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2016 digest

THE SUBWAYS OF EURASIA REGION

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International Association Metro was created by the initiative of subways. It unites 33 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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Dear colleagues,

From November 29 till December 1, 2016, the International Union of Public Transport (UITP), Moscow Metro and Mosgortrans - the largest operators of public transport in Eurasia, will hold the 4th International Conference and the ExpoCityTrans Exhibition in Moscow under the slogan: “Your ticket to the multimodal future”.

The benefits of public transport for the environment, for the city, for its dwellers and enterprises are unquestionable. Today public transport operators are in the lead in terms of the number of employees and they can be justly considered to be the largest employers of the city. The necessity for further development of public transport is evident for everyone.

ExpoCityTrans is an exhibition of technologies and products for public transport, as well as a one-day conference dedicated to the most up-to-date developments in our industry. The 4th Conference and the ExpoCityTrans Exhibition will be held within the framework of the meeting of the UITP Council and Russian Transport Week: Congress and Exhibition “Transport of Russia 2016” organized by the Ministry of Transport of the Russian Federation. We expect participation of the representatives of the Eurasian transport industry - manufacturers, operators, government officials and guests from all over the world.

The Eurasian Conference and Exhibition provide public transport professionals with a platform for international exchange of experience, demonstration of the best practices, efficient promotion of innovations and demonstration of the latest advances in the transport industry which help to make cities more livable and more convenient for work.

We are sure that your participation in ExpoCityTrans will inspire you to bold decisions and our joint efforts will improve the public transport system in the Eurasian region.

We look forward to seeing you in Moscow.

Alain Flausch
Secretary General of UITP

Dear colleagues!

Welcome to ExpoCityTrans, the largest Russian exhibition of public transport!

Today the role of public transport can hardly be overestimated. Vital activity of cities and regions, their social and economic well-being are depended on its reliable and stable work.

This year the ExpoCityTrans Exhibition is going to be held for the fourth time and, according to the tradition, it is going to be the most important event of the year for the transport industry of our country. The leading specialists and transport industry professionals will meet here again to exchange the accumulated experience, to discuss the development of modern technologies and services, to demonstrate the operation of the state-of-the-art equipment and to unveil unique inventions.

For the years the ExpoCityTrans Exhibition became an open discussion platform and an efficient communication space for representatives of the leading domestic and foreign companies working in the transport industry. Every year the exhibition attracts more and more visitors. This is not by accident, because it does not only ensure an efficient combination of the exhibition-related and business events, it unites the unique transport exhibition with the forums and conferences that are open for all competent experts from Russia and overseas.

I would like to wish all the guests and participants of ExpoCityTrans a successful search for new ideas, fruitful contacts and mutually beneficial cooperation!

Dmitry Pegov
Head of the Moscow Metro

Novosibirsk: photos of students will appear in subway trains

The train Museum with a new exhibition dedicated to the history of student groups in the city and region began to operate in the Novosibirsk subway on 28 October. A new exhibition is called «a construction crew go on!». The presentation of the carriage took place at the station «Ploschad Garina-Mihajlovsky». The walls and doors of the carriage were adorned with photos and texts about the movement of student teams of Russia and Novosibirsk, since 1960-ies to the present day.

"The city's residents can find memories, articles, letters, newspapers, annual reports on the work of student groups. All these documents helped to gather experts from the Museum and the veterans of the movement. We also got significant assistance in the preparation of the exhibition from the members of the Novosibirsk branch of the youth organization «Russian student teams», said Director of Novosibirsk regional Fund of preservation and development of Russian language «Native word» Lyudmila Monahova.

Exhibition about the history of student groups have changed in the train-Museum exhibition dedicated to the founder and first Chairman of the SB RAS Mikhail Lavrentyev. The train car devoted to students groups, will run until the end of 2016.

Besides in the museum train there is a carriage dedicated to the anniversary of transport police.

news.ngs.ru

400 students from the Irkutsk region took a tour to the Moscow subway

In the framework of the Federal educational project «My Russia – two capitals: Moscow and Saint-Petersburg» 400 students from the

Irkutsk region for the first time came to Moscow. One of the Central events of their journey was the tour to the subway. Boys and girls ran by train «Soyuzmultfilm» from depot "Varshavskoye" to «Borovitskaya» station.

