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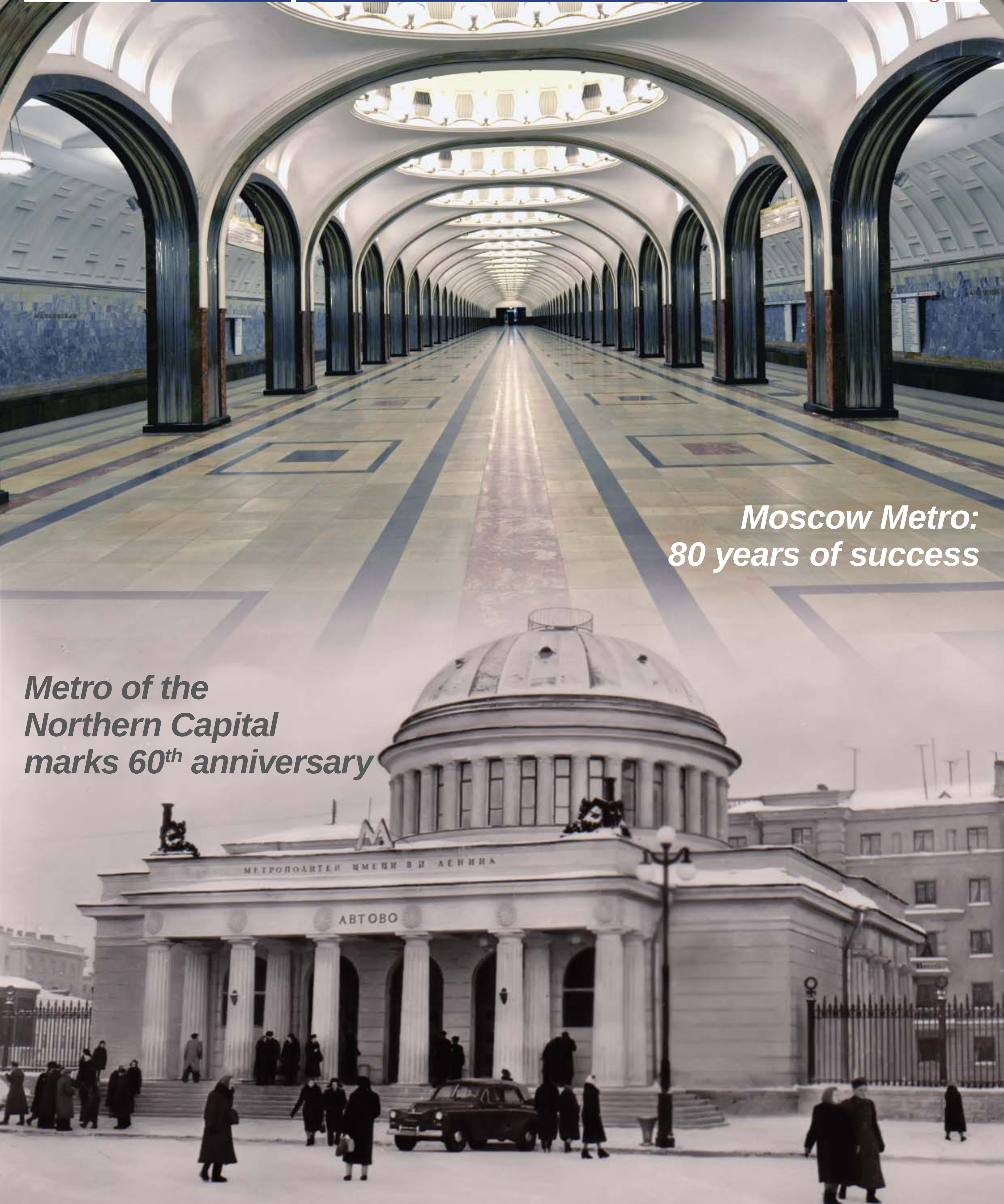

Moscow Metro: 80 years of success

Metro of the Northern Capital marks 60th anniversary

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International Association Metro was created by the initiative of subways. It unites 32 subways and the suppliers from 9 countries of Eurasia region. The Association fulfils coordinating and information-analytical functions, organizes the search for solutions of various problems arising in the process of subway maintenance. The Association is a member of UITP.

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Moscow: Metrovagonmash is expanding the maintenance services for metro cars

On January 1, 2016, the maintenance center at the electric engine house Vykhino (Moscow) started the work on servicing metro cars produced by the Metrovagonmash factory (it is part of ZAO Transmashholding). The electric engine house Vykhino will be a third facility where maintenance services are provided for metro cars. The plant is expanding the successful practice of the proprietary system of maintenance service. Metrovagonmash has already provided maintenance services for 664 metro cars of the series 81-760/761 «Oka» at the electric engine houses Novogireevo and Vladykino.

New trains will arrive at the electric engine house Vykhino within the period from 2016 to 2017. The total number of 31 trains of the new generation, series 81-760/761, will be sent for maintenance. The maintenance services will be provided by the specialists of Metrovagonmash.

Maintenance of the metro cars using the manufacturer's resources enables to increase the coefficient of technical readiness of the fleet. The continued participation of the manufacturer of the metro cars in the process of maintenance and repairs makes it possible to implement the necessary changes efficiently and quickly in order to enhance the passenger comfort and safety.

The series 81-760/761 cars have been operated by the Moscow Metro since 2012.

The opening of the maintenance center at the electric engine house Vykhino was performed in accordance with the agreement signed in March 2014 between Metrovagonmash and the Moscow Metro.

Source: metalinfo.ru

The Moscow metro will renew its car fleet

The «Ezh-3» cars will completely disappear from the Moscow metro in 2019, said Maxim Liksutov, Deputy Mayor of Moscow. He stated: «Currently, the «Ezh-3» cars are still operated only in the Tagansko-Krasnopresnenskaya Line, there are plans to completely renew the car fleet of this metro line before the end of 2019». According to Mr. Liksutov, despite the fact that the «Ezh-3» cars are reliable and safe, they have been operated for 30 years and have already become obsolete. He also reminded of the fact that a new eight-car train started to operate in the Tagansko-Krasnopresnenskaya Line on December 11. It is one of the most advanced versions – 81-760. «It has already been tested at the electric engine house «Vykhino»; the drivers have been trained to work on it. Cars of the same series have been operated since 2012. The Kalininskaya and Serpukhovsko-Timiryazevskaya Lines are fully equipped with them,» – said the Deputy Mayor.

According to him, the new enhanced comfort car can carry up to 320 passengers. «In January, the Tagansko-Krasnopresnenskaya Line will have five such trains, and by the end of 2016 the fleet will include 20 more trains. The new cars are cost-effective and safe. They are decorated with new materials having an increased wear resistance, have a system of climate control with air-conditioning and air disinfection. Each car is equipped with a Wi-Fi hotspot,» – said Mr. Liksutov.

From 2017 the Tagansko-Krasnopresnenskaya Line will start receiving trains of a totally new modification. They will have a walk-through and new characteristics. The trains on the busiest lines will be replaced first, because the new trains will provide 15% of additional seats, which is essential for the Moscow metro.

Source: interfax.ru

Chelyabinsk: it is necessary to continue to build the metro

Chelyabinsk Oblast Governor Boris Dubrovsky counts on the completion of the construction of the metro in Chelyabinsk. On December 8, at the traditional concluding conference the head of the region said that the city is able to put two or three stations into operation. The journalists invited the head of the region to put a comma in the sentence «Freezing impossible to build». Boris Dubrovsky said that he would like to put the punctuation mark after the second word.

«Now we need to understand how it should be done. I came down to see how it looks, how much work has not been completed. A lot of work has been done, there are grounds for believing that we can complete and put two or three stations into operation,» – concluded the governor.

Chelyabinsk authorities are looking for an investor for the completion of the metro construction. In summer, the Mayor's office received an application submitted by an entrepreneur from St. Petersburg concerning the construction of surface metro. The entrepreneur suggested that the passengers should use it free of charge.

Source: telefakt.ru

Kazan: in 2016 the Shakespeare train will start operating

In 2016, the Shakespeare train will appear in the Kazan metro. «It is planned to be put into operation within the framework of the UK-Russia Year of Language and Literature 2016,» – said the director of the British Council in Russia Michael Byrd. «In April, in the Moscow metro and, hopefully, in St. Petersburg, Yekaterinburg and Kazan the Shakespeare train will be put into operation. We will not disclose any details, I will only mention that the passengers of the Filyovskaya line in Moscow can suddenly find themselves in the company of Shakespeare's characters during their usual trip to work,» – RIA Novosti quotes Mr. Byrd as saying.

Besides, within the framework of the UK-Russia Year of Language and Literature several dozens of events will take place in Great Britain and Russia. Among them are the best theatrical presentations of the plays written by the prominent playwright William Shakespeare that will be held in 50 cities of Russia.

Source: business-gazeta.ru

The electric train will serve as a substitute for the metro in Troyeschina

Kiev authorities want to organize the movement of urban electric trains at the intervals of the urban transport, and new platforms are supposed to be built at major transport hubs. This option is being considered by «Ukrzaliznytsya» (Ukrainian Railways) which has recently included the urban electric trains in its asset list. The main idea is to solve the transport problems of the largest residential area of Kiev – Troyeshchina – without the construction of the metro. Troyeshchina is home to more than 300 thousand people. The existing route of the urban electric trains is planned to be extended a few stops further into the residential area.

«Ukrzaliznytsya» is considering a project that provides for non-use of the circular motion of the electric trains. Instead, the company suggests extending the route towards the center of Troyeshchina and placing the second final stop at the station Kiev-Volynsky.

«The traffic performance of the entire electric train is less than 20 thousand passengers per day. Several thousand people travel from Troyeshchina to Petrovka every day - it's almost nothing. Therefore, I suggest extending the route to the middle of Troyeshchina using the express tram tracks. They were built almost according to the railway standards,» - says the project initiator Viktor Petruk.

According to his plan, the electric train will serve as a substitute for the metro for the residents of Troyeshchina. As a result of the construction of a separate track, it will be possible to reduce the movement interval to 5 minutes. «The final stop will be at the station Kiev-Volynsky. Thus, the passengers will be able to reach Livoberezhna, Vydubychi, the train station, the KPI. It will be necessary to finish the construction of the new platforms at Darnytsia, near the metro stations Lybidska and Politekhnicheskaya,» – says Mr. Petruk.

According to him, it will be possible to travel faster than using the Sviatoshynsko-Brovarska metro line (the average speed of electric trains – 51 km/h, the metro – 35 km/h).

«It will be possible to reach Lybidska from Darnytsia in 26 minutes, one will be able to reach the KPI in 34 minutes. Besides, this plan will also considerably lessen the load of the metro. The routes of the urban transport will be adapted to the movement of the electric trains. This is technologically feasible within 1.5-2 years,» – states Mr. Petruk.

The transport experts say that the idea is not bad, it is only important to achieve a minimum interval between the electric trains. «We modeled this scenario and made the calculations using the transport model of Kiev. Passengers will use the electric train, if an interval of about 5 minutes is ensured, and the trip in it will be perceived as the use of the metro,» – said the transport expert Dmitry Bespalov.

«Ukrzaliznytsya» says that the transfer of the electric train system is not yet complete because of the transition of the enterprise into a joint-stock company: «We have not concluded the necessary contracts for the tender yet. But the suggested modernization project is now being considered by the board members».

Source: vesti-ukr.com

Dnepropetrovsk: The Mayor Hopes that the Construction of the Metro Will Be Resumed in February 2016

The Mayor of Dnepropetrovsk Boris Filatov expressed the hope that the construction of the metro would be resumed in the city in February 2016. According to UNIAN, Mr. Filatov made this announcement during a meeting with representatives of the European Bank for Reconstruction and Development and the European Investment Bank in the city council. According to him, all the formal procedures should be agreed upon during the working meeting in order to resume the construction of the metro.

Mr. Filatov underlined that the Central metro station should be put into operation first, because it would link the city center with the bedroom districts and thus would «solve a lot of problems».

As UNIAN reported earlier, in October 2015 the Cabinet of Ministers of Ukraine increased the estimate of the construction cost for the first stage of the metro in Dnepropetrovsk from 4.489 billion to 5.618 billion Ukrainian hryvnias.

Information provided by UNIAN: Dnepropetrovsk metro has been under construction for over a quarter century. The construction was resumed in February 2011. Dnepropetrovsk metro has one line with a length of 7.8 km and six stations. According to the calculations made by the Austrian company SGS Austria, the cost of the project for the completion of the construction of three new stations amounts to 368 mln euros. Late last year the President endorsed an act for attraction of credit amounting to 152 mln euros provided by the European Investment Bank, in 2013 an act was endorsed for the provision of a similar amount by the European Bank for Reconstruction and Development.

Source: unian.net

Minsk: MTS turned the metro cars into a library

On December 7, four metro cars in the Minsk metro turned into libraries. According to 42.TUT.BY, within two weeks the operator «MTS Mobile Library» will introduce its brand in six more cars. Each of them will have one of the five themes: «The Car of Classics», «Bestsellers», «The Car of Mysteries», «The Car of Good Mood» and «The Car of Children's Literature». All the ten cars will be used by the citizens of Minsk for six months. The library-style design of the metro cars is part of the project by MTS which is focused on reminding the Belarusians of the need to read.

«MTS Mobile Library» is a joint project with Bookmate, the international service for reading e-books which provides its users with more than 500,000 books on different subjects. During the first 3 days a subscriber of MTS can use the library free of charge. Later, the cost of one day of use will amount to 1,950 Belarusian rubles. The «book» traffic is not chargeable for MTS subscribers.

Source: 42.TUT.BY

Anniversaries of Eurasia subways in 2015

The year 2015 brought many anniversaries to the metro systems that are members of the International Metro Association. 8 metro systems that are members of the Association celebrated their anniversaries.

On May 15, 1935, 80 years ago, the Moscow Metro was put into operation. It is considered to be the flagship of the Russian metro construction, and many of its stations are objects of cultural heritage and monuments of architecture.

The 60th anniversary was celebrated by **the St. Petersburg Metro**. It was opened on **November 15, 1955**. The St. Petersburg Metro stands out among other metros of the world due to its extremely deep-level location. In 2011, the deepest station in Russia was opened in St. Petersburg. The construction of Admiralteyskaya lasted about 20 years.

The Kiev Metro celebrated its **55th anniversary**. It was opened on **November 6, 1960**. During the construction of the metro in Kiev, many new solutions were suggested. In the history of metro construction they were called «the Kiev solutions». Thus, for the first time in the former Soviet Union in Kiev the metro builders created and introduced the mechanized tunneling shield for tunneling in sticky clays. The use of the shield increased the tunneling speed from 3 to 12 meters a day and became the basis for the development and implementation of a complex mechanized line for the construction of main line tunnels.

On August 23, 1975, 40 years ago, the Kharkiv Metro was opened.

A characteristic feature of the metro in Kharkiv is the absence of the station facilities on the surface, which ensures efficient use of the ground space of the city. All the vestibules of the stations are combined with the underground pedestrian crossings and the city transport network. This significantly improves the possibility for transfer of passengers from the above-ground transport to the metro and back.

The Nizhny Novgorod Metro was opened on **November 20th, 1985, 30 years ago**. The special technical solutions and technologies applied in the construction of the metro include the use of monolithic concrete lining in water-flooded soils.

The Novosibirsk Metro celebrated its **30th anniversary**. It was put into operation on **December 29, 1985**. Today the Novosibirsk Metro includes two lines with a total length of 15.9 kilometers and thirteen stations. The citizens consider it to be the most comfortable and reliable type of urban passenger transport.

The Dnipropetrovsk Metro transported its first passengers on **December 29, 1995, 20 years ago**. The difficult and long-term construction of the first section took place under rough conditions. The complexity of the work is determined by the fact that the underground deep-level structures are located within the solid bed-rocks consisting of granites, diorites, magmatics and gneisses with zones of silicification that have different degrees of fracturing. Another feature is that the ground water table is 40-45 meters above the tunnels.

The youngest Russian metro – **the Kazan Metro** – was opened on **August 27, 2005**. It celebrated its 10th anniversary. Today the Kazan Metro is operated as part of the Municipal Unitary Enterprise «Metroelektrotrans» which is one of the largest transportation companies of the Republic of Tatarstan. The company consists of 19 business units that organize the work of the above-ground and underground electric transport.

Metro systems development history around the world till 1935

1818 – the French engineer Marc Brunel invented the tunneling machine.

1820 – the design engineer Mr. Torgovanov suggested making a tunnel under the Neva River.

1860 – in February the construction of the London Underground was started under the guidance of the chief engineer John Fowler.

1863 – on January 10, the first line of the London Underground opened.

1868 – the New York subway opened, it is the world's largest subway system by the number of stations and the length of the routes.

1869 – the Athens Metro opened. For nearly 130 years only one metro line with 23 stations operated in the capital of Greece.

1870 – the decision was made on the construction of the Budapest Metro – the first metro (in the modern sense) on the European continent.

1871 – in the New York Subway the city railroad line switched from cable haulage to steam haulage.

1875 – in the European part of Istanbul the underground funicular line T nel began to operate. It had two stations.

The first suggestions on the construction of the metro in Moscow were discussed.

1889 – The Management Board of the Baltic Railway suggested a project that was unique at that time. It consisted in an underground connecting line between the Finland railway station and the Baltiysky railway station.

1890 – the world's first deep-level railway line – the City and South London Railway, the first line which used electric locomotives.

The New York Subway was converted to electric traction.

1896 – the F ldalatti line opened in Budapest (F ldalatti — the underground), it was the first "full-fledged" metro on the European continent. The Glasgow Subway was opened in Great Britain. Even today it consists of one circular line and 15 stations.

1900 – on July 19, the Paris Metro opened for the Exposition Universelle.

1902 – on February 15, the first metro in Germany opened in Berlin.

1911 – the first escalator was introduced in the London Underground at the station Earl's Court.

1912 – the second metro in Germany was put into operation in Hamburg.

1924 – one more metro opened in Europe in Barcelona.

1927 – the first Asian metro opened in Tokyo.

1930 – the Metro Subdivision of the Moscow Railway developed a project that was approved with minor revisions for the construction of the Moscow Metro.

1931 – on June 15, after the report delivered by the First Secretary of the Moscow City Committee L.M. Kaganovich at the Plenum of the Central Committee of the All-Union Communist Party of Bolsheviks, the decision was made on the construction of the Moscow Metro. The specialized organization «Metrostroy» was established.

1932 – beginning of the construction of the Moscow Metro.

In the institute «Lengosproekttrans» Professor E.A. Yakovlev created a project of two metro lines for Leningrad – Vitebskaya and Baltiyskaya.

1933 – the second Japanese metro was put into operation in Osaka.

1934 – the Moscow City Council formed the Directorate of the Moscow Metro.

1935 – **on May 15, at 7 a.m. (Moscow time) the first Moscow metro train started**.

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Moscow Subway History, 1935-2015

On January 6, 1931, Moscow was by no means having the best day: the transit system of the capital almost stopped, i.e., in modern language, a traffic standstill occurred in the city. The buses didn't operate, cabs could not move, and foremost, the trams did not go, which jeopardized the image of Russian socialism. The leaders of that time used to say: «If trams operate in the city, it means that there is Soviet power in it». But the trams did not operate, it meant that the workers could not get to the plants, the clerks could not reach their offices, and students could not go to their education institutions. The situation could be explained quite simply: the urban passenger transport could no longer cope with the ever-increasing number of passengers. The Moscow of 1931 was suffocating because of traffic jams and the management measures available at that time were obviously insufficient for solving the problem.

