

Crisis of the Railway Rolling Stock Industry in Russia

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Summary

This article presents the current state of railway rolling stock production in Russia, focusing primarily on locomotives and multiple units manufactured both by the domestic industry and through cooperation with Western manufacturers from Europe and North America. The introduction of economic sanctions following Russia's armed aggression against Ukraine has led to significant declines in the number of vehicles produced; for those already in service, these sanctions have resulted in a lack of access to spare parts. Consequently, the state authorities place an emphasis on manufacturing vehicles utilising indigenous technical design, which is therefore outdated (modern vehicles are produced in rather negligible numbers). For this reason, the process of railway modernisation in Russia has slowed down significantly, and the lack of required investment in the sector will lead to its progressive degradation.

Keywords: railway in Russia, RZD, NEVZ, Ural Locomotives Works, Kolomna Works

1. Introduction – Rolling stock manufacturers in post-Soviet countries after 1991

Although a portion of the rolling stock produced in Russia is destined for export, sales markets have contracted significantly compared to the period before 1991. The dissolution of COMECON in 1991 resulted in the loss of customers in Central European countries, where diesel locomotives (specifically the M62, TEM2, and TE109 series) had previously been exported in hundreds of units. While the production of electric locomotives and multiple units for export did take place, it was on a much smaller scale, including the ET42 series for PKP, Sr1 for VR, 8G for CR, the 312 series for JŽ, and the 32 and 33 series for BDŽ². The collapse of the Soviet Union and the emancipation of the newly formed states facilitated access to Western and Chinese-manufactured vehicles, which were previously virtually unavailable. Furthermore, some existing manufacturers found themselves located outside Russia's borders, such as RVR in Latvia, LTZ in Ukraine, and TEVZ in Georgia³. This compli-

cated vehicle production, particularly as former settlements in the local currency (roubles) were replaced by transactions in US dollars, the exchange rate of which could be calculated in various ways. Additionally, the rolling stock being produced was not modern. Consequently, most post-Soviet countries attempted to acquire new rolling stock independently, with varying degrees of success depending on available funds. The Baltic states (Lithuania, Latvia, and Estonia) integrated into Western structures, such as the EU and NATO, while Belarus, Ukraine, and Moldova opted for cooperation with both Western and Eastern structures, albeit to varying extents. In contrast, Central Asia (Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, and Turkmenistan) saw the entry of Chinese manufacturers, who offered more or less modern vehicles at attractive prices. Given that Russia's economy derives significant revenue from raw material exports, their long-distance transportation within the region's harsh climate can only be carried out by rail, with the transport of natural gas and crude oil via pipelines being the exception. Consequently, the Russian central authorities invited Western manufacturers, namely Alstom, Siemens, Bombardier, and Stadler (companies

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² VR – Valtionrautateiden / Finnish Railways; CR – China Railways; JŽ – Jugoslavenske željeznice / Yugoslav Railways; BDŽ – Bulgarian State Railways (Bulgarian: Български държавни железници).

³ RVR – Rīgas Vagonbūves Rūpnīca: a manufacturer of multiple units (3 kV DC, 25 kV 50 Hz, and diesel) based in Riga, Latvia; LTZ – Luhansk Diesel Locomotive Works: a manufacturer of mainline diesel locomotives based in Luhansk, Ukraine; TEVZ – Tbilisi Electric Locomotive Works: a manufacturer of mainline electric locomotives (3 kV DC) based in Tbilisi, Georgia.

from Japan, South Korea, or possibly China were not interested), to establish joint ventures (JVs) to acquire new technologies, offering the aforementioned manufacturers a substantial domestic market.

However, after 35 years of Western presence in Russia, it is evident that railway modernisation in the country is progressing slowly. An indicator of this is the number of vehicles with three-phase motors, which remain in the minority, while the production of vehicles still utilising DC traction motors continues to dominate. Furthermore, the local industry faces difficulties in manufacturing subassemblies and components of the required quality necessary for the production of modern vehicles. While modern vehicles utilising indigenous technical design are being developed, they are produced in only limited numbers. A separate issue remains the confrontational foreign policy pursued by the country [11], which hinders cooperation with Western companies. Economic sanctions imposed on Russia following the forcible annexation of Crimea in March 2014 and the full-scale invasion of Ukraine in February 2022 have restricted access to Western technologies and impeded the production of modern vehicles. The current crisis in the Russian railway rolling stock industry contrasts with the situation, for example, in the Czech Republic or Poland, or possibly Lithuania or Estonia (not to mention Germany), where ambitious rolling stock procurement (and infrastructure modernisation) programmes are being implemented, generously co-financed by the EU, with numerous orders being awarded to local companies (Škoda, Pesa, Newag). Russia's symbolic return to the past (the Soviet era), when scientific and technical intelligence was used to acquire foreign technologies, is evidenced by the production of the Finist units based on the Lastochka models, where in 2024 Siemens' intellectual property was utilised without the German corporation's consent.

The article includes the Stadler plant in the town of Fanipol near Minsk, which, although located in Belarus and not in Russia, was established with the intention of exporting rail vehicles to Russia. The Belarusian market is too small to become a consistent customer for Stadler; furthermore, BC⁴ lack the appropriate funds (e.g. EU aid programmes) to regularly order vehicles there. Although Belarus is closely integrated with Russia – economically: by estimate, approximately 75% of Belarusian trade is with Rus-

sia, 2024 data, before 2022 – approximately 50%; both countries are also in a customs union; as well as militarily, culturally, etc., formally it is still an independent state. Additionally, Belarus receives natural gas and crude oil at below-market prices. This subsidisation sustains the Belarusian economic and political system, which is a slightly modified command economy and, therefore, inherently inefficient. This system further entrenches Belarus's dependence on Russia.