Most of the children live in small towns and villages and for the first time got the opportunity to see one of the largest transport systems in the world – the Moscow subway. This chance was given by education program implemented by the Government of the Irkutsk region with the support of Federal ministries of culture, education and transport.

Children were not only the first time to take the subway, but also could see how it operates from the inside. There have been prepared a guided tour for the schoolboys from Irkutsk, which began in «Varshavskoye» depot, where they learned how the train is preparing for the operation and how the depot works. After a briefing on the rules of behavior in the Moscow subway the guys took the cars of «Soyuzmultfilm» train and took part in a photo session with the images of there favorite cartoon characters. This train proceeded to the «Borovitskaya» station after which they continued their tour by the Russian capital.

«We are pleased to provide children with the opportunity to visit the Moscow subway as well as to look «behind the scenes», – said the head of the subway Mr. Dmitry Pegov. "I hope that once being here, guys will desire to come back again. Perhaps this tour will help to determine future professional choice for some of them».

PR department of the Moscow subway

Kiev: metro asked not to abandon the tokens

Public activists asked Municipal enterprise «Kyiv metro» not to abandon the tokens as a form of fare payment in the subway. The petition appeared on the website of the Kyiv city Council. «Kyiv metro by 2017 plans to completely eliminate the tokens, replacing them with contactless cards, despite the fact that paying for the subway by the means of tokens is the most convenient for many people (especially for those who rarely use subway). We require leaving the tokens as a form of payment in the underground, at least keeping tokens in use alongside with the cards,» wrote the authors of the petition, the inhabitant of Kiev Mr. Evgeny Podgorny.

The full transition from tokens to contactless cards fare payment is planned for 2017. The subway already started to reduce the number of turnstiles that accept tokens.

112.ua

Faces of the subway exhibition opened in Saint-Petersburg

The exhibition dedicated to the subway employees and their work opened in the Interactive centre of the history of St. Petersburg subway (29, Odoevskogo str.). The exhibition is timed to the Day of road and urban passenger transport employs. The exhibition includes photographs that feature the best subway workers in their fields and their jobs. The photos of drivers, dispatchers, medical, mechanical personnel and even a blacksmith give the opportunity to imagine working conditions of the underground workers, their environment and what functions they run.

There was a great interest to the exhibition from its opening. The first visitors were students of St. Petersburg schools, some of which are going become a specialties of the subway.

The exhibition «Faces of the underground» will run in the Interactive centre of the history of the metro until mid-November 2016. The project «Faces of the subway» can also be seen on the official website of St.Petersburg subway. The pictures with small stories are published in its special section.

metronews.ru

The 93rd UITP Metro Assembly

From October 5th till 7th, 2016, Rio de Janeiro hosted the 93rd UITP Metro Assembly which attracted representatives of metropolitan railways, heads of subcommittees and regional branches of the International Union of Public Transport.

Representatives of the International Association «Metro» took an active part in the work of the Assembly.

The program included events that started in São Paulo shortly before the opening of the Assembly. The delegates discussed the opportunities and perspectives of the modern train control systems at a round-table meeting. It was focused on the issues of implementation and operation of automated metro lines in Brazil. Then the participants had a technical visit to the automated metro line of São Paulo.

The opening of the 93rd Assembly was held in Rio de Janeiro. The welcoming speech was given by Pere Calvet, Director General of FGC Company (Barcelona), Vice-President of the UITP and Chairman of the Metro Committee. Then the participants had a visit to the light rail transport system that had been put into operation in 2016 before the Olympic Games.

Eurasian region was represented by Mr. D.A. Doshchatov, the representative in the Metro Committee, Chief Engineer and Deputy Head of the Moscow Metro. During the presentation he spoke about putting into operation and passenger service management within the Moscow Central Circle that had been integrated into the Moscow Metro system.

The working sessions of that day were focused on acquaintance with the details of construction of metros in the cities of Brazil, with the problems related to their operation and development prospects. Heads of transport companies provided the audience with information on the metro systems of Rio de Janeiro, São Paulo, Salvador, Brasilia, on their performance data and technical features. As it was noted in the reports, the main problems of the development of the public transport in Brazil include poverty, investment difficulties and shortage of funds in the federal budget. That is why the construction is carried out by means of development of the public-private partnership and through arrangement of conditions for attraction of private investors to projects.

