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MAGAZINE FOR PARTNERS

CARS FOR SUNNY UZBEKISTAN

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Competence Center for Diesel Engineering

Ergonomics for Locomotive Crews

TMH

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TMH

Magazine for Transmashholding Affiliates

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^ New non-compartment car mockup presented at Transport Week – 2021

A CAPSULE FOR THE NIGHT

Transmashholding presented a non-compartment passenger car and its brand-new 'herringbone' interior layout at Transport Week 2021.

The presentation was attended by Andrey Belousov, Russia's First Deputy Prime Minister; Oleg Belozerov, CEO and Chairman of the Executive Board of Russian Railways; Kirill Lipa, TMH CEO and a member of the Bureau of the Russian Union of Machine Builders; and Alexander Loshmanov, Deputy CEO for Passenger Transport Development at TMH.

The herringbone concept is inspired by the special arrangement for the beds, which are positioned diagonally to the aisle. A private capsule and an open-space compartment are the two configurations presented in the mockup. The private capsule is separated from the corridor by a wall and a curtain and is designed for passengers who travel alone. The second option - open compartments - is designed for groups, including families with children. Each passenger has access to charging points, clothes hangers, wall pockets, and other features convenient during an overnight train journey. There are also additional luggage shelves beneath the ceiling of the car.

The design of the car was developed by "2050. LAB" National Center for Industrial Design and Innovation under instructions from TMH. This is the third version of the mockup, which offers alternative layouts for non-compartment passenger cars. They are all bound by a common principle of focusing on the individualization of space by offering a personal table, storage space for personal belongings, a lighting lamp, and an air duct. The mockups are made in T dimension offering an enlarged width and length compared with standard rolling stock. The length of the coach was increased by 290cm, the width of the car by 28cm, and beds by 15cm.

The new layout makes it possible to achieve conditions that will make train journeys safer and even more comfortable. The ergonomics of the prospective herringbone layouts were designed with an express night train concept in mind whereby trains travel for up to 12 hours overnight.

^ The new layout is intended to improve comfort for passengers

CONGRATULATIONS TO THE LAUREATE

Metrowagonmash, Russia's largest manufacturer of metro cars and rail buses, has secured an award for its achievements in product and service quality from the Russian government.

The company was recognized for its emphasis on safety and the implementation of highly effective methods of quality management. "It is very honorable for us to be the laureates of such a prestigious award," notes Andrey Vasiliev, CEO of Metrowagonmash. "We seek to provide our customers with products that are based on the most cutting-edge technical solutions and the latest developments."

Metrowagonmash has made significant progress in developing its production methods and improving quality indicators in all areas in recent years. The plant has organized production into five reference lines, purchased advanced equipment, and has been actively applying lean production tools and methods as well as optimizing processing stages.

The plant also won a quality prize from the government in 2019. And by reinforcing its effort to improve processes in all areas, the company became the laureate of the contest just two years later.

LET'S TRAVEL, LET'S EAT

TMH's new model 61-4525 double-deck restaurant car has been certified for operation on the railways of the Eurasian Economic Union encompassing Russia, Belarus, Kazakhstan, Kyrgyzstan and Armenia.

The new restaurant car is designed to operate in trains consisting of new model double-deck coaches and was developed based on a comprehensive analysis of the operating experience of its predecessor, the 61-4473 restaurant car, which manufactured by Tver Carriage Works (TVZ) in 2013.

The new restaurant car has an enhanced body which made it possible to offer increased space on the upper deck. The coach's pneumatic suspension system also offers a smoother ride. The lower deck accommodates a kitchen, a wash room, and a four-seat bar area while the upper deck includes a dining room with 36 seats. The car also has shelves for luggage and a rack for oversized items.

"The new restaurant car produced by TVZ is a new step in our coach building capabilities," emphasized Aleksey Moguchev, Technical Director at Tver Carriage Works. "It was created in close cooperation with the Federal Passenger Company (FPC) and takes into account a new passenger catering concept, which makes this restaurant car significantly different from its predecessors. We hope that customers and passengers will appreciate the innovations."

The new restaurant cars will be manufactured for FPC under a contract for the production of 3730 cars of different types signed in 2019. Deliveries will continue until 2025. The first restaurant car is planned to be handed over in the near future, and the launch of serial production is scheduled for 2022.

ALLIANCE OF INNOVATORS

TMH Alliance of Innovators joins the National ESG Alliance.

Top managers from Russia's largest industrial companies, including Kirill Lipa, CEO of Transmashholding and a member of the Bureau of the Russian Union of Machine Builders, have participated in a conference held to mark the establishment of the National ESG Alliance.

The alliance's objective is to promote the transition to a sustainable model of economic development that helps to preserve and protect the environment, the well-being of society and the long-term prosperity of business within the existing constraints of natural resources. The formation of the alliance is based on the shared interest, cooperation and partnership of all the parties involved.

"TMH is a leader in transport engineering and an innovator in the field of environmentally compatible transport," Lipa says. "We hope that participation in the alliance will make our work much more effective through synchronization of efforts of the largest and most responsible companies, participants of the established Alliance."

The idea of establishing an Alliance to bring together the leading companies in the field of ESG transition was discussed at the Eastern Economic Forum in Vladivostok in September 2021. Representatives from the leading Russian companies involved are supporting the proposal. The initial founders of the Alliance include 28 companies representing more than 18 sectors of the Russian economy.

A NEW RELATIONSHIP WITH SCIENTISTS

The TMH Center for Advanced Technologies and the Emperor Alexander I St Petersburg State Transport University (PGUPS) have signed a strategic cooperation agreement for research and development.

The parties intend to cooperate to address scientific and engineering problems and create breakthrough technologies. The agreement will be valid for five years.

"PGUPS is Russia's leading university engaged in the development of rolling stock, with its research helping to improve performance, reliability, and environmental compatibility," says Denis Karasev, General Director of the Center for Advanced Technologies at TMH. "One of the main tasks to accomplish in the near future is to increase the service life of a number of locomotive components."

NEW HORIZONS

Transmashholding shipped products to Turkmenistan for the first time.

In the autumn of 2020, Demirýollary the Turkmenistan's state-owned railway operator, purchased a TEP70BS passenger diesel locomotive and a 2TE25KM mainline freight diesel locomotive from TMH. Delivery of the new diesel locomotives to the Ashkhabad locomotive depot commenced at the end of September.

The TEP70BS diesel locomotive is manufactured at the plant in Kolomna and is designed to haul passenger trains on 1520mm-gauge mainlines. The current version features a two-line power supply, making it compatible with modern passenger coaches, particularly double-deck cars. The locomotive has an output of 2.942MW (4000hp) per section. The diesel locomotives are approved to transport passengers on the main lines of Russia, Lithuania, Belarus, and Uzbekistan.

The 2TE25KM produced at the Bryansk Engineering Plant is a mainline freight two-section diesel locomotive with an AC/DC electric transmission. The locomotive can haul trains of up to 6400 tons and has a proven record of reliable operation in various climatic conditions. The 2TE25KMs are widely used on railways in Russia and Mongolia, as well as at industrial sites in Russia, Kazakhstan, and Uzbekistan.

CARS FOR SUNNY UZBEKISTAN

Metrowagonmash (MWM) has been cooperating with Tashkent Metro, Central Asia's first metro network, for more than 40 years since it opened in 1977. Today, residents and visitors to the Uzbek capital have the opportunity to see and ride a variety of rolling stock dating from the early years of the network to the latest 81-765/766/767 series trains delivered by MWM from 2019.

Metrowagonmash delivered Ezh3 series cars for the opening of the initial nine-station section of the Tashkent metro Line 1 in 1977. Further extensions to the network resulted in an expansion of the fleet to include 81-717/714 series trains in 1980. Upgrades to the fleet occurred in 2001 with the delivery of 81-719/718 series fleets to coincide with the opening of the 10.5km Line 3. Currently, trains produced by TMH at the plant in Mytishchi constitute the main part of the Tashkent Metro fleet.

