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# TMH vektor

MAGAZINE FOR PARTNERS

## ENERGY FOR PASSENGER TRAINS 4


TMH startup platform

Lean thinking

Bryansk diesel locomotives above the Arctic Circle

ТМН

# IN THIS ISSUE


Александр Астафьев / РИА «Новости»






TMH

Magazine
for Transmashholding
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< Kirill Lipa, CEO of TMH, and Alexander Beglov, Governor of St. Petersburg, at the ceremony of signing an agreement on the implementation of an investment project for the production of modern electric transport

# NEW OPPORTUNITIES

**TMH took part in the 25th anniversary St. Petersburg International Economic Forum. For the Holding, this event was full of business meetings, negotiations, and signing of documents which will enhance the effectiveness of new areas of business development.**

Kirill Lipa, CEO of TMH, and Alexander Beglov, Governor of St. Petersburg, signed a cooperation agreement on the implementation of the investment project "Development of the production plant in St. Petersburg for the production of modern electric vehicles." According to the agreement, Transmashholding will invest not less than 3 billion rubles in its own production facilities located in the Northern capital. The production site should boost the advancement of St. Petersburg electric transport system, industrial cooperation of the Holding with local suppliers of components and launch production of innovative products. At least a thousand new jobs will be created during the project implementation planned for 2022–2024.

Issues discussed in the interview with the Egyptian Minister of Industry and Trade Nevin Gamea included the expansion of TMH's footprint in the country and further maintenance of passenger cars built for the Egyptian National Railways under the largest contract in the history of Egyptian railway transport which was signed in September 2018.

A number of agreements offer new prospects for TMH and its partners. For example, the Holding and PTK Group intend to implement an import substitution program in the field of track engineering and shift completely to using domestic components by 2025. Plans are underway to create a joint research center on the basis of the world-class scientific and educational center Tulatech. The new research center will specialize in developing innovative designs of high-performance track technology for rail transport.

A memorandum was signed with KTZ — Freight Transportation LLP in order to develop partnerships and upgrade the locomotive fleet of the Kazakhstan railways.

A cooperation agreement was signed with Uralchem Group on renewing the traction rolling stock fleet with locomotives produced by TMH, as well as on the development and renovation of the railway infrastructure and implementation of management information systems with the use of computer vision and artificial intelligence technologies. Kirill Lipa announced the application of the most advanced digital technologies in the new locomotives that will be built for the Urals partner.

TMH CEO had a working meeting with the Head of the Republic of Mordovia Artem Zdunov during which a road map defining the areas of cooperation between the region and the company was signed. The document provides for the participation of the Saransk-based company Elektrovypryamitel in TMH's projects.

Kirill Lipa took part in a number of important discussions. At the business breakfast "Import Substitution Technologies: New Tactics in the Context of Sanctions" organized by the Chairman of Promsvyazbank PJSC Peter Fradkov, the Head of the Holding discussed the implementation of digital financial assets in the industry, raising the efficiency of working capital management considering significant logistics expenses specific for the Holding, and the implementation of the UN principles of sustainable development.

In the discussion "Transformation of Cooperation Chains: New Opportunities and Prospects," Kirill Lipa focused on the Holding's contribution to achieving by Russia of technological sovereignty. He cited as an example the Ivolga 3.0 electric train, in which "everything is of domestic manufacture – from the software to the wheels."

TMH's participation in SPIEF 2022 was eventful, and the negotiations and partnership agreements that were signed laid a solid foundation for further development.


^ Discussion of opportunities for cooperation and development of mutually advantageous relations in the present global circumstances has become a major focus at SPIEF 2022

## A NEW DOZEN

**The first in 2022 batch of 12 EP2D and EP3D electric trains produced by Demikhovo machine building plant (DMZ) was delivered to Russian Railways.**

The four-, six-, and eight-car trains will be operated by Krasnoyarsk, Far East, South-Eastern, East Siberian, and West Siberian Railways.

The new comfortable electric trains meet the requirements of the Technical Regulations of the Customs Union. The trains are equipped with comfortable benches made of wear-resistant materials with built-in USB connectors for charging mobile devices, safety systems (crash systems), video surveillance, air conditioning in the salons and vestibules, and information support. The trains are adapted for access to high and low platforms. The cars have a barrier-free environment.

Russian Railways has been purchasing EP3D since 2018 and EP2D since 2019, which run on 11 of 16 Russian railways.

Under the current contract, DMZ will produce a total of 40 electric trains: 23 EP2Ds and 17 EP3Ds.

## BRYANSK-MADE HEAVY WEIGHT

**The 2TE25KM mainline freight two-section diesel locomotive manufactured by the Bryansk Engineering Plant (BMZ) was put into operation at the Bachatsky open pit coal mine owned by Kuzbassrazrezugol.**

The 2TE25KM diesel locomotives are widely operated on the network of Russian Railways, UlaanBaatar Railways in Mongolia, by operator of the railway transport of Turkmenistan Demiryollary, independent transport operator BaltTransService, as well as at large industrial enterprises in Russia and the countries of near abroad – at SUEK-operated Tugnuisky open pit coal mine in Buryatia, Karelskiy Okatysh iron ore plant (Severstal), Nornickel, Shubarkol Komir and Kachary Ruda in Kazakhstan, and Navoi Mining and Metallurgical Plant in Uzbekistan.

"Our enterprise needs such a locomotive for production reasons," says Alexander Beregovoy, Director of the Bachatsky open pit coal mine. "The project on the construction of a technological complex for loading coal into rail cars with a production capacity of 2 Mtpa provides for upgrading and expanding the railway infrastructure of our branch.

Accordingly, there is a growing need for powerful modern equipment."

At the Bachatsky open pit coal mine, the 2TE25KM locomotive will haul trains consisting of up to 25 rail cars on the long sections with a complicated landscape terrain. The increased capacity and the ability to adjust the traction force on each axis allows the locomotive to drive heavy trains weighing 6,400 tons, which exceeds the capabilities of diesel locomotives of the similar series by 20 %. In the near future, another 2TE25KM will appear at the Kedrovsky open pit coal mine operated by Kuzbassrazrezugol.

Read about experience of Norilsk Nickel on operating the 2TE25KM on page 18.

## HIGH RATING

**RAEX Rating Agency (Expert RA) assigned Transmashholding an ESG-II(c) sustainability rating. The rating outlook is stable.**

According to the Agency's methodology, this is the fourth level out of twelve, and assignment of this rating means a very high level of observance of sustainable development concerns in making key decisions. In its report, Expert RA notes that TMH's production activities have a neutral impact on the environment, moderately positively estimates working conditions in the company, neutrally estimates the quality of strategic planning, and positively – the quality of risk management.

According to Agency estimates, the products manufactured by the Holding have a positive impact on society, providing citizens with access to basic infrastructure and expanding social and economic opportunities for people.

## LONG DISTANCE

**Total operating mileage of the TEP70BS passenger diesel locomotives exceeded 250 million km and that of the EP2K passenger electric locomotives – 600 mln km. Both models are produced by Kolomna Plant.**

Currently, there are 356 TEP70BS mainline diesel locomotives and 447 EP2K passenger DC electric locomotives in operation.

The first prototype of the TEP70BS was built and presented to the customer in 2002. This series of the locomotive was named after the Hero of Socialist Labor Boris Salambekov, one of the most respected leaders in the history of Russia's railways. Serial production of the TEP70BS diesel locomotives began in 2006.

Two diesel locomotives in the head of the train provide traction characteristics and power supply sufficient to drive passenger trains consisting of 20 double-decker cars. The diesel locomotive control system allows one crew of drivers to control two locomotives from the cab of the leading diesel locomotive. The diesel locomotives can be disassembled and used separately, if required. The two-wire system allows to provide power supply to passenger cars without using the track circuit as a return wire. The TEP70BS passenger diesel locomotives operate on the Oktyabrskaya, Far Eastern, South Eastern, Sverdlovsk, Volga, South Urals, Gorky, North Caucasus Railways of Russia, as well as on the mainline railways of Lithuania, Belarus, Turkmenistan and Uzbekistan.

The EP2K was created in 2005. The first deliveries began in 2008, to the Barabinsk depot. The locomotive was intended to replace Czechoslovakian electric locomotives of the ChS2 and ChS2T series that were reaching the end of their service life. Over the years of operation, the EP2K has earned a reputation as one of the best and most reliable locomotives on the Russian Railways network. In 2013, by decision of the Russian Railways management, the distance of the EP2K between overhauls was increased from the initial 600 to 800 thousand km.