The heads of subcommittees informed the participants on the work performed in 2016. Some of the researches done by the members of the subcommittees generated considerable interest, e.g.: the efficiency of LED light fittings in metro, the role of the communication based train control system in ensuring rail traffic safety. The head of the operation subcommittee spoke about the research conducted for assessment of risks during the work of the metro system and about the impact of various factors on the occurrence of incidents.

The stationary equipment subcommittee performed an analysis of results of natural disasters and their impact on the work of metro systems, which is related to the increased number of natural calamities.

On the last day of the Assembly the heads of metro systems of the Latin American region delivered their reports. They came from Buenos Aires, Santiago, Mexico, Monterrey and the new member – the city of Valparaíso (Chile). The reports are of particular interest due to the fact that South America has a number of unique features and its metro systems are built and operated with account for the climatic, financial, economic and political factors that are different from the ones in Europe.

The metro lines in Latin America transport 20 million passengers daily, they are located in 22 cities in 10 countries. Considering the high population density of the region (570 million people), 200 million of which use public transport, there is an urgent need for further construction and development of metro systems in cities.

The events of the 93rd Metro Assembly were concluded by a technical visit to the metro stations of Rio de Janeiro, including the new line L4 that had been previously opened in 2016 before the Summer Olympic Games.

The next significant event for the International Union of Public Transport is the International Summit and UITP Exhibition that will be held on May 15th – 17th, 2017 in Montreal.

The next meeting of the UITP Metro Assembly is scheduled for the autumn of 2017 in Vienna.

After the completion of the 93rd Metro Assembly its participants thanked the management of the Rio de Janeiro Metro for the warm welcome and the splendid implementation of the events.

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Tbilisi metro celebrated its 50th anniversary

Tbilisi Metro is a member of "Tbilisi Transport Company", 100% shares of which are owned by the Mayor's Office of the city of Tbilisi, Georgia. It operates since 1966, when the first Metro section "Didube-Rustaveli" was opened. In 2009, municipal buses and associated immovable property in the form of three vehicle fleets were transferred to the company's ownership by decision of the Mayor's Office of the city of Tbilisi. In 2012, business of the company was extended and new cable railroad "Rike-Narikala" was added to its assets. Tbilisi residents and guests of the capital of Georgia must receive the high-quality transport service. The trip should be maximally safe and comfortable. About 5,800 persons are the permanent employees of the company.

11 of January is a landmark of the city of Tbilisi, as this day of all others the Tbilisi Metro was formally opened in 1966. Rugged terrain of the city created the obstacles for ground transport development. It was one of the reasons facilitating the construction of the underground in Tbilisi. On 29 of September 1951, the decision of construction of the Tbilisi Metro was taken by the Regulation of the Council of Ministers of the Soviet Union.

The underground was opened on 11 of January 1966 on the section including 6 stations ("Didube", "Elektrodepo", "Oktyabrskaya" (now "Nadzaladevi"), "Vokzalnaya Square", "Mardzhanishvili" and "Rustaveli") and the length of line was 6.5 kilometers. The underground opening became a milestone and outstanding event for both the city administration and all Tbilisi residents.

In 1967-1971, the first line of the Tbilisi Metro was complemented by five more stations and the second 5.8 km long underground line ("Saburtalinskaya") consisting of 5 stations and connected the Vokzalnaya Square with the Saburtalo district came into operation in 1979.

In 1985-1989, 5 new stations were opened on the first line and one more station on the Saburtalinskaya line was put into operation in 2000.

In 2005, cars remodeling that covered both extensive major repair work and installation of modern systems was started. Old parts were replaced with new ones, the car interior was essentially changed, the exterior received modern appearance, and modern control panel was installed in the driver's cabin. Old systems and assemblies were replaced with new ones containing modern control and data processing microprocessor technologies. At this point, up to 94% of the whole rolling stock, the process of which upgrading will continue in 2016 as well, is already improved.