SUPPLIED IN FIVES

The 81-765/766/767 series trains in use in Tashkent are operated in various modifications in Moscow, Kazan, and Baku. Version 5 of the train was produced especially for Tashkent, and the first batch of five four-car trains was delivered in 2019. Each train consists of two lead power cars, one intermediate motorized car and one intermediate trailer. The trains have received positive feedback from both operating personnel and passengers. This was a crucial factor in the signing of a new contract in April 2021 to produce 10 further four-car trains.

MWM was tasked to fulfill its obligations to a high standard and in due time. In fact, the process took even less time than expected. The contract covered a calendar year. However, the first half of the order was shipped to Tashkent in the summer and the second half in October, completing delivery well ahead of schedule and with all product acceptance, startup and commissioning procedures successfully observed.

Consistent with rules regarding procurement, prior to the shipment of the trains, metro representatives visited the MWM plant to

^ The trains for Tashkent Metro are assembled at Metrowagonmash

< Doors are equipped with light indicators

GRIGORY ILYUKHIN,
Operations Director at Metrowagonmash:

COMMENT

TMH is one of the world's largest developers and manufacturers of rolling stock. All of the company's enterprises, and Metrowagonmash is no exception, remain at the cutting edge of transport technology and consistently apply the most advanced technologies. Our partners in Tashkent were offered a technical solution that has proved efficient and effective in other cities and was adapted to the peculiarities of operation in Uzbekistan. We have experienced no difficulties in implementing the project. All of our export orders are given close attention, and especially those with long-term partners such as Tashkent Metro.

personally check the operability of all rolling stock systems. Upon delivery, the trains were tested on the metro network and only after this has been completed successfully are they allowed to operate with passengers.

The new trains are financed through loans issued by VEB.RF and Russian state corporation, the Russian Export Center Group (REC). A further loan covering part the cost of the trains as well as spare parts and accessories was provided by the Russian Agency for Export Credit and Investment Insurance (EXIAR) (REC Group) and financed by EXIMBANK of Russia.

INDIVIDUAL APPROACH

TMH Engineering experts made some modifications to the basic design of the 81-765/766/767 series to meet Tashkent Metro's wishes for the new fleet. For example, with a significant proportion of the Tashkent metro running at grade, and the warm weather experienced in the city, the designers equipped the cab windshield with a manually adjustable sunscreen to improve comfort for the driver.

A new livery pattern in the customer's corporate colors was also introduced. The car's side walls and doors are painted in white and a horizontal line of the Uzbekistan tricolor

ADVANTAGES OF THE 81-765/766/767 SERIES CARS FORTASHKENT

- AN OPEN GANGWAY FACILITATES THE SAFE AND EASY MOVEMENT OF PASSENGERS THROUGH THE TRAIN
- DOUBLE-LEAF 1.4 M WIDE DOORS WITH EXTERNAL OPEN/CLOSED LIGHT INDICATORS
- AIR-CONDITIONING AND DISINFECTION SYSTEMS IN BOTH THE PASSENGER CAR AND DRIVER'S CABIN
- SPACE FOR WHEELCHAIRS IN THE LEAD CAR
- MOTORIZED CARS EQUIPPED WITH ASYNCHRONOUS ELECTRIC TRACTION MOTORS
- SERVICE LIFE OF METRO CARS – 30 YEARS
- DESIGN SPEED – 90 KM/H

^ All new cars are equipped with an air-conditioning and disinfection system

RAKHMONBEK USMANOV,
Head of the Tashkent Metro:

COMMENT

The tasks we set for the car manufacturer represented by Transmashholding have been fully achieved. The products fully conform with the technical specifications agreed with Tashkent Metro. The quality of new cars is generally satisfying as we recently saw during the running tests. We have been cooperating with Transmashholding for a long time and from our own experience we can see that the best engineering solutions in the world are used in rolling stock offered by TMH. We are planning further purchase of metro cars produced by TMH.

^ The driver's cabin is equipped with an advanced modern digital control panel and a comfortable seat that reduces vibrations

^ Kirill Lipa, TMH CEO, and Rakhmonbek Usmanov, Head of the Tashkent Metro, at the ceremony of signing of the memorandum of understanding for metro development in Tashkent

LET'S LISTEN TO WHAT PASSENGERS SAY

BATYR KARIMOV:
– I regularly use the metro and appreciate the comfort of the trains during my journeys. The new cars have wide doors, comfortable passageways between the cars, and the air conditioner works.

ZHANNA ASKAROVA:
– I like the new trains. The passenger areas are clean and tidy. All the information you need is right in front of your eyes. Visually, everything is very beautiful.

ISLOM KHALILOV:
– Most of all, I like touchscreen monitors: you can quickly plan a route and calculate the travel time so you can arrive at your destination on time.

^ The new train has a well-designed passenger information system

< Open gangways between the cars make it possible for passengers to move freely along the train

runs along the entire train. The roof is painted in light blue, and the center of the front of the train is black.

The passenger information component has also been carefully designed. Among the key features is the use of scrolling text on the nose of the head car to inform the direction of travel. Each passenger compartment is fitted with touchscreen information monitors with interactive search capabilities for the destination station, route planning, and travel time calculation.

"The 81-765.5/766.5/767.5 series train have a modern design, provide a high level of passenger safety and are convenient to operate, especially for the driver," notes Rakhmonbek Usmanov, Head of the Tashkent Metro. "Fire-proof, non-flammable materials are used for the inner lining of the passenger car. Due to its design, the trains make very little noise. The driver's cabin is equipped with a modern digital control panel and a comfortable seat that reduces vibration. The new cars feature a video surveillance system which offer complete monitoring of the train during operation, an air-conditioning system in the driver's cabin, which is especially important in local climatic conditions, open gangways, and an improved train control system which can offer recovery operation in the event of a malfunction."

The trains are serviced at the Chilanzar and Uzbekistan depots. Under the contract, TMH is providing warranty maintenance and service, and is supplying spare parts and components. In addition, MWM specialists offer training for the depot's drivers and employees.

A NEW CHAPTER IN COOPERATION

In November 2021, TMH and Tashkent Metro signed a memorandum of understanding for future metro development in the Uzbek capital. Usmanov and Kirill Lipa, CEO at Transmashholding and a member of the Bureau of the Russian Union of Machine Builders, signed the document. The memorandum is valid for 10 years, from 2022 to 2032.

The parties intend to cooperate in the development of infrastructure, rolling stock, and passenger transportation in general to create favorable conditions for application of new research and technologies in the interests of the social and economic development of Uzbekistan. According to the partners, modernization of infrastructure and further upgrades to the metro fleet as well as the introduction of a digital process control system using modern information technologies will help to improve the efficiency of the metro network. Equally important are tasks to improve safety systems and to introduce microprocessor-based control and traffic dispatching systems. Improving then network's integration with other surface transport modes is also considered important. V

^ Each passenger car is fitted with touchscreen information monitors

< The lead car has a dedicated space for wheelchairs

Reliable Platform

> 40-foot 13-9744-06 platform

Transmash plant specialists have been working on updating their product ranges since 2019. The fruits of this process begin to emerge in 2020 with the introduction to the market of a new contrailer for piggyback operation. In the same year, the development of two new products began, a long wheelbase flat wagon and universal platforms. These new wagons offer increased load capacity and the possibility to transport a wide range of goods.

Fitting platforms are the main products of the Transmash plant and the enterprise has extensive expertise in their production. The most successful solutions include the 40-foot 13-9744-06 flat wagon, the design of which remains unchanged, unlike the 80-foot 13-9751-01 which has been thoroughly revised and replaced by a new model, the 13-6726 platform, which is used to transport high-tonnage containers. The 13-6987 contrailer platform was created for the transport of both semi-trailers and high-tonnage containers.

Both projects were developed by specialists at the St Petersburg design organization, Scientific Innovation Center for Wagons, a long-time partner of the Transmash plant.