The locomotive is equipped with an automatic train operation system and the Russian Global Orbital Navigation Satellite System (GLONASS). For the first time, the EP2K design featured blocks of starting and braking resistors with fan motors powered by resistors instead of the mains, which reduced the locomotive's energy consumption for its own needs. The original special design of the bogie ensures smoother running and less impact on the railroad tracks. The electric locomotives run on the West Siberian, Oktyabrskaya, Moscow and Kuibyshev Railways.

## ACCEPTED!

**The newest Russian DC electric train EGE2Tv Ivolga 3.0 produced by TVZ has received a certificate of compliance with the EAEC technical regulations.**

This certificate allows to start serial production. The initial preproduction series (GOST 15.902) will consist of 35 eleven-car trains.

The Ivolga 3.0 electric train is created by Russian designers and based on domestic components. For the first time in the TMH practice, an asynchronous traction drive developed by the Holding was used in the design of an electric train. The EGE2Tv is the first electric train with a design speed of 160 km/h, which is completely designed and manufactured in Russia.

The Ivolga 3.0 train can be adapted to different configurations from 4 to 12 rail cars, and also is able to operate on a system of many units which ensures efficient operation of the train on the routes with passenger traffic of different intensity. The technical solutions used in the design of the electric train ensure smooth running and a low noise level.

## REPAID IN FULL

**In April 2022, TMH redeemed the third bond issue of the PBO-03 series in the amount of 5 billion rubles.**

Six coupons of the issue were paid on time and in full twice a year. A total of 214.4 million rubles was paid on each coupon. Thus, investors received 1.3 billion rubles over three years of circulation. The issue was placed at the Moscow Stock Exchange in April 2019 at 8.6 % p.a. Bonds of this issue with a nominal value of 1,000 rubles were bought by 23 investors.

Three more issues of securities with maturity in 2023, 2024 and 2026 remain in circulation under TMH's exchange bond program.


# Power supplied!

**The power plant car designed by Transmashholding can be widely used in Russia and all over the area 1520.**

## COLLECTIVE WORK

Transmashholding is constantly generating ideas and introducing new products to the market. In the last five years alone, more than 7 billion rubles have been spent on R&D. Transmashholding carries out research and engineering on its own initiative, and its developments enjoy demand. A unique for Russia company, TMH Engineering owned by Transmashholding is responsible for the engineering of new equipment and is capableof creating modern rail vehicles of any class.

Tver Carriage Works (TVZ) initiated the creation of the power plant car that is intended to provide electric power to passenger trains. Specialists of the Design Bureau "Passenger Transport" of the TMH Engineering division in Tver, which became the project supervisor, developed technical requirements for a new car under TVZ instructions. The main developer of the design documentation is the Central Design Bureau of Transport Engineering (CCB TM), which is also based at TVZ. The documentation was developed on the basis of the existing Tver paired cars of the model 61-4517 (61-4516). TMH Engineering specialists provided support at all stages of development and production of a prototype of the new product.

Using a power plant car as a part of the train guarantees that the train will be supplied with electric power at any time of the year, and this is especially important in conditions of frost on non-electrified sections of railroads.

The power plant car created at TMH can be used in any country where the railway infrastructure is based on the Russian gauge of 1520 mm.

The average power consumption of one passenger car with a centralized power supply system is about 55 kW for a single-decker car and 65 kW for a double-decker car, and the power required for the whole train is quite significant. The model 61-4551 power plant car generates 1,350 kW, which is sufficient to supply electric power, including for heating, for up to 23 single-deckers or 15 double-deckers.

The electric power is supplied via a 3000 V two-wire high-voltage line, which is responsible for power supply on non-electrified sections of railroads. This solution eliminates the need to use coal or any other dirty fuel.

This is a truly innovative product. Until now, a power plant car with similar characteristics has never been produced anywhere else. The existing competitive equivalent products have a capacity of up to 900 kW, i.e. virtually 1.5 times less, moreover, it is limited by the redundancy requirement, so the actual capacity is only 700 kW. Also, there are trains which are supplied with electricity via a 380 V line, but they are composed of fewer cars.

## WHAT'S INSIDE?

Inside the power plant car there is an operator's room with a control panel, a zone of high-voltage static converters and a machine compartment.

Two main components of the car are responsible for the electric power supply of the train.

The first component is a three-unit diesel power plant KAMSS-1875-1D-52 with a nominal capacity of 1,365 kW developed by KAMSS-Service. The diesel power plant is based on one of the most advanced, environmentally friendly and reliable engines in the world and includes three stand-alone, interconnected 450 kW diesel-electric installations. Each diesel-electric installation can operate as an independent power source, or in parallel in any combination.

v Machine compartment of the power plant car

**SERGEY PLATONOV,**
*expert at Design Bureau "Passenger Transport" of the TMH Engineering division in Tver, power plant car project supervisor:*

COMMENT

The idea to develop our own power plant car was born in 2013, after Tver Carriage Works produced the first double-decker cars, but it had not come to fruition at the time. We periodically returned to this issue at different levels, including at Russian Railways. Finally, we have implemented the long-awaited project. First, we thoroughly examined foreign experience, and we found out that no one in the world produces such powerful power plant cars. In Europe, for example, there is simply no such need because the average passenger train configuration is much smaller than in Russia. So we have created a really exclusive product.

### MODEL 61-4551 POWER PLANT

Structure clearance – 1VM, for antenna and other equipment – 1TA

Length – 25.5 m

Width – 3.1 m

Base – 17 m

Weight of the equipped car – 72 t

Maximum static axle load – 18 t

Autonomous run time – 50 hours

The diesel power plant includes:
- a double-circuit cooling system for each diesel-electric installation;
- a ventilation system of the ceiling embedded design which is a structural part of the car body, located in the machine compartment;
- a system of additional filtration of the air entering the engine and the machine compartment;
- a control system located in two zones: in the machine compartment – implemented as control panels for controlling diesel-electric installations, in the operator's room – implemented as remote control consoles.

The second component is a high-voltage static voltage converter which converts electric power generated by the diesel power plant. The converter includes three power transducers of 450 kW each.

**HOW IT ALL WORKS**

A power plant car does not require maintenance personnel to stay in it all the time. One operator is sufficient for the operational control mode which is specified by the regulations of the operating company.

The control system itself estimates the power required for consumption. Firstly, the train can include different numbers of cars, and secondly, in summer the train needs about 40 % less power than in winter, because air conditioning consumes less energy than heating. Depending on the traffic and operating time of each diesel-electric installation, they start or stop in the automatic mode. In the manual mode, the diesel power plants are operated in the order and volume specified by the operator.

To ensure the operation of the diesel-electric installation, there is a main diesel fuel tank with a capacity of 4,200 liters located under the car, and a supply tank with a capacity of 600 liters inside the car. Such amount is sufficient for 14 hours at the maximum power output of 1,350 kW. Fuel is pumped from the main tank to the supply tank automatically by two redundant pumps.

All equipment, including the diesel-electric installations and converters can be also controlled from the control panel. All information about performance of the traffic safety functions is transmitted to the control panel: temperature control in the service rooms,


**ARTEM OVELYAN,**
*General Director at Tver Carriage Works:*

COMMENT

The need for power plant cars that supply electric power to the rolling stock on the non-electrified sections of railroads arises from the fact that current cars are becoming more and more complicated, both in terms of design, the range of connected options and the amount of services provided to passengers, which is why they consume more and more energy.

For Tver Carriage Works which specializes in manufacturing a full range of locomotive-hauled cars – single- and double-decker cars, the construction of the power plant car has become not just an initiative development, but also capturing of an absolutely new line of business, mastering of a new competence. In terms of capacity, there are no equivalents of our power plant car in Russia: for the first time ever, three diesel generator sets are used in one car, their operation is regulated depending on the load at a certain period of time. Its high capacity allows to serve up to 15 double-decker cars simultaneously. The use of the power plant car can significantly expand the geographic spread of modern cars, including double-decker cars, on the routes with non-electrified sections.

## THE POWER PLANT CAR DOES NOT REQUIRE MAINTENANCE PERSONNEL TO STAY IN IT ALL THE TIME

**SERGEY KHOMYAKOV,**
*General Director at KAMSS and KAMSS-Service:*

COMMENT

A power plant car project is the first experience of cooperation of KAMSS-Service and TMH. Working as a team, we have achieved our goals and certainly gained invaluable experience.

Our specialists provided full technical support at the stages of installation of the diesel power plant, performing connections in the car, start-up and commissioning, and all types of tests. Repair and maintenance services would be provided all over Russia, from the Far East to the North-West. All divisions have spare parts warehouses and turnover stock to ensure minimum downtime during maintenance.