In 2006-2010, the major repair of 8 stations, as a result of which the facades and interiors were renovated, work on improvements of power supply and water drainage systems, security systems of telephone, television and computer networks was carried out, the firefighting system was upgraded and major repair of escalators, service and utility spaces was executed, was executed within the frames of improvement and development of the Tbilisi Metro infrastructure.

In 2014, Tbilisi Transport Company implemented a large-scale project: the Tbilisi Metro was equipped with modern dispatching system, which replaced the old one. Within the frames of this project, the eastern wing of the third floor of the Company's administrative building, where the dispatching centers of underground and bus traffic and power supply control were located, was subject to reconstruction. Mentioned wing was adapted both for current workflow and emergency operating control.

Tbilisi Transport Company and the city authorities are hard at work on the development of the Tbilisi Metro. It is planned to complete the numerous projects, which will aim to the infrastructure development, enhancement of safety and improvement of passenger service quality.

In 2015, construction of new underground station "State University" was started. Mentioned station was planned as the terminal station of the Saburtalinskaya line and the train stub tracks infrastructure was combined in it. Construction of the station was started several decades ago, but it was shortly suspended. Municipal Development Fund with funding from Asian Development Bank resumed the construction of mentioned station. Within the frames of the project development, the complex of station "State University" will be completed and the second line tunnel will start to operate at stations "Delisi" and "Vazha-Pshavela" that will increase the train traffic volume on mentioned section.

Cost of work described above is 83,000,670 laris (about Euro 32 mln.) and they are planned to be completed in two years. Construction of new underground station is a very important event for the city transport system of Tbilisi.

In 2016, Tbilisi Transport Company plans the recovery of underground stations, within the frames of which the major repair of seven stations is prepared. Improvement of the rolling stock will be in progress: major and midlife repair will cover 28 cars.

Brief information on major structural service of the Tbilisi Metro

Tracks and Tunnel Structures Service

The Tracks and Tunnel Structures Service plays one of the key roles in the Tbilisi Metro operation. Smooth and safe train traffic being the main factor in the context of passenger transportation depends on well-arranged Service operation.

The Tracks and Tunnel Structures Service includes:

- Track distance
- Tunnel structures distance
- Motor and rail vehicles distance
- Failure detecting laboratory
- Surveying and emergency response teams.

Well-arranged operation of all above-mentioned subdivisions ensures safe operation of the facilities of the Tracks and Tunnel Structures Service: track infrastructure (track miles is 63.9 km); 22 stations; 56.6 km of tunnel (including station tunnels); two electric engine houses (Nadzaladevi and Gldani) and a range of other structures, including overhead crossings, pedestrian and transport (train) bridge, air shafts, water pump station, etc.

Maintenance and treatment of track facilities involve their improvement and repair according to the set standards. The broken down rolling rails (according to passaged tonnage, wear and tear and received defects), fixture elements, cross-ties, crossing sleepers, etc. are replaced periodically.

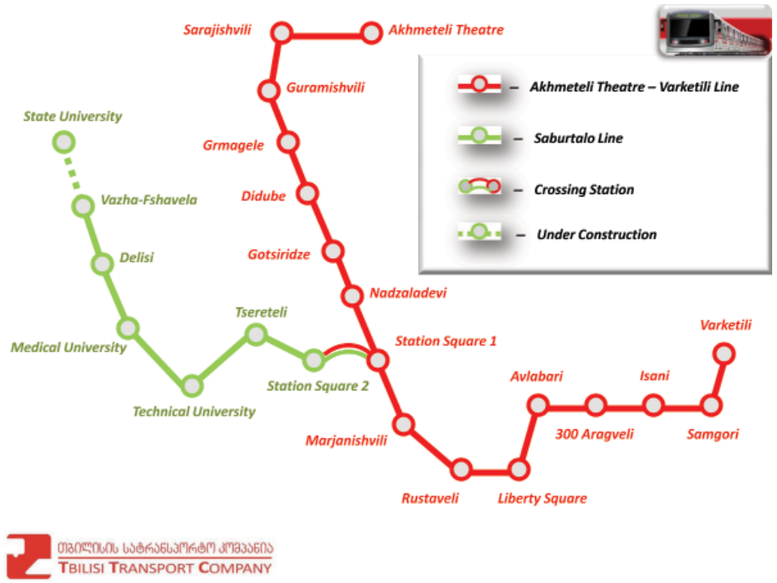
Maintenance and treatment of tunnel structures is carried out by executing repair work: removal and diverting of ground water, treatment and recovery of track concrete, concreting of replaced cross-ties, executing of discharge work for plugging of ground water leaks and filling of voids behind the tunnel lining, treatment of drainage and water collecting system, facing and plastered surfaces, structures in the tunnel (metallic foot-paths, pedestrian banquettes, etc.).