2. Cooperation with Western companies (from Europe and North America): electric locomotives and multiple units

The first modern electric locomotive produced in Russia after 1991 in cooperation with Western manufacturers was the EP10 series (Fig. 1). For this Russian-designed vehicle, electrical equipment produced by Bombardier, including main and auxiliary converters, was purchased. This was a dual-system locomotive intended for passenger services. Only 12 vehicles of this series were manufactured in 1998 and between 2005 and 2006. The series suffered from teething troubles, and unplanned downtimes occurred frequently, as the production of modern rolling stock required significantly higher quality standards compared to the vehicles previously manufactured in Russia or other post-Soviet countries. Consequently, RZD⁵ and NEVZ⁶, in agreement with the Russian central authorities, decided at the time to invite Western manufacturers (Alstom, Siemens, Bombardier, and Stadler) to participate in the production of modern vehicles [9].



Fig. 1. Dual-system EP10-006 (supply voltage 25 kV 50 Hz) at Kyiv station (30/04/2013) [photo: M. Graff]

⁴ BC – Belaruskaya Chyhunka (Belarusian: Беларуская чыгунка) – Belarusian Railway; the Russian name, BZD (Belorusskaya Zheleznaya Doroga), is also used.

⁵ RZD – Rossiyskiye Zheleznnye Dorogi – Russian Railways.

⁶ NEVZ – Novochoerkasskiy elektrovostoitelnnyy zavod – Novochoerkassk Electric Locomotive Plant: a manufacturer of mainline electric locomotives (3 kV DC, 25 kV 50 Hz) based in Novochoerkassk.

Table 1

Summary of electric locomotives manufactured in cooperation with Western manufacturers

Series	Voltage	Manufacturer	Number of vehicles	Production years	Axle arrangement	Service type	Notes
EP10	3 kV DC, 25 kV 50 Hz	NEVZ	12	1998, 2005–2006	Bo'Bo'Bo'	passenger service	electrical components by Bombardier
EP20	3 kV DC, 25 kV 50 Hz	NEVZ + Alstom	80	2011–2021	Bo'Bo'Bo'		–
2ES5	25 kV 50 Hz		5	2012, 2014, 2015	2 × Bo'Bo'	freight service	only a prototype was built
2ES20	3 kV DC, 25 kV 50 Hz		0	–	2 × Bo'Bo'		only the design was completed
2ES10 2ES10S (3ES10)	3 kV DC		181 60	2010–2023 2014–2021	2 × Bo'Bo' 3 × Bo'Bo'		mechanical components from 2ES6, electrical components by Siemens
2ES7	25 kV 50 Hz		35	2013, 2019–2022	2 × Bo'Bo'		
2ES8 3ES8	3 kV DC	Ural Locomotives	2 3	2022	2 × Bo'Bo' 3 × Bo'Bo'		variant of the 2ES10 (3ES10) with domestically produced electrical components
2EW120	3 kV DC, 25 kV 50 Hz	ELZ + PLK* + Bombardier	2	2015, 2016	2 × Bo'Bo'		only a prototype was built

* ELZ + PLK: Engels Locomotive Plant + First Locomotive Company
[Author's own compilation based on Transmashholding data].

To date, several modern series of locomotives and multiple units have been produced in single- or dual-system versions (3 kV DC, 25 kV 50 Hz) for passenger or freight services in cooperation with Alstom and Siemens. In contrast, although a Russian entity established a partnership with Bombardier, only two twin-unit locomotives were produced. Stadler built its own plant in Belarus, where vehicles are manufactured, including those for export to Russia (details are provided in Table 1):

1. Alstom formed a joint venture with the local locomotive manufacturer, NEVZ from Novocherkassk. Between 2009 and 2015, a 33% stake in the Transmashholding group was acquired for a total of 441 million euros, which enabled the design of several electric locomotives:
 - the EP20 series (Fig. 2) – a single-unit dual-system locomotive for passenger services. A total of 80 vehicles were produced between 2012 and 2021 (RZD had planned to purchase 200 locomotives of this series). Production was halted at the end of 2021 because many components and subassemblies were manufactured by Alstom, and the local industry was unable to produce them independently. In 2022, many locomotives of this series were taken out of service

due to the wear of monobloc wheels; however, the problem was resolved with assistance from China through so-called grey imports.



Fig. 2. Dual-system EP20-052 (supply voltage 3 kV DC) with a passenger train at Kazansky Station, Moscow (27/10/2024)
[photo: from the author's collection]

- The 2ES5 series – a twin-unit single-system locomotive (25 kV 50 Hz) for freight services; only five vehicles were produced.
- The 2ES20 series – a twin-unit dual-system locomotive for freight services; not a single vehicle was built, as only the design was completed.