"Our mutual technical interests include production of new equipment that offers advantages over the existing alternatives," says Alexey Lipatov, General Director at Transmash, commenting on the collaborative experience. New products were presented at the International Railway Fair, 1520 "PRO // Motion.Expo," which was held in Shcherbinka in late August 2021.

ANOTHER RECORD IS BROKEN!

For the 13-6726 flat wagon, Transmash is using a bogie suitable for an axle load of 23.5 tons. Three prototypes have been manufactured so far, two of which have successfully passed a set of the required tests, with the third presented to the professional audience in Shcherbinka. The launch of serial production is planned in 2022.

"The design made it possible to improve the performance characteristics of the car," Lipatov explains. "The platform can carry any container used in the market. The wagon is designed for the transportation of high-tonnage containers and tank wagons, including those with hazardous freight."

Experience from both Russian and European wagon designers was used to create the new model. Transmash has developed a good relationship with a Slovakian company that produces railway tooling, including for European railcar builders. This made it possible for Transmash to study solutions that are implemented in Europe and try to adapt them to the Russian market. The symbiosis of European and Russian design solutions resulted in a flat wagon with increased load capacity. Two patents for the unique technical solutions applied in the development of the model 13-6726 flat car are a source of pride.

GOODS IN THE BASKET

The 13-6987 flat wagon is the first Russian serial contrailer platform, unmatched in the domestic market. It is fitted with a special basket, a removable reusable cargo attachment device for the transport of semi-trailers. Regular containers can also be transported on the platform. They are installed on fitting stoppers located on the wagon frame.

> Assembly shop at Transmash plant

TRANSMASH IS CAPABLE OF PRODUCING OF UP TO 200 PLATFORMS PER MONTH

MODEL 13-6726

FLAT CAR FOR TRANSPORTATION OF HEAVY-TONNAGE CONTAINERS AND TANK CONTAINERS

Maximum load capacity – 72 tons

Design speed – 120km/h

Operating conditions – temperate and cold climates (from -60 to 50 °C) with the influence of any weather factors (rain, snow, dust in strong wind)

Loading options – up to four empty heavy-tonnage containers or tank-containers or two loaded 40-foot containers with a gross weight of 36 tons

May be used as a part of the freight train of any length and weight without limitations

Fitting stoppers are used to prevent empty containers from shifting when exposed to cross-wind loads

More than 70 wagons have been produced so far and are already in operation with the First Federal Contrailer Operator. FFCO together with its financial partner VTG ordered the development of the model and its launch into production.

"The first batch was tested on a pilot production basis," Lipatov says. "Based on these results, we made adjustments to the design documentation to improve the wagon's performance. We were also able to increase the service life. The point is that it is impossible to predict specific outcomes during the design process. Only when we use the wagons for operation can we see what has been done perfectly and what can be improved. For example, the basket in which semi-trailers are loaded onto the car have supports that require additional reinforcement to increase the thickness of the side walls to improve the reliability of the attachment. We also added some structural elements to ensure the supports can fold easily. In addition, to improve reliability, we added a few more welds and replaced the caprolon sleeves with non-flammable polymers."

ALEXEY LIPATOV,
General Director at Transmash:

COMMENT

Our plant is not the largest platform manufacturer in the world. But we have our own niche and long-standing and loyal partners. We strive to provide better quality and offer flexible conditions and that's why our customers appreciate us.

I believe that our fitting platforms have good export potential, particularly in the market of Kazakhstan, which already buys them in quite significant volumes. We have also received requests from Mongolia. Contrailer platforms are in demand in Latvia, Lithuania and Estonia and we constantly receive requests from these countries for the purchase and lease of our wagons. The European market is much more difficult to break into. But Transmash is planning to seek certification to meet European standards and enter the market for components. German partners, for example, are interested in purchasing welded car elements.

READY TO GO

Tests of the new universal 13-6719 flat wagon, which offers an increased load capacity of up to 72 tons, began in 2021. This high load capacity enables Transmash to compete with products already available on the market. One of 13-6719's distinctive features is the sides that can be fully opened and put into the vertical position. New fittings are also used which prevent empty containers from being displaced when subjected to strong crosswinds. Tests are expected to be completed before the end of the year, after which a decision will be made to start serial production. "We are sure that a new platform with improved performance characteristics will be in demand on the market," Lipatov says.

A FULL PRODUCTION CYCLE IS NINE DAYS – FROM METAL CUTTING TO A FINISHED PLATFORM

In 2022, the Transmash product range will include five models of flat wagon: two 80-foot, one 40-foot, a contrailer and a universal platform.

MADE IN RUSSIA

Wheelsets manufactured in Kazakhstan are the only foreign-sourced components used in Transmash wagons with all other components from Russian suppliers. "We only buy a wheelset assembly from Kazakshtan," Lipatov says. "Everything else, both metal structures and components, is of Russian origin.

"We try to work with all of our suppliers to help them to develop and improve the quality of their products. We choose the best to be our partner."

TO SUIT ALL TASTES

In the last three years, Transmash has supplied products to more than 60 companies. This includes orders from smaller companies for just one or two wagons, to deals with major players such as VTG, TransContainer and others. The plant tries to work with all customers who need fitting platforms, demonstrating the company's focus on the customer.

"We are driven by a desire to create a product range suitable for a number of clients," Lipatov says. "We work in the commercial market, and we look for and negotiate with customers. We cooperate with large companies on a long-term basis and we try to build mutually beneficial relations when both agreeing on the cost for our products and for steady and reliable deliveries."

Many partners come back to Transmash and conclude new contracts because they appreciate both the quality of the products and competitive lead times. The contracting process is well established: sometimes it takes just one or two weeks from receipt of the order to the ability to start delivery. Transmash is always open to constructive suggestions and is ready to consider the individual wishes of each customer.

Following the results of 2021, Transmash plans to produce 1549 wagons. In line with the objectives set by the management of its parent company, the plant aims for consistency in its work with eight wagons leaving the plant daily, six 80-foot platforms and two 40-foot platforms. The same production volume is planned for 2022 with the company anticipating the production of 1500 flat wagons of all standard sizes.

MODEL 13-6987

flat car for transportation of semi-trailers and high-tonnage containers

Maximum load capacity – 69 tons

Design speed – 120km/h

One 1-T size semi-trailer, one to three heavy-tonnage containers according the size can be transported on the platform.

Tented and platform semi-trailers, etc. can also be transported.

The car can be operated anywhere on the 1520mm gauge railway network

MODULAR LOCOMOTIVE

A TEM23 modular shunting diesel locomotive is the first TMH locomotive to adopt the new DNA branding. The unit was presented in all its glory at the International Railway Fair in the area 1520 "PRO // Motion. Expo," which was held in Shcherbinka in late August 2021. Acceptance tests and certification is planned to be completed in spring 2022. Serial production of the diesel locomotives will be carried out at Bryansk Engineering Plant.

OLEG BELOZEROV, *Chief Executive Officer and Chairman of the Executive Board at Russian Railways:*

COMMENT

Transmashholding did not offer just a locomotive, they offered a platform-based solution. Here we need to cooperate with external markets. We seem to have great potential for this.