Failure-free operation of the motor and rail vehicle distance and service trains included into it is instrumental in organizing and carrying out of listed work. Significant work is carried out by the failure detecting laboratory, the responsibility of which includes checking of railway facilities, fixing of defects and taking of corresponding measures ensuring the safety of passenger train traffic.

The surveying team systematically monitors overall dimensions of the structures by using clearance gauge, timely fixes the defects and keeps the survey markers on the Metro route in good repair. Detected defect symptoms, operative repair of which is executed by the service emergency response team, are under the constant control.

The service workshop provides manufacturing of products necessary for the facilities and repair and preventive maintenance of the machines and tools.

All above mentioned on-line work is carried out by the staff members in number of 360 persons, the main part of which works in night time after voltage removal from the conductor rail.



“Gldani” depot

Electric depot “Gldani” was put into operation on 7 of November 1985 as a part of the First line of the Tbilisi Metro. The depot consists of administration and amenity building, train parking and repair building, consisting, in its turn, of three repair pits and fourteen parking and inspection pits with work areas and auxiliary facilities: washing and blasting chambers, cleaning devices, compressor station, paint shop and cars turning bay.

Territory of the depot is 12.8 hectares. Tbilisi branch of “Electric Stock Repair Plant” is also situated at the mentioned territory. “Gldani” depot designated rolling stock yard includes 162 cars; the operational yard includes 124 cars, among which 112 remodeled cars were formed into four-car trains.

The trains “Gldani” operate on the First line of the Tbilisi Metro from station “Varketili” to station “Ahmeteli Theatre”. Total line mileage is 40,304 km and the number of stations is 16. The depot is connected to the line by double-track tunnels laying to station “Guramishvili” with total length of 3,969 km.

From the day of putting into operation and till now, the depot fully carries out the work specified in the regulations by all types of maintenance and routine repair of the Metro rolling stock. “Gldani” have 346 emloyers from which 155 are the electric train drivers.

Since 2005, Tbilisi branch of “Electric Stock Repair Plant” executes major repair of the cars with remodeling. Within the frames of remodeling, the following equipment is installed on the cars:

- microprocessor-controlled traction apparatus with application of power intelligent IGBT-modules;
- compressor device equipped with screw pairs and asynchronous inverter drive;
- electronic units of automatic speed control apparatus and onboard power sources;
- non-spillable batteries, etc.

Along with specified work, the work sections and laboratories are organized in the depot with the purpose of control, service, repair and adjustment of remodeled apparatus and assemblies.

“Nadzaladevi” depot

“Nadzaladevi” was accepted for operation in 1965. The depot consists of administration and amenity building, train parking and repair building and track raising building. Total territory is 2 hectares. The operational yard includes 33 remodeled cars formed into three-car trains. Staff – 122 persons, 64 are the train drivers.

The trains “Nadzaladevi” operate on the Saburtalinskaya line of the Metro with the length of 13.2 km and 6 stations. Opening of the seventh station is planned for 2017.

Traffic Service

The Traffic Service is a structural unit of “Tbilisi Transport Company” with 506 employees. Scope of activities of the Service includes organizing of trains traffic and carriage of passenger, providing qualitative service of passengers and their safety.

The Service includes the following subdivisions:

- Administration – 9 employees;
- Dispatch office – 12 employees;
- 22 stations – 481 employees;
- Accounting – 4 employees.

The basis of train traffic is an automatic train signaling with automatic speed control. In 2014, the old-fashioned centralized dispatching control system was reconstructed that resulted in essential improvement of both train traffic safety and work conditions of the dispatch office employees.