- By way of comparison, Kazakhstan Railways purchased Alstom-designed Prima III locomotives, including 144 freight locomotives of the KZ8A series and 21 passenger locomotives of the KZ4AT series, out of a total order for 295 and 90 vehicles respectively. These units were adapted to the harsh local climatic conditions, with a temperature range from -50°C to $+50^{\circ}\text{C}$, and featured equipment such as roof- and bogie-mounted snow and ice melting devices, along with efficient insulation and heating for the driver's cab [1, 3]. In 2023, Alstom completely withdrew from Russia, selling its stake to local entities for 122 million euros, representing a financial loss [2, 6].
- 2. Bombardier established a joint venture with the Engels Locomotive Plant (Engelskiy Lokomotivnyy Zavod). This cooperation resulted in the dual-system twin-unit 2EV120 series locomotive, two units of which were produced 2015 and 2016. Although the production plans for these vehicles were ambitious and included export targets, serial production was never commenced.
- 3. Siemens established a joint venture with a local manufacturer, Ural Locomotives, based in Verkhnyaya Pyshma near Yekaterinburg, which is owned by the Sinara Group. Several series of freight locomotives and multiple units were developed:
 - The 2ES6 series: an outdated design developed independently by Ural Locomotives, utilising features such as resistor starting for traction motors. The vehicle is designed for 3 kV DC. A total of 1,340 twin-unit vehicles (Bo'Bo'+Bo'Bo' axle arrangement) and 163 triple-unit vehicles ($3 \times \text{Bo'Bo'}$ axle arrangement) were produced. Production commenced in 2006, and as of late 2024, the vehicles were still being manufactured.
 - The 2ES10 "Granit" series (Fig. 3): this model incorporated numerous solutions provided by Siemens, including most of the electrical components, while the mechanical parts were adapted from the 2ES6. The 2ES10 series was manufactured between 2010 and 2022, although production declined steadily from 2018–2019, with only two locomotives produced in 2022. A version of the 2ES10 was also offered to UZ⁷. However, the crisis in Russian-Ukrainian relations from March 2014 (the forcible annexation of Crimea by Russia) resulted in the three vehicles delivered to UZ being returned to the manufacturer, as the contract was terminated by the Ukrainian side. In total, 181 2ES10 locomotives and 60 3ES10 vehicles were produced. Four units were delivered to the operator Apatit from the October Railway, while the remainder were supplied to RZD. Currently, following the imposition of sanctions on Russia, the primary operational challenge for both series is the insufficient availability of Western spare parts. The 2ES8 and 3ES8 "Malakhit" (Fig. 4) versions, which utilise Russian-made components and subassemblies, were developed, with five units built in 2022, but serial production has not been launched.
 - The 2ES7 series (Fig. 5): a 25 kV 50 Hz variant of the 2ES10, produced as a prototype in 2013 and in serial production between 2019 and 2022. A total of 35 vehicles were manufactured, of which 22 were purchased by the Kazakh operator SilkwayTransit and 13 by RZD.



Fig. 3. 2ES10-139 (3 kV DC) during the Expo 1520 trade fair at the VNIIZHT experimental ring in Shcherbinka, near Moscow (31/08/2017) [photo: Self-photographed / Wikimedia Commons]



Fig. 4. 3ES8-001 (3 kV DC) during trials at the VNIIZHT experimental ring in Shcherbinka, near Moscow (09/04/2022) [photo: VadimZD / Wikimedia Commons]

⁷ UZ – Ukrzaliznytsia (Ukrainian: Укрзалізниця): Ukrainian Railways.



Fig. 5. 2ES7-001 (25 kV 50 Hz) during trials at the East Siberian Railway of RZD (10/10/2016) [photo: Ural Locomotives]

- The Lastochka multiple unit was designed jointly by Siemens and Ural Locomotives. Based on the Desiro construction platform, a dual-system version (3 kV DC, 25 kV 50 Hz) known as the Desiro RUS was developed. These vehicles were manufactured in Germany, while a single-system version (3 kV DC) was initially produced in Russia, followed later by a dual-system variant (Fig. 6). The units are adapted for commuter and regional services, with the number of cars ranging from 4 to 12 (initially 5). From 2013, and early 2025, a total of 325 units were manufactured (Table 2); these are operated in the European part of Russia, including services to Belarus, such as the Moscow–Minsk route (approximately 750 km). In March 2024, a scandal emerged when it was revealed that the Russian side had infringed upon Siemens' patent rights by producing the Finist multiple units. These featured only minor modifications

to the electrical and mechanical components and the styling of the vehicle body (Fig. 7) [5].



Fig. 6. ES2G-042 (3 kV DC) at Svetlogorsk station, Kaliningrad Oblast (2 June 2018) [photo: Ural Locomotives]



Fig. 7. Ural Locomotives. Fig. 7 ES104-017 (3 kV DC) at the Yekaterinburg-Passazhirsky locomotive depot (24 March 2024) [photo: Maximus091182 / Wikimedia Commons]

Table 2

Summary of production for the Lastochka and Finist multiple units

Series	Production years	Number of units	Number of cars per unit	Voltage	Manufacturer	Notes
ES1	2011–2014	54	5	3 kV DC, 25 kV 50 Hz	Siemens	entirely manufactured in Germany
ES2G	2014–2022	165	5 / 6 / 7 / 8 / 10	3 kV DC	Siemens, Ural Locomotives	–
ES2GP	2016, 2018–2019	17	5	3 kV DC	Siemens, Ural Locomotives	–
ES1P	2018–023	47	5 / 10	3 kV DC, 25 kV 50 Hz	Siemens, Ural Locomotives	–
ES104	2023	39	4–12	3 kV DC	Ural Locomotives	–
ES105	2024	3	4–12	3 kV DC, 25 kV 50 Hz	Ural Locomotives	Siemens' patent rights infringed

[Author's own compilation based on Transmashholding data].