^ Zone of high-voltage static converters

> The operator's room is equipped with air conditioning, heating and disinfection systems. Two operators can temporarily stay in the room

**ALEXEY POTERYANSKY,**
*Chief Designer at Mys JSC:*

COMMENT

Multicyclone filters used in the TMH power plant car are designed to capture dust from the air supplied to the power plant and the ventilation systems of traction electric machines and units. The filter demonstrates versatility and a wide scope of applications. Its main advantages include minimum power loss compared to other air filtration devices and ease of operation as it does not require constant maintenance, and the need for replacement or maintenance of consumables is minimized.

This is not the first project with TMH. We have more than 10 years of experience of joint work over the projects related to ventilation and air cleaning in the systems of diesel and electric locomotives, as well as design and supply of the interiors and exteriors of driver's control cabins, control panels, modular cabins for shunting and mainline locomotives. Our experience with TMH has been very productive. We look forward to our further cooperation and participation in the development of new interesting projects.

CAPACITY OF THE POWER PLANT CAR IS

**1,350 kW,**

WHICH IS SUFFICIENT TO SUPPLY ELECTRIC POWER TO 23 SINGLE-DECKER OR 15 DOUBLE-DECKER CARS.

lighting control including signal lights, fire alarm and fire extinguishing system. The car is equipped with an aerosol gas fire-extinguishing system which can reliably suppress fire in the machine compartment. The operator's room is equipped with air conditioning, heating and disinfection systems. Two operators can temporarily stay in the room: a large seat can be transformed into a table and two seats.

The power plant car is equipped with bolsterless model 61-4095 bogies with disc brakes. The same are used in double-decker passenger cars. The car is equipped with an anti-skid protection system which minimizes wheel abrasion.

**WHERE SHALL WE GO?**

The prototype has passed the full cycle of preliminary, acceptance and certification tests. Tver Carriage Works has received a certificate of compliance with the requirements of the Technical Regulations of the Eurasian Economic Union entitling to start serial production in 2022–2027. The power plant car is now planned to be transferred to the network of Russian railroads for trial operation.

"This basic model can be modified to solve different tasks," says Sergey Platonov, the project supervisor. "For example, we are currently considering the possibility to upgrade the car to supply 380V 50Hz electric power.

This will allow to use the power plant car as a part of mobile medical centers, or "wheeled hospitals", that are very much needed by people living in the remote Russian regions. Medical diagnostic units can be connected to the power plant car. In any case, we already have both development experience and test results of the finished product. It's always easier to modify something than to create a new product from scratch."

There are a lot of non-electrified sections of railroads for which the power plant car is designed, especially in Kazakhstan and India. There are also many of them in central Russia, for example, on the way to Arkhangelsk.

The power plant car can be widely used in tourist trains. They make many stops during which they cannot supply themselves with electric power, and the power plant car would save from this problem. V

**EVGENY ULYANOV,**
*General Director at Multifunctional Converters and Systems:*

COMMENT

Our company was established in 2015. TMH is not our only customer, but it is the main customer of our products. We have been supplying converter equipment for TVZ since 2017. By the time of the start of the project, we have already gained extensive experience in developing converters for single- and double-decker passenger cars, only with much lower capacity.

A high-voltage static voltage converter for the TMH power plant car is unparalleled. What makes the converter unique is a combination of high power and minimum weight of the product, which is very important for rail transport. To achieve the compact size of the converter and create a reliable product, we have made a lot of research and applied innovative technical solutions. We are particularly proud of high reliability of the converter: it has nine independently operating channels, and if one of them fails, it will in no way not lead to the failure of the entire system. The equipment passed certification tests in five test centers to obtain the Customs Union certificate.

We felt very comfortable working with representatives of TMH and Design Bureau "Passenger Transport", who directly participated in the discussion of the new converter selected as the most suitable for supplying electric power to passenger cars. The mutually beneficial cooperation allows us to keep our engineering center busy with new tasks and projects, and creates new jobs for the residents of Domodedovo where our company is located, and therefore it stimulates industrial development in the Moscow Oblast.


v The power plant car can be used for power supply of double-decker cars


# On the rails **of new ideas**

**Developers from all over Russia have proposed innovative solutions for the Moscow Metro. The implementation of the best ideas will make the capital's metro trains even more reliable, efficient and comfortable.**

### THE UNION OF INNOVATORS AND THE INDUSTRY LEADER

In 2021, TMH launched the New Vision startup platform – an accelerator of innovative solutions for the metro and urban rail transport. Such format of selecting and supporting innovations is widespread all over the world and covers a wide range of industries – from IT to sciences and agriculture.

TMH needs to have its own startup platform due to growing consumer expectations.

Transmashholding is the leader among manufacturers of railway and urban rail transport in Russia and the CIS countries, but like any leader, it needs new breakthrough ideas and a fresh look. The main task of the TMH accelerator is the search and implementation of promising projects for the benefit of developers, manufacturers, operating and maintenance organizations, and end users.

The Skolkovo Foundation, which has been successfully operating technological startups for more than 10 years, has become a co-organizer and operator of the platform. At the same time, the launch of New Vision has become a new experience for both the Foundation and TMH. This is Russia's first accelerator in the field of transport engineering.

In April 2022, the results of the first cycle of the accelerator program were summed up. The accelerator was aimed to find ideas for perspective metro trains.

The platform received more than 200 applications. They include products ready for implementation, as well as perspective projects at various stages – from idea development to a prototype. Dozens of specialists, design engineers, and designers of TMH and the Holding's enterprises examined the applications. Along with them, business experts from the Skolkovo Foundation and dedicated institutes gave an independent assessment. As a result, the solutions which better meet the criteria of novelty, competitiveness, potential, stage of readiness and team were selected. The selected 18 finalists personally presented their ideas at the demo day. TMH will continue to work with them to further implement the best projects.

### A TOTAL OF 29 TOPICS WERE ANNOUNCED, GROUPED INTO SIX CATEGORIES:

- DRIVER AND PASSENGER SAFETY AND COMFORT
- INFORMATION TECHNOLOGIES IN THE TRAIN CONTROL
- EFFECTIVE DESIGN AND MATERIALS FOR METRO CARS
- NEW SERVICES FOR PASSENGERS
- TRAIN'S ENERGY EFFICIENCY
- NEW SOLUTIONS FOR OPERATION, MAINTENANCE AND REPAIR

**VITALY VAKULISHIN,** *Project Supervisor at the TMH Center for Advanced Technologies:*

COMMENT

TMH continues to work with all finalists. We have defined the requirements to the characteristics of innovative solutions for their successful integration into the Holding's products, and the plans for interaction with the best startups. Such approach will allow us to add a technological effect to the development of rail transport in order to implement ideas for the largest customer – the Moscow government.

**NUMBERS**

THE FIRST CYCLE OF THE TMH ACCELERATOR

**29** TOPICS

**6** CATEGORIES

OVER **200** APPLICATIONS

**18** FINALISTS

### ENERGY EFFICIENCY ON TRAINS

Two companies presented the braking energy regeneration technologies based on the process of storing energy in supercapacitor units that are installed on the rolling stock.

"The ERC system reduces the peak power consumption of the train from the traction network, the amount of heat emissions from braking resistors and ensures partly autonomous operation," says Sergey Ageyev, General Director of TEEMP. "The supercapacitors produced by our company use environmentally-friendly electrolyte based on propylene carbonate in order to meet passenger safety requirements."

Another development features a predictive analysis system which monitors the condition of the energy storage units without the need to take the rolling stock out of service and predicts the time of their replacement. "The use of supercapacitor storage units reduces energy consumption and the carbon footprint of power generation sources," says Vladimir Vorozheikin, General Director of TPS. "In addition, this ensures the stability of the power grid and traction substations, and improves reliability of the rolling stock performance. Failure of the traction equipment can be prevented because supercapacitors can reduce spikes in the network."

Another interesting proposal is the use of electric drives with permanent magnets. According to Alexander Tishin, General Director of AmperMagnet, this will allow to achieve the highest efficiency and reduce operator's costs. Such drives are smaller, lighter, generate less noise, and run smoother.

Kinetic presented a new solution for the metro traction system which will reduce

its weight and size while maintaining the cost and functionality of the traction system component.

This will allow to accommodate additional equipment on the rolling stock, including such for improving passenger comfort.

## NEW IN OPERATION

Pilot tests of solutions for surface treatment with protective coating compositions and dry ice cleaning of the equipment have been planned at Metrowagonmash-Service.