Electrical and Mechanical Service

514 employees are employed in the Electrical and Mechanical Service of “Tbilisi Transport Company”. The Service combines: escalators department, electrical and mechanical department, facilities under construction service department, as well as sanitary group, remote control group, dispatch office and workshop.

- Escalators department serves 59 escalators of different types that means executing of day-to-day repair and audit work with the purpose of ensuring of their failure-free operation and safe carriage of passengers.
- Electrical and mechanical department services the water supply system (64 km of water pipeline) and water discharge system, as well as sewerage network and drainage basins. With the purpose of implementation of above-mentioned measures, 171 pumps of different types, well-organized and failure-free operation of which is ensured by the electrical and mechanical department, are used. At the same time, the electrical and mechanical department executes day-to-day repair and audit work and ensures failure-free operation of main (56 devices of different types) and local (210 devices of several types) ventilation systems used for provision of normal microclimate in the Tbilisi Metro.

- Facilities under construction service department fulfils maintenance of the tunnels under construction, ground water transit and drainage channels cleaning, as well ensures failure-free operation of the respective lifting and drainage devices.
- Dispatch office provides coordination activity of the electrical and mechanical service’s subdivisions, monitors failure-free and well-organized operation of escalators and electrical and mechanical devices, as well as other devices and equipment of the electrical and mechanical service’s departments. The dispatch office executes operating and technical management of day-to-day repair and audit work and measures aimed to troubleshooting.

Power Supply department

The Power Supply department is engaged in receiving of high-voltage electrical power from the urban distribution with its further conversion and supply to all facilities of “Tbilisi Transport Company”. With the purpose of improvement of electrical power supply reliability, all substations are interconnected by high-voltage cable lines. 267 people work in the department. It includes five subdivisions (groups):

- Electrical power supply group;
- Cable networks group;
- Lighting group;
- Electrical protection and automatic remote control group;
- Dispatch office and emergency and recovery bay.

Equipment on the Metro substations is operated from the opening day and needs to be replaced and upgraded. Specific work was executed in that regard: from four traction substations, old-type high-voltage oil switches were replaced on three (“Mardzhanishvili”, “Avlabari” and “Gotsiridze”) ones; and from ten integrated substations, high-voltage magnetic switches were replaced with modern vacuum switches on two – “СТП-9” (Station “Delisi”) and “СТП-5” (Station “Vokzalnaya Square”) ones. Feeder switches 825 V were replaced on all traction substations.

Over the past year, the cable lines were recovered (replaced) in tunnels and on ground sections by efforts of the Service: 6 kV – 1,800 meters, 825 V – 2,000 meters and 380/220 V – 12,000 meters. Work on replacement of old-type batteries with new maintenance-free batteries is in progress.

Up to now, work on upgrading of lighting of the tunnels and entrance halls is in progress: old lighting devices are replaced with new energy saving lamps and LED lamps that allows significant decreasing electrical power consumption.

The dispatch service was provided with the remote control systems that allowed making dispatch control more flexible and dynamic.

Signaling and Communication department

The Signaling and Communication department is a structural unit of “Tbilisi Transport Company” with staff of 215 employees. The Signaling and Communication department handles train and rolling stock separation systems; all communication facilities; call signaling devices; clock system; fire and protection signaling devices; passenger automation devices.

The department includes the following subdivisions:

- Signaling group;
- Communications group;
- Repair and technology group;
- Passenger automation group.

In 2015, new upgraded centralized dispatching control system based on using of modern digital technologies and including actually infinite possibilities of management and control was accepted for operation. It is planned to replace old-fashioned local control machines existing at the stations with computer equipment in future on the basis of the system.

Service of old-fashioned communications systems is one of the outstanding issues of the department activities due to production end of necessary spare parts and materials. In this regard, upgrade of radio train communication, dispatch and operational communication and fire signaling, as well as their switching to modern digital systems are provided for in the development plans for 2015-2017. Completion of these projects will provide improvement of train traffic and passenger carriage safety that in its turn is the main purpose of the department.

Combined Workshops

The Combined Workshops (CW) of “Tbilisi Transport Company” started operation in November 1972. Their territory is 5455 hectares. Numbers of staff are 96 persons, among which are the veterans working as from the date of the facility establishment.