From 1920 to 1926 the population of Moscow increased up to 2 million. In 1928-1929 a significant proportion of the rural population moved to the city for a guaranteed salary, and since 1928 – for food rationing, thus adding 2 million more to the population of Moscow. And all these millions of people had to go to work by tram. Back in 1927, the public transport specialists of that time made the following conclusion on the prospects of public transportation: «For carriage of so many passengers by tram the frequency of tram departures should be 12 seconds in summer and 20 seconds in winter, which is absolutely inconceivable. Besides, only the passengers who have exceptional agility and physical strength will be able to get into the tram-cars».

The book «How We Built the Metro» tells its readers that one German stone mason came from Germany of his own accord to help his fellow communists to build the metro. He was allowed to come to work an hour later than all the workers, because he was heavily-built and simply could not get into a crowded tram every morning. That is why he had to go to work on foot.

So, in June 1931 the Plenum of the Central Committee of the All-Union Communist Party of Bolsheviks discussed the problems of the country's municipal infrastructure and made the fateful decision: to get rid of the hell on earth the authorities needed to build an underground paradise, i.e. the metro. The Plenum resolved that it was necessary to «immediately start the preparatory work for the construction of the Moscow metro as the only means of fast and cheap passenger transportation, so that the construction of the metro can start as soon as in 1932».

The idea of the construction of the Moscow metro was in the air 30 years before the memorable traffic jam.

In 1901 the word «metro» was first uttered in Moscow, and in 1902 the project was presented: «The engineers Balinsky and Knorre will place the central station in Red Square near St. Basil's Cathedral, with metro trains running from it. The metro trains will have first-class, second-class and third-class cars. They will only occasionally dive under the ground, moving mostly above the surface – in the air». But the Moscow City Duma decided that the project was premature and resolved that «Mr. Balinsky's suggestion should be rejected».

The issue of the construction of the underground transportation network was raised later in 1912 – 1913. The suggestions were mostly based on the idea of a system of suburban trains passing through the city center.

The First World War and the Civil War that followed it prevented these projects from being implemented.

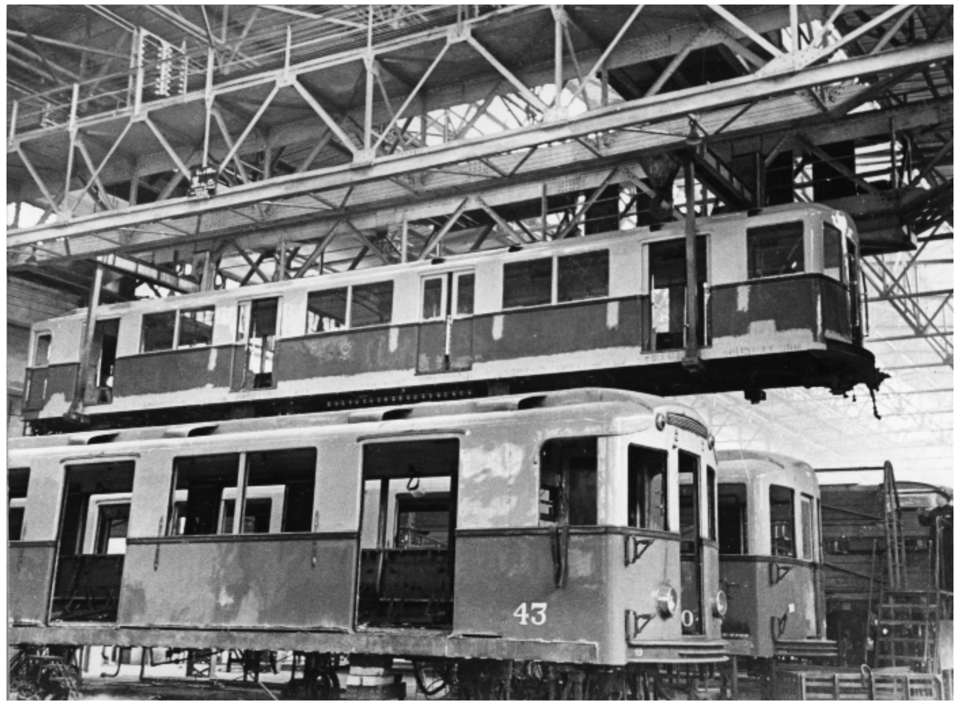
In Soviet Russia the idea of creating the metro was revived in 1923. Since the country had no relevant professionals, knowledge and experience, the project was commissioned to the German company Siemens. In 1925 the project was developed. It involved the construction of 80 km of underground lines and 86 stations. But for the lack of funds the project remained on paper, and the metro was not built in Moscow. At the same time the metro subdivision was created in the Moscow city railway system. It prepared the metro project for Moscow by 1930. It probably should be regarded as the basis for the metro of today, because according to this project, many stations were planned at the locations where metro stations can be found today. Vladimir Mayakovsky dedicated a few lines to the forthcoming transport revolution:

Comrade Mole was so surprised,
He could not believe his eyes:
With a weird electric sound
Trams are going under ground!

The great poet was right: the creators of the project of 1930 suggested building a system in Moscow that would have technical capabilities and, most importantly, a carrying capacity which would be similar to those of a modern express tram. But life made its adjustments later.

If the project of 1930 was implemented the Moscow Metro could have become a monument to Soviet Constructivism which would have no match in the world. However, in November 1930, a sound case started in Moscow in order to find the persons guilty of the failure of the first five-year plan. All the specialists who had pre-revolutionary education fell into the category of saboteurs. The metro subdivision was closed, the design engineers were arrested. And on January 6, 1931 Moscow experienced the standstill.

Six months after the above-mentioned transport problem in Moscow the construction of the metro was announced again. L.M. Kaganovich was appointed the «right» construction manager. Kaganovich was considered to be the second in command in the country and Stalin's right hand. He took resolute steps during the supervision of the design and construction of the new transportation system. Thanks to his influence, he made sure that his decision to build the metro was approved at a party plenary meeting. And in September he insisted that the Moscow authorities send a request to the OGPU (the Joint State Political Directorate) for the return of the experts arrested for sabotage who had previously worked on the metro project. In November 1931 the project of the first line of the Moscow metro was presented, it was a revised version of the project previously designed by the metro subdivision. It was decided to build two lines: from Sokolniki to the Palace of the Soviets and from Smolenskaya Square to the Lenin Library. At that time, Moscow had two particularly problematic places: Lubyanskaya Square (in the very heart of the city) and Kalanchovskaya Square (nowadays – Komsomolskaya Square). Three major railway stations of the capital were located in Kalanchovskaya Square; it was the point of intersection of the routes of a huge number of passengers arriving from the suburbs to work. Kalanchovskaya Square could not handle such a heavy passenger



flow. The first metro line was supposed to solve the problems of these bottlenecks.

«The Iron People's Commissar Lazar Kaganovich is constantly keeping a wary eye on the work». He became a central figure in the management of the construction of the metro. In fact, Kaganovich autocratically consolidated the power related to the construction. However, he had not finished even a single year of school studies; he had received his vocational training as a shoemaker. There is even a Moscow legend which attributes the authorship of one of the above-ground vestibules to Kaganovich – it is the station Arbatskaya in the Filyovskaya line. The outline of the vestibule is star-shaped. This vestibule has a rather convoluted history – it was erected and dismantled three times, because its designer was not satisfied with its location in different parts of Arbatskaya Square.

In late November 1931 the work on the construction of the metro was started. The site was located in the yard of the building number 13 in Rusakovskaya Street. According to one of the construction workers, this first team included 7 people at most. In January 1932, when the work began on all sites, the equipment of Metrostroy included the following: 1 truck, 8 horses, 70 sets of harness, the spades were borrowed from the yard-keepers. There was no clear plan. At first the metro was planned as a subsurface line and the construction was started using the so-called «Berlin method». This option was the cheapest one and it consisted in excavating a trench along the entire length of the route. The tracks are installed inside the trench, platforms and other structures are built. Then the trench is closed with a vault. This method had a lot of shortcomings, especially for Moscow with its dense development. There was a real risk that the buildings standing along the edges of a trench could slide into it. A street where such kind of work was in progress became temporarily unfit for traffic and the life of the people living in the construction area turned into hell.

But the main peculiarity of this method is the location of the tracks under the roadway, which does not always meet the requirements of the project. The connecting line Alexandrovsky Sad – Okhotny Ryad was used for passenger trains until 1938. It was supposed to pass under Arbat Street, but then the route was changed. According to the official version, it was done due to unfavorable geological conditions. However, according to the legend, Kaganovich insistently demanded that the project should be changed, and this fact presupposes another reason. At that time Arbat had the status of the government route, because Stalin used this street for going by car from the Kremlin. Any work carried out in this

street was under special control, and underground construction was totally prohibited. As a result, it was decided to build the line not under the street but under the residential buildings, that is why the «trench» method of construction was used. Later it was called the «Moscow» method. It was applied for the first time during the construction of the Arbat radius, today it is part of the Filyovskaya line. But this method of construction did not solve the problems related to re-laying of the intricate utility systems and the very difficult geological conditions that were caused, in particular, by numerous flowing sands and other unpleasant features of the Moscow soil. But in late 1932, the engineer Veniamin Makovsky suggested building a deep level metro with a depth of 30-35 m. Despite the lack of funds, machinery and, foremost, the necessary knowledge of the methods of deep tunneling, of the methods for transportation of passengers to such a depth, the management of Metrostroy liked this idea. In May 1932, the construction project was reviewed, revised and personally approved by Stalin. The stage of deep tunneling and construction of the metro tunnels began. In this regard, we must mention the builders and managers of Metrostroy. Before the assignment to the position in Moscow, Kaganovich was the head of capital of Ukraine of that time, Kharkov. The most powerful construction facilities were concentrated there. Many qualified specialists worked there, and he transferred them from Kharkov to Moscow for the construction of the metro. The management of the work was entrusted to the talented engineer Pavel Rotert who had been the construction manager at Kharkov's greatest construction site of that century – the State Industry Building.

The construction of the deep level metro also involved the participation of specialists from Ukraine, Donbass. They were miners who had had experience in pit sinking but not in underground construction. They started pit sinking without performing the necessary preparation, geological and hydrogeological surveys in order to comply with the directives of the party and the government on the construction of the metro by 1934. Such haste led to disastrous results: after reaching the depth of 40 meters with only a general geological forecast available, the miners encountered unstable soils and flowing sands, there were in-rushes of water that flooded the shafts. Especially tragic were the accidents during pit sinking under Lubyanskaya Square. The shaft technology turned out to be unsuitable for the Moscow soil. The wooden timbering broke under the weight of the consolidated soil, the colossal pressure of water washed away the stable strata. In some places there appeared cracks on the surface of Lubyanskaya Square and a landslide threatened even the building of the OGPU. Under these circumstances, the authorities decided to use the tunneling shield that had been purchased in England in 1933. It had not been used before because the builders did not believe in its efficiency for some reason. However, the circumstances forced them to use the tunneling shield, and it was a real breakthrough in the construction of the metro – the flowing sands no longer hampered the construction. In May 1934, the English tunneling shield was taken as a model for making a Soviet shield. After overcoming some setbacks the metro construction project was revised once again. The authorities gave up the idea of extremely deep tunneling and decided to use a combined method of construction, i.e. to apply the deep tunneling method mostly in the center of the city and in some sections of the lines.

Alongside the construction of the underground facilities in 1934, the work was done for the creation of the rolling stock, escalators and various underground infrastructures. The metro needed fundamentally new cars which would be similar to the cars of suburban trains but would be adapted for the dimensions and conditions of the metro. In Mytishchi Machine-building Factory special rolling stock was created. It had an engine designed for the voltage of 825 V and a streamlined body. It was equipped with leather sofa-type seats and wall-mounted lighting fixtures.

Many problems were caused by the escalators. The Soviet metro tunnelers had little knowledge of this device: it was first presented in 1900 at the Exposition Universelle in Paris. The London Underground escalators appeared in 1932, and in 1933 the Soviet designers started the negotiations with the manufacturers of these machines. One imported escalator cost 200 thousand gold rubles; it was purchased solely for the purpose of studying its design. It required a substantial modification for bringing it to conformity with the length of the inclined tunnels and the numbers of the Moscow passengers. In January 1935 the first escalators were introduced in Moscow. One of the escalators was mounted in 20 days and on February 6, 1935 it transported 2000 delegates of the All-Union Congress of Soviets. It was the test of the escalator. And 2 days before the event the first test train had run along the section Sokolniki – Komsomolskaya Square. The construction of the Moscow Metro provides a great number of examples of genuine enthusiasm and heroism; it was selfless work of dozens of thousands of people: workers, engineers and managers. Thanks to the efforts of the metro builders the long-awaited event took place on May 15, 1935 – the Moscow Metro opened its doors for its guests – the passengers.

The first phase of the metro included 11.5 kilometers of railway track, 13 stations, 14 trains ran along the line. At 5:48 the contact rail was energized. At 6:45 the doors of the vestibules opened. There were tickets of two colors: yellow ones for traveling towards Sokolniki and pink ones for going to Park Kultury and Smolenskaya. The validity period of tickets was 35 minutes.

In the early days of the metro people visited it like a museum. The implementation of the grand project impressed the visitors of the stations by the deep contrast between the squalor of the shabby buildings in the old quarters of Moscow and the shining marble and ceramic finish of the metro. The opening of the metro was a real treat and Muscovites felt pride in having such facility in their city.

However, such a magnificent decoration of the metro appeared almost by chance, at the very last minute. «Build with no drips!» was the slogan that was often uttered by the encourager of the great construction L.M. Kaganovich. Beauty was not mentioned. About a year before putting the metro into operation the management started thinking about the decoration of the stations and decided to «give each station an individual architectural appearance that would be different from other stations». Taking the international experience into account, at first the experts of Metroproyekt decided to face the surfaces of stations with materials that would have such main advantages as wear resistance, moisture resistance and dust-proofness, i.e. they planned to finish stations with ceramic tiles. But as it turned out, the industry of the country was not able to produce the required number of tiles immediately. It was decided to perform finishing with materials based on marble and natural stone. A competition was announced among architects for the decoration of stations and, thanks to the creative approach to the work, the Moscow Metro acquired its majestic and even pompous appearance that is admired by its passengers today. But this is the content, as for the form, the consultants from London suggested that the deep level stations should have a classic appearance, from their point of view. There were supposed to be two tubes with platforms connected by walkways, with small anterooms at the ends which provided access to the surface via the inclined tunnels with escalators. That was the way the station Lubyanka looked at the beginning; in 1973-75 it underwent rebuilding and acquired the appearance that is common among the stations of the Moscow metro. The architect S. Kravets suggested removing the soil between the two tunnels and turning the resulting space into a spacious hall. Such practice had never been applied in the world before.

Even though at first the Moscow metro was the salvation from the main transport problems of the city, it did not play the leading role in the transport system: it was too short and the territorial coverage was too small. Its share in the transportation of passengers among all modes of transport was only 2% at that time. It was necessary to develop the metro network and to build new lines.

The second phase of the Moscow metro consisted of several independent stages of construction. First there was a continuation of the branch from the first phase from the station Smolenskaya to the Kiyevsky Rail Terminal, the section was put into operation in early 1937. It included 1346 meters of main line tunnels and a bridge across the Moskva River. Then the branch was extended to the other side, till the Kursky Rail Terminal. The tracks between Alexandrovsky Sad and Okhotny Ryad changed their function and began to be used as a connecting line, and instead of a line that split in two parts there were two different lines: Sokolniki – Park Kultury, and Kiyevskaya – Kurskaya. The new radius had a length of 3405 meters; passengers could use it in early 1938. In the autumn of the same year the Gorkovsky radius was put into operation. It had a length of 9.6 km. The trains moved from the station Ploshchad Sverdlova (today – Teatralnaya) till the station Sokol.

The construction of the Moscow metro never stopped and it became a platform for implementation of the most daring architectural designs, for introduction of advanced technologies and developments in the areas of rolling stock, railway automatic equipment, signaling equipment, communication, microclimate control and other important areas.

The Great Patriotic War became a serious challenge for the Moscow metro. While performing its basic function – transportation, the metro had to operate as a bomb shelter. The population of Moscow hid from air raids at the metro stations. At the station Kurskaya the Historical Library was located. Part of the station Belorusskaya was used for

housing the General Staff, it was located at Kirovskaya. Many people think that the metro was originally adapted as a bomb shelter in case of war, but in fact the Council of People's Commissars resolved that the metro should be used as a bomb shelter only in April 1941. Due to the shallow locations many stations and sections were not suitable for being used as bomb shelters. A bomb fell on Smolenskaya Square, pierced the ground and hit a metro train. 50 people were killed at the station Arbatskaya – the star-shaped vestibule was a very good landmark. The station Mayakovskaya became a peculiar symbol of the days of the war. During the first night air raid it provided a bomb shelter for 50 thousand people. People used not only the platforms and in the middle hall, but also the station tracks and sections between stations. Special wooden panels were prepared and used for this purpose. They formed the flooring on the tracks. On November 6, 1941 the station Mayakovskaya housed the ceremonial meeting dedicated to the 24th anniversary of the October Revolution.

About a month before that event the Moscow metro had experienced probably its most tragic days. In October 1941, a state of siege was declared in Moscow, evacuation of government agencies and manufacturing companies started, many buildings were mined. On October 15 Kaganovich ordered to close the metro and to destroy its facilities and equipment that could not be removed and transported. October 16 was the only day in the history of the metro when its stations did not open for the passengers, because dismantling of valuable equipment and elements of architectural decor was in progress, the metro was being prepared for an explosion. Some elements of the architectural decor were removed and transported to a safe place; in particular, the famous sculptures from the station Ploshchad Revolyutsii were evacuated. They returned to their places in 1944. By the evening of October 16 the order on the destruction of the metro was canceled, and at 18:45 the trains started to operate according to the schedule and the metro opened its doors for the passengers.

In late 1941, when the assault of the Nazi troops against Moscow failed, the further construction of the metro was resumed. In 1942, the work on extension of the lines Gorkovsko-Zamoskvoretskaya and Arbatsko-Pokrovskaya line proceeded at full speed. In January 1943, the trains started to run till the station Zavod im. Stalina (today – Avtozavodskaya station) without stopping at Paveletskaya and Novokuznetskaya where the work was being completed during the operation of the line.

These two stations deserve special mention. Their fates got intertwined at the design stage: very few people know that some design elements of the present-day Novokuznetskaya were intended to be used at Paveletskaya. Paveletskaya itself was supposed to look different from what appears before the eyes of the passengers today.

The ceiling of Novokuznetskaya station was decorated with mosaics according to the sketches by the famous artist Alexander Deineka. The mosaic plafonds were created by the outstanding Russian mozaicist Vladimir Frolov. One of the examples of his work are the plafonds at the station Mayakovskaya, they were also created according to the sketches by Deineka. They were united by the theme «Twenty-four Hours of the Soviet Country».

The creation of the mosaics that adorn the station Novokuznetskaya is associated with the circumstances which were overcome through the true heroism of their creator. The commemorative plaque installed at the station is dedicated to that heroism. The mosaics were assembled in the besieged Leningrad in a cold damp basement by the light of a miserable kerosene burner. In winter of 1941 Vladimir Frolov continued the work on the creation of the mosaics for the Moscow metro in the studio of the Leningrad Academy of Arts. He worked in spite of hunger, lack of heating and normal lighting. In January 1942, all the panels were ready. On February 3, 1942 Academician Frolov died.

The mosaic pictures were part of the project of Paveletskaya station which was created in peacetime and did imply any intervention of war. The structures for Paveletskaya were produced in Dnepropetrovsk and the authorities did not manage to evacuate them all to Moscow before the Nazi invasion, that is why they remained in the occupied city. The project of the station had to be changed urgently, and the new one did not include the mosaics, because they were no longer awaited from the besieged Leningrad. When the mosaics finally arrived in Moscow, they found their place in Novokuznetskaya. They blended in with the interior of the station and became its true adornment.