TEM23 MAIN ADVANTAGES

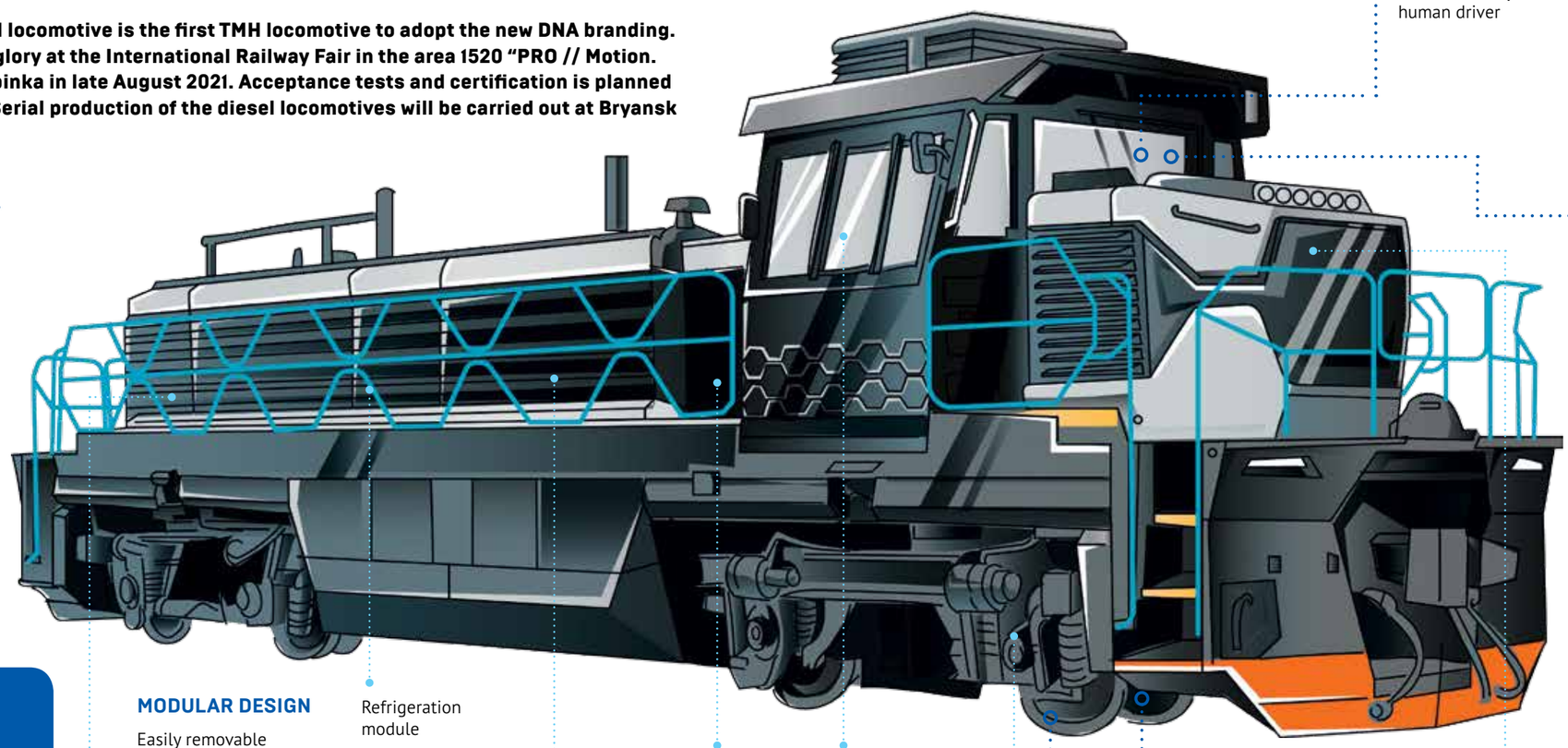
- No limitations on the duration of operation regarding the entire range of the locomotive's traction characteristics
- Capable of hauling six-axle machines
- Minimum curve radius – 40 m
- Fuel and oil savings – up to 30% compared with serial diesel locomotives
- Reserving locomotive's main components

POWER UNIT

- Two diesel engines of either 309 or 368kW
- Possibility to convert diesel engine to gas fuel
- Ambient noise reduced by half
- Improved environmental compatibility

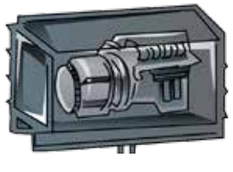
MAINTENANCE AND REPAIR

- Maintenance system based on actual operating hours, not on intervals
- Easier access to components and equipment
- Modular repair is available
- The quantity of maintenance and repairs for the TEM23 diesel locomotive has reduced almost three times compared with earlier shunting locomotives



MODULAR DESIGN

Easily removable module panelling for straightforward access to equipment



VLADIMIR SUDAREV, *Chief Project Designer at TMH Engineering:*

COMMENT

The locomotive was designed from scratch. This is a fundamentally new product, it does not look like any other locomotive, so it was not possible to share any manufacturing assemblies.

The main advantage of the modular design is that in case of failure of any of the modules, or if there is a serious breakdown that requires long repairs, the module can be easily replaced, reducing the time the locomotive is out of service. It also greatly reduces the labour required to assemble the locomotive. The locomotive can operate with either one or two diesel modules according to the required capacity for a particular task.

Locomotive starts with an engine

In 2018 the decision was taken to establish the TMH Engine Engineering Center, with the company formally beginning its operating activities in 2019. I would like to tell you about what projects have been implemented since then and what our designers are currently working on.

ANATOLY MELNIKOV,
CEO at TMH Engine Engineering Center

NECESSARY CHANGES

It is a common assertion that long-term business prospects are limited if there is no emphasis on researching and developing new equipment. This is especially true in engineering. That is why TMH has created a separate competence center for the design and improvement of diesel products.

The decision was made in 2018, and a year later the Engine Engineering Center (EEC) began its activities. The centre houses the design divisions for two TMH diesel plants, Kolomna Plant and Penzadieselmash. These divisions are based in the same city as the plants in Kolomna (at the Kolomna Plant) and in Penza, with both managed from Kolomna.

EEC is responsible for all tasks relating to engine development, including both new products and updates to existing lines as well as support for current contracts, working with new sub suppliers, and incoming control of the first article inspection and others. The major emphasis of its work though is on designing new equipment.

Close communication between employees at the two divisions makes it possible to harmonize design solutions. Joint procurement of materials also helps to reduce the cost of large orders while minimizing stocks.

The overarching goal for the transformation of the design division is to establish an engineering centre within the TMH group of the same calibre as those seen in Europe. The role of designers is becoming increasingly crucial as the company strives to develop innovative products to compete in the global market. The company's management recognizes and appreciates our work, which is noticeable in recent improvement in wages and working conditions.

In 2020 the EEC division at the Kolomna Plant moved to a renovated building that meets the latest standards. The designers' workplaces are equipped with the latest computers and design workstations with powerful processors, graphics cards, and a large amount of memory. Specialists also work with the most advanced software, which is used by leaders in the field of engineering. This includes AutoCAD, Inventor, and Ansys, all advanced software for engineering analysis and 3D modeling. Using this software means that creating three-dimensional drawings is no longer a novelty, but common practice.

NEW DEVELOPMENTS

In the field of locomotive engineering, we are currently developing two diesel engine generators: the 18-9DGM and 16LDG220, for locomotives manufactured at Bryansk Engineering Plant (BMZ). The main testing cycle for these new products is expected to be completed in 2022, and the locomotives should be ready by 2023. EEC specialists are also actively involved in maintaining and enhancing the D49 diesel engine and advancing new developments based on the D500 diesel engine.

To explain why TMH has been creating new internal combustion engines (ICE), it is helpful to look at the history of the product. During Soviet times, serious resources were allocated to engineering development. However, the planned economy meant that certain enterprises were required to produce specific ICE types. With no competition in the internal market, consumers had no choice.

When the market economy did get underway existing enterprises were limited in their ability to expand their portfolio to other ICE types and sizes due to the huge costs involved. For the first 15-20 years after the fall of the Soviet Union there was only very limited competition in the domestic Russian market, especially for large engines, enabling foreign manufacturers to take advantage.

With state support this situation began to change in the 2010s. Now the main objective when developing new engine families is to create products that match the technical level and quality of the models offered by foreign manufacturers in the specific product types where Russian plants have traditionally been active. This approach is now finally facilitating the development of modern equipment that meets the requirements of customers with minimal or no reliance on imports. It is also helping to gradually fill the gaps that arose in the 1990s.