- Siemens is also the manufacturer of the Sapsan trains (EWS 1 / EWS 2 series, or Velaro RUS), which are adapted for operation on 1,520 mm gauge tracks with a maximum speed of 250 km/h and are used on the Moscow – St Petersburg route (650 km, 3 h 45 min). Between 2007 and 2022, 25+4 units were acquired in single- or dual-system versions. Production was carried out entirely in Germany. Siemens finally withdrew from Russia in 2022, after 170 years of presence [8].
4. Stadler: In 2013, the Swiss manufacturer opened a plant in the town of Fanipol near Minsk (24 km from the Belarusian capital), where vehicles for 1,520 mm gauge are produced (multiple units, passenger carriages, metro trains, and trams) for both the domestic market and export. However, following the Russian invasion of Ukraine in February 2022 and the imposition of further economic sanctions on Russia (and Belarus), vehicle production is being progressively phased out and relocated to Poland (the Siedlce plant). BC has purchased Flirt units for commuter services in Minsk, as well as for regional and long-distance⁸ routes, and modern metro trains were acquired for the underground railway in the Belarusian capital. Export production includes KISS 3 kV DC units in 4- and 6-car versions for the operator Aeroexpress (serving Moscow's civilian airports: Sheremetyevo, Vnukovo, and Domodedovo). Since the exchange rate of the Russian rouble fell against the US dollar and the euro during the fulfilment of the order (a consequence of Western sanctions imposed on Russia following the forcible annexation of Crimea), only a portion of the manufactured units was delivered; the remainder were offered by the manufacturer to the railways of Georgia and Azerbaijan.

3. Modernised vehicles and modern indigenous designs

Modernised vehicles are also manufactured in Russia, i.e. while retaining the mechanical or electrical components, the produced vehicles have received new interiors (in the case of multiple units) and control systems, often featuring modified external styling for both locomotives and multiple units. For example:

1. The Kolomna Works has been producing the EP2K series electric locomotives (Co'Co', 3 kV DC)

since 2008, with the prototype developed in 2006. These locomotives were developed based on the TEP70BS diesel locomotive, from which the mechanical components were adapted, and in cooperation with NEVZ, which supplies the electrical equipment along with the Kaluga Works (Fig. 8). A total of 507 EP2K series vehicles have already been built (as of February 2025). Notably, this locomotive utilises an outdated resistor starting system for its traction motors. The EP2K series replaces the ageing CS2, dating back to the 1950s, and is simultaneously the first 3 kV DC passenger locomotive entirely designed and manufactured in Russia (previously, similar vehicles were supplied by Škoda) [8].



Fig. 8. EP2K-239 (3 kV DC) with a passenger train on the Bykovo – Ramenskoye section, Moscow (27/04/2017) [photo: LevM_34 / Wikimedia Commons]

2. The Ivolga EG2Tv/EGE2Tv series multiple units produced by the Tver Carriage Works: the prototypes were built in 2014 and 2015 respectively, differing in, among other things, their maximum speed (120 / 160 km/h), while the series-produced vehicles have been in operation since 2017 in the Moscow and October Railway (four subseries of the aforementioned units have been developed: 1.0, 2.0, 3.0, and 4.0) (Fig. 9). As of February 2025, 41 and 47 units of the EG2Tv and EGE2Tv series (3 kV DC), respectively, have been manufactured. These are relatively modern vehicles equipped with asynchronous motors; initially, these were the TME 46-32-4 models from Traktionssysteme Austria (TSA), followed by units manufactured under licence by RVR in Riga (designated as 1DTA.002 U1). In 2019, the Pskov Electrical Machine Build-

⁸ RZD offered Lastochka units, but BC was not interested in them as they are not strictly low-floor vehicles, which was a requirement specified by BC.

ing Plant developed the DATE-1U1 electric traction motor, which was subsequently installed in the Ivolga units during serial production. The traction motors are powered by main converters (BORD-LINE CC1500 DC 3kV U 2000 037 A02) designed by ABB and manufactured by RVR in Riga. Starting from 2016, in subsequent vehicles (to reduce the purchase price), analogous domestically produced equipment supplied by NEVZ and designed by LLC TMH Engineering in cooperation with GK KSK was installed. As the quality of these devices was likely unsatisfactory, PSN-200-U1 units from the domestic firm GAMEN were eventually procured. These units incorporate components such as diodes manufactured by Mitsubishi, Semikron, and Infineon.



Fig. 9. Ivolga multiple unit, series EG2Tv-028 (3 kV DC) at Odintsovo station, Moscow (24/11/2019) [Press service of the Moscow authorities / Wikimedia Commons]

3. The EP2D and EP2DM multiple units have been manufactured by DMZ (Russian: Demikhovskiy Mashinostroitelny Zavod) since 2016 and 2023 respectively, with 223 and 14 units produced. The number of cars per unit varies from 2 to 12 for the EP2D, and 4, 6, or 8–11 for the EP2DM. Both series are a development of the ED4M design, featuring DC motors and resistor starting. The vehicles are adapted for operation on lines electrified at 3 kV DC, and are currently operated by RZD on the Moscow, October, Sverdlovsk, West Siberian, Northern, and Kuybyshev Railways, as well as in Crimea, occupied since March 2014, and also for the Armenian railways (RZD is a major shareholder in the Armenian railways). De facto, this is a modified variant of the ER2 electric multiple units produced (until 1991 for SZD) by RVR in Riga during the Soviet era. The production of both series remains uninterrupted, primarily because their manufacture does not require the advanced technologies that are currently difficult for Russian firms to acquire. A distinct 25 kV 50 Hz series was also developed – utilising solutions from the ER9 or ED9E (manufacturers: RVR or DMZ), the EP3D series units were designed, in which, similarly to the EP2D and EP2DM, the electrical and mechanical components remained largely unchanged. A total of 127 units have been manufactured and are operated by RZD in the North Caucasian, Volga, Far Eastern, Krasnoyarsk, Gorky, South Eastern, and West Siberian directorates. A number of these units were also produced for export to the railways of Kazakhstan and Uzbekistan. The manufacturer has also designed a variant of the DP2D series adapted to be hauled by a diesel locomotive as a push-pull train. To date, this series has remained solely in the prototype phase (no decision has been made to commence serial production).
4. The Novocherkassk plant produces both direct current (DC) and alternating current (AC) freight locomotives, as well as AC passenger locomotives. In addition to the vehicles manufactured in cooperation with Alstom, designs are also being produced that utilise technical solutions from vehicles developed during the Soviet era. The 2ES5K, ES5K, 3ES5K, and 4ES5K, as well as the 2ES5S, 2ES5S, and 2EL5 series locomotives (the first digit indicates the number of units) are adapted for operation on lines electrified at 25 kV 50 Hz (Fig. 10), with a total of 2,183 vehicles (5,911 units) having been built (Table 3). The ES5K family still utilises outdated technical solutions derived from the VL80 series, whereas the 2ES5S and 3ES5S series (Fig. 11) feature newly implemented solutions. These include pulse-controlled starting of domestically produced three-phase traction motors (so-called import substitution production). The 2ES4K, 3ES4K, and 2EL4 locomotive family is the equivalent of the 2ES5K family, intended for operation on lines electrified at 3 kV DC (Fig. 12). In total, between 2008 and 2022, 230 vehicles (with the prototype built in 2006), or 539 sections, were produced. The EP1, EP1M, and EP1P series (Fig. 13) for 25 kV 50 Hz, used for passenger services, were designed based on the VL85 / VL65, or EP1 dating back to the 1980s. These are not modern designs; however, the chronic shortage of rolling stock at RZD and the high purchase price of new vehicles (with three-phase motors) have led the operator to acquire vehicles that, although cheaper to purchase, are more expensive to maintain – though the latter factor is not a problem for RZD. Admittedly, modern locomotives are being developed based on domestic technical solutions, but their production does not exceed