Due to the lack of the structural units Paveletskaya station was opened in a somewhat temporary version. Elements of its «wartime» interior can be seen today: part of the platform hall that is adjacent to the inclined tunnel from the Paveletsky Rail Terminal is very different from the rest of the station. The narrow vestibule with low pylons merges into a spacious hall that was meant to be a variation on the theme of Mayakovskaya. This splendor appeared after the victory, but there were no mosaic panels.

The difficulties of the construction of the metro in the war years are illustrated by numerous facts, some of them are related to the lack of materials and the need for austerity. A superproductive metro builder wrote the following in a newspaper article of that time: «In the fan-shaped part of the inclined tunnel of Paveletskaya (site controller: comrade Danelia) we concreted a winch, a tripod for a surveyor's level, overalls, doors and other objects that have no relation to the construction of the facility».

In 1944 the section of Arbatsko-Pokrovskaya line from Kurskaya to Izmailovskaya (today – Partizanskaya) was put into operation. The employees of the Moscow metro also made their contribution to the cause of the great victory. For example, in the spring of 1943 the Red Army received the armored train «Moscow Metro» built with the money donated by the employees of the metro. This train was involved in the Battle of Kursk where it accomplished one of the important battle missions that determined the tide of the battle.

The postwar metro is, first of all, Koltsevaya line. The work on its construction began during the war years. There is a statement that while the Moscow metro is the apotheosis of the Soviet empire, Koltsevaya line is the apotheosis of the Moscow metro.

11 years were spent on 12 stations. That includes the glazed images of guerrilla fighters on the azure background of Tagankskaya station, the ancient Roman coffered ceilings with plafonds adorned with Florentine marble mosaics at Belorusskaya, the imperially magnificent Komsomolskaya, Pavel Korin's stained-glass artwork at the marvelous Novoslobodskaya and many other works. When examining the stations of the Koltsevaya line one's imagination is boggled by the diversity and richness of the decoration, materials, the beauty and originality of the design.

The cult of victory was embodied in the triumphal, festive decoration of the stations with elements of temple architecture. A vivid example of this is the station Oktyabrskaya, at the end of it there is an illuminated niche that hides the doors of the entrance to the restricted areas and resembles an altar. Oktyabrskaya was called by the people «the station with an altar».

Other temple motifs are present at the station Novoslobodskaya – these are the stained-glass panels. «Stained-

glass artwork was considered to be a religious anachronism and had never been used before in modern design». The creator of the artwork for the station Alexey Dushkin originally intended to make relief stained-glass artwork of uranium glass, and Vera Mukhina was supposed to be the sculptor. But due to the fact that uranium was a strategic raw material, the idea of relief artwork was rejected. A good substitute was found for the strategic raw material: according to a special order the stained-glass artwork was created in Riga by Latvian old craftsmen according to the sketches of the famous artist Pavel Korin. The basis of the motif was the pattern found by Dushkin and Korin on the robes of priests of the medieval era.

A fundamental theme for decoration of the stations of the postwar period was the image of Comrade Stalin. He was regarded as a symbol of the victory and drawing a distinction between the cult of victory and the personality cult was very difficult. There were 15 sculptures of Stalin in the metro and countless murals and mosaics. One of the mosaics on the ceiling of Komsomolskaya had the image of the leader reviewing the Victory Parade. Pavel Korin, the creator of the artwork, had to change it several times. First he had to delete the image of Beria, then the image of Molotov and then, finally, the image of Stalin.

At the station Arbatskaya the passengers moving up the escalator could see a full-length image of «the Father of Nations» who looked at them with a keen glance. Arbatskaya was opened a month after the death of Stalin, but two years later the grand marble mosaic artwork was removed.

Overcoming the personality cult necessitated a radical alteration of many works of art, because sometimes the destroyed images were the basis of the themes of murals, paintings, etc.

The next period of building the metro did not have glowing prospects. In 1955 the infamous decree of the Central Committee of the CPSU and the Council of Ministers of the USSR «On Elimination of Excessiveness in Design and Construction» was issued. The decree stipulated that all architectural excessiveness in construction, including the construction of the metro, is contrary to the policy of the party and the government in the field of architecture and civil engineering. And this policy was very simple: kilometers at the expense of architecture. And N.S. Khrushchev held the «credit» of the introduction of such approach. He had made his first steps in this area under the leadership of Kaganovich. And together they built the famous beautiful metro. But now, after coming to power, he decided to build a utilitarian metro. The creative delicacies of forms and decor were canceled, and the architects were turned into quantity surveyors, their main task was to design with account taken of the cost saving. That was the ideology of the new method of construction. This period gave the Moscow metro many stations in the outlying «bedroom» districts, and the people nicknamed them «centipedes».

In the early 70s the metro saw a revival of its classic architecture, the famous style started to return, but there was a more modest and strict finish of the stations and vestibules.

It should be noted that the Moscow metro is famous not only for its architecture. All the years of its construction and operation are marked with constant introduction of achievements of the scientific and technological progress, improvement of the equipment, research work for the development of new technologies to improve the transportation process, improvement of the safety level and passenger services culture.

Back in 1943, the average daily level of passenger transportation exceeded the prewar level. And then the passenger flow grew steadily, which necessitated the work on the technology for its control. In 1945, many stations started to restrict the entry of passengers and even to completely block it.

It was possible to restore the production of new rolling stock in the Mytishchi Machine-building Factory only three years after the war. The problem was solved partially at the expense of the capital of the defeated Germany. 120 metro cars were transported from Berlin to Moscow.

In 1947, the intervals between the trains were reduced, and the number of cars in the trains that had been decreased during the war was increased to six. The country's leadership set a serious task before the metro employees: within the shortest possible period of time they had to reach the pre-war average car occupancy rate - 51 people per car. In 1947, on average, there were 72 passengers in each car. In fact, this task was completed by 1949, because numerous new cars were delivered from the Mytishchi Machine-building Factory.

But it was not the time to rest. It was necessary to significantly improve the safety, quality and standards of passenger services. In December 1951, the names of the stations were first announced in the metro cars. Two years later there was a wide-scale installation of public address systems in metro cars.

In 1959, a competition was held for the best design of the turnstile – the automatic controller, and then their

wide-scale introduction began. The technical revolution in the metro was gaining momentum. The increased scientific and technical potential of the country enabled the development of fundamentally new systems for the metro, for example, systems for radio communication between the electric train drivers and the train dispatchers. The research and development establishments were actively working in this area; they had to adapt the recently emerged computers to the needs of the national economy. In the metro it was planned to reduce the locomotive crews from two to one person.

In 1959, the Moscow metro started the work in partnership with the Penza Research and Development Establishment for Control Computers for the development of the automatic control system for metro trains – SAU-M. Three years later the passengers of a metro train on the Koltsevaya line heard an unusual announcement: «Dear passengers! Our train is operated by an automatic train driver!» At the same time the work was carried out for the creation of yet another automatic control system for trains – SAMM – «the automatic control system of the Moscow metro – MIIT».

Many of the technical innovations developed and tested in the Moscow metro in the 50s - 60s began to be implemented only in the 70s. These include the systems ALS (Automatic Locomotive Signaling System) - ARS (Automatic Speed Control System), dispatching communication and centralization and others.

The Moscow metro celebrated its 80th anniversary as a modern, high-tech transport enterprise whose employees use the potential accumulated during the past years for successful solution of the problems related to uninterrupted, reliable and safe operation of the complex and branched organism – the metro.

The Moscow Metro celebrated its 80th anniversary

Within the framework of the celebration of the 80th anniversary of the Moscow Metro, more than twenty festive events were held for the Muscovites and guests of the city.

In order to inform journalists and passengers of all the festive events, the website www.mosmetro80.ru was introduced on April 8. The website published announcements of the forthcoming events and the results of the completed activities.

On April 15, a social advertising campaign was launched. It was aimed at attracting the attention of a wider audience to the celebration and at the formation of a favorable image of the Metro. Within the framework of the campaign, 692 posters were placed in the metro and on the billboards installed in the city.

On April 29, the presentation of the new exhibition «Selected Works from the Collection of the Moscow Museum of Modern Art» was held at the station Partizanskaya in a unique train – the Art Gallery «Watercolors».

Special attention of the passengers was drawn to the unusual event called «The Voices of the Metro» which started on May 1 and encompassed all the metro lines. The participants of the project were 24 Russian celebrities: actors, musicians and TV stars. They recorded the announcements that are transmitted for the passengers in a metro train.

The attention of the young passengers was attracted by another event which also started on May 1 – the interactive game «Mobile Quest». To participate in this event, one needed to install a special application «Mobile Quest» in his/her phone. It could be downloaded free of charge from Google Play or App Store. The players had to take one of the three themed routes: «Stations that have changed their names», «Sporty Moscow» and «Inspiration in the metro», each of them included five questions.

On May 5, special stands were installed in the vestibules of 12 stations in the Koltsevaya line. They were meant for taking photos. They had a cutout for the face and depicted the metro employees.

From May 11 to 13, 2015 the health complex of the Moscow Metro «Forest Town» hosted the Spartakiad among teams representing different metro systems. It was organized by the International Association «Metro» and dedicated to the 80th anniversary of the Moscow Metro. The event is traditionally held with the aim of strengthening the friendly ties between the metro employees who come from different cities and states, as well as to promote a healthy lifestyle and sports.

«Forest town» welcomed the participants of the Spartakiad for the eighth time. There were teams from Moscow, St. Petersburg, Kazan, Nizhny Novgorod, Yekaterinburg and Samara.

When opening the Spartakiad, the Chairman of the Council of the International Association «Metro», Head of the Moscow Metro Dmitry Pegov noted that the effect of the Spartakiad can be seen in the improved quality of work of the metro employees of subways, because the competitions and the preparation for them require constant training, which undoubtedly has a positive effect on the health of the employees.

The trade union organization of the Moscow Metro organizes annual competitions in 17 sports, where participants can prepare for the forthcoming annual Russian Spartakiad. First of all, the invitations are provided to the best players of the teams that participated in the Spartakiad that was held at the Moscow metro.

This year the teams will compete for the champion's title among the metro systems of Russia in the most popular sports: indoor soccer, volleyball, table tennis, bowling and chess. Each team consists of 18 sportsmen. Thus, over a hundred people will participate in the competitions.

The photo exhibition «The Faces of the Metro» was opened on May 12 at the station Delovoy Tsentr. The exhibition presents 84 portraits of employees of different services and departments of the Moscow Metro. The exhibition is unique, because the portraits depict not only the honored workers of the enterprise – the visitors could see completely different specialists: those who work in the tunnels and stations and the employees of the Metro Directorate.

On May 13 the Serpukhovsko-Timiryazevskaya line presented a train dedicated to the 80th anniversary of the Moscow Metro. Each car of the new train is associated with a decade in the history of the Moscow metro.

The Moscow Metro issued half a million copies of festive tickets dedicated to the 80th anniversary of the Moscow Metro, they could be purchased at the ticket offices of all stations from May 14 to 17.

On May 15, the Moscow Metro received birthday greetings from officials, actors, business partners and ordinary passengers.

An anniversary parade of trains was held on the Koltsevaya Line on May 15 and 16. Besides the usual «Rusich» trains,

one could see trains of a variety of models running on that line on those days. The parade of trains was started by Head of the Moscow Metro Dmitry Pegov. Each train left the station Oktyabrskaya to the sounds of music played by an orchestra.

An exhibition of vintage metro cars took place at the station Partizanskaya on May 15 and 16. The exhibition presented examples of the rolling stock that operated in the Moscow metro in different years. One could travel to the past thanks to an exhibition of uniforms of the metro workers of those periods - a uniformed worker stood by each type of car, and the uniform of each worker matched the period when these cars were operated.

Six types of paper models of Moscow metro trains were specially developed for the anniversary: «A», «Ezh3», «Yauza», «Rusich», the most common type of car 81-717/714 («the numbered one») and the newest type – 81-760/761. Anyone could build a collection of cars – on May 15 and 16 the metro employees distributed more than 70 thousand paper models in the vestibules of the stations on the Koltsevaya Line and on the Sokolnicheskaya Line from the station Sokolniki to the station Park Kultury.

On May 15 the first Career Center in the history of the Moscow Metro was opened at the station Vystavochnaya.

An unusual exhibition was opened on May 15 in the lobby of the Metro Directorate – it presents portraits of the managers of the metro who headed the enterprise in different years. An unusual exhibition was opened on May 15 in the lobby of the Metro Directorate – it presents portraits of the managers of the metro who headed the enterprise in different years.

On May 15 Head of the Moscow Metro Dmitry Pegov personally presented awards to the best employees.

A festive concert for the employees of the Moscow Metro was held on May 15 at the State Kremlin Palace.

On May 16 the park «Sokolniki» held the music festival «80 years to the beat of the capital» dedicated to the anniversary of the Moscow Metro. The headliners of the festival were Valery Syutkin, the bands «Moralny Codex» and «Neschastny Sluchai».

On May 18-19 an exhibition of maintenance trains and service trains was held at the Partizanskaya station. The exhibition featured the trains which are used for repair and maintenance of the track, tunnel structures, electric power supply equipment, signaling and communication equipment, installation of equipment.

On May 16 the jubilee lottery «80 years to the beat of the capital» was launched.

On May 20 a unique train started to operate on the Arbatsko-Pokrovskaya Line. Its appearance is based on the design created by the passenger who won the competition «The Colors of the Metro».

On May 20, cancellation of the picture postcard «The Armored Train «Moscow Metro» was performed at the station Partizanskaya. Head of the Moscow Metro Dmitry Pegov and Deputy Head of the Federal Communications Agency Vladimir Shelikhov ceremoniously stamped the postcard with the date May 20, 2015 and signed envelopes. The official events and receptions were attended by 45 representatives of metro systems and transport companies of Russia, CIS and other countries from the 23 largest transport companies of the world – a total of about 100 people.

Source: the Official website of the Moscow Metro

Meeting of the Council of the International Metro Association in Moscow

On May 14, 2015, within the framework of the events dedicated to the celebration of the 80th anniversary of the Moscow Metro, a meeting of the Council of the International Metro Association was held. An international round table discussion was also organized jointly by the Metro Association and the International Union of Public Transport (UITP).

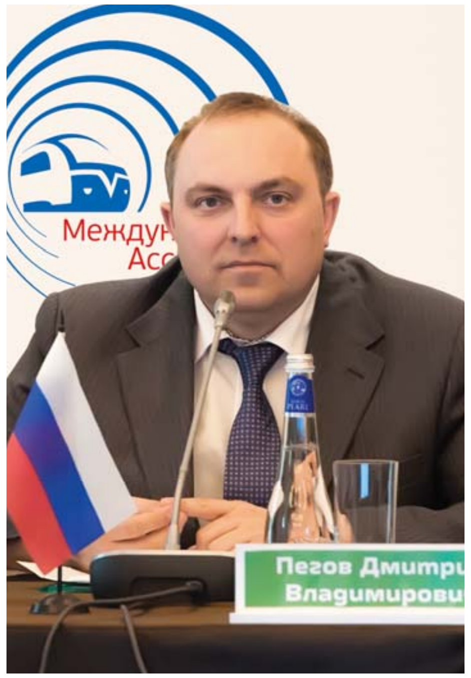
These events were part of the extensive business program of the Passenger Forum – the event that was dedicated to the discussion of the development of passenger transport and was held that day in Moscow. Representatives of the International Metro Association were invited to the Passenger Forum where they took an active part in the discussion on the development of the metro. This subject was discussed in the context of the development of urban rail transport and suburban railway transportation.

The meeting of the Council of the International Metro Association was opened by the Chairman of the Council, Head of the Moscow Metro Dmitry Pegov. He greeted the participants of the meeting and thanked them for their support of the activities of the Association and for active participation in its events.

During the meeting the Council members listened to the report of the Director General on the work of the Association in 2014. In particular, it was noted that in the reporting period the Metro Association continued to work actively to expand its activities in many areas. The metro systems and enterprises forming the Association used the achievements of the scientific and technological progress, innovations in the field of technology, safety and personnel management, which resulted in significant achievements. The events provided for in the Plan of activities of the Association for 2014 were carried out in strict accordance with the Plan.

Along with its main activities the Association steadily continues to expand its media profile. This is largely promoted by the recently established information resources: the website of the Metro Association http://www.asmetro.ru and the Association's magazine «METRO Info International», the third issue of which appeared in April 2015 (No. 1 for 2015). The magazine is issued on a regular basis, and the management is working on the preparation of the next issue.

One of the important items on the agenda of the meeting was the admission of the new participant to the Association – Axis Communications, LLC. This enterprise works in the sphere of production and installation of video surveillance equipment. It is highly respected, and its technologies are now very important for metro systems which are focused on the issue of transport security.



In addition to the organizational issues the Council discussed the technical issues raised by the representatives of metro systems. The decisions that were made allowed to introduce changes to the updated technical documentation of metro systems. Taking into account the forthcoming jubilee – the 60th anniversary of the St. Petersburg Metro, the Council decided to hold the next meeting in St. Petersburg in November 2015.

At the end of the meeting of the Council D.V. Pegov invited those present to visit the numerous events organized by the Moscow Metro to celebrate its 80th anniversary.

The international round table discussion on the current problems of metro systems that was held on the same day gathered a respectable audience of metro experts, manufacturing enterprises, research and development organizations. The event was held under the chairmanship of the Mr. Alain Flausch, Secretary General of the International Union of Public Transport. The reports on behalf of the UITP were delivered by Mr. Pere Calvet, Chairman of the UITP Metro Committee, the Head of the Barcelona Metro and Mr. Yo Kaminagai, Head of the Design Department of the Paris Metro. The report by Pere Calvet «Modern Trends in the Construction of Metro Systems in the World» discussed the issues of the need for the design and construction of subways in cities while taking into account their long-term development. It also included an evaluation of the attractiveness of the construction of automatic metro lines. This issue caused a great interest among those present. At the end of the report there was an active discussion on the criteria that determine the need for automation of the movement of trains in the metro. Mr. Calvet's report also provided the historical material on the origin and formation of the International Union of Public Transport and the first metro systems of the world.

Mr. Kaminagai's report «Design Innovation: The Key to Integrated Management of New Metro Stations» invited the attention of the participants to the options for using the station design stage to eliminate the problems that arise in organizing the work of a station. Using the example of the Paris Metro he presented solutions that enable to regulate the passenger traffic by optimizing the locations of the entrance lobby equipment and the cash registers, the placement of the service personnel. Also, attention was paid to the design of stations. With account taken of the experience of urban transport systems in different countries, he presented an analysis of the operational efficiency of the passenger area at different degrees of coordination of the metro with other modes of transport, as well as an analysis of the importance of the construction of transfer hubs.

According to the Program of events, on May 14, 2015 the heads of the metro systems forming the International Metro Association visited the official reception by the Mayor of Moscow where they were welcomed by Mayor of Moscow S.S. Sobyanin and Mr. M.S. Liksutov, Head of the Moscow Transport Agency. An outstanding event of this meeting consisted in signing of an agreement on cooperation and partnership between the Moscow and the Beijing metros. The agreement was signed in the White Hall of the Moscow City Government by Head of the Moscow Metro D.V. Pegov and Vice-President of the Beijing Transport Authority Chen Xilin.

The events of May 14 were followed by the reception held by Head of the Moscow Metro where heads and representatives of metro systems and enterprises of the International Metro Association congratulated the staff of the Moscow Metro on the anniversary and gave D.V. Pegov souvenirs.

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Innovation project of ZAO Transmashholding – rolling stock for the metro «Jubilee»

In 2015, ZAO Transmashholding started the deliveries of the new trains for the St. Petersburg metro. In the implementation of this project the main role was played by the members of the holding company: OAO Oktyabrskiy Electrovagonoremontniy Plant (St. Petersburg) and JSC Metrovagonmash (Mytishchi).

