produces the RD-107A/108A under Energomash's design oversight. This Moscow/Khimki area thus covers everything from jet engines to rocket propulsion.

The Moscow area also includes suppliers of specialized components. For instance, the Naro-Fominsk Machine-Building Plant (NFMZ) in Moscow oblast, which is also under the ODK corporate umbrella, produces compressor blades for many engine models. Another example is MKB "Gorizont" (another ODK branch), which performs engine test-stand work and produces tooling and packaging for engines. Additionally, the Lytkarino Machine Plant (a branch of UMPO near Lyubertsy) contributes to assembly and parts manufacturing.

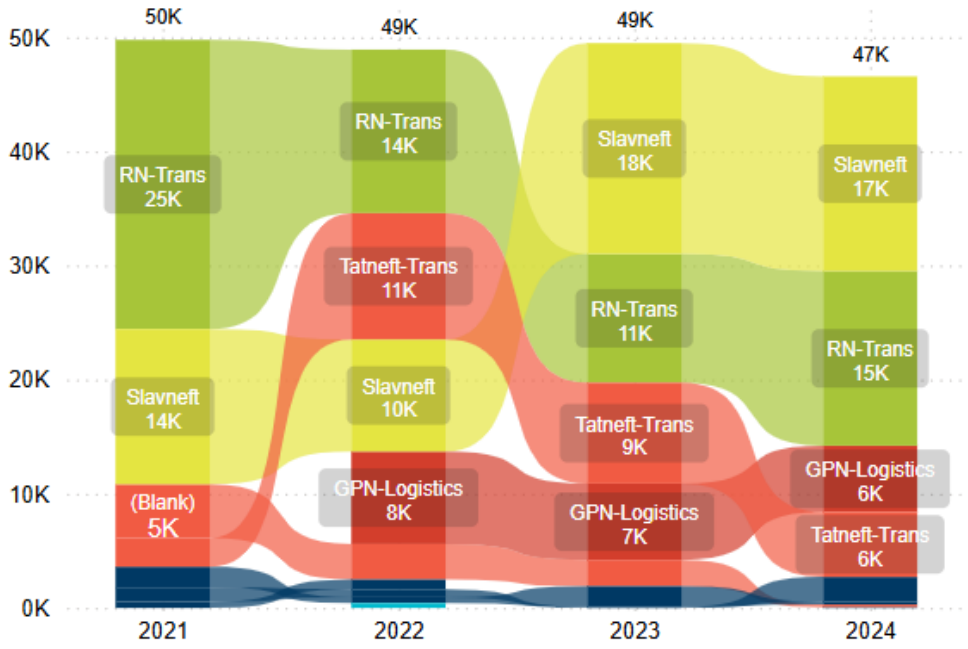
St Petersburg is another node in the engines supply chain, albeit less prominent than Moscow. ODK-Klimov is the area's leading player, designing and producing helicopter turboshaft engines and small turbofans. Klimov's new plant at Shuvalovo produces the VK-2500 series engines that power Mi-8/17, Mi-28, Ka-52 and other helicopters, replacing the Ukrainian firm Motor Sich's supply after 2014. It also produces the TV7-117 family turboprops/turboshafts (for Il-114 transport planes and Mi-38 helicopters), and is developing next-gen engines like VK-1600V and VK-650V for light helicopters. Klimov includes a strong design bureau and an advanced test center. St Petersburg is also home to JSC Zvezda, a manufacturer of high-speed diesel engines for the Russian Navy.

Beyond the major hubs above, Russia's military engine industry includes a number of smaller nodes. In **Omsk**, the ODK's OMO Baranova branch (formerly Omsk Motor-Building Plant) now specializes in producing engine components and performing overhauls. In **Chelyabinsk**, the Chelyabinsk Tractor Plant (ChTZ, under the Uralvagonzavod corporate umbrella) produces tank diesel engines that include the V-92 series ~1000hp engines for T-72B3/T-90 tanks and is developing higher-powered units. In Kolomna (100 kilometers southeast of Moscow), Transmasholding's Kolomna plant builds large marine diesel engines for warships.