a few units (i.e. the prototype stage). Examples include the 2ES5S and 3ES5S series, or the EMKA2 (Fig. 14), which is an electric shunting locomotive (3 kV DC) manufactured in 2023 (two units were

built), equipped with batteries allowing it to run light without power from the overhead line for approximately 100 km, or with a 2,000-tonne train for a distance of 14 km [13].



Fig. 10. 4ES5K-004 (25 kV 50 Hz) during the Expo 1520 trade fair at the VNIIZHT experimental ring in Shcherbinka, near Moscow (31/08/2017) [photo: Self-photographed / Wikimedia Commons]



Fig. 11. 2ES5S-001 (25 kV 50 Hz) at the Bryansk Machine-Building Plant during a presentation (26/06/2018) [photo: Transmashholding / Wikimedia Commons]

Table 3

List of series-produced locomotives manufactured by NEVZ between 2004 and 2023, utilising domestic technical solutions

Series	Voltage	Number of vehicles	Production years	Axle arrangement	Service type	Notes
E5K	25 kV 50 Hz	32	2007–2009	Bo'Bo'	freight service	–
2ES5K		588	2004–	2 × Bo'Bo'		–
3ES5K		1484	2007–	3 × Bo'Bo'		–
4ES5K		55	2014–	4 × Bo'Bo'		–
2ES5S		4	2018	2 × Bo'Bo'		new domestically produced technical solutions were implemented (three-phase motors and main converters)
3ES5S		2	2018	3 × Bo'Bo'		production in cooperation with LTZ from Luhansk, vehicles for UZ
2EL5		18	2005–2011	2 × Bo'Bo'		–
2ES4K	3 kV DC	148	2008–2011 2017–2018	2 × Bo'Bo'	freight service	–
3ES4K		78	2014–2020	3 × Bo'Bo'		–
2EL4		4	2009–2011	2 × Bo'Bo'		production in cooperation with LTZ from Luhansk, vehicles for UZ
EP1	25 kV 50 Hz	381	1998–2007	Bo'Bo'Bo'	passenger service	–
EP1M		455	2006–	Bo'Bo'Bo'		shared numbering with EP1
EP1P		74	2007–2010	Bo'Bo'Bo'		–

[Author's own compilation based on Transmashholding data].



Fig. 12. 2ES4K-001 (3 kV DC) (2005 r.) [photo: Transmashholding / Wikimedia Commons]



Fig. 13. EP1M-754 (25 kV 50 Hz) with an Adler – Moscow long-distance train at Rostov-on-Don station (06/09/2013) [photo: W. Anochin]



Fig. 14. EMKA2-002 (3 kV DC) at Kazansky Station, Moscow (01/11/2024) [photo: from the author's collection]

4. Diesel locomotives

Since the 1960s, the manufacturer of diesel locomotives for passenger services has been the Kolomna Works, where the TEP60 series vehicles were pro-

duced (1,241 units were built between 1960 and 1987), and later also the TEP70. After 2000, modernised versions were developed, such as the TEP70BS (Fig. 15) and TEP70U, which were also intended for passenger services, alongside the twin-unit 2TE70, although production of the latter series did not exceed a dozen or so vehicles (Table 4). In other words, it was not possible to easily convert a passenger diesel locomotive into a freight one, as they are designed under different assumptions (e.g. higher speed at the expense of tractive effort, and a lower axle load, which impacts the bogie design). The primary differences between the TEP70 and TEP70BS include a new vehicle control system, the capability for electric heating of the carriages, and a smoother styling of the body, which incorporated plastic components in its construction. The diesel engine remained virtually unchanged, with only slight modifications made to the electric traction motors. The TEP70BS locomotives are operated on railway networks in Russia (330 vehicles), Belarus (26 vehicles), Lithuania (4 locomotives; until 2023), Turkmenistan (1 unit), and Uzbekistan (10 vehicles). The bodyshell and driver's cab from the TEP70BS (following modifications) were used in the EP2K series electric locomotives.