As a result of the work of the specialists of these enterprises, there is an absolutely new, modern, efficient and comfortable train which is the next step in the development of domestic metro trains.

The train was developed under the technical design assignment based on the tender requirements of the State Unitary Enterprise «Petersburg Metro».

During the design stage the modular concept of design was adopted as the basis, that provided the possibility of duplication and replacement of most systems without additional modifications and adaptations of the train, which enables to optimize the product price and to ensure a stable rate of production.

The train was created with maximum use of products by the Russian suppliers and Russian materials, the load-bearing structures of the body and the bogie frames were completely made and designed in Russia using the existing national normative and technical documentation.

The train uses a modern asynchronous traction drive based on IGBT-transistors, which helped to get rid of the bulky and heavy contactor equipment, to reduce the size and weight of the underfloor equipment and bogies. The traction equipment was designed as a single power unit – a container, which enabled to significantly reduce the length of the power lines and to reduce the weight and the complexity of manufacturing the cars. The higher traction characteristics of the traction drive enabled to make two of the six cars non-motorized, which also significantly reduced the total weight of the train.

The car bodies are made of stainless steel for durability and stability of the mechanical characteristics for the entire operating period. During the design of the train computer modeling was widely used, as well as analysis of the mechanical parameters of the underframe. The results of computer modeling were confirmed experimentally during the tests of the first train, which enabled to create the underframe which has the required strength parameters and minimum weight of the structure.

Due to the optimal selection of the structural elements and their parameters, the total weight of the six-car train determined during the tests is comparable to the weight of a similar train with a body which was designed with the use aluminum alloy elements, the difference is not more than 5%.

The load from a wheel pair of an empty car on the rail is not more than 12.3 t for the motorized car and 10.1 t for a non-motorized car. This helps to minimize the dynamic loads on the track and, consequently, to reduce the maintenance costs.

The overall reduction in the weight of the train allowed to increase its energy efficiency. The specific energy consumption demonstrated during the tests in real mode of motion (a section with a length of 1100 m, grading of track +3‰, velocity of circulation: 31 km/h, intensity of traffic: 28 cycles of starts per hour) is not more than 30 W*h/t*km.

The weight reduction has also had a positive impact on the dynamics of acceleration and deceleration of the electric train. Despite the presence of non-motorized cars in the train, during the tests the train demonstrated a maximum acceleration of more than 1.4 m/s^2, a maximum deceleration of over 1.5 m/s^2, the acceleration time to 80 km/h – 28 s, these are currently the best performance figures among similar trains in the Russian Federation.

The train enables start of movement and smooth operation on gradients of up to 60 ‰ in case of shutdown of one or two motorized cars, which ensures the safety of passengers and compliance with the timetable, even in the event of faults.

Much attention in the design and manufacture of new trains was paid to the safety and convenience of train control. The company designed a new comfortable and spacious cabin with a control panel which meets all the sanitary and ergonomic requirements. The cabin is equipped with a single-piece windshield over the entire width, but it is possible to evacuate the driver and the passengers through the front part. The front part of the control cabin is equipped with LED lamps specially designed for this project.

The train is equipped with a modern control and diagnostics system, as well as with a system of safety and radio communications. During the tests, the functioning of all systems of the train was thoroughly checked, as well as their impact on the operation of the metro safety systems. As a result, the tests confirmed full compatibility of the train with the infrastructure of the metro and the safety of its operation.

In order to ensure comfortable working conditions of the driver, the cabin is equipped with an individual air conditioning system. On the side surfaces of the body there are video cameras providing a view along the train with the information output to the CCTV monitor and rear view mirrors with remote adjustment from the driver's workplace. The driver's seat is equipped with air suspension and provides a large number of adjustments, which significantly reduces the driver's fatigue.

The passenger compartment is equipped with a seating area with individual seats, which ensures comfortable travel of the passengers. The head cars are equipped to accommodate a handicapped person in a wheelchair and those who accompany such person. Also, in the absence of a handicapped person these areas equipped with folding seats can be used for placing perambulators, bicycles and other bulky luggage. To facilitate boarding and disembarking of a handicapped person in a wheelchair, the doorways of the head cars are equipped with folding entrance ramps. The system of handrails in the passenger cabin provides comfort for the standing passengers and safe movement inside the car during the movement of the train. The artificial lighting inside the train was arranged on the basis of LED light lines which provide maximum illumination with minimum power consumption.

The cabins are equipped with a forced air ventilation system providing fresh air to the passengers. The noise level of the system is significantly lower than with the traditional ventilation system that uses air supply ducts. The

information system provides the passengers with all the necessary information about the position of the train on the line and the route, as well as other information and advertising materials. The communication between the passengers and the driver is provided by means of the emergency communication units located in the cabins. A video surveillance system is integrated into the information system, it allows the driver to assess the situation in any car of his choice and to see the passenger calling him when communicating via the emergency communication units. The surveillance system cameras are integrated into the interior elements and due to this are inconspicuous and protected from vandalism.

To ensure the comfort of the passengers and to reduce the vibration load of the car elements and the impact of the car on the track, the suspension design has been optimized. The first stage uses specially selected helical springs, the second uses air springs based on rubber-cord casings which provide high smoothness of movement and invariance of the floor level relative to the platform level at any passenger load. These devices are equipped with rubber-metal elements that ensure safe movement of the car when an air spring is disconnected or damaged.

Entrance doors are equipped with a pneumatic actuator. Above the entrance doors from the outside there are lighting fixtures that provide warning for the passengers about the closing doors.

The train is equipped with a fire detection and extinguishing system that ensures timely detection of a fire and informing of the driver on the location of the fire or smoke.

The traction drive and traction electric motors are supplied by one of the world leaders in the industry – the Japanese company Hitachi. The traction electrical equipment provides acceleration and deceleration of the train with minimum consumption of electricity, the possibility of recuperation of electric energy during braking, high reliability at the lowest possible amount of maintenance. Traction drive is asynchronous, based on IGBT-transistors. The modular design of the train ensures cost-effective integration of any traction drive, i.e. a drive provided by foreign suppliers or a drive developed by OAO «Metrovagonmash».

So far, the SUE «Petersburg Metro» has received seven trains, six of them have already been put into operation. In the summer of 2015 the first train successfully passed the acceptance tests which confirmed its compliance with the requirements of technical specifications.

Considering the number of the new technical solutions applied to the construction of the train «Jubilee», it can be regarded as an innovative product, and its technical characteristics make it one of the best in its class in Russia.

Parameter	Car models		
	Head motorized car 81-722	Middle motorized car 81-723	Middle non-motorized car 81-724
Car tare weight, no more than, t	32	31	24
Train tare weight, no more than, t	174		
Number of seats, no less than	36	44	44
including the folding seats, no less than	4	12	12
Number of locations for wheelchairs	2	-	-
Rated capacity at the rate of 5 pax/m² of vacant floor space with account taken of the sitting passengers, number of passengers	174	187	187
Capacity at the rate of 8 pax/m² of vacant floor space with account taken of the sitting passengers, number of passengers	253	272	272
Maximum capacity at the rate of 10 pax/m² of vacant floor space with account taken of the sitting passengers, number of passengers	306	330	330
Maximum passenger load of the car, tons	21.42	23.1	23.1
Maximum passenger load of the train, tons	135.24		
Maximum capacity of the train, number of passengers	1932		
Rated capacity of the train, number of passengers	1096		
Number of seats in the train with account taken of the folding seats	248		
Design speed, km/h	90		
Maximum acceleration during starting up to speed, m/s²	no less than 1.4		
Maximum deceleration during braking action, m/s²	no less than 1.5		
Acceleration time up to 80 km/h	28		

60th anniversary of the St. Petersburg Metro

The first ideas of the construction of metro in St. Petersburg began to appear at the beginning of the 19th century. Emperor Nicholas II was offered several options for off-street public transport designed in the European tradition – the railway was supposed to pass both underground and above it via elevated lines.

Back in 1820, the engineer Torgovanov addressed Alexander I with the assistance of Count M.A. Miloradovich for presenting a project of construction of a tunnel under the Neva. The resolution was as follows: «Give out 200 rubles to Mr. Torgovanov from the office and bind him with an obligation signed by him not to engage in any projects, but to practise in the areas that are appropriate for him.» Similar ideas were suggested by the famous self-taught inventor I.P. Kulibin but without success. Due to certain circumstances, the unfulfilled projects also included the St. Petersburg inventions of the famous «father of tunneling», English engineer of French origin Marc Isambard Brunel. The Nikolaevsky (Blagoveshchensky) Bridge built in 1855 postponed for some time the solution of the problem related to the connection of the Neva banks and to passenger and freight transportation from the city center to Vasilyevsky Island. But soon the problem became rather urgent. At the turn of the century St. Petersburg became a fast-growing industrial city, its historic center turned into the focus of business activity. The fast-paced urban life, the increase in the traffic intensity in the old streets and avenues forced the authorities to pay attention to new and not yet traditional ways of solving the transport problem.

The intensity of traffic on the streets of St. Petersburg in the late 19th – early 20th century: more than 26 thousand carters, about 15 thousand passenger carriages, 370 cars with horse and steam traction, hundreds of omnibuses and automobiles, in 1907 a tram appeared and there were about 10 buses.

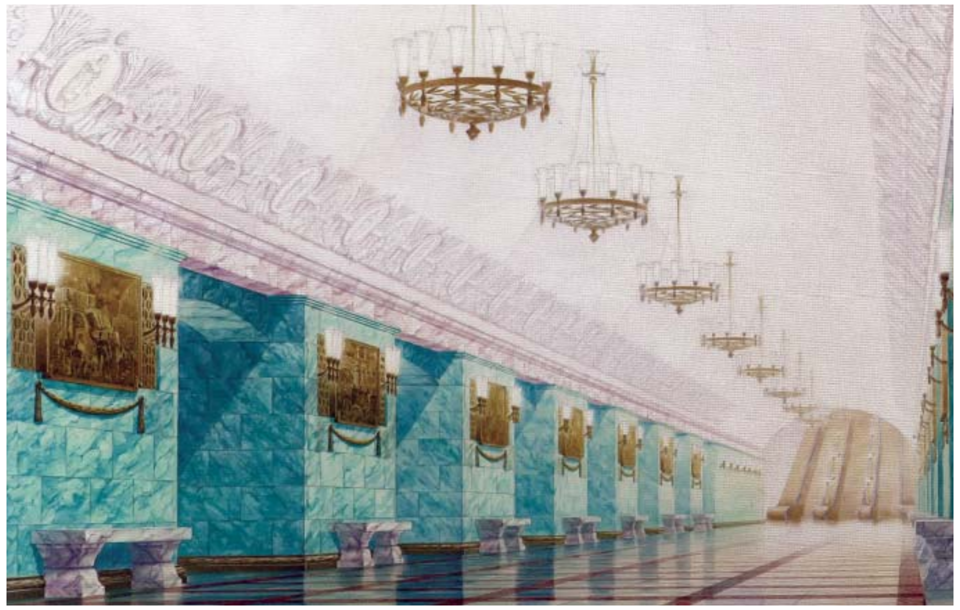
In 1889, the Directorate of the Baltic Railway put forward the first project of an urban line between the Baltiysky and the Finland Railway Stations. This was the beginning of numerous suggestions and developments which were predecessors of the St. Petersburg metro. Since the late 1890s such suggestions and developments came almost every year from different organizations and individuals. In most of the first projects the urban railway was designed primarily for connecting all the stations with a single line, as well as for relief of traffic on Nevsky Prospect – the main thoroughfare of the Russian capital. It should be noted that the projects of that time were characterized not by a desire to connect the city center with the outlying suburbs in the south or beyond Novaya Derevnya as to relieve it from street traffic. Almost all the pre-revolutionary developments included the construction of overhead lines on elevated structures which were applied in many cities of the world at that time, with extensive use of St. Petersburg's canals – Obvodny, Yekaterininsky (today – canal named after Griboyedov), Vvedensky and others. In 1900 I.V. Romanov tested a section of an overhead monorail near Gatchina. The tests were successful. Later Romanov created a project of the Ring road around St. Petersburg.

In 1901, the engineer Pechkovsky suggested building a suburban station in the middle of Nevsky Prospect, near the Kazan Cathedral, and connecting it with a line that is partly located on elevated structures and partly underground (over Yekaterininsky and Obvodny canals and under Zabalkansky Prospect) with the Baltiysky and Varshavsky railway stations. In the same year the engineer Reshevsky who had worked on a task given by the Ministry of Transportation developed two versions of a project aimed at connection of the lines of all the Petersburg railway stations into a single urban transportation hub. The most interesting developments were the result of several years of hard work performed by one of the first theorists of the Russian subway construction, the railway engineer P.I. Balinsky. (Photo 3) His project provided for the construction of six urban lines, including two large circular routes with a total length of 95.5 versts (172 km). The cost of the construction work (including the filling operations in the low-lying areas of the city to avoid floods, the construction of 11 major bridges, the construction of embankments and elevated structures with a height of 5-10 m, railway track laying, etc.) according to his project was estimated at 190 million rubles.

Using such grounds as the statistical calculations and having carefully analyzed examples from world practice, Balinsky was absolutely convinced of the feasibility of implementing this initiative in Russia. «In our difficult time, – he wrote, – it is impossible and simply outrageous to make the poor and average citizens spend so much time on transportation alone during the day. Therefore, there is no doubt that in the cities with a population of over a million... the necessity itself is making us start building such means of transportation that would not depend on the ever increasing urban street traffic and would have the greatest carrying capacity and speed, i.e., in other words, it is necessary to start building metro.» When speaking in 1902 in the Moscow City Duma in support of his projects, he said with regret that by that time all the biggest cities in the world «with a population of a million people or more already have or are building (like in Tokyo) urban high speed railways or metro systems, and the exceptions ... include only three European cities: St. Petersburg, Moscow and Constantinople, as well as six Asian cities: Canton, Calcutta, Beijing, Xiangtan, Hong Kong and Changzhou.»

Such judgments, in general, found sympathy among entrepreneurs and some prominent statesmen. The idea of the metro was supported by S.Y. Witte who was familiar with Balinsky's projects and approved of his cost estimates.

Almost simultaneously with Balinsky's proposal (in 1902) another project was submitted by the engineer G.A. Girshson. Its creator continued to work on it for the next seven years. It presupposed the connection of the Baltic and Warsaw Railways and planned further extension of the line along the embankment of Fontanka, Yekaterininsky canal, Lebyazhya kanavka, across the Neva to Kamennoostrovsky Prospect and further across the Bolshaya Nevka to the Finland Railway. This project planned laying of an underground line under Nevsky Prospect – from the Moskovsky railway station to Palace Square.



Ideas on the urban railway system were suggested at different times by the engineers N.O. Kulzhinsky (1902), A.N. Gorchakov (1909), F.E. Yenakiev (1912), G.O. Graftio (June 1917), as well as by the Directorate of Urban Railways (1917). However, the conflict of different interests which often contradicted each other during the discussions of all of these projects in various agencies, as well as the need for great financial expenses for their implementation, appeared to be insurmountable obstacles to the implementation of the idea of the St. Petersburg metro.

The idea of the construction of the metro was later discussed in the Soviet era. In 1937, at the initiative of the Chairman of the Leningrad Executive Committee Alexey Kosygin the issue was raised again, and the construction of the metro was eventually entrusted to the experts of the Moscow Institute «Metrogiprotrans». The key directions of the future lines were determined, these were the prototypes of the currently operating ones. It was planned to draw up the main project in only one month. According to the project, the first line of the Leningrad subway was to link four out of the five railway stations of the city and to provide about 30 percent of all the transportation by public transport. In January 1941, Construction Directorate No.5 of the NKPS was created in Leningrad. It was to provide and coordinate all the work on the construction of the metro. Its successor was ZAO Metrostroy. Initially, the project of the first line included 12 stations from Avtovo to Baburin Pereulok.

In April 1941, 34 pit shafts were laid, but the war that began soon made its own adjustments to the construction of the Leningrad metro.

In December 1944, the Secretary of the Leningrad City Committee of the CPSU (b) A.A. Kuznetsov addressed the People's Commissar for Transport L.M. Kaganovich with a request to resume the work on the construction of the metro. This step resulted in the Decree of the State Defense Committee of the USSR «On the resumption of the work on the construction of the metro in the city of Leningrad» signed by the Chairman of the State Defense Committee Joseph Stalin.

In 1946 the Institute «Lenmetroproekt» was established, and in September of the following year the construction of the first stage of the metro was started, it included eight stations and an electric engine house. By that time the Soviet Union already had the experience of the construction of the Moscow underground structures. But the experts from Leningrad did not merely copy the Moscow technical solutions and applied a number of innovations.

In particular, one of the interesting effects is the so-called «slope», when stations were built on a hill and the tunnel went to a lower level. This enabled trains to save electricity during the descent. When they went up the next station, the train used inertia and moved with minimum power consumption. The trains have to descend to a considerable depth - the St. Petersburg Metro is one of the deepest in the world. Its tunnels pass at the level of the Archean strata which were formed about 4 billion years ago.

Another know-how of the 20th century which still surprises the visitors of the city is the so-called «horizontal lift», or the enclosed type stations. The automatic doors at the platforms prevent people from falling on the track. Construction of such barriers in accordance with the modern technologies will be continued; glass doors may appear at the stations on Line 3 prior to the 2018 Football World Cup.

The opening of the Leningrad Metro was planned for November 15, 1955. But a few days before that date, the first passengers were allowed to see the metro using the invitation tickets. (Photo 5) The interest in the opening of the metro was immense. The invitation tickets were received mostly by activists and best workers. A few days before the official opening of the metro the stations were visited by tens of thousands of people. The invitation tickets enabled those lucky visitors to move in the metro, see the stations without any haste and admire the architecture and artistic decoration of the vestibules. Most of the passengers made enthusiastic reviews about their first visit to the metro.

Main figures for St.Petersburg subway

Main indicators	1955	2015
Length of the maintained track	10.8 km	113.6 km
Number of lines	1	5
Number of stations	8	67
Number of electric engine houses	1	5+1*
Number of the employees of the metro	2000 people	15 000 people
Number of passengers transported (per year)	81 mln people	784 mln people
Number of passengers transported (per day)	220 thous. people	2,5 mln people

These and many other facts can be learned by visiting the exhibition at the Museum of the St. Petersburg Metro that was opened to celebrate the 50th anniversary of the metro in 2005 at the following address: ul. Odoevskogo, 29. It has been seriously updated recently. The modern multimedia system and unique exhibits will let you know the history of the metro by fully immersing the visitors into the fascinating world of the metro. The advanced technologies used in the reconstruction of the museum made it an information center which can be used as the basis for holding classes on introduction to the speciality for students of industry-specific educational institutions, as well as events for occupational guidance for the youth.

On the eve of the 60th anniversary of the metro the unique project «Professionals» was launched. Its goal is to acquaint the passengers with the people who ensure the correct and coordinated operation of the subway every day. Posters with photos of 60 metro specialists are placed in the inclined tunnel of each station. Employees were photographed at their workplaces, which illustrates the variety of professions in the metro. The official website of the metro provides the stories of their achievements and information about their hobbies. The list of the professions includes electricians, engineers, dispatchers, mechanics, drivers, walking inspectors and other representatives of the big and friendly team.

Another good tradition is the issue of collectors' tokens. They are dedicated to the anniversary of the metro, the first engine, the 5-copeck coin which was used as a token for a long time. You can also find the token from the series «The History of the Rolling Stock» – the car 81-722/723/724 (project «Jubilee»). All the tokens were made at the St. Petersburg Mint.

A limited edition of the electronic ticket «Plantain» was released for citizens and guests of the city. It is based on the contactless smart card and has a new, anniversary design.