Protective coating compositions can be used in cold winters and in the event of escalation of the epidemiological situation. "De-icers form a stable protective and separation layer on the surface, protect against corrosion, and prevent snow and ice buildup for a long period of time.

The composition is safe for the undercarriage equipment and effective for up to 180 days," Abdurashid Vokhidov, General Director of ASPM, comments. "Unlike other counterparts, the disinfectant not only destroys viruses and bacteria but also forms a bacteriostatic film on the surface, which provides additional protection for 14 days and cannot be washed off by water."

Dry ice surface cleaning has already shown good results earlier, but now the Russian developer has patented a blasting crusher which allows to use larger pellets instead of standard 3 mm pellets. They do not stick together and evaporate more slowly, which saves dry ice and improves cleaning efficiency. "This technology can replace current abrasive cleaning, which damages surfaces and generates dust in the shop," says Artur Gimadeev, General Director of Irbistech. "Dry ice evaporates immediately after the process is completed, does not damage surfaces, and additionally removes grease. You can also replace manual cleaning with blasting: dry ice cleans difficult surfaces gently, quickly and effectively. All this will allow to optimize labor costs, reduce service time, and improve service quality."

## STRUCTURES AND MATERIALS

Finalists in two areas "Structures and Materials" and "Comfort and Safety" participate in the creation of the model of the car interior elements with the use of the presented technologies at the National Center for Industrial Design and Innovations "2050.LAB".

Aluminium honeycomb panels, a finishing material offering excellent resilience and toughness on the basis of honeycomb core with individual specifications, attracted special attention. "The material can be used both as a decorative and construction material," emphasizes Alexander Okshin, Sales Manager at PVK Forus-Prom. "The honeycomb structure makes the panels light yet rigid. These characteristics, including low combustibility, make the product really innovative, surpassing many traditional finishing materials."

High-quality insulation materials that help prevent condensation on board and reduce heat loss inside the car in the winter and prevent heat ingress in the summer, provide fire protection and soundproofing also seem to be perspective. "The insulation materials known today solve narrow tasks, but cannot address the problems of heat insulation, fire protection, prevention of metal corrosion, noise absorption and vibration damping," says Alexander Shevtsov, General Director of Intechenergo. "We have developed a new type of composite coating that addresses these issues.

**ALEXANDER NIKITENKO,** *Head of the Service Development Unit at the TMH Urban Rail Transport Department:*

COMMENT

The accelerator is a good opportunity for TMH to find innovative and tailored solutions to address relevant issues, and for developers – to assert themselves and propose their technologies for mass implementation. The ideas of dry ice blasting and application of thin-layer anti-icing coating merit our attention and consideration. For example, the Filevskaya line of the Moscow Metro is facing a severe problem of ice and snow build-up. We have already planned to conduct pilot tests of the proposed solutions. In the future, we will be reaching out for the initiatives received by the startup platform.


^ One of the proposals is a driver's cabin access control system

< New protective compounds can be used for cold winters and in the event of public health hazards

**ROMAN MIRONOV,** *Head of the Technical Unit at the TMH Urban Rail Transport Development Department:*

COMMENT

Improving the energy efficiency of electric trains is one of the main areas of the metro rolling stock development. Modern electric trains are equipped with many electronic systems and electrical equipment. Traction motors are more powerful than the motors of cars of old series. Also, new energy-consuming equipment has appeared. Although the asynchronous traction drive has a high efficiency, we still have to address the challenge of reducing the load on the overhead network and traction substations. However, upgrading in terms of increasing the metro's power capacity, especially the sections of old lines, may be constrained. Another task is to ensure autonomous train operation without power supplied from the overhead network. This task becomes complicated due to the specific operating conditions in the metro: for example, the size of trains and extremely high pace of operation. The proposed solutions can help partly solve these issues.

It has one base and several layers. Each of them has different fillers that provide the necessary properties. The overall thickness of the coating for a metro car is 4 mm only. This insulation has better characteristics compared to other counterparts."

Another innovative material is low-combustible fiberglass plastic (duroplastic). The developer also offers a technology for its cost-efficient production. "Duroplastic surpasses many fiberglass plastics in its characteristics," says Vladimir Alpatov, Deputy General Director at Rosizolita. "The material is perfect for electrical insulation and can be used as a structural material. Our technology allows to make molded, high-precision, 3D products of desired color, shape and characteristics according to the customer's needs. For example, increased physical and mechanical properties are required in cases where there is vibration or risks of impact. Improved electric insulation properties are important, for example, for boxes where electrical equipment is located. Both advantages can be combined in one material."

## COMFORT AND SAFETY

The world is already familiar with electronic ink, but a software and hardware system of the Russian developer allowed to create e-paper displays that are easily built-in, cost-effective and durable. “The use of such displays is an innovative and environmentally-friendly approach to displaying information on urban transport,” says Denis Drozdov, General Director of Energy Efficient Technologies. “With this technology, the rolling stock manufacturer can easily implement non-volatile solutions, and the operating organization – conveniently and timely change information messages on the train, saving operating costs and electricity. The environmentally-friendly technology does not affect users’ eyesight and ensures timely information.”

Another finalist is the developer and manufacturer of electrofunctional glass. “One smart glass with variable transparency is designed for privacy management and space zoning. Privacy smart glass can change from clear to a frosted appearance at the flick of a switch,” says Yulia Adrianova, Head of the Development Unit at Privat Glass.

“Another smart glass is designed to protect against direct sunlight or bright light. It has a smooth dimming function – from completely clear to saturated blue, while maintaining complete visibility. Our double-glazed windows can block a significant portion of infrared and ultraviolet rays at the touch of a button. The products are moisture-resistant and can be used in conditions of precipitation and washed in the depot.”


^ TMH is constantly improving the information display systems on the train

< Developers propose multifunctional smart glass that may be used in the metro

Digital solutions based on facial recognition technology that can be used for verification of employees without physical media have high relevance. “This will contribute to increased safety on urban transport,” says Mikhail Kozlov, Commercial Director at OVISION. “The system for controlling access to the driver’s cab is convenient, reliable, the identification speed is less than a second, and there is integration with analytics. During the train movement, the system checks whether the driver is at the workplace and records his condition. Our other proposals include a face recognition and analysis system that can be used for pictures and video, a corporate employee movement system and a time and attendance system.”

## WHAT’S NEXT?

The initiators of the startup platform are satisfied with the first results and expect that the ideas received will be added to the production cycle of TMH, will be in demand, and the Holding’s products will get new unique characteristics.

Project participants also point out a positive effect. For the developers, this is an opportunity to find a major investor and implement their technologies on an industrial scale.

It is equally important that in the process of competitive selection the innovators can better understand the demands of the market and develop in the most promising areas.

“Participation made the most positive impression,” says Vladimir Alpatov. “It was great to experience the atmosphere of advanced technologies, feel the demand for new ideas and projects on the part of a major technology company. It made us realize that we are heading in the right direction. The organizers of the accelerator and the experts helped us with preparations and responded to all our requests.”

The same kind of assessment was given by Vladimir Vorozheikin: “The entire process was very well organized. Of course, the final was especially impressive which included a direct dialogue between the participants and TMH experts. Now the work continues outside the accelerator framework, which was the main objective of the event.

The idea of opening a startup platform was a complete success. It was decided that the selection of innovations will become regular and will take place every few years. Each new cycle will be dedicated to different areas of TMH’s activity. Next time, as expected, it will be locomotive engineering.

Radical changes in the organization of the process and the format of the program are not expected. Applications will be selected on the platform tmh.sk.ru. Please follow our updates!

**DENIS KARASEV,**
*General Director of the Center for Advanced Technologies, Transmashholding:*

COMMENT

The accelerator pilot project has been a success. We received innovative ideas, which is what it was all about. We also consider interesting solutions based on technologies already known in the world but adapted to the Russian realities.

It is no less important that by launching such a platform, TMH positioned itself on the global market as a major seeker of innovations. This fact has stirred up the start-up community, and I hope that many companies have thought about developments for railway rolling stock or upgrading the existing technologies to meet the Holding’s needs because demand creates supply.

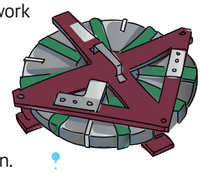
v By 2023, the portion of modern trains in the Moscow Metro will exceed 80 %

# KEY COMPONENT

**For the first time in TMH practice, the newest electric train Ivolga 3.0 design features a set of traction and auxiliary equipment of domestic manufacture.**

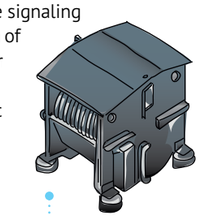
### RADIO INTERFERENCE SUPPRESSION CHOKE

It is designed to limit the interference effect of alternating components of electric current supplied from the high-voltage overhead network via a current collector (pantograph collector) on radio communication.