Fig. 15. TEP70BS-113 of the BC at Vilnius station (14/08/2010) [photo: M. Graff]

Table 4

Summary of production for the TEP70 diesel locomotive family*

Series	Production years	Number of vehicles	Service type
TEP70	1973–2006	576	passenger service
TEP70BS	2002, 2006–	367	
TEP70U	2006–2007	26	
2TE70	2004, 2006–2007	12	freight service
Total	–	981	–

* as of the end of 2024.

[Author's own compilation based on Transmashholding data].

During the Soviet era, the primary manufacturer of diesel locomotives for freight services was the plant in Luhansk, in present-day Ukraine. As the central Ukrainian authorities refused to sell the plant to Russian entities (attempts were also made to produce vehicles jointly, but this ended in failure, resulting in a small number of 2TE116U series locomotives being built), a decision was made in Russia to commence the production of mainline locomotives at the factory in Bryansk. This plant specialised in the manufacture of shunting locomotives, the roots of which dated back to the Second World War, when the Soviet Union received economic (civil-military) aid under the *Lend-Lease* programme, which included the transfer of medium-power diesel locomotives⁹. After 2000, the twin-unit 2TE25K series locomotive (Fig. 16) was designed, equipped with DC traction motors (the letter K in the series designation stands for commutator [motor]). A variant designated as 2TE25A, equipped with asynchronous motors, was also developed. However, vehicles with DC motors continue to dominate over those with AC motors among the vehicles ordered by RZD (a ratio of 17:1) (Table 5). The quality of the manufactured vehicles, design flaws, and inadequate maintenance facilities remain a separate issue (electric traction motors are particularly problematic), as reported in an official letter [7]. However, according to RZD, there is currently no alternative to the 2TE25 vehicle family. In 2023, production commenced on the 2TE28 series locomotives equipped with the domestic D49 diesel engine, type 18-9DGM, designed and manufactured by the Kolomna factory, since the import of GEVO12 engines from the USA was halted as a sanction for Russia's armed aggression against Ukraine.



Fig. 16. 2TE25K^M-0207 at Likhaya station, Rostov-on-Don region (12/02/2018) [photo: mashinist23 / Wikimedia Commons]

Table 5

Summary of production for the 2TE25 and 2TE28 diesel freight locomotive families*

Series	Production years	Number of vehicles	Notes
2TE25K	2005–2009	15	equipped with DC electric traction motors
2TE25K ^M	2014–	753	
2TE25K ^{2M}	2020	1	
3TE25K ^{2M}	2017–	139	
2TE25K ^{3M}	2019	1	
3TE25K ^{3M}	2019	1	–
3TE28	2023–	56	variant of the 2TE25K, equipped with domestically produced diesel engines
Total	–	966	–
2TE25A	2006–2016	55	equipped with three-phase electric traction motors
2TE25A ^M	2016	3	
Total	–	58	–

* as of the end of 2024.

[Author's own compilation based on Transmashholding data].

5. Passenger carriages and freight wagons

For passenger carriages and freight wagons, no major declines in production have been recorded since 2022. The manufacture of passenger carriages is carried out by the factory in Tver, which for several decades has been supplying passenger carriages, initially for SZD and currently for RZD, as well as for export to, among others, KTZ, MTZ, and LDZ¹⁰. Production fully meets domestic needs; however, during the Soviet era, carriages were imported from East Germany, from the factories in Bautzen and Görlitz, in order to ensure transport links between the USSR and Western Europe (this was due to the narrower loading gauge used in Europe, or on railway networks with a 1,435 mm track gauge). These were Y-type WLABm series carriages ordered from 1959, and in the early 1990s, Z-type WLABmee series carriages (approximately 90 carriages). The last order involved the delivery of 200 Z-type

⁹ Examples include the TEM1 and TEM2 series, which were developed based on the DA series, manufactured by ALCO (American Locomotive Company) and designated as the RS-1 and RS-2 series for US operators.

¹⁰ KTZ – Qazaqstan Temір Joly (Kaz. Қазақстан темір жолы) – Kazakhstan Railways; MTZ – Mongolyn Төмөр Зам (Mong. Монголын төмөр зам) – Mongolian Railways; LDZ – Latvijas dzelzceļš – Latvian Railways.

WLABmz series carriages, which were manufactured in cooperation with Siemens, partly in Russia (the TVZ plant in Tver) (Fig. 17). This was a novelty (the contract was signed in 2009, with deliveries taking place between 2012 and 2013). Additionally, double-decker carriages were also developed, which were entirely designed and manufactured in Russia (also by TVZ) and have been operated by RZD since 2013 on the most heavily used routes (Fig. 18). The introduction of economic sanctions in 2014 (moderate) and 2022 (severe) did not fundamentally affect the production process, as advanced equipment or components, such as axle drives and converters (main and auxiliary), are not required, unlike in the production of locomotives or multiple units.



Fig. 17. An RZD WLABmz carriage in the formation of the Polonez long-distance train to Moscow at Warszawa Zachodnia station (01/09/2018) [photo: M. Graff]



Fig. 18. Double-decker carriages (with sleeping berths) in the formation of an Adler – Moscow long-distance train at Rostov-on-Don station (06/09/2013) [photo: V. Anochin]