The metro is a part of the transport system of St. Petersburg. And according to the needs of the city it is changing the usual rhythm, making changes in the organization of work of the stations and movement of the trains.

In 2015 the St. Petersburg Metro organized the movement of trains around the clock without the night-time technological break for the first time. This work was organized during the city holidays: on January 1 and 7, April 24 (the Orthodox Easter), May 2 and 10, May 16-17 (the Night of Museums), May 27 (the Day of the City), June 20-21 (the holiday of the school leavers «The Scarlet Sails»).

Taking into account the characteristic feature of the city on the Neva River, with its drawing-bridges, the night-time shuttle movement of trains was organized on the section between the stations Sportivnaya and Admiralteyskaya. During the bridge raising period from April 30 till November 15 the trains carry passengers from 1:00 till 3:00 a.m.

Not so long ago the St. Petersburg metro started to widely use contactless smart cards and electronic tickets based on them. But today one can see passengers who use their bank card or mobile phone for making a payment at the turnstile. Non-cash payment can significantly increase the visitor capacity of the metro vestibules, while reducing the workload of the cash registers, reduce the work effort of the staff related to the organization of cash circulation, reduce the passenger service time at the ticket machines. The method of payment using the PayPass and PayWave technologies is becoming increasingly popular.

The power supply system has seen major changes in the recent years. New equipment and advanced technologies are regularly introduced. There is a program of measures to increase the lighting at the stations by replacing the existing light sources with the new LED ones. In 2014, the station «Technological Institute-1» started to use metal halide lamps of the latest generation. After the major repairs in 2014, LED lighting fixtures were installed at the station Ligovsky Prospect in the vestibule and in the service facilities of the inclined tunnel. Additional electricity meters were installed, so it is possible to assess the economic impact and reduce the operating costs.

Since 2008, the activities of TsLM include a new direction - thermal imaging diagnostics. For its implementation it was necessary to solve several problems: to select a thermal imaging camera that is suitable for this type of work, to ensure its integration with the laboratory car of the special train, to develop software that would allow to anchor the individual frames of the thermal imaging film to the tunnel coordinate (picket), to carry out the selection and training of the personnel. Since July 1, 2009, the system of thermal imaging control has been in permanent operation.

For the first time in the practice of the CIS metro systems, the switch assembly of project 3045 was laid and put into trial operation at the station Mezhdunarodnaya on Line 5. It uses a reinforced concrete slabs and elastic grouting compound with anchors and reinforced concrete supports produced by the company Tines with the fastenings by Vossloh.

To improve the stability of the contact rail, composite brackets of the contact rail were used, as well as electric connectors for the joints of the contact rail (new type – ETS-250).

The St. Petersburg Metro was the first to implement and successfully apply the technology of alumino-thermite welding of joints of the rolling rail and the contact rail under the conditions of the tunnel.

The special pride of the tunnel structures service is the tunnel inspection test station (TOIS). Its task is not only to examine and assess the condition of the structures, to organize monitoring of the metro facilities, but also to issue specific recommendations for elimination of defects and malfunctions.

The combined workshops of the metro are a unique base for repair of escalators that meets the requirements of the enterprise for overhaul and manufacture of spare parts and non-standard equipment not only for the escalator service but also for other departments of the metro.

In 2015, the metro completed the implementation of a strategic project for the creation of new production facilities. Using the resources of the combined workshops the work was performed for dismantling, transportation and installation of the available process equipment in the new shop and within the vacant floor space of the main production building. The obsolete equipment was replaced by the new one.

The implementation of the strategic project enabled to equip the blank production shop with a 800-ton press for the production of the subfloor plates for escalator steps. In 2015, the first batch of 700 subfloor plates for escalator steps (type ET and E) was produced. The plans for the next year include production of such plates for the type LT escalator steps.

The electromechanical service of the St. Petersburg metro found a new, progressive method of saving the electrical energy consumed by the air handling units of the metro tunnel ventilation system. It is the Parametric System for Tunnel Ventilation Control. The Parametric System will enable to efficiently use the power of the air handling unit to ensure smoke removal with the greatest efficiency the lowest power consumption.

Press service of the State Unitary Enterprise St. Petersburg Metro
Photos: M.Kolodkina, D. Grafova, V. Morokina, D.Raikina, I. Mashevskaya

2014 Outlook and focus on automated lines

Introduction

In 2014, 156 cities around the world had a metro system in operation. Nearly two thirds of these networks are located in Asia and Europe (54 and 46 respectively). There are 18 systems in Latin America, 16 in both Eurasia and North America, and 7 in the Middle East and North Africa (MENA) region.

The last 15 years have seen a considerable expansion in terms of metro systems and infrastructure. A total of 194 metro lines pertaining to both existing and new networks, accounting for approximately 40% of the length of metro infrastructure worldwide, have been inaugurated in this period. In total, 53 new metro systems were built and put into operation since the turn of the millennium.

In 2014 alone, 513 km of new metro lines and 355 new metro stations were put into service. New metro systems were inaugurated in Salvador (Brazil), Changsa, Ningbo and Wuxi (China), Mumbai (India), Shiraz (Iran), and Panama City (Panama).

Patronage

Metro systems carry over 160 million passengers per day (50 billion per year), a 7.9% increase compared with 2012, representing 11% of all public transport journeys worldwide.

The busiest metro network in the world is Tokyo (see figure 1), with close to 3.6 billion passenger journeys per year, and a 10% increase compared with 2012. Chinese metro systems, have experienced even more significant passenger growth, with Beijing (+39%) and Shanghai (+25%) rising to 2nd and 3rd busiest networks. Taken together, metro systems in Asia carry over 80 million passengers per day, nearly half the world total (see map).

Outside Asia, Moscow Metro remains the busiest network, with over 2.4 billion passengers per year. In North America, New York City has the highest ridership (1.8 bn). Mexico City is the busiest network in Latin America (1.6 bn, world's 8th). Paris metro has the highest ridership in Europe, with over 1.5 bn passengers per year. London (1.3 bn), Sao Paulo (1.3 bn) and Cairo (1.1 bn) complete the list of metro networks carrying over 1 billion passengers per year. Together, these 13 networks carry 54% of the world's metro passengers.

City		Annual journeys (million)	Change from 2012 (%)	Ranking variation (2012-2014)	City		Annual journeys (million)	Change from 2012 (%)	Ranking variation (2012-2014)
JR JR-EAST	Tokyo Metropolitan area*	3,636	+10%	=		Guangzhou	2,280	+6%	=
	Beijing	3,410	+39%	+2	MTA	New York metropolitan area	1,785	+7%	=
	Shanghai	2,830	+25%	+2		Mexico City	1,614	0%	=
	Seoul*	2,661	+ 8%	-2	MTR	Hong Kong	1,548	+3%	+1
	Moscow	2,451	-1%	-2	RATP	Paris	1,526	0%	-1

Fig. 1: 10 busiest metro networks (2014)
** Tokyo and Seoul have multiple operator networks. Ridership figures refer to the complete network; the logos correspond to UITP member companies in the city.*

Infrastructure

In 2014 there were 549 metro lines in operation, totalling over 11,300 kilometres of infrastructure and 9,200 stations. The average line length is approximately 21 kilometres, with an interstation distance of 1.2 km.

The highest share (45%) of the metro infrastructure is in Asia, the continent also being home to five of the ten longest networks in the world. Shanghai and Beijing are the world's longest networks, both surpassing 500 km. London is the longest network outside Asia, followed by New York, Moscow, Madrid and Mexico. Paris and Chongking (not in the graph) complete the list of cities with over 200 km of metro infrastructure each.

Looking ahead: metro automation
What is an automated metro?

Fully automated lines can be operated without staff on-board of trains – technical progress has made train control systems capable of supervising, operating and controlling the entire operational process. A defining characteristic for automated metro lines is the absence of a driver's cabin on the trains. This type of operation is also known as Unattended Train Operation (UTO), or Grade of Automation 4.

Automation brings many operational advantages, in particular, increased safety and flexibility in operation, unrivalled reliability, and more attractive job profiles for the staff on the line. Building on these strengths, metro operating companies can seize on automation as a lever for change at all company levels: operational, maintenance and customer service.

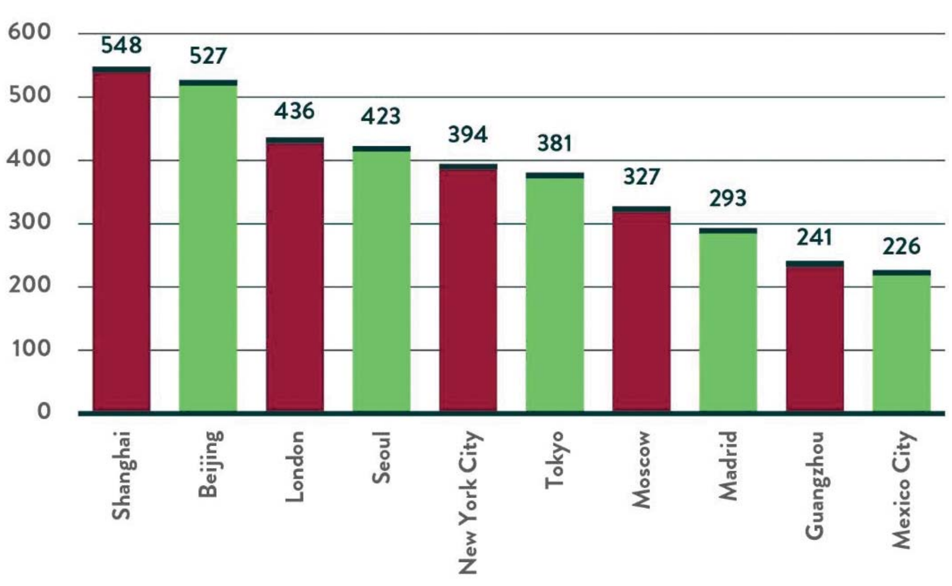


Fig. 2: Cities with the longest metro infrastructure (km)

Metro automation in 2014

Nearly a quarter of the world's metro systems exploit at least one line in UTO mode. There are in total 732 km of automated metro lines, spread over 52 lines in 35 cities across the world.

Automation has a global standing – Asia and Europe account for two thirds of the world's automated lines, but automated lines are present in all the world's metro regions – with North America playing a pioneering role. In the last decade, both Latin America and MENA have developed automated lines, with MENA showcasing one of the higher rates of growth.

At the country level, France has the highest share of the world's UTO km with 17%, followed by South Korea (15%), and the UAE – which, in spite of opening its first UTO line only in 2009, accumulates now 11% of the world's UTO km in particularly long lines. Dubai is actually the longest automated metro network in the world with 80km, followed by Vancouver (68 km) and Singapore (65 km); Asian cities take up 5 of the 10 longest automated metro networks, the remaining 3 cities being all French: Lille, Paris and Toulouse.

Characteristics and trends

Unattended train operation is possible thanks to the technological evolution on two key areas: signalling (which allowed trains to run safely at shorter intervals) and track protection systems (which substituted the driver in detecting possible obstacles on the track):

Signalling

The introduction of Communications-based train control (CBTC) systems has marked a turning point. Currently 72% of automated lines are based on CBTC, and this share is set to increase, as all suppliers increasingly adopt CBTC as their technology of choice for automation.

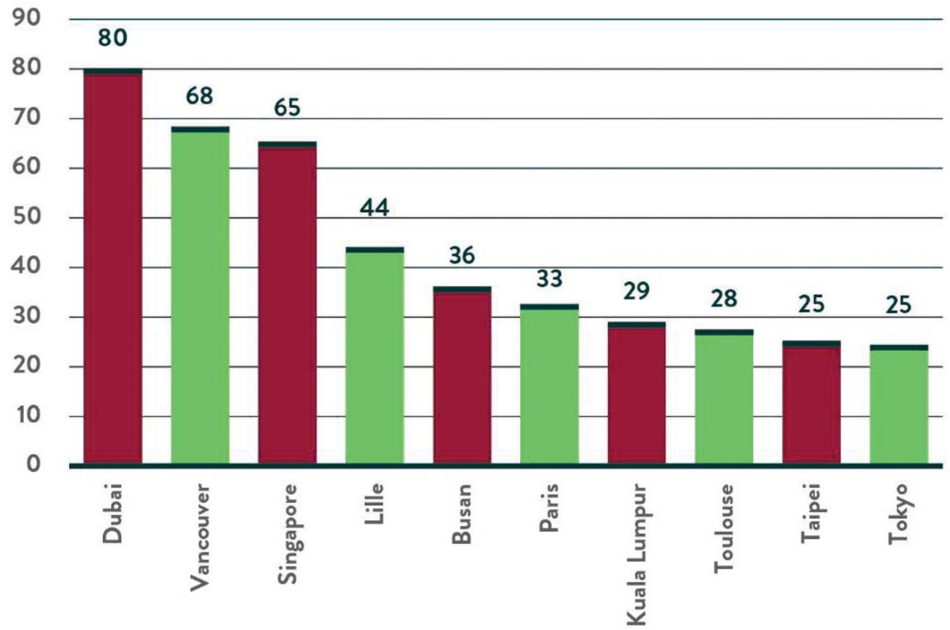


Fig. 3: 10 longest automated metro systems in the world

Platform/track protection systems

Ensuring the safety of the interface between the platform and the track is a compulsory requirement for fully automated operation. Two different approaches exist, the installation of Platform screen doors (PSD), or the use of intrusion detection systems, which detect objects or persons on the track and signal any incoming trains to stop. Platform Screen Doors is the dominant solution (see graph), since they prevent passengers/objects from falling on the track, improving the performance and regularity of the line.

Capacity

Full automation was initially developed for low capacity lines (under 300 passengers/train, as running trains at shorter intervals made up for the design of lines with shorter trains and smaller stations. While they represent 28% of the total number of automated lines worldwide, only 10% of the lines opened since 2006 are low capacity. As full automation is becoming a trusted solution for key lines, higher capacity automated lines are being introduced: mid-capacity lines (300-700 passengers/train) make up 46% of the worldwide total but 61% of the newly opened systems; high capacity lines (over 700 passengers/train) make up 26% of the total and 29% of the systems opened in the last decade.

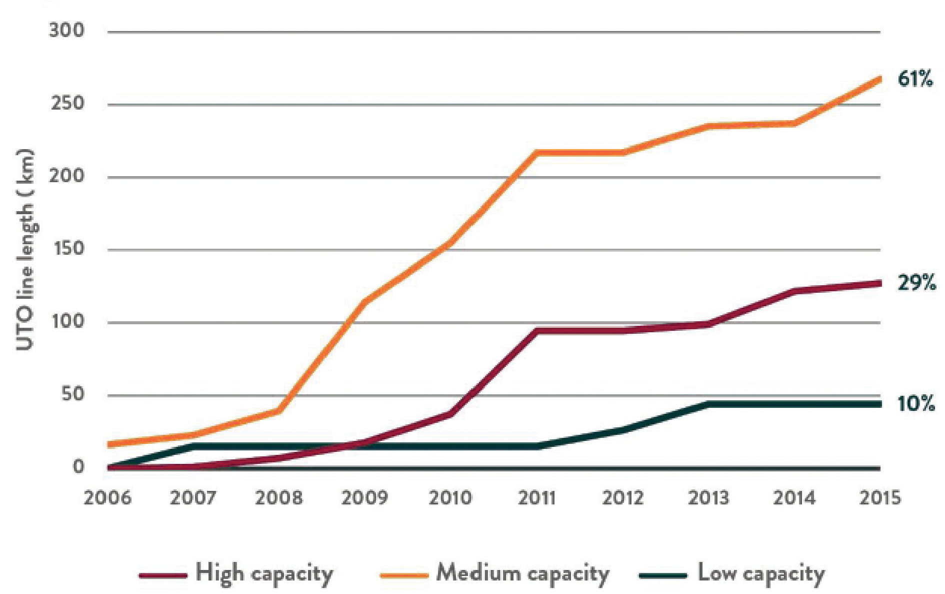


Fig. 4: Automated metro systems opened since 2006 according to train capacity

Growth

In the 40 years since the implementation of the first fully automated metro line, the growth rate for automation has accelerated exponentially with every decade – the current forecasts estimating the total length of automated metro lines to over 2200 km by 2025.

The MENA region and Asia will spearhead this growth. By 2025, the Middle East will account for 24% of the world's km of automated metro. Asia will maintain its leader position. It is significant to note that mainland China has yet to announce its first UTO project.

Methodology

The data on which this report is based was extracted from a database compiled by UITP using official company, or other authoritative sources. Please visit www.uitp.org for more information on access conditions.

Metros are high capacity urban guided transport systems, mostly on rails, running on an exclusive right-of-way without any interference from other traffic or level crossings and mostly with some degree of drive automation and train protection. These design features allow high capacity trains to run with short headways and high commercial speed. Metros are therefore suitable for the carriage of high passenger flows, and as such constitute the backbone of many public transport systems.

Metro lines included in the above statistics run with trains composed of minimum two cars and with a total capacity of at least 100 passengers. Suburban railways (such as the Paris RER, the Berlin S-Bahn and the Kuala Lumpur International Airport express line) are not included. Systems that are based on light rail, monorail or magnetic levitation technology are included if they meet all other criteria. Suspended systems are not included.

Automation criteria – Asides from the above criteria applicable to all metros, the metro automation data reflected in the statistics correspond exclusively to metro lines without staff on board (GoA4 as considered in standard IEC 62267). All data on Automated Metro lines is sourced on the work of the Observatory of Automated Metros.

UITP

This is a publication of the International Association of Public Transport. UITP has over 1,400 member companies in 96 countries throughout the world and represents the interests of key players in this sector. Its membership includes transport authorities, operators, both private and public, in all modes of collective passenger transport, and the industry. UITP addresses the economic, technical, organisation and management aspects of passenger transport, as well as the development of policy for mobility and public transport world-wide.

UITP Observatory of Automated metros

The Observatory of Automated metros gathers the world's leading operators with experience in UTO. It exchanges best practices in key issues affecting automated metro operation and monitors the global evolution and trends in line automation development and implementation. For more information, consult the Observatory website: www.metroautomation.org

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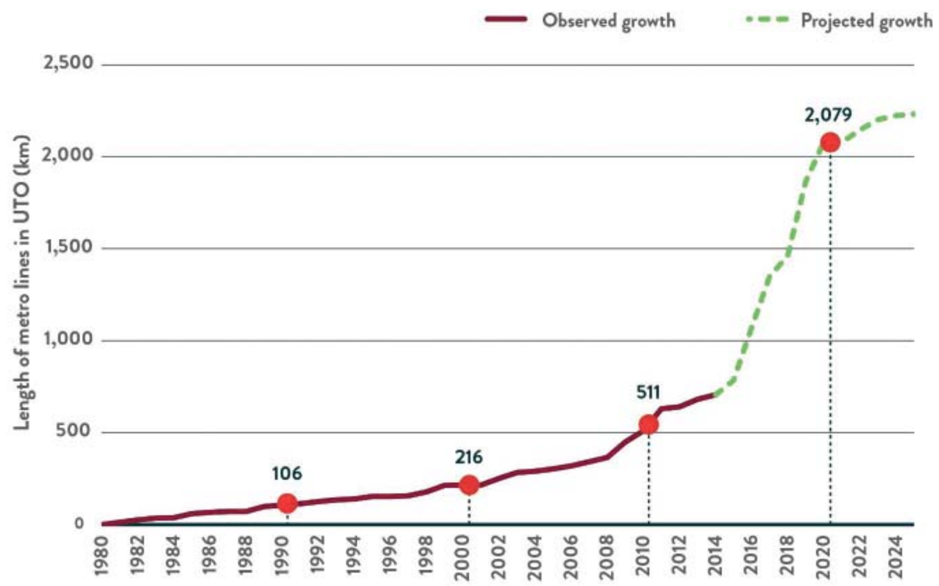


Fig. 5: Total growth in automated metros (km of line length)

Technology of Servicing of Elements of the Track at the Moscow Metro

In early 2014 the Moscow Metro put into operation a new rail-welding station and a mechanization base for maintenance and repair of track machines. The company performs the following tasks:

- Maintenance of track machines;
- Repair of the track tools;
- Welding of CWR;
- Assembly of switches;
- Repair of frogs;
- Production of non-standard equipment.