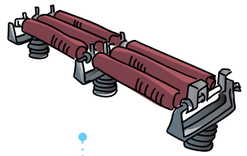
### INPUT CHOKE DV-35M

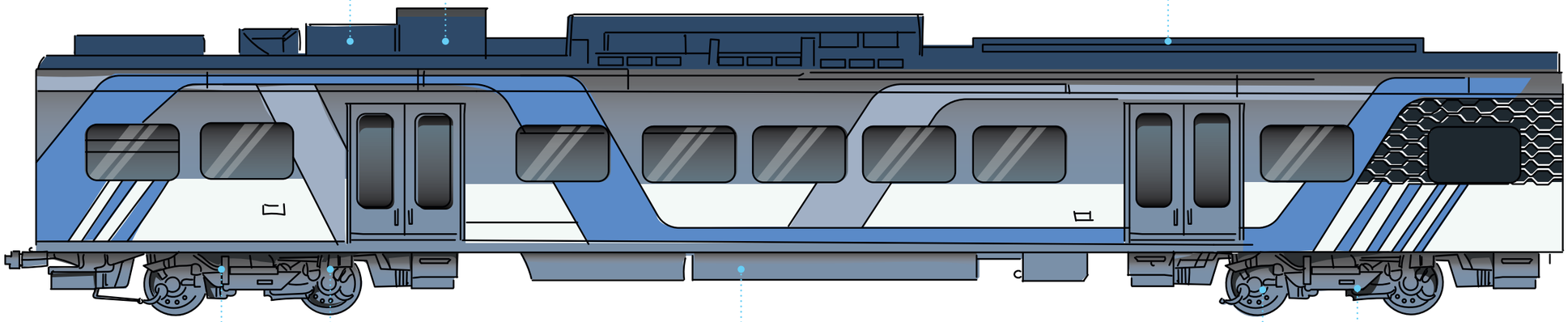
It is designed to limit the influence of traction currents and their harmonics on the rail circuits of signaling arrangements and automatic locomotive signaling and ensure operation of the traction converter in all traction and regenerative dynamic braking modes.

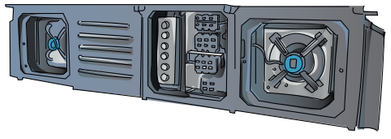


### BRAKING RESISTORS

These are designed to dampen the energy which a motor generates during deceleration and dissipate it in the form of heat. On the Ivolga 3.0 train, they have a ceiling embedded design.

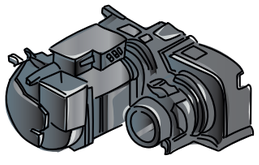






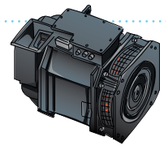
### TRACTION CONVERTER PST-1200

The core of the whole system, it provides control and power to four asynchronous traction motors DTA-380U1. It is developed by TMH Engineering. It has forced air cooling and outperforms the imported converter in terms of weight and dimensions which was previously installed on the EG2Tv electric trains.



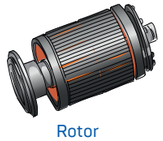
### MOTOR-GEAR UNIT

It ensures the train movement through the conversion of electric energy supplied from the overhead network into mechanical energy, thereby developing the torque at the motor shaft, which, in its turn, ensures the rotation of the car axle through the coupling and gear. The motor-gear unit includes an asynchronous traction motor DTA-380U1 with air forced cooling.



Motor assembly

Stator



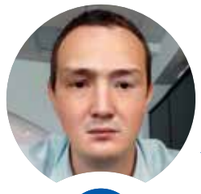
Rotor

**ALEXANDER GULTYAEV,**
*Chief Designer at TMH Engineering, Design Bureau "Urban Transport":*

COMMENT

A traction drive system was originally designed as a single unit and it helped achieve high traction-energy performance. The traction drive is installed on the motor car. The Ivolga 3.0 electric train contains 5 motor cars. In the generator mode, the drive provides joint regenerative and rheostatic braking by converting mechanical energy reduced to the shaft from the rotation of the wheelsets into electrical energy which could be returned to the overhead network.

The traction drive developed by TMH Engineering showed outstanding energy efficiency. According to the test results, the traction drive consumes less than half the power specified in the technical specification.



**EVGENY MARCHENKO,**
*Head of the Electric Machines Unit of the Technology Support and Development Department at TMH-Energy Solutions:*

COMMENT

Asynchronous traction motors for metro cars and MU rolling stock have been in development since 2018 as part of the import substitution program. We started this work from scratch, using our long experience in developing asynchronous traction motors for locomotives. The result of the efforts made was an absolute success of the first DTA-380 series motor which ensures running of the Ivolga 3.0 electric train at a speed of 160 km/h and matches the leading world counterparts, both European and Japanese ones.

**OLEG GLAZKOV,**
*Director for New Equipment and Technical Development at KSC Drive Systems:*

COMMENT

A complete asynchronous traction drive system was assembled and delivered by the Electrical Engineering Division of KSC – a strategic partner of TMH in the development of components and systems for its rolling stock. The electrical equipment, control system and traction components are manufactured by KSC Drive Systems which with technical support from the developer has organized pilot production, built a test center and established serial production. And today, the company has provided the first eight Ivolga 3.0 trains in the 11-car configuration with equipment of its own manufacture.

In June 2022, the PST-1200 traction converter was certified as compliant with the Technical Regulations of the Customs Union.

Of course, PST-1200, like other high-tech equipment, includes imported electronic components, which are subject to international sanctions. However, the experience gained as a result of creating this unique converter (which, by the way, appeared to be more efficient than the world equivalents) is now being effectively used by TMH Engineering with the participation of KSC Drive Systems in the program of import substitution of components, and in the very near future we will see its new version made on the domestic element base.

Generally speaking about the strategic tasks of import substitution, especially in electronics, we are striving for and are already ensuring our technological sovereignty. On the other hand, we definitely need international cooperation to ensure and develop an exceptionally high level of competence.

# Northern service record

**TMH locomotives are operated almost in all climatic zones. This time, we will go to the Arctic Circle and look at the experience of operating Bryansk diesel locomotives on the railroad tracks of Norilsk Nickel, one of the world's northernmost industrial and technological centers.**

## TIME TESTED

Today, the fleet of the Technological Railway Transport Enterprise of the Norilsk Nickel Polar branch consists of 62 diesel locomotives – 16 mainline and 46 shunting locomotives. Of them, 21 locomotives were manufactured by the Bryansk Engineering Plant (BMZ) in various years.

Bryansk shunting locomotives have been operating in the Norilsk industrial region for decades and have performed well in the severe climatic conditions of the Far North. The newest 2TE25KM mainline diesel locomotives drive freight trains with ore, bulk, oil and other cargo on the Norilsk – Dudinka and Norilsk – Talnakh sections.

The TEM18DM shunting diesel locomotives perform shunting operations at the stations of the Technological Railway Transport Enterprise and loading/unloading dead-end sidings.

## FIRST-HAND

The 2TE25KM locomotive has increased traction effort at starting, which is especially important for northern latitudes because in snow drifts locomotives get stuck, slip and cannot move. The new model is more responsive in winter conditions.

The driver's cabins are equipped with a microclimate control system, a refrigerator, a microwave, a kettle, as well as a heated washbasin and an eco-friendly closed type toilet. All these details have significantly increased the level of comfort for locomotive crews compared to the earlier series of diesel locomotives.

Of course, the locomotive drivers know the advantages of the new equipment best. "I've been working as a driver for 10 years, I started on the 2TE116. If you compare it to the 2TE25KM, they are as different as day and night. It is a real technological breakthrough: it surpasses its predecessor both in traction characteristics and in operation.

The cabin is much better, more spacious, warmer and more beautiful. For rare, but still warm summers over here, the air conditioner is very much needed, and in winter which lasts here for most of the year – window heating," driver Sergey Grinko expresses his personal experience.

In his opinion, work has become easier. The 2TE25KM has automatic malfunction diagnostics. All malfunctions are immediately displayed in the driver's cabin. Earlier the driver had to go to the diesel compartment to control the main parameters. The "brains" of the locomotive fully control performance of the diesel generator set, cooling system, and other equipment," the driver says. "Unlike the 116 series, where everything had to be done almost manually, we have automation here – and that's great. Moreover, the productivity of the 2TE25KM is higher as there are no downtimes for visual inspections, which means that less time is required for a trip."