There is an administration building, main production shop and other ancillary buildings in the CW territory.

The Combined Workshops consists of two main structural units:

- Integrated service shop;
- Escalators repair group.

Primary activity of the enterprise includes executing of routine, midlife and major repair of escalators. Assembly units are remodeled in the CW by using the latest technology with the purpose of extension of escalators service life.

International round table gathered subways in Tbilisi

The International Round Table Meeting on the current problems of metro systems was held on January 28, 2016 in Tbilisi in accordance with the activity plan. This event is of great importance for the activities of the International Association «Metro». The meeting was jointly organized by the International Association «Metro», JSC «Tbilisi Transport Company» and the International Union of Public Transport. It was held within the framework of the events dedicated to the 50th anniversary of the Tbilisi Metro. It was not the first time that the association organized such meetings: the round table meetings held in Minsk, Moscow and St. Petersburg proved to be efficient due to the relevance of the issues raised and the interest that is constantly aroused by the speeches of the spokespersons representing domestic and foreign metro systems, manufacturing and research companies.

The Round Table Meeting in Tbilisi was opened by Mr. Aleksandr Dzhaparidze, Director General of JSC «Tbilisi Transport Company», and Mr. Vladimir Garyugin, Head of the St. Petersburg Metro. They welcomed the audience, thanked them for their participation and wished the delegates efficient work.

In accordance with the program, Mr. Gautier Brodeo, the expert representing the RATP (the Paris Metro) delivered the report "The Operating Experience of the Paris Metro and the Peculiarities of Automation". The spokesman presented the basic indicators of the work of the RATP. It is the main transport operator of Paris and it includes the metro and part of the above-ground transport. The expert raised the issues of investment policy, renewal of the fleet of cars, the further development of the system of automatic metro lines. The report also included general information about the status of the RATP network which comprises 14 metro lines, 8 tram lines, 2 electric train lines which pass through the city center and bus routes. But the major focus of the speaker was on the introduction of modern technologies, in particular, the automatic metro and the 4-level automation system for the metro adopted by the RATP. Today, the 14th line of the Paris Metro is fully automatic.

Mr. Brodeo's report aroused great interest among the participants of the meeting, and the discussion touched upon various issues related to the construction and operation of the automatic metro: from the construction time and return on investment to the impact of human factors.

The next report on mobile rail milling under the conditions of the metro was presented by Mr. Igor Popadyuk, head of the Austrian company DUKE'S Handels GmbH.

Upon detection of certain defects the rails must be replaced, which requires material expenses, time and financial expenses. However, many rail defects can be eliminated by milling its work surface on site, without its removal from the track. This operation is successfully performed by the rail milling unit as part of a special train.

Mrs. Olga Bronskikh, the representative of the Moscow Metro, told the participants of the Round Table Meeting about the issue of preservation of stations which are under state protection, and how this problem is solved in Moscow.

At present, 45 stations of the Moscow Metro are monuments of history and culture. All these stations have unique architectural and artistic features that need to be retained in their original form. In this case it is especially important to ensure strict compliance with the standard operating procedures for maintenance and repair of the station facilities and interiors.

Mr. V. Garyugin, Head of the St. Petersburg Metro, emphasized the acuteness of the problem under the current conditions of operation of metro systems, when, for example, a station that is a monument of architecture needs to be adapted for providing services to people with limited mobility.

The participants of the meeting unanimously decided to raise this issue at the core meeting of the managers and specialists of the services of tunnel facilities representing the metro systems that form the International Association «Metro».

Mrs. Yekaterina Sol, the representative of the French company TOLLENS delivered the report "Application of Paint Materials for Finishing and Maintenance of Metro Stations". The subject of the report was definitely related to the previous one.

Mr. A. Popov, Acting Director General of NIIEFA-Energo LLC, delivered the report "Manufacture of Equipment for Traction Energy Systems of Metros".

After the completion of the Round Table Meeting its participants, representatives of metro systems, enterprises and companies congratulated the staff of «Tbilisi Transport Company» LLC on the 50th anniversary of the Tbilisi Metro and wished the major transport company of Georgia further development and prosperity.