The situation regarding freight wagons is more complex. Although their production is not complicated (open wagons, tank wagons, etc.), the problem lies in the roller bearings fitted in the bogies, which have largely been imported. An example supplier is the US company Amsted Rail, which has 40 plants worldwide

and had previously cooperated with a bearing factory in Saratov. In early April 2022, Amsted Rail decided to withdraw from Russia (from production at the Saratov plant and following the closure of its Moscow office) [15]. The American company supplied Metric Bearings: 130x230, 150x250, 130x250 for 1520 mm rolling stock [14]. OVK (Russian: Obyedinyonnaya Vagonnaya Kompaniya), a leading freight wagon manufacturer in Russia, which controls the Tikhvin Carriage Works [10], recorded a 40% decrease in revenue to 28.4 billion roubles (USD 415 million) in 2022, and a loss of 14.8 billion roubles (USD 216 million), compared to a loss of 6.1 billion roubles (USD 83 million) in 2021. Wagon production was halted because international sanctions reduced the availability of bearings [16]. Western-produced bearings were required for wagons with an axle load of 25 t, as the domestic industry in Russia lacked the appropriate technologies. In extreme cases, it is possible to fit Russian-produced bearings, but this automatically reduces the maximum axle load to a nominal 22 t, which consequently lowers the payload in each wagon, given a tare weight of 23 t, from 77 t to 65 t. Consequently, the gross train weight also decreases, meaning a larger number of wagons is required to transport an equivalent mass of cargo [18]. Although increasing the power of locomotives, especially electric ones, is not a problem in Russia, the track lengths at stations pose a limitation, which determines the maximum train length [12].

In 2022, Uralvagonzavod reduced the number of manufactured freight wagons in favour of military production (primarily T-80 tanks) by as much as 47.8% to 7,200, and the company's market share fell from 21.9% to 14.4% [4]. For comparison, the production level in 2021 was 13,800 units. Nationwide wagon production decreased by 20.4% to 50,200. For OVK, the reduction was as high as 53%, dropping to 8,200, whereas Altaivagon paradoxically increased production by 17.7% to 9,800 wagons. The capacity of Russian wagon manufacturers is estimated at 50–60 thousand freight wagons under wartime conditions, whereas prior to 2022, it fluctuated around 80 thousand. In total, 1.3 million freight wagons are operated on the RZD network (2023).

6. Analysis of the reasons for the decline in locomotive production in Russia

The decline in the production of passenger locomotives from the EP1 family began between 2012 and 2013 (Fig. 19), coinciding with the deterioration of the Russian economy. At that time, from several dozen locomotives (a record of approximately 100)

delivered to RZD, this level dropped to a few vehicles per year. In the case of freight locomotives from the ES5K family operated on lines electrified at 25 kV 50 Hz, the declines were not as drastic, although a reduction in 2023 compared to 2022 can be observed (Fig. 20). For locomotives from the 2ES4K family, the decline in production has been evident since 2014–2015 and has occurred over several years; thus, it can be termed a pattern (Fig. 21). The production of TEP70BS locomotives steadily decreased from 2014–2015, from a level of around 30 units to a dozen or so, and since 2020, to just a few vehicles per year, reaching a lower level than even during the crisis years of the 1990s. (Fig. 22). Initially, the first decline was caused by the economic crisis, exacerbated as a result of the sanctions imposed following the forcible annexation of Crimea, while the second – likely resulting from a combination of the SARS-Covid-19 pandemic compounded by the sanctions introduced after Russia's invasion of Ukraine (vehicle production has not returned to pre-2020 levels). The production of freight locomotives from the 2TE25K/A and 3TE28 families has remained at an unchanged level for several years – approximately 100 vehicles per year (Fig. 23). However, the decline in the number of manufactured EP2K series locomotives (Fig. 24), which is a vehicle of exclusively domestic production, demonstrates that the industry in Russia is dependent on imported components and subassemblies. The observed phenomenon of declining production is likely related to the depletion of stocks of previously purchased components and subassemblies, as well as attempts to acquire them through not entirely legal means (thus at higher prices; the aforementioned *grey imports*).

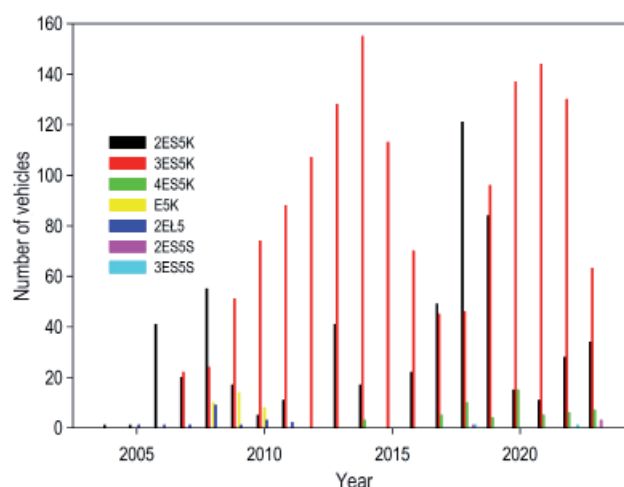


Fig. 20. Number of manufactured locomotives from the 2ES5K family [Author's own elaboration, based on Transmashholding data]

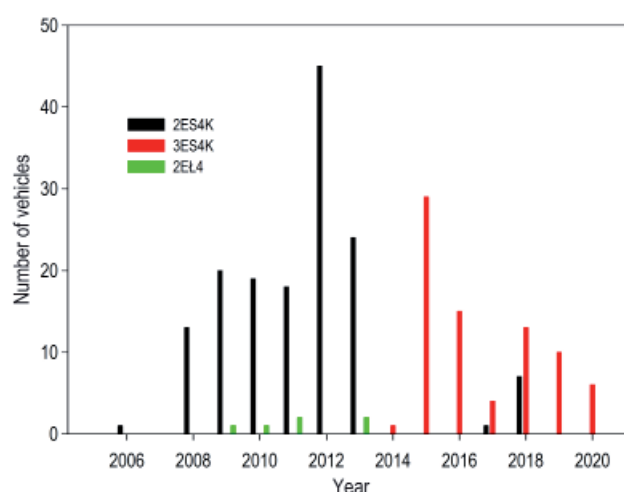


Fig. 21. Number of manufactured locomotives from the 2ES4K family [Author's own elaboration, based on Transmashholding data]