^ The 2TE25KM diesel locomotives surpass their predecessors both in traction characteristics and operation


< The TEM18DM diesel locomotives perform shunting operations at the stations of the Technological Rail Transport Enterprise

**THE 2TE25KM DIESEL LOCOMOTIVE HAS INCREASED TRACTION EFFORT AT START-ING, WHICH IS ESPECIALLY IMPORTANT FOR NORTHERN LATITUDES**

### NORNICKEL OPERATES 21 DIESEL LOCOMOTIVES PRODUCED BY BMZ

- 3 mainline diesel locomotives of the 2TE25KM series — 1 (2021), 2 (2022)
- 9 shunting diesel locomotives of the TEM18DM series — 4 (2000–2005), 3 (2012), 2 (2021)
- 9 shunting diesel locomotives of the TEM2UM series — 9 (1986–1995)

(before BMZ became a member of TMH)

Sergey Grinko also worked on the TEM18DM, and it was the first vehicle, under number 3346 that arrived at the Norilsk site. “Now we have new TEM18DM – 3356 and 3362. Though it is the same series, the same line, however, you see the difference between them,” he remarks. “The latter are much more comfortable: they are warmer, the noise insulation is better, and the number of computer-controlled parameters has increased. It’s obvious that production is continuously developing, and we, the users, see constant improvements.”

## EVERYTHING IS UNDER CONTROL

Full TO-3 maintenance is performed for each new locomotive arriving in Norilsk (connection of power cables of traction motors, sleeves of the support-returning devices, ventilation hoses for air-blown motors), the cover of the muffler and the protective guards from the air intakes of the main generator and electric machines are removed, and service liquids are filled in. The BMZ representative on site inspects a diesel generator set, locomotive underframe, fuel equipment, auxiliary mechanisms, checks oil and coolant levels in the diesel-generator set and in the compressor.

After starting the locomotive, there are additional checks of oil pressure, fuel pressure, charging air pressure, feed and brake mains pressure, coolant and oil temperature, correct operation of electrical equipment, interlocking systems and safety systems, as well as the direction of rotation of the traction motor.

The rolling stock is repaired by general contractor Norilsktransremont owned by Norilsknikelremont.

The Technological Railway Transport Enterprise is satisfied with the promptness and quality of works, but in the future maintenance of the 2TE25KM and TEM18DM diesel locomotives will be carried out by LokoTech-Promservice. This will further increase operational reliability of locomotives.

Currently, the roadmap of this project is undergoing approval procedures and the provision of maintenance is planned for January 2023. Service maintenance will be set up in Norilsk on the sites of the general contractor Technological Railway Transport Enterprise using local personnel. “For its part, LokoTech-Promservice will upgrade the existing production facilities in order to carry out all types of maintenance and current repairs in the amount of TR-2.

Also, a base of equipment for diesel locomotives, a stock of spare parts and materials for assembly replacement will be created in Norilsk. Large repairs of equipment as well as overhauls of diesel locomotives will be performed at specialized enterprises of LokoTech in other Russian regions.

**OLEG SAFIN,**
*Chief Engineer at the Technological Rail Transport Enterprise of the Norilsk Nickel Polar branch:*

COMMENT

The issue of customizing vehicles to meet customer requirements is probably an eternal, never-ending and very important process. We also have our own suggestions and wishes. For example, LED lighting installation, insulation of the machine compartment of the 2TE25KM body. Our operating conditions are extremely severe: frost down to -50 °C, strong winds and snowfalls.

The first locomotive of the new series was delivered in summer 2021. When winter started, we covered the air inlet from snow, insulated the lining: we covered the walls of the inner diesel room with mineral wool to prevent quick cooling of the locomotive at low temperatures.

It would be a good idea to install view cameras on TEM18DM diesel locomotives in addition to mirrors, as well as tool boxes, and to change the location of the water level sensor in the expansion tank.

We give all our ideas to the BMZ specialists when they visit us for adjustment and commissioning, or warranty service. They listen to our opinion and try to incorporate our suggestions.

“If it is a warranty case, we cannot fix something using our own resources,” explains Evgeny Minov, Deputy Head of the rolling stock repair shop at the Technological Rail Transport Enterprise. “We contact experts at BMZ, who advise us both remotely and on site when their personal presence is required. The main cyclic and running repairs are performed by NNH and NTR, our internal contractors.”

At the moment, the Technological Rail Transport Enterprise is operating 13 2TE116 diesel locomotives. Almost all mainline diesel locomotives underwent overhaul with the extension of their designated service life, however many locomotives are reaching the end of their extended service life. Overhaul of diesel locomotives is performed at specialized enterprises on the mainland. For this purpose, the locomotive is conserved and transported to the Krasnoyarsk river port (if shipped in summer – via the Yenisei River) or Arkhangelsk (in winter), and then the service companies deliver it to the place of repair.

v 2TE25KM is built with 90 % of Russian-made spare parts. In the photo, a motor at 3600 h.p.

The 2TE25KM is built with 90 % of Russian-made spare parts, so reliance on imports is very low. As for the existing imported components, there is a lot of work being done on the selection of Russian-made equivalents the use of which is discussed and agreed with BMZ.

“The chief mechanic service prepares a package of documents which is then sent to BMZ for approval. If operational tests and equipment test runs are required, we check and send these as well,” explains Evgeny Minov. Most importantly, the manufacturer meets the needs to address all matters and helps to find the best solution.

## FUTURE PLANS

Work on upgrading the fleet of diesel locomotives at the Technological Rail Transport Enterprise continues. In July-August 2022, seven more 2TE25KM mainline twin-section diesel locomotives are expected to be delivered. The investment program covers the period up to 2027. In the light of the positive experience on the operation of Bryansk diesel locomotives, Nornickel will further purchase rolling stock manufactured by TMH. V


v Sergey Grinko has been working as a driver on various locomotives for about 10 years, and he finds 2TE25KM as the most comfortable vehicle to drive

^ Seven more 2TE25KM diesel locomotives will be delivered by autumn

**EVGENY MINOV,**
*Deputy Head of the rolling stock repair shop at the Technological Rail Transport Enterprise:*

COMMENT

TEM18DM locomotives have been in operation for many years and have been fully serviced by us. The locomotives are good. We have no complaints. There are also no questions with regard to repairs. We know what pitfalls we may encounter during operation, and we are fully prepared for them.

As for the 2TE25KM locomotive, we are still studying it, if I may say so. This is a more interesting and much more powerful vehicle than 2TE116, it has a higher freight transportation rate. In a year or two, our repair facility will adapt to these locomotives as well. We’ll gain experience, gather and analyze statistics, and acquire everything we need.

# The focus is on **the client**

**Today, most companies operate in an extremely competitive market environment, in a market where customers demand high quality products and services, to be delivered on time, at a lowest possible price. TMH applies Lean Thinking principles that eventually have a positive impact on strengthening cooperation with partners and customers. I would like to share how a business can stay profitable and leverage its advantages in a highly competitive market.**

**VALOGI ALEKS SUHININ,**
*Managing Director, Quality and Reliability, at Transmashholding*

**A NEW FINANCIAL MODEL**

The answer lies with "waste" reduction, and taking a "Value Stream" approach in operating a business. The old financial model of "Profit + Cost = Selling Price" no longer works, the new financial model is "Selling Price - Cost = Profit", so a business must reduce cost through waste reduction and elimination in its Value Stream to be profitable and competitive.

A Lean Production System focuses on utilization of existing facilities, materials and labor as efficiently as possible. The ultimate goal is providing perfect value to the customer through a perfect creation process that has zero waste. This is done by empowering every employee to achieve their full potential so to make the greatest possible contribution to the company. Improved customer focus and productivity gains lead to leaner operations, which in turn help to expose further waste and quality problems in the system.

Value is what the customer wants and is willing to pay for. It includes product features, quality and delivery times, as well as service and attitude of the supplier to the customer. In simple terms, value is work that changes or transforms a product or service from its original state to a more valuable state. Waste is anything that does not add value to the product, but consumes resources. This should be eliminated as the customer is not willing to and must not pay for waste.

In any organization where there are manufacturing processes and supporting functions in offices, there are likely to be eight different types of wastes.

**1. Transportation**

Waste in transportation includes movement of people, tools, inventory, equipment, or products further than necessary. It can lead to an increased risk of damage, wear and tear of equipment, exhaustion of resources, and unnecessary work.