REPLACING DIESEL FUEL

The use of alternative fuels is a new trend in the power engineering market. Work to develop medium-speed gas engines for railway transport is particularly advanced in the Russian market. There are currently limited or no foreign alternatives to these types of engines for rail although gas engines are common abroad in other areas such as off-grid

9GMG DIESEL-GAS GENERATOR

The generator was developed by TMH EEC designers for use with a shunting locomotive manufactured at Bryansk Engineering Plant under the state program to develop gas-powered vehicles. Preliminary tests of the engine proved its compliance with the requirements of the project. Introduction of gas-powered equipment is intended to increase transport fuel efficiency and reduce the release of harmful emissions into the air.

electricity provision and in the automotive industry. EEC is active in this field, with work underway to design a modular power plant with a 1-9GMG gas engine for the needs of small-scale energy facilities.

However, we are most excited about our work to create a medium-speed gas engine for locomotives. This is touted to reduce fuel costs while significantly improving environmental performance and locomotive compatibility. The solution developed by the EEC designers is the 9GMG gas engine generator for the TEM29 shunting locomotive. The engine has passed a full cycle of tests and acceptance is expected soon. In the future, it will be installed on a diesel locomotive that will be designed by TMH Engineering and manufactured by BMZ.

In addition, we are working to develop a gas-diesel engine for a mainline freight locomotive, which will be capable of running on both diesel and a combination of diesel and gas. Dual fuel engines have been used widely for a long time and EEC specialists have experience of developing diesel-gas engines for the energy market. We are adapting this work to design a diesel-gas engine based on the 16LDG220 for the Bryansk mainline locomotive. This project is still in the development stage.

We foresee demand for these types of engines from the small-scale energy supply sector. The diesel-gas engine will reduce the cost of the gas preparation and supply equipment when applied in stationary facilities or in gas supply infrastructure.

A growing shortage of liquid fuels derived from oil and on the ongoing tightening of regulations governing exhaust toxicity as well as requirements to reduce greenhouse gas emissions means the alternative energy market is set to continue to develop. EEC designers are exploring and calculating the possible use of methane, propane, methanol, biofuel and ammonia as alternative fuels. These changes require significant alterations to the design of existing engines, potentially making them far more sophisticated than today.

This work was discussed at the recent interdepartmental meeting held at EEC. The event was attended by representatives of Russian Railways (RZD), leading universities (N.E. Bauman Moscow State Technical University, Moscow Polytechnic University, Yaroslavl State Technical University), affiliated institutes of RZD including the Research & Design and Technology Institute of Rolling Stock (VNIKTI) and Railway Research Institute (VNIIZhT). The meeting reviewed work to optimize the use of alternative fuels in railway transport, primarily in the interest of the main customer, RZD.

18-9DGM DIESEL GENERATOR

This is a major upgrade of the serial 18-9DG diesel generator produced at the Kolomna Plant for 2TE25KM diesel locomotives which haul freight trains that can weigh up to 6400 tons. The new engine was developed to meet Russian Railways' requirements for use with a future diesel locomotive suitable to operate in severe climatic conditions and in challenging terrain. The locomotive must also be capable of hauling trains weighing 7100 tons. The 18-9DGM diesel generator differs from previous models by offering an increased power rating and improved reliability. Designers were also able to ensure the engine's environmental compliance. Tests of the 18-9DGM prototype are underway at diesel test shop at Kolomna Plant.

NUCLEAR SUPPORT

New requirements stipulate that the emergency power systems at nuclear power plants must have a standby diesel engine that is interchangeable with diesel engines used in the plant's diesel generator unit. Our designers are meeting this demand by offering the 19D49 diesel engine, a standby engine which is compatible with the DGU3200 diesel generator unit. It is used during scheduled repairs and has already been installed in the standby diesel unit at Beloyarsk NPP Unit 4. Here three DGU3200s are installed in the emergency power supply system along with two DGU4000 in the conventional supply system. Both are compatible with the 19D49 diesel engine.

IT'S ALL ABOUT THE PEOPLE

EEC employs 236 staff, and the average age is 45 years. These are experienced diesel engine designers with comprehensive knowledge of the subject. At the same time, promising young engineers are constantly joining the team. We work very closely with N. E. Bauman Moscow State Technical University and Kolomna Institute (Branch) of Moscow Polytechnic University. Every year we accept the best graduates in the field of power engineering to join our team. The institute has a specialized internal combustion engine department, where students are involved in research work under the guidance of a TMH EEC staff member, A.B. Matisen. Several employees of TMH EEC headed by Chief Designer, A.N. Kostrygin, teach vocation-related subjects.

Spinning off the design departments of the two plants into a separate company had a positive impact and was a successful move. Substantial progress has been made towards the goal of creating an engineering center that is comparable with those seen in Europe. Indeed, designers have been able to create products that rival or even exceed those produced by foreign companies, and EEC's revenues are growing.

A future priority for EEC is to supplement engine design with finished product and power plant design, and a partial shift from piston engine construction to alternative power generation projects. We are also ready to seek other activities depending on the direction of the market. V

^ The TMH Engine Engineering Center building

16LDG220 DIESEL GENERATOR

This generator is based on the D300 family and was developed under the "National Technological Base" federal target program. These engines are planned for use with the 2TE30A twin-section freight diesel locomotives, which are under development and will be manufactured by BMZ. These locomotives are intended for operation on the Eastern polygon of Russian Railways. With 3300kW output per section, they should be capable of hauling 7100-ton trains in challenging terrain. EEC have aligned the technologies used in the 16LDG220 diesel generator with the 18-9DGM to retain existing work processes and for straightforward maintenance of diesel generators at the depot. The 16LDG220 diesel generator prototype is currently being prepared for testing.

Caring about drivers

When designing new equipment, Transmashholding pays special attention to safety and ergonomics to create comfortable working conditions for drivers and other locomotive crew members.

SAFE AND COMFORTABLE

Innovation is at the heart of every TMH project, whether it is a diesel locomotive, electric locomotive, or a metro car, and can range from the technical and operational characteristics of rolling stock, to the convenience and functionality of essential equipment for personnel.

TMH Engineering specialists regularly consider how to improve the layout of the driver's cab. Engineers take into account the latest trends in industrial design and ergonomics and try to create the most comfortable and practical working environment.

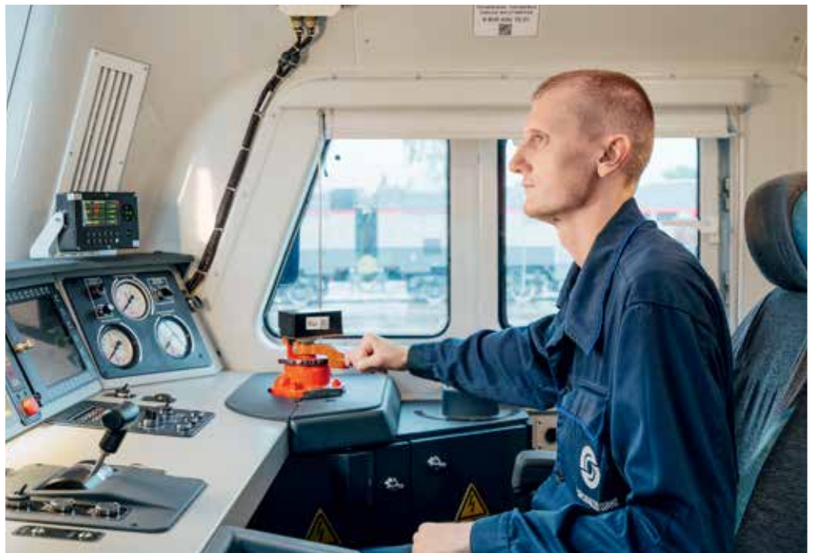
Modern materials that meet fire safety requirements and all health and safety standards and regulations are used for the driver's cab interior. For example, the rear walls of the cab on all types of rolling stock are formed of fireproof partitions that prevent a fire that might break out in the engine room from entering the cab during an evacuation. All wooden parts used in the design are treated with fire-proof coatings including flame retardants and only noncombustible or low-combustible nonmetallic materials are used for the interior. Special lifelines are located above the side windows, which enable members of the locomotive crew to easily leave the driver's cab in the event of an emergency.