Select Input and Production Dynamics

Jet engine fuel represents the most significant rail-transported input for engine manufacturers, and its consumption can be used as a proxy measure for intensity of their production. Despite large investments and claims that production had been expanded, the consumption of jet engine fuel and other oil products remained relatively constant throughout the 2021-24 period at just under 50 thousand tons per year. The fuel supply network relies on four major providers: Slavneft, Tatneft, Rosneft, and Gazpromneft, with Lukoil playing lesser role (see **Error! Reference source not found.**).

Figure 48: Jet engine fuel inputs of engine manufacturers by supplier, in metric tons



Source: KSE Institute

In Ufa, ODK-UMPO secured a RUB2 billion low-interest rate loan in late 2022 from the federal Industrial Development Fund to build a new production and testing complex. Slated for completion by 2027, this complex aims to expand assembly and test capacity for AL-series gas-turbine engines to 50 units per year. While targeted at industrial derivatives (gas-compressor turbine drives), the investment also supports the broader manufacturing base for military turbofan engines. ODK-UMPO's director noted that this program is key for import substitution and boosting high-tech output at military enterprises.[125] In parallel, ODK-UMPO has been upgrading machining and casting capabilities: a new titanium casting workshop opened in 2023 to support increased production of

[125] See "UMPO will receive a 2-billion-ruble soft loan to expand production," RBC [ru]

components for the PD-8/PD-14 engines.[126] Titanium workshop was manufactured by Drobmash, which is under the Ruspolymet corporate umbrella.

ODK-Saturn's Rybinsk site is also involved in scaling up naval turbine output—by 2025 it aimed to triple its production of marine and gas-powered turbines to meet energy and naval needs.[127] It was also planning to install robotic inspection systems in 2024.[128] Breaking from the top-line trend, jet engine fuel consumption at ODK-Saturn has been increasing, almost doubling between 2021 and 2024.

In Samara, a major modernization drive was underway at ODK-Kuznetsov's facilities to support both strategic bomber engines and rocket engines. In 2023 alone, five new production objects were being commissioned: new workshops for turbine assembly and for metallurgical processing, a new engine test stand, and a brand-new design bureau building. The total investment for these projects is about RUB9.6 billion.[129] These upgrades are tied to fulfilling state military orders, chiefly the resumed production of the NK-32-02 engines for Tu-160M bombers.

In Perm, Perm Motors has expanded its assembly lines for PS-90A engines and begun serial production of the new PD-14. By the end of 2024, ODK-PM aimed to deliver an initial batch of 12 PD-14 engines, then ramp up to 24 and 36 units per year in subsequent years. Additionally, ODK-STAR has been increasing production of the new SAU-8 digital control system that will equip the PD-8 turbofan and future engines.[130]

In Moscow, ODK-Salyut has ramped up production of new engines and modules, especially for the PD-8 and PD-14. In 2022 Salyut began serial production of assemblies for PD-14—such as gearboxes and shafts—and is installing new equipment, including new 5-axis CNC machining centers and a precision production line, and even constructing a new production hall to accommodate this.[131] The Naro-Fominsk (NFMZ) blade plant has ramped up production of compressor blades for at least 6 different engine types.[132] ODK reported the printing of certain engine parts based on in-house technologies developed by Center of Additive Technologies (TsAD ODK).[133] Increased activity was also observed at MMP Chernyshova and Energomash, illustrated by increased consumption of mineral inputs and jet engine fuel.