The mechanization base for repair of track machines and the rail-welding station include the following facilities:

The production building in which the following facilities are located:

- Two process lines for welding of CWR;
- Line for re-contouring of used rails;
- Blank preparation mechanical shop;
- Frog repair shop;
- Rail motor car shop;
- Storage facilities

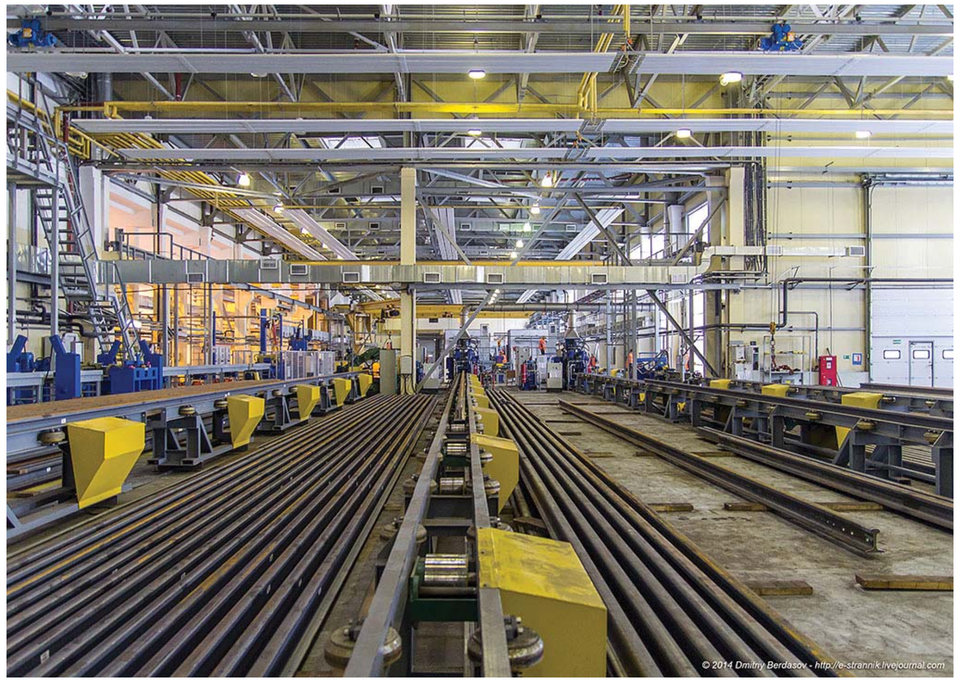
Service and amenity rooms intended for the employees of the mechanization base and the rail-welding station /

Outside process pads intended for:

- unloading and storage of rails coming from plants, length: 25 meters;
- storage and cutting of used rails to the required length;
- unloading of the track superstructure materials supplied by rail;
- carrying out of operations for the unloading of rolled metal products, pipes, sheet metal delivered by automobile transport.

Line for re-contouring of used rails is designed for processing of used rails with a length of 12.5 m for subsequent installation on the lines of the metro. The production capacity of the line enables to perform renovation of 80 km of track using R-50 rails and 30 km of track using P-65 rails annually. Restoration of the geometry of the rail head is produced by milling. Quality control is carried out by ultrasonic testing.

Two process lines for welding enable to perform welding of new rails using the electric contact method with the latest equipment manufactured by ZAO Pskovelectrosvar which ensures the highest level of production and quality control through the introduction of electronic control systems and certification of the processes.


Line for re-contouring of used rails

The total area of the industrial and office premises of the mechanization base for repair of track machines and the rail-welding station is 8000 m².

Number of employed people – 85, including:

- direct labor workers – 57 people;
- auxiliary personnel – 11 people;
- engineers and technicians – 17 people.

Commissioning of the mechanization base for repair of track machines and the rail-welding station Pechatniki will enable to:

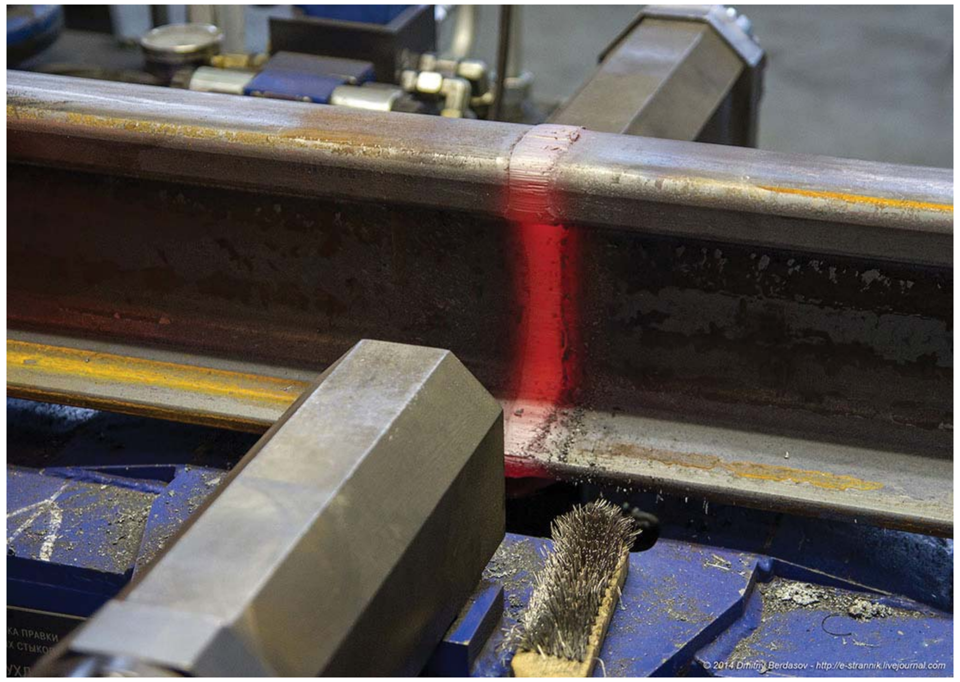
- Ensure welding of volume hardened rails in the required quantities, to increase the amount of rail welding for repair of track from 74 km to 100 km of track in 2015,
- Ensure welding of rails using own resources for the newly commissioned metro lines in 2014 – 38.5 km of track, 2015 – 84.6 km of track, 2016 – 58.6 km of track, 2017 – 20 km of track, 2018 – 29 km of track, 2020 – 18 km of track,
- Ensure re-contouring of used rails with an increase in their service life by 2-3 years,
- Ensure building-up welding of frogs in the amount of 60 pieces,
- Ensure the delivery of rail bars to the sections of South-West and South-East directions within a day (from the station Sokol – within 3 days), which will lead to a two-fold decrease in the operating costs,
- Ensure repair of all the track vehicles in the required quantities,
- Meet the needs for the repair of the track tools,
- Increase the production of the materials of the track superstructure and the manual track tools by the amount of 40 mln RUB (currently – 15.1 mln RUB).

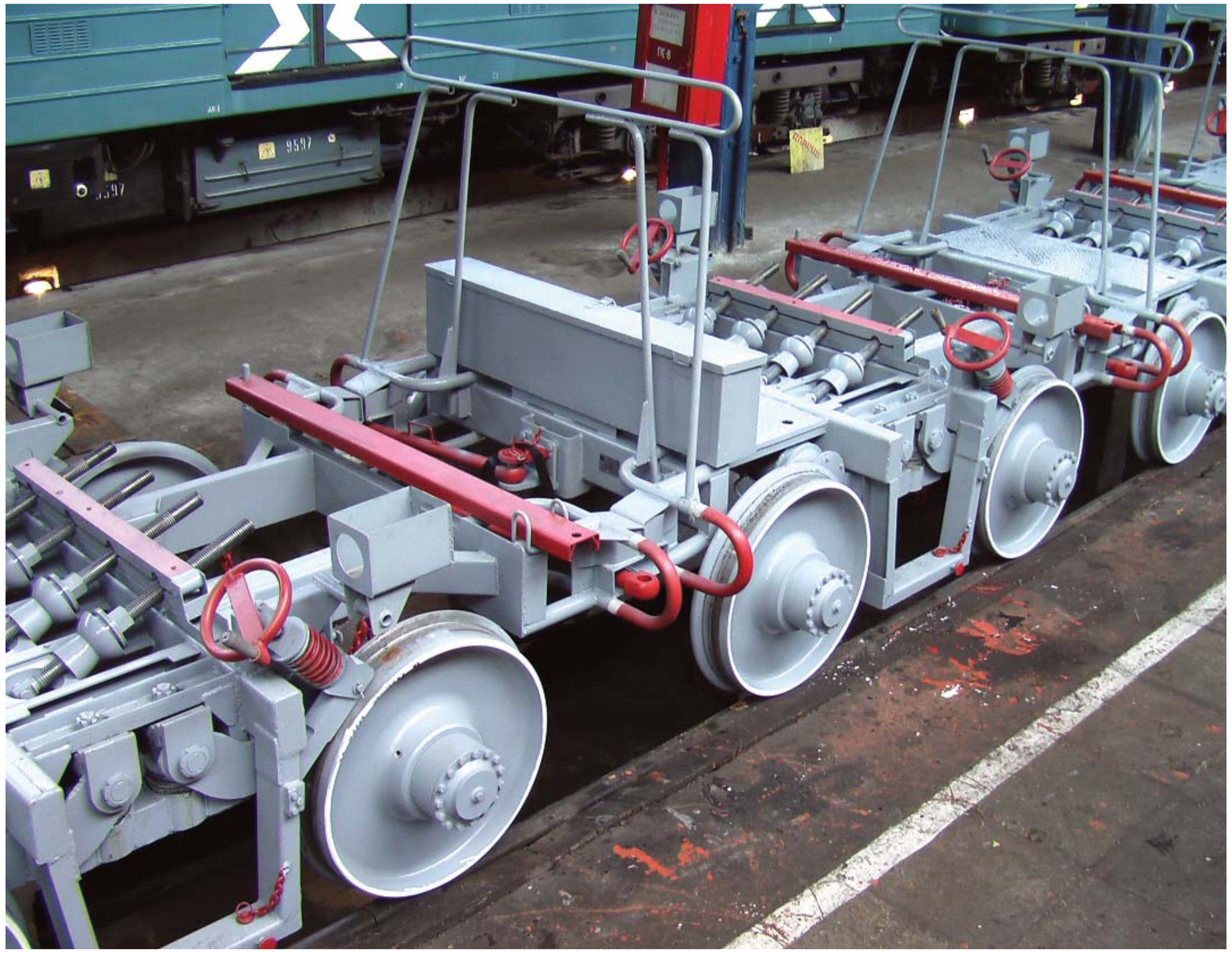
Currently the electric engine house Solntsevo is being designed. Within the framework of the electric engine house it is planned to carry out the construction of the mechanization base for repair of track construction machine with a rail welding station. Design and construction of the facility is very important for the Moscow Metro, because the technical policy provides for the introduction of modern integrated means of mechanization of track work in connection with the transition to the new track designs and the increase in the length of the metro lines almost two-fold by 2020.

The integrated work plan provides for operation of new equipment and the track machines described below for the maintenance and repair of the track superstructure.

Rail transportation trucks, type TR-4M and TR-7K

Manufacturer: ZAO MENP (Mozhaisk). Purpose: mechanization of upkeep and repair of railway lines with a track gage of 1520 and 1435 mm. The trucks are used for replacing worn rails with new ones on the tracks of metro, station areas, parking areas, shunting areas, as well as connecting tracks and main trunk lines by means of transportation of rails having standard or different lengths from the place of storage to the place of installation. The trucks are equipped with mechanisms for gripping rails at the place of storage and their unloading at the places of installation, as well as transportation of worn rails to the warehouse without loading platforms and crane equipment. The trucks have stability of movement at speeds up to 80 km/h when moving under load and during no-load run.


Welding of rails using the electric contact method



Model TR-4M trucks are used for the transportation of long CWR (up to 200 m) by means of formation of a train of 4-12 units and two rail motor cars at the ends. TR-7K trucks are used for the transportation of rails in standard lengths of 12.5 and 25 m by means of a train of 2-3 units and one rail motor car. The design of the trucks can be adapted to the conditions of use on the tracks of the consumer.

Type TR truck consists of a base frame and four full-size wheels having the railway profile arranged in pairs. In the space between the wheels, on the truck frame screw mechanisms are installed symmetrically with respect to the longitudinal axis. The screw mechanisms have rail tongs and spherical supports. Suspension of each wheel is made independent in the form of two sets of elastic elements to provide stable motion under load and during no-load run. Trains of trucks are equipped with special drawbars, rail motor cars and cross arm grips.

Technical characteristics of the trucks TR-7K and TR-4M

Capacity of one truck – 6.0 tf
Carrying capacity of one lifting mechanism –1.5 tf
Number of transported rails (CWR) – 7/4
Type of rails – P50 and P65
Overall dimensions (length x width) – 2650x2000 mm
Weight of a truck – 21000/1950 kg

Type TR-7M trucks are equipped with a device that ensures entry of the wheels of a truck into a curve at curved track sections while maintaining a straight orientation of short packs of rails and with the possibility of their transportation in a single pack of rails of varying lengths.

Large-format self-propelled hydraulic crane KPM-65M

Manufacturer: ZAO MENP (Mozhaisk). The crane is designed to work on the railway tracks of metro in tunnels and in open areas and is used:

- for works related to repair and replacement of switches on operational metro tracks in tunnels and open areas;
- for performance of work on laying elements of the track skeleton on the ballast base during repair of the existing lines or construction of new metro lines on elevated structures and other open areas;
- for mechanization of loading and unloading operations at the depot and sections between stations within its loading characteristics without disturbing the dimensions of the neighboring tracks.

The crane is equipped with a diesel engine (emission class E-4) and is made on the basis of a self-propelled biaxial platform that has a reinforced structure, it is equipped with motion transmission, braking system and equipment that are similar to those used on the railway. The crane equipment is mounted on a full-revolving wheel and is equipped with a special telescopic boom that ensures performance of lifting operations during its horizontal position in the reduced clearance of the tunnels when the machine is supported by two pairs of hydraulic outriggers.

The control of the crane is carried out at three locations:

- in the driver's cab – the control desk for the carrier;
- lighting and signaling devices and the remote control station for the hydraulic mechanisms of the crane equipment;
- in the middle of the travelling platform – the backup station for manual control of the outriggers system from a standing position;
- on the rotating platform of the crane – the backup station for manual control of the hoisting system of the crane from the driver's seat.

There is also a portable remote control for all the hydraulic mechanisms of the crane.

Operation of these machines will significantly improve the labor efficiency and quality of work during maintenance, repairs of the track superstructure, it will also ensure the safety of the production cycle.

Technical characteristics of the crane «KMP-65M»

Rated carrying capacity, tf	*12.8*
Maximum hook radius with the horizontal position of the boom, m	*8.2*
Minimum hook radius, m:	
with the horizontal position of the boom	*3.5*
with a raised boom	*1.4*
Lifted weight at a horizontal reach of 8.25 m in the sector of laying the track, tf	*8.2*
Lifted weight at a radius of 8.25м in a radial sector, tf	*3.5*
Allowable load moment, tf. m:	
in the sector of laying the track	*68*
in a radial sector	*29*
Maximum hook height, m:	
with the horizontal position of the boom	*2.8*
with a raised boom	*7.0*
Hook lowering depth below the rail level, m	*25*
Maximum lifting speed for a load, m/min	*8.8*
The rotational speed of the loading platform, rpm	*1.4*
Dimensions according to GOST 23961-80	
Main dimensions in transport position, mm:	
length (along the axes of automatic couplings)	*9000*
width	*2650*
height (from the rail level)	*3650*
Total weight in the state for running without a load, kg	*29500*
Maximum axle load, kg	*15000*
Speed of movement, km/h:	
self-propelled	*60*
on body tracks	*30*
with a trailing platform	*40*
Limiting gradient, ‰	*52*
The smallest radius of curve negotiation, m, at a speed of 10 km/h	*60*
Laid element of the track skeleton:	
length, m	*12.5*
weight, t	*8.2*
Lateral base for outrigger arrangement, mm	*3200*
Longitudinal for outrigger arrangement, mm	*3160*
Permissible load on one outrigger, t	*35*

On-board Automated System for Monitoring of Potentially Dangerous Metro Areas

The Moscow Metro is a complex transport system consisting primarily of underground structures for transportation of up to 9 million passengers per day.

The power supply for the Moscow Metro is provided by 309 traction step-down substations and traction substations. The cable network of the company's own lines and external maintenance lines laid using the open method in the tunnels, collectors, shafts and under the platforms of the stations has a total length of more than 25.2 thousand km. The lighting facilities of the stations, vestibules, tunnels and facilities adjacent to them include over 584.8 thousand lighting devices, distribution networks, powered lineups and switchgear lineups.

The engineering infrastructure of the Moscow Metro is developing dynamically and requires constant modernization of the electricity supply system. In 2010-2014 the new combined traction step-down substations were put into operation in the Lublinsko-Dmitrovskaya line: STP-905 (station «Zyablikovo»), STP-906 (station «Shipilovskaya»), STP-907 (station «Borisovo»).

As part of the Government's program to improve the efficiency of electrical energy use at the facilities of the SUE «Moscow Metro» a set of measures was implemented. It can save up to 1030.45 thous. KW•h of electricity per year. The principal volume of work was performed for the replacement of the equipment at the step-down substation P-50.

The Moscow Metro constantly performs work to ensure reliable and uninterrupted supply of electricity to the consumers of the metro. The organization of maintenance of the substations, cable and lighting networks is being improved. However, the saturation with technical devices, high power supply capacity, the constant increase in energy consumption, high ambient temperatures and a considerable amount of combustible materials pose a potential fire hazard in metros. The statistics of the last six years shows that the number of major accidents and fires in the Moscow metro is growing every year.

The power supply system is the most vulnerable area of metros. Most of the recent emergencies were due to the fact that the cables of the power supply system of the Moscow metro had exhausted their limits and had to be changed in advance. In addition, increase in the share of static power converters to 50-70%, as well as frequency control devices of electric drives, switching power supplies, compact fluorescent and LED lamps, etc., led to a dramatic change in the nature of electrical loads and appearance of harmonics.

The excess of the nonlinear load in electrical networks over 25% alone causes significant current distortion, which can lead to well-known negative effects (overheating of the cables, transformers, automation hardware failure, electric motor overheating, overuse of electricity, and so on) and, ultimately, it affects the electric power safety of metros.

The majority of large fires (42%) take place on the metro rolling stock: 25.3% – in tunnels, 17.4% – in the vestibules and other areas of the stations. The share of the escalator machine room, inclined tunnel and cable collector accounts for 7.4% of the total number of fires in the metro. The shares of distribution of the number of fires at all the facilities of metros, as well as their causes, are shown in Table 1.

As a result of stopping trains in the tunnel a timely evacuation of passengers becomes a complex problem, because the escape routes will be blocked by fire hazards within 8-13 minutes. Abnormally high temperatures combined with heating of the conductive elements with the operating currents, smoke in the outdoor air in Moscow in the summer of 2010 seriously complicated the work of staff, electrical equipment, traction and step-down substations, cable collectors, contact rails, the track and created the preconditions for the development of accidents. Repetition of such anomalies is not excluded in the future.