The cab also includes a restraint system which reduces the risk to personnel in the event of the train colliding with an obstacle. The sill bar of the cab's frame on TMH mainline locomotives is reinforced. The interior and all its elements are also designed to minimize the chance of injury to members of the locomotive crew in a wide variety of circumstances.

"The effectiveness of these safety devices and measures requires careful consideration during the design phase," says Vladimir Chernyshev, Director at Bryansk division of TMH Engineering, which is responsible for development of new equipment for Transmashholding. "There is in turn a need for continuous improvement of these methods and the use of mathematical modeling to identify possible contingencies in railway transport. Maintaining the highest possible level of safety for locomotive crews is our priority."

It is equally important to minimize the exposure of drivers to external phenomenon such as excessive noise and heat. As a result, innovative finishing materials with high noise absorption and heat insulation properties are used in cab interiors. Modern driver seats are also designed to reduce the negative impact of excessive vibrations. The cabs of advanced electric and diesel locomotives intended for operation on Russian Railways' Eastern polygon and other areas that experience extreme climatic conditions will also offer much higher heat insulation properties and additional heating elements than in current units.

^ Driver's cab on the model 81-722 metro car



< Driver's cab on the 3TE25KM diesel locomotive

Designers also take into consideration the living conditions for drivers operating locomotives that travel extremely long distances. For example, the driver's cabs of Bryansk diesel locomotives are fitted with wardrobes and ceiling cabinets for storage of personal belongings, documentation, and the tools required for work. There is a table for meals, a microwave oven and a refrigerator, everything to make people feel at home. The same level of comfort is provided in electric locomotives manufactured in Novocherkassk.

PUTTING THOUGHT INTO DETAIL

The design of control panels on most TMH locomotives consists of a tabletop and three pedestals. The main locomotive controls, including the controller, switch units, control system displays, along with the information display devices - the electric meters, gauges, alarm panels - are positioned according to their importance and frequency of use, with the most important controls all within easy reach of the driver.

Locomotives are operated in all weathers and times of the day, which means that design solutions must be suitable for use in all kinds of operating conditions. For example, driver's cabs are fitted with several types of lighting to support operation of electric locomotives at night: operational - 20-60 lux; emergency - at least 3 lux with automatic switching to an

ELECTRONIC SYSTEMS USED IN THE DRIVER'S CABIN ON TMH LOCOMOTIVES

LOCOMOTIVE CONTROL SYSTEM

SAFETY SYSTEM, INCLUDING DRIVER VIGILANCE SYSTEM

VIDEO AND AUDIO RECORDING SYSTEM

FIRE EXTINGUISHING SYSTEM

LOCOMOTIVE DIAGNOSTICS SYSTEM

DISTRIBUTED BRAKE CONTROL SYSTEM

IGOR SEVOSTYANOV, *Head of the Mechanical Integration Department at Novocherkassk division of TMH Engineering:*

COMMENT

To maintain a comfortable microclimate, the cabins are equipped with heating, ventilation, and air-conditioning systems. For example, the cabs of the Yermak and Donchak electric and EP1M locomotives are equipped with two 2.4kW air heaters, and 3.5kW electric panel radiators, which are built into the walls and floor. The locomotives also have four electric heaters with a total capacity of 3kW, and a 5.6kW air conditioner. To avoid injuries to the locomotive crew, the temperature of the outer surfaces of the heaters does not exceed 55°C. The heaters are arranged so that warm air is evenly distributed, with a special focus on heating the feet of the driver and the assistant, and along the side walls of the cab. The driver is responsible for manually switching on the electric heaters and electric panel heaters by using the corresponding switches on the desk. The other heating devices have both manual and automatic controls to maintain the pre-set temperature.

The air-conditioning system consists of an air conditioner and a network of ducts located between the roof and the lining of the cab ceiling. It is switched on at all times to provide a continuous supply of fresh air from the outside into the cab. The microclimate is adjusted by changing the mode of the air conditioner and the position of the air duct shutters.

Rather than air ducts, new electric locomotives are fitted with additional blow-through air heaters on the cross wall on the right and left side of the entrance door. This stops cold air from entering the cab when the door is open. In addition, the EP20 series electric locomotives are equipped with an automatic microclimate system which maintains the cab's temperature to within ±2°C of the set levels during the summer and winter months.

Sergey Fadeichev / TASS, Yury Smityuk / TASS

^ Driver's cab on Yermak electric locomotives

independent power source (battery) if there is no voltage in the main network; and local lighting with a smooth brightness adjustment – for 0.6 to 2.5 lux to enable the driver to read the train schedule and from the dials of control and measuring instruments on the control panel. All lamps in the cab are positioned in such a way as to avoid direct light and light reflected from the surfaces from getting into the driver's eyes when operating in a standing or sitting position.

The cab front and side windows are electrically heated to offer uninterrupted visibility during frosty winter days. Roller sun blinds with locking mechanisms are also available. In addition, electrically operated windshield wipers are installed outside the cab in special recesses. The wiper blades effectively clean rain and snow from the windshield.

The side windows are also fitted with sliding frames and serve as emergency exits. Armrests are installed along the lower edge of the side windows for convenience during locomotive operation. The window openings, the position and height of the driver's desk and seats are also designed to optimize conditions for drivers that are 165-190cm tall.

< Driver's cab on the model 81-765 metro car

All NEVZ electric locomotives feature a driver vigilance system, which continuously monitors the driver's performance by monitoring the electrical resistance of the skin on his wrist with data shown on an LED display. If the driver is sufficiently awake, the system cancels periodic vigilance checks, thus reducing mental and physiological stress to the driver. In the event of drop in performance, the system resumes the checks helping the driver to regain focus. If the driver fails the checks, the train will be stopped by automatic brake, preventing possible fatal consequences.

Locomotives from the Yermak and Donchak families, as well as EP1M passenger electric locomotives, use a video/audio recording system that records conversations of the locomotive crew in the cab. There is also a camera to record the situation in the cab and outside of the locomotive in the direction of travel. On the EP20 electric locomotive, cameras are also fitted to the body of the locomotive, and the feed is displayed in the driver's cab. This functionality will be further expanded on the future twin-section electric freight locomotive to display images from CCTV cameras mounted to the body, which will replace rear view mirrors, and to the roof.

On existing and new electric locomotives, the control system monitors the status of the equipment to support both a self-diagnostics system and to inform the driver of any

KEY FEATURES OF THE DRIVER'S DESK ON THE 81-775 MODEL METRO CAR

CAREFULLY DESIGNED ERGONOMICS AND MODERN DESIGN

AN EXPANDED DIAGNOSTIC AND DATA PANEL, WHICH OFFERS AN ACCURATE STATUS OF THE TRAIN SYSTEMS AND EQUIPMENT PROVIDED TO THE DRIVER AND MAINTENANCE PERSONNEL

USER-FRIENDLY MAN-MACHINE INTERFACE WITH INTUITIVE MENU

CONTROL BUTTONS WITH TOUCH FEEDBACK

CONTROLS ARE ARRANGED ACCORDING TO WISHES OF DRIVERS WHO PARTICIPATED IN THE PROJECT TO DEVELOP THE DRIVER'S DESK CONCEPT

IMPROVED VISIBILITY

^ Driver's desk on the EP2D electric train

potential fault. The new electric locomotives will also be able to transmit diagnostic information from the locomotive to a remote server to provide real-time information on the locomotive's location and the reason for stopping in the event of a malfunction.

WITHIN EASY REACH

The EP2D and EP3D EMU driver's desk is fitted with an integrated control, diagnostic and safety operation system. The trains feature systems that monitor power output, offer equipment diagnostics, register driving performance, as well as a driving optimization system. There is a fire alarm and a passenger information system. Video surveillance is carried out in the cab, cars, vestibules and outside of the train, and to monitor the roof equipment.