The countermeasures to this type of waste include creating continuous flow between processes, preventing over-producing work in progress, reducing inventory and stocks. Materials necessary for production must be easily accessible at the production location, and double handling of materials must be avoided.

**2. Inventory**

Waste results from the cost of maintaining too much inventory, work in progress, or finished goods. Over purchasing or poor forecasting and planning, a broken or poorly designed process link between manufacturing and purchasing can lead to inventory waste. It may cause greater lead time in the production process, an inefficient allocation of capital.

Here, implementation of standardized work principles in the form of defined minimums and maximums level of inventory, purchasing raw materials only when needed, reducing WIP, eliminating or narrowing the definition of "safety stock" will help reduce this type of waste.

**3. Motion**

The waste in motion includes any movement of people, equipment, or machinery which might be necessary but inefficient. For example, this waste may include reaching for materials, walking to get a tool, and readjusting a component after it has been installed.

**5 KEY PRINCIPLES of Lean Production:**

**1.** Specify what does and does not create value from the customer's perspective and not from the perspective of an individual organization, function and department.

**2.** Identify all the steps necessary to engineer (design), order components and materials, and assemble or produce the product across the whole value stream to highlight activities that do not add value and make waste.

**3.** Make those actions that create value flow without any interruption, detours, back-flows, waiting or scrap.

**4.** Only make what is required by the customer.

**5.** Strive for perfection by continually and consistently removing successive layers of waste as they are uncovered.

**A LEAN PRODUCTION SYSTEM FOCUSES ON UTILIZATION OF EXISTING FACILITIES, MATERIALS AND LABOR AS EFFICIENTLY AS POSSIBLE**

The unnecessary movements can be reduced by layout improvements, workflow improvements, ergonomically designed workplace or work station, a well-organized work place, i.e. 5S, when spare parts are located next to the workstation, and they do not have to be fetched.

**4. Waiting**

The waste of waiting includes waiting time for people, and waiting time for a machine to complete a cycle. Waiting time is often caused by unevenness in the production stations and can result in excess inventory and overproduction. In manufacturing, waiting waste includes waiting for materials to arrive, waiting for the proper instructions, waiting for releases and quality inspection, waiting for decisions to be made or approvals. In an office environment, waiting waste includes waiting for information or feedback from internal departments, ineffective meetings.

Countermeasures for waiting include designing processes to ensure continuous flow, leveling out the workload by using standardized work instructions, and training flexible multi-skilled workers.

**5. Overproduction**

Overproduction involves producing more products than demanded. Overproduction occurs when manufacturing a product or an element of the product before it is being asked for or required. It may be tempting to produce as many products as possible when there is idle workers or equipment time. However, rather than producing products just when they are needed under the 'Just in Time' philosophy, the 'Just in Case' way of working leads to a host of problems including preventing smooth flow of work, higher storage costs, hiding defects inside the WIP, requiring more capital expenditure to fund the production process, and excessive lead-time. Additionally, overproduction also leads to an increase in likelihood that the product or quantities of products produced are beyond the customer's requirements. In an office environment, overproduction includes creating reports no one reads, or holding meetings for the sake of having meetings that do not solve problems or add value to business.

There are three key countermeasures for overproduction. Firstly, using a 'Takt Time' ensures that the rate of manufacturing between stations is even. Secondly, reducing equipment setup times enables manufacturing small batches or a single-piece flow. Thirdly, using a pull or 'Kanban' system that controls the amount of WIP.

**6. Over-processing**

Over-processing refers to doing more work, adding more components, or having more steps in a product or service than what is required by the customer. For example, using a higher precision equipment than necessary, using components with capacities beyond what is required, running more analysis than needed, over-engineering a solution, and having more functionalities in a product than needed.

One simple way to counter over-processing is to understand customer's requirements. Always have a customer in mind before starting work, produce to the level of quality and expectation that the customer desires, and make only the quantities needed.

**7. Defects, errors and corrections**

When defects occur, the product is not fit for use. This typically results in either reworking or scrapping the product. Both results are wasteful as they add additional costs to the operations without delivering any value to the customer.

This type of waste is minimized and stopped by "do not accepting errors", "do not make errors", and "do not pass error to the next process." Firstly, look for the most frequent defect by using Pareto analysis and focus on it.

Secondly, design a process to detect and prevent abnormalities, and do not pass any defective items along the production process. Thirdly, redesign the process so that it does not lead to defects. Lastly, use standardized work to ensure a consistent manufacturing process that is free of defects.

v Each employee at their workstation is able to add value to the end product

**8. Skills and knowledge**

This is the waste of human potential. By not engaging the knowledge and expertise of the personnel, it is difficult to improve processes. This is due to the fact that the people doing the work are the ones who are most capable of identifying problems and developing solutions for them. In manufacturing, this waste can be seen when employees are poorly trained, when employees do not know how to effectively operate equipment, when employees are given the wrong tool for the job, and when employees are not challenged to come up with ideas to improve the work.

Obviously, it is necessary to develop and train personnel, as well as motivate employees to take initiatives to improve work processes.

**PLAN OF ACTION**

Being able to see wastes is always the first step. This is best done by going to Gemba where the work takes place, and talking with the workers. Observe the worker and steadily take away each and every bit of waste, continue doing that, engaging the worker in the process, until nothing is left except value-added work, until all the waste has been eliminated. To achieve this level of leanness, you will have to rely on your people.

The next step means developing personnel. As the lean saying goes, "Before we make a product, we make people." Most of all, respect means doing what we can to make things better for people.

Value Stream Mapping (VSM) is a Lean tool used to understand customers' needs and wishes. It is an effective tool for mapping out flows of information and material as they occur, as well as manufacturing or business processes involved, displaying the relationship between them in a clear visual manner. In addition, VSM allows to separate value-added, value-enabling and wasteful activities. VSM highlights where eight types of wastes are occurring in a process, it shows where the bottle necks of the process are in terms of "cycle time", "lead time" and "delay time", as well as points of inventory buildup.

In order to identify wastes, use the VSM and start with the end customer in mind. Work backwards from the end customer to the start of the production processes. By creating a value stream map, you can visualize how end-to-end operations work, track actual performance, improve cross-functional collaboration, improve end-product quality.

Once the wastes are identified through the value stream mapping process, an action plan must then be prepared to minimize or eliminate the wastes, so our customers receive high quality products and services, delivered to them on time, at a lowest possible price.

Value stream map, as a tool, gives teams and businesses an organization-wide perspective on how to improve the business activities, then develop a plan for eliminating or reducing waste. Engage with the frontline workers and elicit their ideas for improvement.

In conclusion, as our people begin to understand, identify and reduce eight types of waste through direct observation at Gemba, as well as value stream mapping process, they will gain more confidence in their problem-solving capabilities, so over time reducing waste becomes a part of their daily routine. This is the course TMH has embarked on. At the same time, the Holding helps its suppliers and partners apply a similar approach to synchronize their work and capitalize on the synergies which end consumers of our products will definitely feel. V

^ In manufacturing, everything must be in its place and accessible without unnecessary movements

# Leadership evolution

**On 18 May 2022, Metrowagonmash celebrated the 125th anniversary of its foundation. Over the years, metro cars have undergone several metamorphoses dictated by time, economic conditions of society development and, of course, technological evolution. But for Metrowagonmash, quality, reliability and safety have always come first. Also, beauty and comfort.**


< Motor car for the Moscow – Sabunchi railway (Azerbaijan), 1925

## HISTORICAL HERITAGE

In 1895 a hereditary honorary citizen Savva Mamontov, a nobleman Konstantin Artsybushev and a citizen of the North American United States, the temporary Moscow 1st guild merchant, engineer Alexander Barry presented to the Ministry of Finance of Russia a project called "Moscow Joint-Stock Company of the Carriage Works." In January 1896, the Committee of Ministers authorized the "establishment of the designated Company," and its Charter, as was then adopted, was approved by Nicholas II.

A new plant was opened in Mytishchi of the Moscow region in 1897. It was intended for the construction of rolling stock and the manufacture of spare parts. The first products of the plant were cars for the Northern Railway of Russia.

In 1903, production of tram cars and snow plows for Moscow began. During that period the Mytishchi plant ranked second among machine-building enterprises in the country in terms of production output. Before the beginning of the First World War, the plant took orders from the military department and began to manufacture field cars and platforms to transport military equipment.