For stable and safe operation of the metro in everyday conditions it is of great importance to ensure a permanent system of monitoring of pre-emergency situations and, first of all, the temperature control in the safety-related units and energy-intensive elements of the traction and step-down substations, cable collectors, contact rails and the track in the tunnels. This problem is solved in an integrated manner by the hard work of the maintenance services, each of them performing specific functions.

An integral part of the track is the contact rail. It determines the need for installation, in-service inspection and repair of the contact rail by the personnel performing maintenance of the track. The power supply service is responsible for uninterrupted

The statistics of major accidents in the Moscow metro

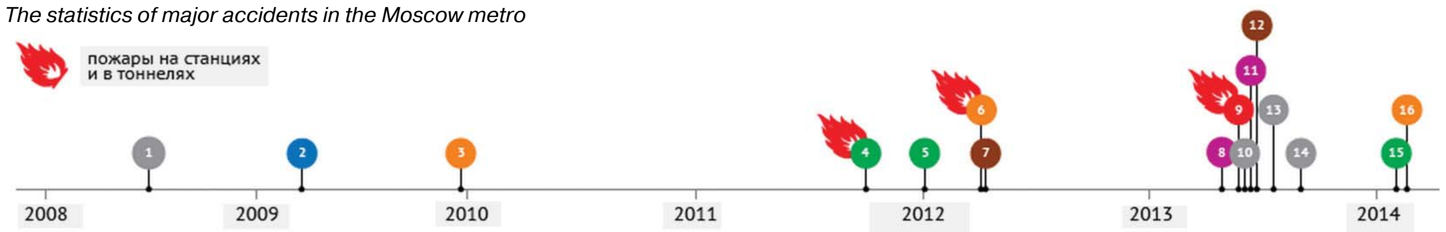


Table 1

Cause of the fire	Electrical fault	Mechanical fault	Short circuit due to foreign objects or water	Sparks from welding or rolling stock	Careless handling of fire
Number	288	96	13	96	100
%	48,6	16,2	2,2	16,2	16,9

power supply to all the consumers of the metro. The track service and the tunnel facilities service can perform their work at night during a specially designated «gap» (from 0:30 to 4:30). The power supply service can perform emergency recovery work in the tunnel at the same time, after removing the voltage from the contact rail. In this context the repair work has to be performed within a very limited time period at night regardless of the volume of work.

However, the most strenuous work of the metro and maximum power consumption are observed in the rush hours, when the interval between trains (from departure of one train till the departure of the next one) may be from 90 to 120 seconds. At the same time (from 8:00 to 9:00 and from 18:00 to 19:00.) there is the greatest flow of passengers. The growth of traction loads due to an increase in traffic of trains brings the need to clarify the permissible currents and their influence on the thermal efficiency of the contact rail.

The first step is to set a long and especially two-three-hour allowable current to the contact rail on the basis of the duration of the peak loads. The current value is limited by the permissible temperature of the heating and the structural features of the compensation of linear extension of the contact rail.

At the limiting (specified) air temperature in the tunnel of +35 ℃ the permissible temperature of the contact rail should not exceed +70 ℃. Under real conditions taking into account the degree of the emission of heat to the environment by the rail is impossible because of the sharply variable airflow speed in the tunnels.

We must not exclude cases where overheating can occur at the electric connectors of the thermal interface of the contact rail and other elements of the traction network above the permissible limits. For example, due to resonance phenomena in the electric network and (or) presence of current harmonics there can occur overheating of the impedance bonds and breaks in its primary winding in the zone of the center tap due to the thermal and dynamic effects which are in quadratic dependence on inrush currents of trains. Other points susceptible to overheating from the current of the network may include the points of connection of the cables to the contact rail, connectors and wires of the chock cables, point bonds, intertrack jumpers and cables of the feeder lines.

These phenomena can lead to disruptions of the fastenings due to the contact rail extension from overheating and that can cause accidents. Especially dangerous are the areas with excessive gradients and long sections between stations with a centralized power system. In Moscow the longest section between stations is «Krylatskoye» – «Strogino», it has a length of 6625 m. It should be borne in mind that the current load depends on many factors: the total weight of luggage and passengers, the voltage at the collector, the mode of driving the train, track profile, the type of electric drive and the type of car, etc.

Local overheating of the cable network and the contact rail elements may be caused by short-circuit currents in the traction network. The range of possible values of short-circuits (SC) in metro traction networks is wide and cannot be estimated. When a short-circuit is near the substation it can reach 50 - 80 kA, which is significantly greater than the maximum load currents that varying in the range of 4 kA to 12 kA.

The studies carried out in 2009 at a station's traction substation (STP) in the St. Petersburg metro, allowed to assess:

- the STP load levels during the hours of moderate and heavy traffic of the electric rolling stock (EPS);
- distribution of the current levels over time;
- to determine the maximum and minimum values of the current and voltage at the traction substation;
- to explore the range of noise and harmonic components of the currents in the traction network.

Processing of the results of the measurements showed that the period of occurrence of inrush currents (i.e., the time from the start of the inrush current of the traction substation until the next start of the EPS) during a rush hour is 54.55 s (0.91 min.), while during the period of sparse traffic - 85.71 s (1.43 min.). Table 2 presents the main results of processing of the measured data.

At the same time, the steady-state currents of remote short-circuits (at the buses of the neighboring substations, at the cable jumpers of the contact network) can reach only 3-6 kA, i.e. they may be less than the maximum load currents or commensurate with them. Small remote short-circuit currents are dangerous for electrical equipment and may create preconditions for fires. This is due to the fact that during a short-circuit an electric arc emerges, which causes a drop in the voltage of the source (traction network) to 150-300 V and a local overheating occurs with the thermal damage of cable cores. If the duration of the short-circuit current is small and the arc does not manage to significantly damage the cable core, there may be the so-called «floating disruptive discharge» which creates the illusion of serviceability of the line, because for some time it can withstand the rated voltage. In such cases, it is important to detect damaged, overheated section as soon as possible and to replace the cable in the «night gap».

Table 2

Parameters	Rush hour
Number of peaks above 3000A per hour (pcs)	66
Maximum value of current rushes (A)	8400

In a similar way the damage and burning of the insulation occur on the suspension block of the contact rail assembly. Local overheating can occur at the ends and joints of the contact rail due to the condition and quality of coating with contact graphite lubricant.

The listed events indicate that the problem of temperature control in the area of the tunnel in real-time mode is urgent and requires speedy solutions. Safe operation of the power supply system can be largely ensured by monitoring of their status in real-time mode by means of automated on-board equipment in the process of movement of the rolling stock.

The monitoring system is a set of technical means designed to detect and measure various parameters, including the accumulation and processing of the incoming information individually for each particular object. Timely information about overheating and overloading will enable to take the most efficient measures to prevent accidents or mitigate their consequences in emergency situations.

Temperature control will reveal not only the areas of possible ignition at the early stage, but also will solve the problem of energy saving by reducing the power loss in the running rails and the intertrack connections, as well as of optimization of train movement and reducing thermal losses.

Until now, there is no solution to this problem in the worldwide experience in operation of the metro.

The main feature of the architecture of building a monitoring system is the reliance on the existing, domestic, well-established technologies for receiving operational information in real-time mode, but within the framework of the new structure of combining the elements. The architecture of the onboard automated system for monitoring areas of critical temperatures (BASKT) in a metro tunnel in the real-time mode is a set of standard sensors, with the addition of built-in intelligence elements, digital signal processing, digital wired and wireless communication channels and feedback to all the levels of the system.

The architecture of BASKT includes the following elements:

- digital ultra-high-sensitivity video cameras, sensors and annunciators of measurement, control and IR-diagnostics of temperature changes in the controlled areas of the tunnel using the «non-contact method» (i.e. without directly exposing them to the measured element);
- a complex of means for automation of collecting, processing, storing and transmitting information to an external automated dispatch control system of the metro lines;
- a multifunctional wireless data transmission system through communication channels to other computer systems operated in the metro and in the Ministry of Emergency Situations of Russia;
- a multi-channel digital recorder on the basis of an intelligent onboard controller;
- special software (SW) for registration and processing of signals;
- standard interface;
- metrological support.

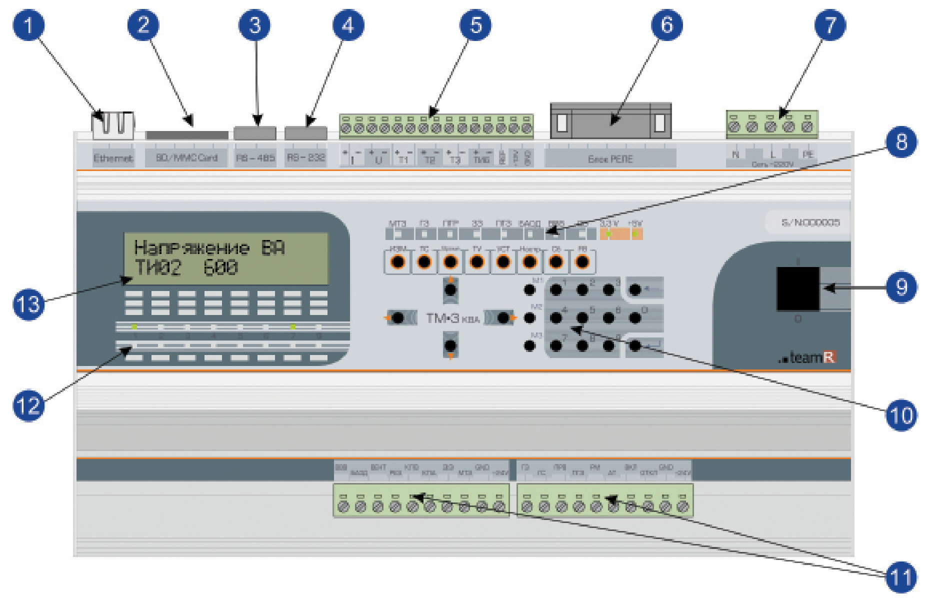
The software of BASKT will enable to:

- determine the location of the rolling stock;
- record and store the sequences of thermal images with reference to the location in the tunnel for further analysis and to save real images at a high speed;
- create diagrams (trends) of dependence of temperatures on the time and location in the tunnel;
- configure the system for creating streaming images, records and schedules;
- visualize thermal fields.

Functionality of BASKT:

- monitoring of thermal fields in real time mode;
- non-destructive and non-contact control of traction network elements;
- representation of different kinds of data in a single image;

Integrated branch node TM3com



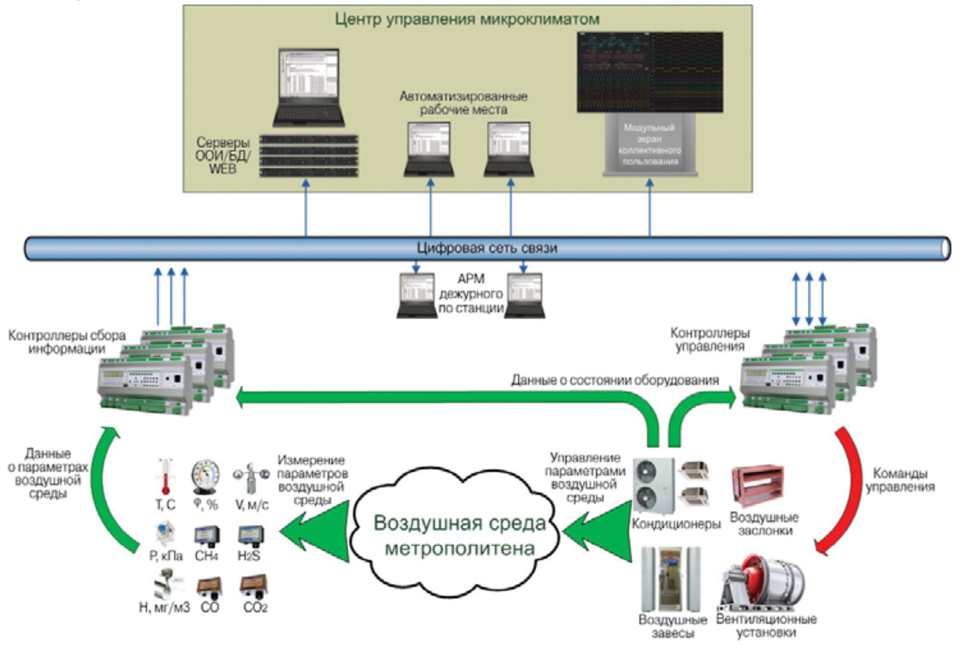
1 – Fast Ethernet Connector
2 – Slot for SD, SDHC, MMC cards
3 – Interface connector RS-485/422
4 – Interface connector RS-232
5 – Contact terminals of inputs for reception of analogue signals
6 – Connector for connection of the relay module TR02A
7 – Connector for power supply
8 – Controller mode indicators as part of a cell or a rectifier unit
9 – Power switch of the controller
10 – Keyboard
11 – Input terminals for remote signaling (TS)
12 – Status indicator for internal nodes of the controller
13 – LC-indicator

- export of graphs into standard formats (cvs, bmp, jpg);
- examination of the surface of the equipment and devices of the traction network in varying temperature conditions (change in load or other parameters in the process of train movement);
- automatic determination of the maximum / minimum temperature, automatic marking of a field with the display of maximum, minimum and averaged temperature, linear profile, isotherm, histogram;
- monitoring of changes in the temperature of the walling of tunnels, cable network and contact rail elements or other components during load change in the process of movement of trains on the line;
- an immediate response to pre-emergency situations associated with abnormally high temperatures in the controlled elements of the traction network and transmission of the coordinates of the critical sections and their images to the dispatching services of the metro.

Features:

- the ability to view, record and quickly save the images;
- the possibility of subsequent processing of the rapidly changing thermal events;
- the ability to create graphs of dependence of temperature on the time for the sections of the tunnel on the basis of «live pictures» or the recorded image sequences;
- enhanced function of the start/finish of the recording of thermal images with the ability to control according to the condition (e.g., the temperature exceeds +60 0C etc.);
- unlimited variety of analysis functions («Point», «Line», «Field»);
- function of zooming and panning (Zoom & Pan) with the possibility of detailing that allows to examine the problem area in detail;
- the possibility of connecting additional sensors for monitoring the parameters of air in tunnels and at stations in real time mode (including the monitoring of CO, control of hazardous substances, radiation control, significant concentration of toxic and explosive gas-air mixtures, etc.).

The single control center climate control in the metro



The main qualitative characteristics of the onboard controller:

- accuracy of the conversion of signals from the sensors - better than or equal to ±0.2%;
- the resolution of the reception of digital signals – better than or equal to 1 ms;
- speed of information processing and transmission – the polling period and the delay is not more than 1 second;
- high reliability and accuracy of the information delivery – no more than one error in 26 years;
- continuous round the clock work without operator intervention;
- resistance to electromagnetic interference and climatic factors under the conditions existing in the metro;
- remote self test and servicing under conditions of limited access to controllers during the working hours.

Additional features of the onboard controller:

- possibility of implementation of local control algorithms;
- event logging and storing in an archive.

BASKT equipment can interface with integrated branch nodes such as TM3com using the highways of the RS-485 interface. The data exchange is carried out in the protocol GOST R MEK 60870-5-101 at the speed of 460.8 kbit/s.

«TM3com» can transmit the necessary data sets in the direction of the systems of the dispatcher centers in the protocols GOST R MEK 60870-5-101 / 104 using the wireless communication channels of the metro. Configuring the controller can be performed via the unit's built-in WEB-server, allowing the user to edit the configuration parameters and the logic of the statistical analysis.

Several levels of access to data is provided, they define the user privileges when configuring the device and reading the information, the access levels are password-protected.

The time of simple isolated solutions is over. To solve the problem of increasing the reliability of electricity supply in the metro it is necessary to ensure a system-wide approach through the introduction of energy management and appointment of personally responsible managers, in accordance with the international standard ISO 50001: 2011 (GOST R ISO 50001- 2012).

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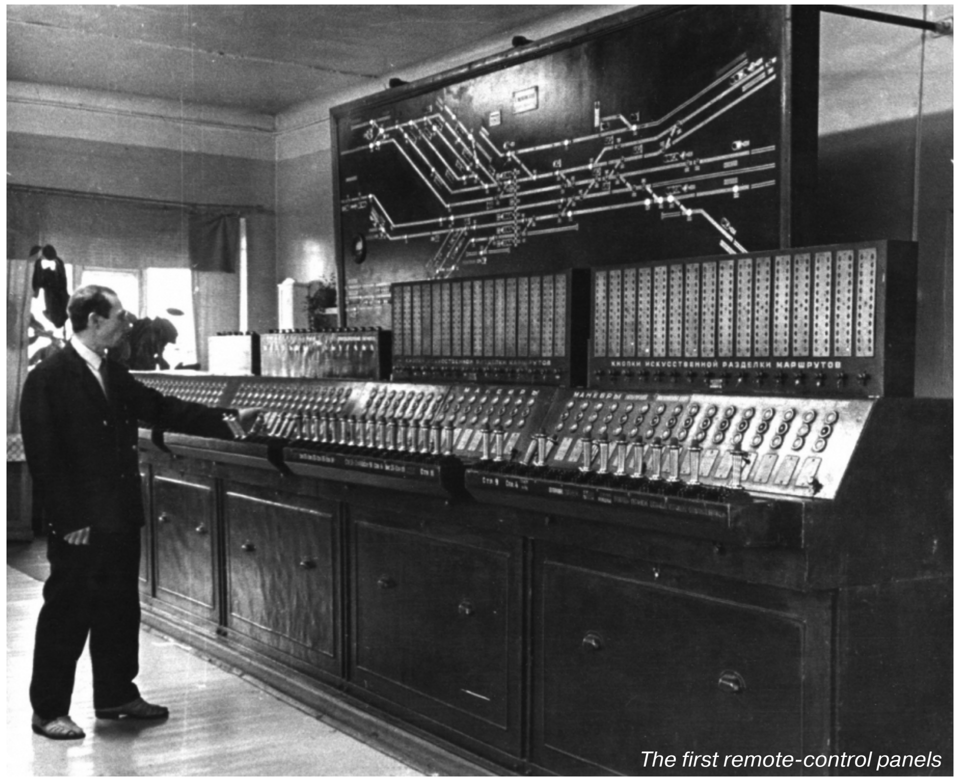
From November 1934 till present

In November 1934 the Moscow City Council established the Metro Directorate. On November 25 the Communication and Signaling Service was organized among the first similar services. On January 29, 1935 V.T. Kashutin was appointed the first Chief of Service in accordance with order No. 39 issued by the Moscow Metro Directorate. At the end of 1935 (November 16) the consolidation of the metro facilities was performed by the order of People's Commissar of Transport and the Communication and Signaling Service became part of the Traffic Department. However, due to the increased volume of work in the metro from February 1, 1938 the Communication and Signaling Service became an independent business unit, and for many years it was unchanged. In connection with the reorganization of the Moscow metro in July 2012, the Service was transformed into the independent units of the metro: the Signaling and Interlocking Service and the Communication Service.

During the 80-year period of the activities, the Service (besides the abovementioned V.T. Kashutin) was headed by Sergey Stepanovich Stepchenko, Alexander Demyanovich Grishechkin, Anatoly Mikhailovich Solntsev, Vasily Vasilyevich Lavrik, Kamil Makhmutovich Makhmutov, Nikolai Mikhailovich Novikov, Vladimir Alexandrovich Medenikov, Igor Kuzmich Yermolenko, Valentin Markovich Kozlov, Sergey Vasilyevich Ponomaryov. Currently, Boris Alexandrovich Driker is the Chief of the Service (since 2009). Each of these managers made his contribution to the development of the facilities of the Signaling and Interlocking Service and the Communication Service.