The screens and indicators display all relevant information in real-time. These data are valuable not only for the driver, but also for maintenance crews because it reduces the time to diagnose a fault. All controls and display equipment are grouped on the desk by functions and have symbols - mnemonic signs instead of explanatory inscriptions or abbreviations, which reduces the time the driver spends on reading information and improves the crew's reaction and reliability in an emergency. The train can be controlled by

v EP3D DC electric train

^ EP3D AC electric train

a single driver, with a functional workplace arranged for the assistant. The seats are fitted with convenient footrests, and the entire cabin space is illuminated with functional lamps.

In recent years, a completely new driver's desk has been developed for 81-775 metro cars, the design of which was provided by Italian company SPII. The new concept is intended to improve working conditions for the driver and increase the attractiveness of the profession to young people.

All devices are based on the same information display design principles, which aligns with the interior concept. The driver's desk consists of three parts: a tabletop and two pedestals, which are designed to be straightforward and convenient to install and maintain. In addition, all equipment and information displays on the driver's desk are arranged according to their functional purpose. The main controls which require constant use and attention of the driver are located in the center of the desk so they are easy to access. This includes information screens which provide the driver with an immediate assessment of the situation and offer prompts when required.

The crew's physiological and psychological wellbeing and hygiene was an important consideration when finalizing the layout. The design process included analysis of the control's ergonomics and accessibility as well as an anthropometric assessment of the driver's seating posture with all equipment and controls arranged on the desk in accordance with health and safety rules for railway transport.

The TMH design division has wide-ranging experience of developing effective solutions to improve working conditions for locomotive crews. Work continues to improve cab design and increase the level of comfort for drivers of all types of rolling stock manufactured by the company. All innovations are based on world best practice and take into consideration driver suggestions and recommendations. This ensures the chosen design is compatible with actual operating conditions and optimizes the working environment for the driver. V

Hard Working Ezh

The Moscow Metro has been operating trains built by TMH enterprises since it opened in 1935. Of these, the Ezh electric trains were, perhaps, the most successful railway vehicle of Soviet times. The trains were affectionately called Ezhik (Ezh, Ezhik in Russian means hedgehog.)

EXPANDING AND ACCELERATING

The first Ezh metro car was produced in 1970, but its story would be considered incomplete without recalling the entire E-series. In the mid-1950s, the Moscow Metro needed to expand and conquer new territories, particularly as new commuter towns emerged on the outskirts of the capital. Branches of the metro network soon reached these new neighborhoods, resulting in a rapid growth in passenger traffic and the need for both longer trains and improved metro network capacity.

^ Retro train made of Ezh3 cars

Demand from Moscow was matched by the construction of metro networks in other cities throughout the Soviet Union, including Leningrad, Kiev, Tbilisi, and Baku. Soviet specialists also participated in projects to expand metros in Budapest and Prague. Metro car builders were tasked with producing faster, more comfortable, and technically advanced trains than the earlier D series.

The first prototypes emerged from workshops in 1959. They were five tonnes lighter but much more powerful than previous vehicles and could reach speeds of up to 90km/h compared with 75km/h previously. They also offered improved acceleration and braking performance. Aesthetically the train's doors were 20cm wider, but the slightly different arrangement of the end doors close to the driver's door proved a step too far. Serial production of these original E type cars lasted for only six years, from 1963 to 1969.

HORIZONTAL LIFT

The first modifications of the E cars were made due to difficulties with compatibility with Leningrad Metro. The network's stations do not have classic platforms, only a central hall with access to the train possible through platform screen doors. This requires the driver to stop the train as accurately as possible so that the doors of the train align with those on the platform.

This is where the decision of the car builders to shift the door location caused problems as the E cars did not align. The trains were also not yet equipped with an automatic train operation system that could have offered more accurate stopping patterns.

Mytishchi specialists subsequently developed a new type of car which was designated Em. The engineers made the body 40cm longer, reduced the distance between the door openings, and installed an early version of an automatic train control system. The first two dozen of these cars were manufactured in Mytishchi in 1967. Production subsequently transferred to the Egorov Leningrad Car Building Plant where about 150 cars were built until 1970.

THE EZHIK COMES ON THE SCENE

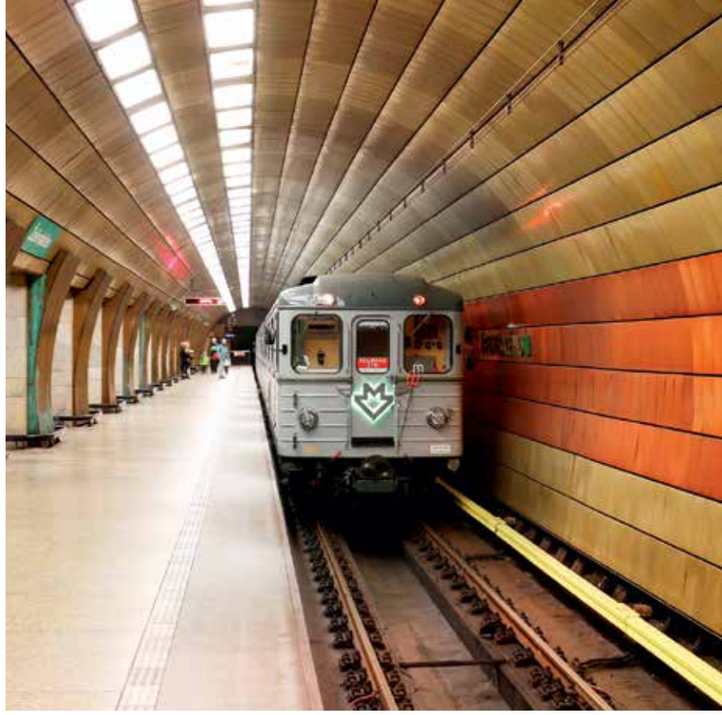
The Ezhik is often referred to as the second generation of the E-type cars. Development started in 1966 under a project for the Budapest metro. These models were designated Ev ("v" meaning Hungarian) and they differed from the Em by adopting 1435mm gauge.

Having learned a lot from the experience of producing the Em and Ev trains, the Mytishchi Plant began developing the Zh type in 1969. These were effectively a modified Esh that used Em bodyshells. However, the Zh designation did not work, and this was soon changed to Ezh.

Six variants were developed based on the initial model: the Ezh head car, Ezh1 intermediate car with a control cabin, EZh2 intermediate car without a control cabin, and three powered intermediate cars, EZh3, EZh4 and EZh5. Unfortunately, Ezh2, Ezh4 and Ezh5 did not enter series production. 170 cars of the basic EZh series were manufactured in 1970-1971, which was followed only by the EZh1 series, which continued until 1973, with a total of 460 Ezh cars manufactured.

During the design process for the Ezh, a team of developers headed by A.G. Akimov considered all the shortcomings of the E type cars. The first amendment was made to the bogie to enable an increase in the car load capacity from 18 to 21 tonnes. Secondly, like in the Em type, the door was shifted towards the driver's cab, which made it possible to position three-seater sofas at the rear of the cars, helping to increase the total number of seats. The car interior was also no longer finished with Lincrusta, a wallcovering with a pattern embossed upon it, and was replaced by a simpler, cheaper and safer plastic.

< Modification of E type rail car for Budapest



^ Echs type metro cars for Prague

EZH TYPE CARS

UNLADEN WEIGHT – **31.7 TONNES**

ENGINE POWER OF
EZH1 – 4 x 68 KW
EZH3 – 4 x 72 KW

MAXIMUM SPEED – **90 KM/H**

NUMBER OF CARS IN THE TRAIN – **2-8**

PASSENGER CAPACITY – **265 PASSENGERS**

In Moscow, the basic version of the Ezh remained in operation until 2010. The final car, No. 5170, was preserved for display in a museum.