In St Petersburg, ODK-Klimov reported doubling its helicopter engine production in 2023 compared to 2022. This was achieved by building a new production site.[134]

[126] See "Anton Alikhanov opened new production at the aircraft engine plant in Ufa," Bashinform [ru]
[127] See "ODK to triple its production of gas turbine power equipment ," Rostec [ru]
[128] See "ODK to implement artificial intelligence into aircraft engine production in Rybinsk," Metalinfo [ru]
[129] See "ODK-Kuznetsov plans to commission five production facilities worth 9.6 billion rubles in 2023," Volga News [ru]
[130] See "It became known what difficulties ODK faced in developing the PD-8 aircraft engine," 1ru [ru]
[131] See "PK Salyut to start serial production of components for the PD-14 engine in 2023," ODK [ru]
[132] See "ODK has mastered the production of compressor blades for several more gas turbine engines," Metalinfo [ru]
[133] See "ODK uses additive technologies for the creation of aircraft engines," Aviastat [ru]
[134] See "ODK-Klimov plans to double its production of helicopter engines this year," Russian Aircraft Union [ru]

IV. Conclusions

Russia's military-industrial complex (MIC) is grappling with profound structural challenges that compound the broader pressures on its economy, including a tight labor market, elevated inflation and interest rates, and a potential recession. Chief among these challenges are dwindling Soviet-era stockpiles and insufficient domestic industrial capacity to replace them, which have forced Moscow to rely heavily on external partners—most notably North Korea for critical supplies like munitions and missiles, and China for components and machinery. Nonetheless, Russia's military output continues to grow and, absent new constraints, is likely to expand further as current wartime mobilization and external support persist. Moreover, the resources devoted to capabilities not directly relevant to its aggression in Ukraine—particularly in the naval sector—indicate that Moscow is not only replenishing reserves for its current war but also preparing for a confrontation with NATO down the road.

The key takeaway from this investigation is that the Russian MIC is expanding but vulnerable; above all, its vulnerabilities stem from its foreign dependencies and the presence of critical chokepoints in its supply chains. Now in the fourth year of the full-scale war, inputs to and outputs from MIC producers continue to grow across a variety of sectors and products necessary for the military. Their expansion of industrial capacity has benefitted greatly from imported machinery, components, and materials—overwhelmingly from China. Just a handful of logistics firms and hubs facilitate the majority of these imports, serving as intermediaries between Chinese firms and the Russian MIC. Domestically, ostensibly civilian suppliers dominate particular niches—from reinforced concrete and raw materials to explosives—in MIC supply chains yet remain unsanctioned by the West.

Dwindling stockpiles exemplify the unsustainability of the Russian war effort, whereas deliveries of North Korean munitions have plugged critical gaps. The irreversible depletion of Soviet-era materiel—tanks, armored vehicles, and artillery platforms—means that Russia will not have a 'head start' on military production for its next war. What can be remedied, at least in part, is the Russian army's churn through munitions stockpiles: North Korean explosive materials now make up the majority of deliveries to Russia's arsenals and depots.

Our policy recommendations are as follows:

- **Sanctions relief to Russia should be out of the question**. It would allow its military-industrial complex to reconstitute itself before an eventual confrontation with the West, for which Russia is already preparing. Furthermore, all scientific and commercial ties with Russian companies, institutions, and individuals should be halted as they may inadvertently strengthen Moscow's military capacity.
- **Sanction the MIC's "civilian" chokepoints and the logistics firms that facilitate its critical machinery and components imports**. Firms that control sizable MIC market share should not enjoy access to Western financial or export markets. Western countries should cast a wider net with their sanctions to introduce more meaningful costs for both Russian MIC firms and their Chinese suppliers. This will require credibly communicating to China that its firms' machinery and components shipments to the Russian MIC, even through intermediaries, are not acceptable, and will result in secondary sanctions.
- **Remain vigilant for future shipments of North Korean missiles and munitions to Russia and ensure an appropriate response, including sanctions on all involved parties.** If preliminary reports are to be believed, more deliveries of North Korean munitions—which Moscow will undoubtedly seek to conceal—are expected in the coming months. Western governments must identify and pursue ways to disrupt the military and technological cooperation between Russia, North Korea, and Iran.