Thanks to the coordinated work of the employees for the past 80 years, the Service achieved a high performance level as for the enhancing the rail traffic safety and the development of automation, telemetry and communication within the Moscow metro. It was a long way from the relay devices for point control by means of centralization and manual switching of points to the microprocessor centralization, from the decade-step exchanges to digital ones, from the wireline communication to the creation of an integrated radio environment (ERIS-M) for providing the metro employees and the police with mobile radio communication devices, from tickets, coins and tokens to non-contact transport cards and the automated fare system, from the experimental use of industrial television cameras to the station control system using a television surveillance system (SURST) and to the equipment of all the metro stations with surveillance cameras, which seems essential for the work of the metro today.

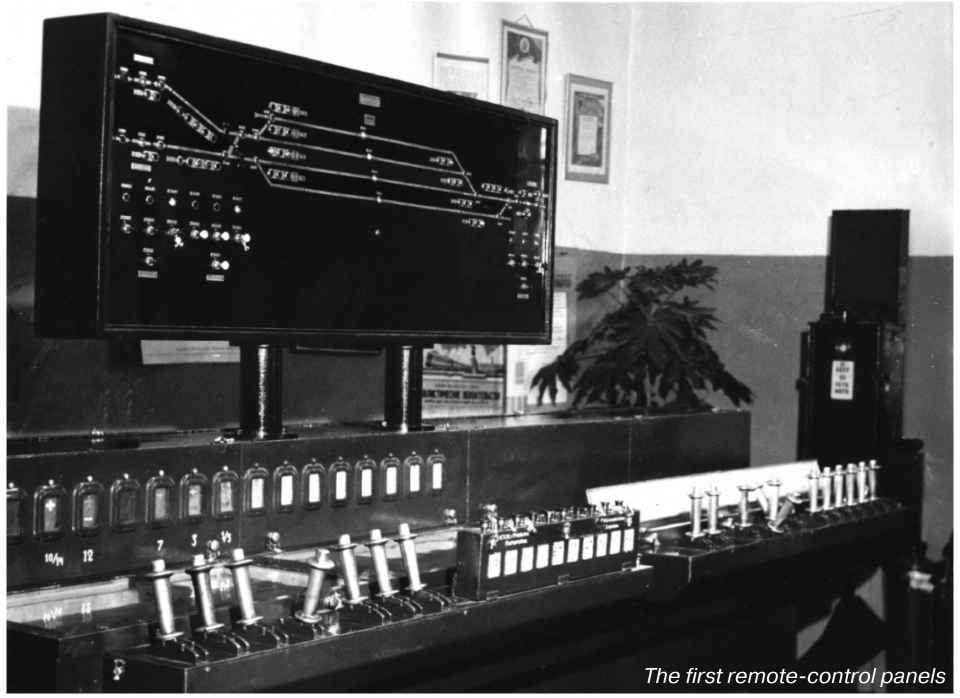

The first remote-control panels

In 1935 the first metro line used an automatic blocking system with color light signals, automatic train stops and overlaps. It ensured a traffic capacity of 34 pairs of 6-car trains per hour. This system used two-aspect signaling, AC track circuits with two-element sector-type relays, DOMB-type track chokes. The equipment was housed in a decentralized manner, in the relay cabinets of the automatic block system installed within the sections between stations near the color light signals. The fact that each of them had an electromechanical automatic train stop significantly increased the safety of train movement.

In the process of operation the automatic block system continuously improved. Later to increase the traffic capacity the metro started to use the train speed control devices, opening of the color light signal up to incomplete lifting of the clamp of the automatic train stop, offset of the automatic train stop against the current of traffic, etc. An important role in the improvement of the automatic block system was played by the heads of the Service, such as A.M. Solntsev, S.S. Stepchenko, K.M. Makhmutov, M.L. Semernik and others.

M.L. Semernik was the designer of the automatic speed control system (ARS-ALS). For the first time the automatic cab signaling devices (ALS) with automatic speed control (ARS) were used in the Koltsevaya Line in the early 60s. Later the system became a standard and gained widespread use in the metro lines. Currently, the system ARS contains a complex of track side facilities and train devices. The system ALS-ARS-PS provides the driver with the information not only on the speed of movement along the section, but also warns of the permissible speed of movement along the section lying ahead. In cases when the actual speed exceeds the permissible speed the system automatically reduces the speed of the train and gives a warning signal.

The information on the permissible speed of trains is transmitted to the track


The first remote-control panels

circuits. They perform the function of the sensors. Currently jointless track circuits are operated (BRTs). They were developed by the Service in collaboration with the VNIIAS. The development of the BRTs in the VNIIAS was headed by V.S. Dmitriev, while K.M. Makhmutov was in charge of the development in the Service. An active role in the development, operation, and further improvement of the BRTs was played by I.K. Yermolenko, V.P. Korovin, V.I. Yefremenkov, K.A. Yeliferov, E.A. Anisimov and many others.

These track circuits have a completely new system, it was built on the electronic element base. To increase the stability of the operation of the system ALS-ARS and to facilitate the labor of the driver, the track side facilities and the train devices of the ALS-ARS were supplemented by doubling devices (DAU-ARS) which enable the driver to get the information on the permissible speed within the given section of the route, as well as within the next one. Changes were also introduced to the frequency feed diagram of the ALS-ARS to the track circuits, as well as the track side hardware of the ALS-ARS. All these innovations made it possible to organize the movement only using the system ALS-ARS in such lines of the Moscow metro as Lyublinskaya, Kalininskaya, Sokolnicheskaya, Serpukhovsko-Timiryazevskaya, Butovskaya and part of Arbatsko-Pokrovskaya.


In the relay room

Visual inspection of an electric drive

The system made it possible to increase the traffic capacity to the maximum of 40 pairs of trains per hour on both tracks. There are no such systems in the world.

In the late 50s a centralized traffic control system was developed. Initially the RChK-4m type frequency-code system was tested. However, it did not become widespread because of a lack of quick action. The SKTs-67 type stationwide code interlocking system gained wider use.

During the existence of Service much attention was paid to the improvement of the service technology for the devices. The managers of the Service N.M. Novikov and V.A. Medenikov developed a system for centralized arrangement of the equipment in collaboration with the Institute «Metrogiprotrans». This enabled to safely carry out the replacement of the equipment of the Signaling and Interlocking Service, to significantly reduce the time required for the maintenance of the signaling and interlocking devices and for troubleshooting. The development of technology for maintenance of electric signaling devices was significantly promoted by the work of V.V. Lavrik, V.A. Medenikov, A.I. Zhukov, O.I. Potapov, V.S. Agafonov, L.G. Kogan and many others. The book «Electric Interlocking of Points and Signals of the Metro» written by V.V. Lavrik became a handbook for the electricians of the Signaling and Interlocking Service.

Over the past 80-year period extensive work was carried out on the modernization of the devices of the Signaling and Interlocking Service in the Zamoskvoretskaya, Sokolnicheskaya, Arbatsko-Pokrovskaya, Kaluzhsko-Rizhskaya, Tagansko-Krasnopresnenskaya, Kalininskaya and Filyovskaya lines. This involved the direct participation of I.K. Yermolenko, S.V. Ponomaryov, V.A. Zuev, S.A. Fotchenkov, V.M. Kozlov and many others.

In 2014, modernization of the system was performed in Arbatsko-Pokrovskaya line from the station Smolenskaya to Elektrozavodskaya, now the automatic speed control system ALS-ARS-PS is operated there instead of the automatic block system with automatic train stops and overlaps. The new system enables to reduce the number of color light signals by 90 %. In 2015 it was planned to complete the modernization of the entire line from the station Semyonovskaya to Shchyolkovskaya.

In 2005 the metro began to introduce the station-based automated control system for train movement (ASU-DPS) based on microprocessors. The system ASU-DPS includes an automated workstation of the signal tower operator on duty (ARM-ETs) and an automated workstation of the electrician of the Signaling and Interlocking Service (ARM-ATDP).

The metro introduced the automated system of dispatch control of metro

trains (ASDKP-M). This system enables the train dispatcher to monitor the location of the trains on the line and the status of the automatic block devices and electrical interlocking devices.

The Signaling and Interlocking Service works hard on the implementation of automated control systems for train movement that are based on the microprocessor technology. A significant role in the introduction of these systems was played by B.A. Driker, V.M. Kozlov, S.G. Shinkaryov. In the future the new system will replace analog devices with digital ones, and now the Signaling and Interlocking Service is actively testing microprocessor devices produced by both domestic and foreign companies. The service participates in the development of regulatory documents for microprocessor systems. In the nearest future it is planned to use the microprocessor devices designed and manufactured by JSC «Metroinzhrekonstruktsiya». They will be used in the experimental operation mode at the station Mitino on Arbatsko-Pokrovskaya line.

Unfortunately, the scope of the article does not allow me to provide more information on the work of the Service.

In spite of the fact that the Service is getting younger every year (the age of

And we are already 80. The signaling and interlocking service.

52% of the employees is not more than 35), the link between generations is preserved and strengthened. The staff of the Service includes 1.5 thousand people. 42% of the employees have higher professional education. The structure of Service includes 8 signaling divisions, an overhaul division, electrical workshops, a laboratory of automation and telemetry and a metrology laboratory.

Today the Signaling and Interlocking Service is one of the most intelligent and highly skilled units of the Moscow metro and it is ready to provide new technical solutions in the field of railway automation devices for the metro.

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Work in progress

Transport Security is Always Important

The topic of transport security is always important for the simple reason that it concerns not just all people in general, but also each person individually. After all, every day every citizen deals with transport one way or another, and in large cities 70% of people use the services of such type of transport as the metro. The main goal of many thousands of employees of the Moscow Metro (like of any other metro) is to perform the transportation of passengers efficiently, comfortably and safely.

The Moscow Metro celebrated its 80th anniversary, it is a key element of the transport system of the city of Moscow. Without the metro it is difficult to imagine the life of the multi-million metropolis. Therefore, the management and employees of the Moscow Metro have to pay a great deal of attention to the issues of ensuring the safety of the operation of the metro.

In the recent years, taking into account the challenges and threats existing in the modern world, the Moscow Government and the management of the Moscow Metro, were forced to take measures to enhance the security of the metro against acts of unlawful interference, while being guided by the current legislation on transport security and the respective regulatory acts.

The system-wide and comprehensive approach to transport security enabled the State Unitary Enterprise «Moscow Metro» to successfully meet the requirements of Federal Law No. 16-FZ of February 09, 2007 «On transport security», of Order No. 130 issued by the Ministry of Transport of the Russian Federation on April 29, 2011 «On approval of requirements for ensuring transport safety, with account taken of the levels of security for different categories of the metro facilities» and of the Comprehensive Program for ensuring public safety in transport. In 2013, the majority of the metro infrastructure facilities underwent a vulnerability assessment, plans were developed to ensure transport security. In 2014 they were approved by the competent authority in the field of transport security – Roszheldor, which made it possible to carry out active implementation of the measures within the framework of the Comprehensive Program for ensuring public safety in transport. The activation of the work was also promoted by the amendments to the Federal Law «On transport security» adopted in February 2014 (Law No. 15-FZ of February 02, 2014) which significantly expanded and clarified many of the concepts of Law No. 16-FZ of February 09, 2007, conferred the powers of the inspection functions on the transport security divisions and determined the system for training of the transport security personnel.

Delegation of the authority to perform the inspection functions to metro requires that the metro employees working in the inspection zones should only act in a lawful manner in strict accordance with the regulatory acts. Currently, the work in the inspection zones is performed on the basis of temporary regulations that were designed in accordance with the current legislation of the Russian Federation. At the same time the work in the inspection zones is

carried out by the metro employees in cooperation with police officers. The long-awaited order of the Ministry of Transport of Russia «On approval of the Rules for inspection, additional inspection and secondary screening for the purpose of ensuring transport safety» will include the lists of weapons, explosives or other devices, objects and substances that are prohibited or restricted to be moved into the area of transport security or a part thereof. The Order will also define the «Procedure for performance of inspection and/or interviews for the purpose of ensuring transport safety».

Today the Moscow metro fulfills the measures of the «Comprehensive Program for ensuring public safety in transport» systematically and in stages and performs work on the equipment with the latest technical means for ensuring transport security the technical characteristics of which fully meet the imposed requirements. All these technical means are combined into a single unit – an automated system for ensuring transport security. According to the report of the Deputy Chief of the Metro – the Chief of the Security Service of the Moscow Metro V.P. Muratov delivered at the 14th International Conference «Terrorism and Security in Transport» in the 181 vestibules there are 294 inspection areas that are fully equipped and staffed with the employees, in the other vestibules installation and commissioning works are in progress.

It should be noted that equipment of the inspection zones in the metro is a very difficult and meticulous kind of work, because many stations, especially old buildings, are individual facilities that have their historical and architectural value. Considering the significant shortage of vacant space in the vestibules, specific individual technical decisions are made on each station. It is extremely important to ensure the necessary traffic capacity of the stations, especially during peak hours, and not to paralyze their work. The equipment in the vestibules of stations includes: radiation monitoring equipment, multi-zone stationary frame-type metal detectors, while directly in the inspection zones there are stationary X-ray machines of the conveyor type or non-conveyor type, depending on the area of the inspection zone, stationary frame-type and hand-held metal detectors, hand-held detectors of vapors and traces of explosives substances.

The use of the above-mentioned equipment in the ticket halls of stations enables to create a three-level security system that is unique for Russia. Persons who are suspected by the police officers will be asked to pass the first level of inspection: the frame-type metal detector. If the signal exceeds the permissible limits, the person will be asked to pass the second level: the machine for inspection of baggage. After that, in the third step, a passenger will pass the machine that scans clothes.

In all the vestibules of the stations there are explosion-proof containers, special equipment is installed for suppression of radio lines that control explosive devices.

Following the publication of the necessary legal documents the final decision will be made on the strength of staff for performing the inspection functions on a 24-hour basis. For the time being there are no final regulations that determine the mechanism of accreditation of transport security units, that is why the metro strengthened the security service and staffed inspection zones. It is the employees of the security service who work in the inspection zones after the necessary training.

Let us hope that the necessary regulatory framework is about to appear and the services market will see accredited transport security subdivisions. Perhaps the SUE «Moscow Metro» as a legal entity will be able to receive accreditation on its own to carry out these activities, to establish a transport security subdivision (on the basis of the security service or as a individual separate subdivision), to ensure training and certification of the personnel, provision of standard weapons and impact munitions and to carry out activities at the transport infrastructure facilities in accordance with the legislation.

In metro an important role is played by the system for transmission of alarm information which is used for ensuring interaction between citizens and the Situation Centre of the Metro using a bidirectional audio channel in case of emergency. The Situation Centre receives the latest information in the real-time mode concerning all emergencies that occur within the territory of the metro. The system for transmission of alarm information can provide citizens with virtually any support information. All metro stations are equipped with in-

formation terminals which have proved their practicality.

Video surveillance is the basis of any security system. The introduction of video surveillance in the Moscow metro dates back to the late 60s - early 70s. But it did not take root until mid-80s when it was directly linked to the station operational processes. After the appearance of the SURST (system for operation of the station using television surveillance) video surveillance was actively introduced in metros. Video surveillance systems were installed at all the stations and underground passages. Also, video surveillance cameras were installed in many cars of metro trains. By means of equipment of passages and cars with video surveillance systems it is possible to control the situation in the metro in a much more efficient way and to significantly reduce the number of criminogenic factors.

But time goes by, the number of stations is increasing, and the operator is not able to track the events at the increasing number of stations. In connection with the need to combat terrorism more rigid requirements are set for video surveillance. There is a need for the creation and implementation of an intelligent video surveillance system that can be integrated with other active security systems in the metro (access control systems, security and fire alarm systems, warning and evacuation systems, radiation control).

Metro pays a lot of attention to the establishment of a modern system of intelligent video surveillance. Currently, a project has been developed for a new system which is undergoing the state examination. The system will cover virtually all of the metro facilities, including the rolling stock, it will respond to unattended objects, falling of foreign objects and people on the track, entry of unauthorized persons in restricted areas, it will also respond to appearance of smoke. The video cameras will have high resolution, which will provide high-quality video. Storage of the video information at the first category facilities is planned for at least 30 days.

Considering the high cost of the system, it will be introduced in phases, gradually increasing its capacity. Previously at a number of metro stations tests were carried out on pilot prototypes and individual elements of the proposed intelligent video surveillance system, this enabled to design the system and the transport security control center based on actual practical results and, consequently, to adapt it for the Moscow Metro. During the tests the specialists also carried out computer modeling of individual elements and subsystems of the intelligent video surveillance system, which allowed to perform initial theoretical assessment of the efficiency of their work.

Metro is a phenomenon which has its own influence on people which is still largely unexplored. Metro is the world's only mode of transport where there are attributes of all other modes of transport. Therefore, the establishment of a security system within the metro is a challenge. This comprehensive security system includes a complex set of technical and organizational measures, taking into account the socio-psychological, socio-political, religious and other interrelated factors.

A distinctive feature of a comprehensive security system is a functional relationship of all its subsystems, both on the software and hardware levels, as well as its ability to build itself and adapt to the requirements of the customer and the environment. This system allows to materialize the transport security environment. The concept of «security environment» involves a system-wide review of the combination of the factors and technologies that influence the security. The systemic approach makes the security environment different from other technical systems.

When creating a comprehensive security system in the metro, we must not forget that for the normal and efficient operation of such system there should be a common timing system, otherwise it will be difficult to compare events and properly take this or that decision. It is necessary to have a system for controlling the parameters of the air environment, an automated control system for the auxiliary devices of the metro.

The Moscow Metro will continue to work to improve the security of the metro, covering all the infrastructure facilities: the tunnels, open areas of the sections between stations, electric engine houses, railway substation and other facilities. It is necessary to solve the issue of the organization of video surveillance at escalators, because this area is now a blind spot for the video surveillance system and it remains uncontrolled (technical control is ensured only for the area of the escalator combs). It is necessary to create and put into operation an up-to-date control center for ensuring transport security. This center, in view of the increased volume of the information, is required for 24-hour monitoring of security in the metro, as well as for making decisions on responding to acts of unlawful interference and the necessary measures to stabilize the situation.

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The Glasgow Subway (Scotland)

The Glasgow Subway is one of the oldest (it ranks fifth according to the opening year, 1896) and the third underground metro in the world. It is also interesting due to the fact that since the opening on December 14, 1896, it did not expand. The subway is a circular line with 15 stations and a length of 10.6 km. The subway system has three interchange stations providing access to the railway stations bearing the same names: Partick, Buchanan Street and St. Enoch. All the stations are underground ones and most of the platforms are island ones (12 stations). The platforms are narrow – the width is about 10 feet (3 meters) and the length is 40 m, they were designed for a train consisting of 3 cars. The subway line has an unusual track gauge of 1,219 mm and a tunnel diameter that is smaller than a usual one – only 3.35 m.

Originally a clutch-and-cable system was used, a single cable was driven from a steam-powered plant. The modernization and electrification of the subway took place only in 1935, when the line was transferred into the ownership of the city due to unprofitability. However, due to the lack of funds only the counter-clockwise trains became electric and the clockwise trains remained cable-hauled for a long time, until 1980.

In 1977-1980 the system was completely closed for modernization. As a result, all the tunnels and stations were rebuilt, Merkland Street was closed, it was replaced by the new station Partick.

The official name of the system in Glasgow is the Subway, unlike the Underground in London. Some believe that the Glasgow Subway's nickname was coined when the city authorities promised that after the modernization the line would run «like clockwork», hence the nickname – «The Clockwork Orange» suggested by the orange color of the cars of that time and the line that indicates the subway on the map of the city.

That is the unique subway system which never expanded for almost 120 years of its existence. According to the latest data, the subway is used by about 14 million passengers every year. There are plans for modernization and development, but the construction work has not started yet.

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