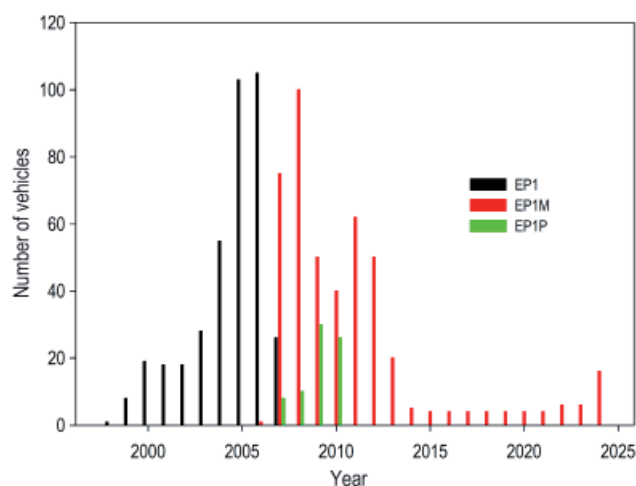


Fig. 19. Number of manufactured locomotives from the EP1 family [Author's own elaboration, based on Transmashholding data]

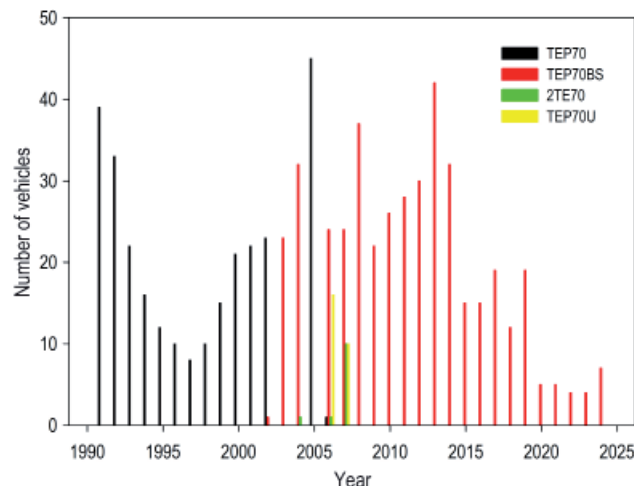


Fig. 22. Number of manufactured locomotives from the TEP70 family [Author's own elaboration, based on Transmashholding data]

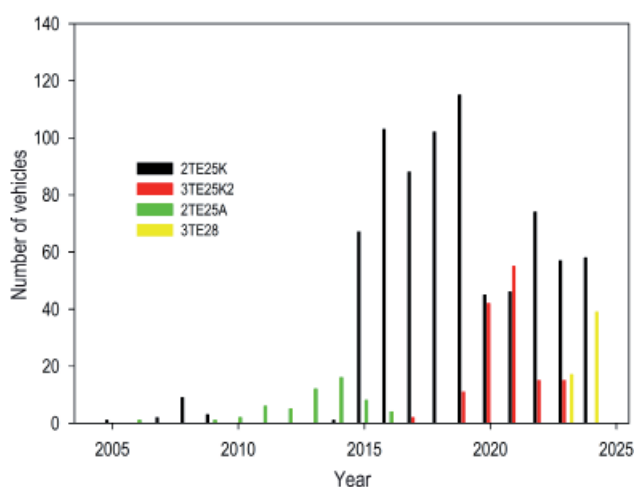


Fig. 23. Number of manufactured locomotives from the 2TE25K/A and 3TE28 families [Author's own elaboration, based on Transmashholding data]

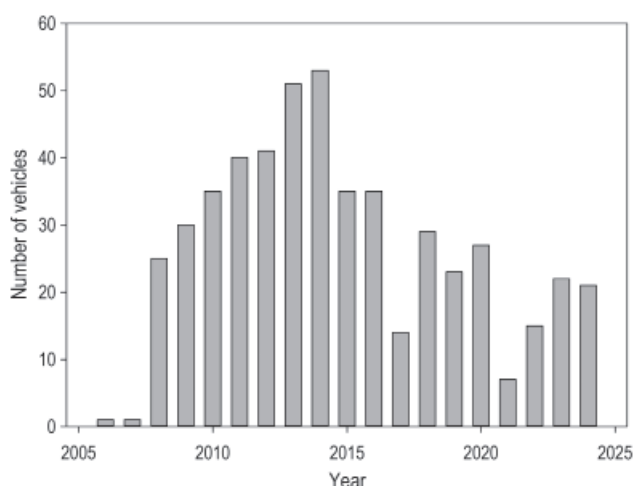


Fig. 24. Number of manufactured EP2K locomotives [Author's own elaboration, based on Transmashholding data]

7. Conclusions

The promising cooperation between RZD and Western companies after 2000 resulted in the emergence of modern rail vehicles in Russia and the slow but progressive modernisation of the railways in Russia. Thus, locomotives appeared, predominantly electric, single- or dual-system, as well as multiple units, which stood out positively against the existing RZD rolling stock. The production of a new generation of passenger carriages also commenced, enabling more comfortable journeys. However, the extreme dominance of politics over economics in Russia discouraged practically all Western rolling stock manufacturers, who decided to withdraw from the country after 2022. Although railways play a very important role in Russia in both passenger and freight transport (significantly greater than in Europe and North America),

the chances for modernisation, the progressive renewal of rolling stock, or increasing management efficiency have currently decreased significantly, furthermore without any realistic prospects for change in the short or medium term.

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