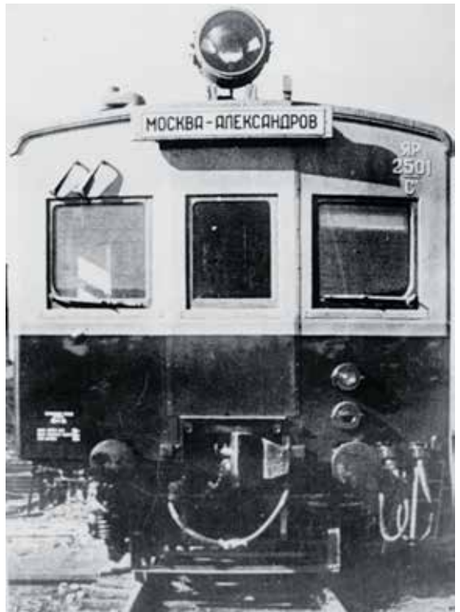
## NEW HORIZONS

Since July 1, 1920, the Mytishchi plant was included in the "strike group" of the largest enterprises in Moscow and the Moscow region, which were supposed to perform the most important work to restore the national economy and, above all, transport.

The plant's management tried to overcome the consequences of the civil war, solve supply problems, get the necessary tools and equipment.

In 1924, the Bureau of production and technical control were created. As a result of the measures taken, the output of the plant began to grow rapidly and in 1926 the plant gave about two standards of rates of production from the pre-war level.

1925 and 1926 were critical years for the plant. Since that time, its specialization as a carriage works manufacturer was restored, and the production of agricultural machinery decreased. The plant produced electric trains which were assigned the "C" index ("Northern type"). In 1926, plant designers Babin and Dvuhsherstnov developed the country's first 19-meter metal car based on the serial trams for the electrified railway Baku – Sabunchi – Surakhany.




> The first electrified car, 1025

In 1929, the Mytishchi carriage works produced the first electric passenger trains for the Moscow – Mytishchi railway.

## THE FIRST SOVIET METRO

The growth of the Soviet capital called for an urban metro system. On May 17, 1933 the plant's management issued an order to start work on metro cars.

The prototype of the first domestic metro car was an American model which was put into service in 1932. The design of the car for the Moscow Metro was developed at the Central Design Bureau of Car Building of the All-Union Association of Carriage and Brake Plants under the supervision of engineer P. Travin. The first metro car appeared in May 1933. Soon a commission from the Moscow Committee of the Party visited the plant and gave a number of valuable recommendations. In particular, as Travin later recalled, it was suggested to give the car a streamlined shape which would create a special beauty and help reduce air resistance. It was also emphasized that only the best cars in the world had to be designed for the Soviet metro.

The designers took the commission's advice into account and improved the design. The plant built the first 40 metro cars in January 1935. The metro cars manufactured at the Mytishchi plant for the first time in the practice of domestic railcar building were all-metal, welded structures. Cars of types "A" and "B" of 1934–1939 years of manufacture operated in the Moscow metro for almost 40 years.

## WORLD FAME

In 1956, production of the most famous "E" type cars started in Mytishchi. The cars of the basic model were manufactured in the 1960s. In 1973-1977, a new modification was developed – the "Ezh3" type car. It was used as the basis for export modifications – "Echs" and "Ev3" type cars intended for the Prague and Budapest metro.

In 1974, tests of the «I» type cars began, the body of which was made from aluminum alloys. This car was three tons lighter than the "E" type car, its interior was wider and accommodated 25–30 passengers more.

Development of the design and the launch of production of new models 81-717 and 81-714 metro cars became a glorious page in the history of the plant. Head cars (with control cabin) and intermediate cars (without cabins) appeared in this series, which allowed to increase the carrying capacity by 10 % and increase the traction motor rating. Export modifications were developed on the basis of these models.

In 1993, the plant switched to the production of the modernized model 81-717.5/81-714.5 metro cars. Modernization consisted in improving reliability and fire safety of the main units and systems. At the beginning of the 1990s, the plant mastered the production of new generation cars – models 81-718 and 81-719 with a thyristor-pulse traction DC electric drive. In 1993, the plant unveiled a new model of the Yauza metro car with an asynchronous traction drive.

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^ Model 81-717/714 metro cars

The production of the next generation, the Rusich trains, began in 2002, and its modifications were produced until 2013. After manufacturing several hundreds of the Rusich trains, serial production of the Oka trains began. For the first time in the Russian transport engineering practice, these trains were supplied under life-cycle contracts: the manufacturer took direct responsibility for the fleet performance for several decades.

In 2014, the 81-722/723/724 series Yubileyny train for the St. Petersburg Metro was created. For the first time, the trains featured intermediate non-motored cars in their configuration. To date, three modifications of this train have been created.

**NUMBERS**

METROWAGONMASH PRODUCTION CAPACITY –
**800**
**CARS PER YEAR**

**OVER**
**9,000**
**METRO CARS**
MANUFACTURED BY METROWAGONMASH ARE OPERATED IN 19 METROS IN 11 COUNTRIES AND
**CARRY MORE**
**16**
**MILLION PASSENGERS**
MORE THAN 16 MILLION PASSENGERS IN 19 METROS IN 11 COUNTRIES OF THE WORLD

## RAIL BUSES

In 1997, the plant commenced production of rail buses designed for passenger service on non-electrified sections of railroads. Before RA-1 appeared, Riga and Hungarian diesel trains, and Czech motrices were running on the railway lines through sparsely populated areas.

After the collapse of the USSR, there was a pressing need for import substitution of diesel transport.

In 1997, the Ministry of Railways held a tender to develop a rail bus model for non-electrified railroads, i.e. for those places without the overhead network, where electric trains could not run on their own. Metrowagonmash of the Moscow region won the right to build the railway novelty. The rail bus promoted the development


> RA-1 railbus for non-electrified sections of railroads

COMMENT

**ANDREY VASILIEV,**
*General Director at Metrowagonmash:*

Our metro cars are the most beautiful in the world, which was confirmed last year by the international Red Dot 2021 award for industrial design. The work of our team was recognized by the Russian Federation Government Quality Award. All this beauty, reliability, quality of the rolling stock do not come easy. They are achieved through our efforts to improve our equipment, modernize production sites, develop the production system by applying lean production tools and methods, make significant investments in the automation of production processes.

transport with the undercarriage arrangement of the engine and transmission.

The RA-1 model was developed on the basis of the Yauza metro car. Transverse dimension of the metro car was increased to the standards of a passenger car. This increased the number of seats from 62 to 80. Vestibules were located at both ends of the car which ensured combined exits to high and low platforms.

RA-1 operation showed that travel conditions for passengers improved, travel speed increased and fuel consumption dropped by almost four times. At the same time the operating costs decreased by 2.7 times. Later designs of the rail bus were improved with account of the operating experience. RA-1 modifications were supplied to Hungary and Czech Republic. In the mid-2000s, this rolling stock was developed as the RA-2 model: its modernized DP-S version was supplied to Serbia.

In 2019, Metrowagonmash put RA-3 Orlan rail buses into service. RA-3 service began on Sakhalin Island.

v 81-775/776/777 series Moskva-2020 metro cars

To date, more than 80 RA-3 Orlan trains have been delivered to Russian regions under the contracts with Russian Railways and the Central Suburban Passenger Company.

In 2005, Metrowagonmash became a part of Transmashholding. Such partnership guarantees increased financial stability of the enterprise, winning additional orders, emergence on the international scene, access to advanced technologies.

**MODERN CARS**

Over the past 20 years, Metrowagonmash has produced more than 6,500 metro cars.

In 2017, Moskva metro cars, which became the basic model for a whole line of metro trains, were put into serial production. In total, from 2017 to 2019, more than 1,500 cars of different Moskva modifications were supplied to the Moscow Metro.

> RA-2 railbus

The train variations intended for operation in other cities were designed. In 2018–2019, Metrowagonmash delivered 40 metro cars of the 81-765.4B/766.4B series to the Baku Metro. Afterwards, a new contract was signed for the manufacture and delivery of 60 more metro cars of this series in the period 2020–2023.

In 2019, metro cars of the 81-765.4/766.4/767.4 Moskva-2019 series were developed. They were supplied to metros in Moscow, Kazan and Tashkent.

In 2020, the next generation cars of the 81-775/776/777 Moskva-2020 series began operation in the Moscow Metro. In the period from 2020 to 2023, 1360 new metro cars will be delivered.

Metrowagonmash was also a pioneer in introducing service maintenance of metro cars under the life cycle contract, i.e. during the entire service life of the car. Branded maintenance ensures safety and comfort for passengers, and operation of the required number of trains on the line – for the metro.

Today, Metrowagonmash is one of the leading Russian enterprises operating in the field of transport engineering and specializing in the development and design of metro cars. V

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