THIRD-GENERATION EZH

Increasing demand for export orders resulted in the next update to the E-family. At the end of 1971, a contract was signed for the delivery of Echs type metro cars to Prague. With the Czechs wanting to replace traditional signals with an automatic speed control system (ASC), these vehicles required special attention.

STRATEGIC EZH

A further modification of the Ezh train was developed for strategic underground lines (D-6) used by the Soviet government and was designated as the Ezh6 index. These cars were hauled by L-type electric locomotives and were fitted with auxiliary batteries. Their exterior design was not too different from the Ezh3.

The first batch of six cars, which operated with three electric locomotives, was built in 1973. They were followed by a second batch of four cars and three more electric locomotives in 1986. Although these trains were operated in D-6, they stopped periodically on the regular metro to recharge batteries and for maintenance.

The D-6 rolling stock was eventually upgraded, and the first four cars were converted into intermediate cars and transferred to the Tagansko - Krasnopresnenskaya line, where they ran jointly with the Ezh3 cars until 2019. The Ezh6 cars from the second batch were decommissioned from D-6 in the late 2000s.

^ Driver's cab of the Ezh3 car

Thankfully employees at the Mytishchi Plant were able to deliver. At the end of 1972, the first Echs seven-car train fitted with ARS and a pulse control system for the traction motor was shipped to Prague. Pulse control worked in a wide speed range making control of the car more flexible. Czechoslovakia received 85 of these cars up to 1977, and they remained in service until the end of the 1990s. The trains proved to be very reliable and were well liked - the Mytishchi Plant was even awarded the Order of Labor by the Czech government.

In Russia, a modification of the Ezh3 featuring automatic speed control was also developed around this time. The new trains were equipped with more powerful DK-116A engines, a dispatcher communication system, and an upgraded control panel. Wooden window frames in the car were replaced with duralumin, and more durable seats installed.

At the same time, LVZ manufactured an Em508T intermediate car, which was standardized with the Ezh3. Ezh3/Em508T trains were supplied to Moscow for the Zhdanovsko - Krasnopresnenskaya line (today Tagansko - Krasnopresnenskaya). These trains were produced until 1978-1979 and heralded the start of eight-car operation in Moscow in 1983. They remained in service until June 10 2020.

^ Ezh3 car in the Ukraine

During its time in service the Ezh was upgraded, including in the early 2000s when the control cabin was removed from the intermediate cars. This resulted in an area resembling a small dance floor emerging at the end of the car, providing additional standing space for passengers. In addition, the original lights were replaced with fluorescent lights and seats in many of the cars used in Moscow and Tbilisi were replaced with plastic ones with individual backs for each passenger.

As well as Moscow and Tbilisi, the Ezh3 ran in Kharkov, Tashkent and Baku. In Georgia and Ukraine, the Ezh3 are still in operation, although the Ukrainians have modified the cars and replaced most of the original equipment. Ev3 cars were also delivered to Budapest, where they were in service until 2018, when they were sent to MWM for comprehensive upgrading.

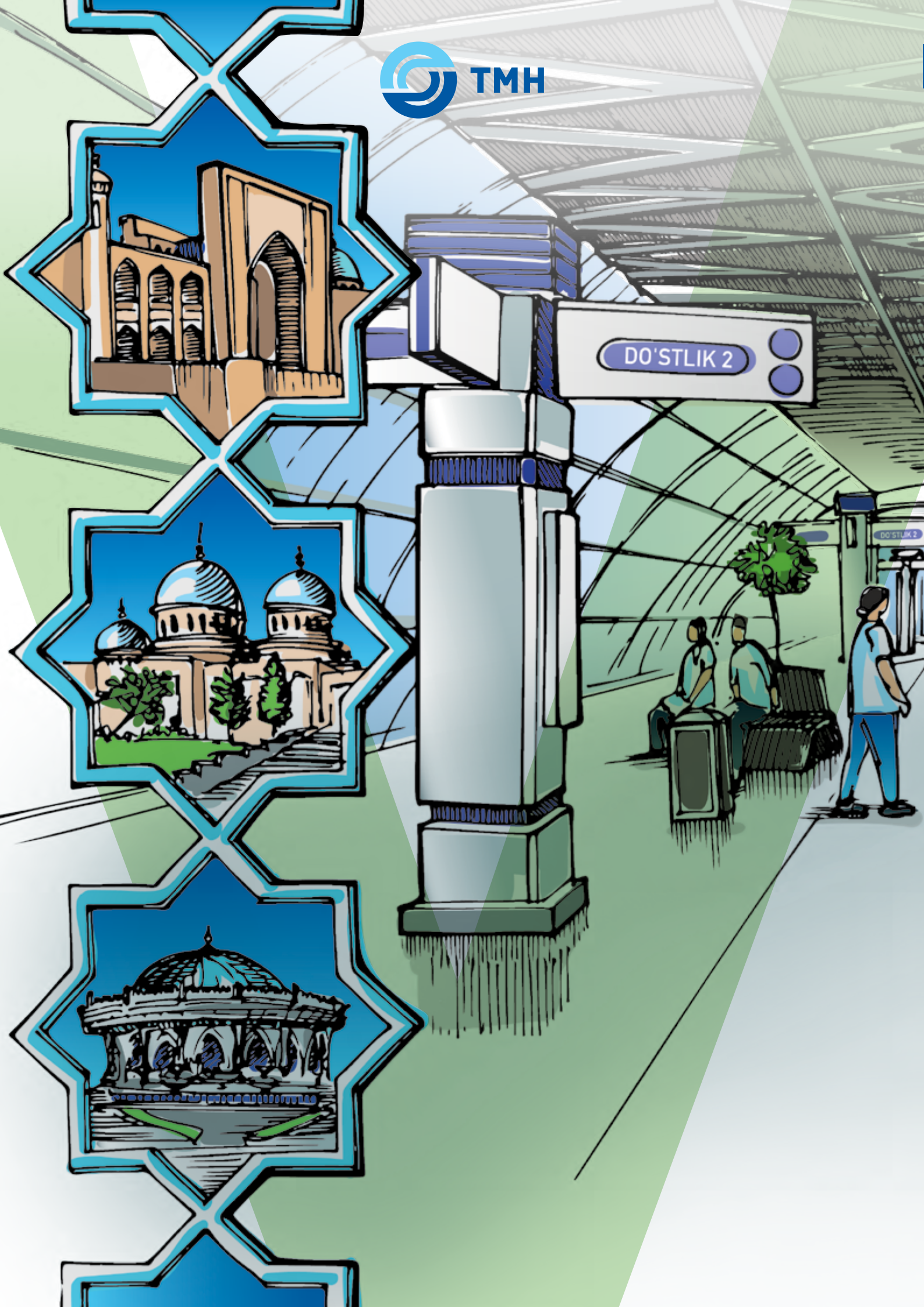
From the mid-1970s Ezh trains operated alongside the 81-717/714 series, development of which began in the second half of the 1970s. These were the first Russian metro trains without a letter designation and were simply called "numbered" trains. In general, passengers like the Ezh for their power, speed and attractive look and they remained in service for many years, only being withdrawn entirely following the emergence of the Moskva new generation train in recent years. V

NEW YEAR EZH

Although the Ezh is now entirely out of service in Moscow, the city's residents still have an opportunity to ride this retro train. In 2016 the Ezh3 became the capital's special New Year train, operating on the Circle Line. The cars were decorated with images of snow finches, fir tree branches, snowflakes, and an inscription of the coming year placed on a white and gray background to look like snow. Inside, the train was decorated with tinsel and electric lights.

In the winter of 2016-17, the train ran in a six-car configuration, and on Christmas Eve one of the cars was replaced with a new one dedicated to the Christian holiday.

The train returned as an eight-car unit on December 31 2017, this time on the Zamoskvoretskaya Line, with the two additional cars adopting a similar design. The following two winters the train ran on the Tagansko - Krasnopresnenskaya line, and in 2020 a seven-car train ran on the Koltsevaya Line, continuing this new tradition.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