Then the participants of the Round Table Meeting were invited to a ceremonial reception at the City Hall of Tbilisi, where the Mayor congratulated the metro employees on the anniversary and presented awards to the long-service employees of metro construction and the metro system.

Within the framework of the events dedicated to the anniversary of the Tbilisi Metro, the delegates had the opportunity to see the display organized in station Rustaveli. It presented historical photos and documents related to the construction, the first days of work and the significant events of the Tbilisi Metro.

D.A. Golovin
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Innovative rolling stock for subways

Operating efficiency of metro lines largely depends on used rolling stock. Increasing metro carriage volumes and high-level requirements to carriage safety make designers improve the construction and reliability of rolling stock, which must be comfortable, fast, cost-effective and modern.

Currently, the cars of different models and variants operate in the Moscow Metro; 70% of total fleet are the old model cars designed and manufactured from 1970 to 2000; they are the cars of model Ежз/Ем508Т and 81-717/714; the cars of model 81-717/714 and their variants, which represent 55% of the total number of old model cars, are still the most common model of obsolete rolling stock.

Currently, obsolete model cars do not already match the rate of growth of passenger carriage and the up-to-date comfort levels, and extensive plans regarding the construction of new sections and lines of the Moscow Metro and necessity of replacement of life-expired cars fleet dictate their specific terms to the new rolling stock.

The following equipment is used in the cars of model 81-717/714 and their variants:

- direct current traction drive with rheostatic power operated motor controller with direct current commutator traction electric motors with power of 114 kW, during car breaking all energy generated by the traction electric motors operating in generator mode is absorbed on the rolling stock itself in the break resistors that results in their excessive heating and heat emission into the undercar space;

- relay contactor equipment of the traction drive and train relay control and automatic speed adjustment system, the main causes of failure of which are the defects of group devices and individual relays and contactors due to the defects of bridge-type contacts, springs of cam elements and electrical-mechanical relays;

- electric signals communication is executed by using train wires, which are available in large quantities that do not allow to reliably transmit electronic and electric signals to the car and train equipment and implement comprehensive equipment diagnosis system;

- car bodies are made of common steel that affect the car body resistance to aggressive environments during operation on the Moscow Metro lines, thus the body roof corrosion problem was detected in the cars in operation;

- natural ventilation of the car saloon executed through special air intakes installed on the car roof. Such ventilation system works only during train movement in any direction. Volume of air input in the saloon depends on the car movement speed and the temperature of air supplied into the saloon equals to the ambient temperature. The air intakes in the car roof substantially raise the noise level in the saloon during train movement;

- sliding door does not allow to provide substantial reduction of noise level in the car saloon and to eliminate occurrences of foreign objects falling under the door leaves or into the door aperture fold and the lack of grip-prevention system with light and audio indicator of door closing warning do not provide proper safety during passenger pick-up and drop-off at a station;

- car suspension is made of stiff springs completed with hydraulic shock absorbers.

That's why the Moscow Metro, during development of technical specifications for new rolling stock in 2000s, paid special attention to solving of problem of passenger carriage comfort improvement and ability to fulfill targeted volumes and schedules of passenger carriage by using the latest engineering solutions.

The first project in this area included the cars of model 81 740/741 and 81-740.1/741.1 for Butovskaya and Filyovskaya lines of the Moscow Metro, which were put into operation in December 2003, where the saloon heating and ventilation system SHVS was applied for the first time ever in the metro. That system provided forced ventilation of passenger saloons and their automatic heating in winter period depending on actual temperature in the car. For en-

suring of normal operation of the passenger saloon heating system, a range of measures such as sealing and heat insulating of passenger cars by using isothermal materials, multiple glazing and sliding plug door construction was taken.

The same measures also showed the positive result in solving of another problem – reduction of noise level in passenger saloons during train movement. Thus noise level was reduced from 90 dB to 75 – 80 dB.

In addition, for improvement of passenger carriage conditions, air suspension of the car body, new digital information complex DIC and route digital table on the control cabin windscreen were applied in the fortieths-series cars.

Asynchronous traction drive with autonomous IGBT-modules voltage source inverter that allows implementing regenerative-rheostatic braking, smoother train acceleration and braking were applied in that rolling stock.

With the purpose of improvement of passenger carriage comfort and safety, the fortieth cars project was carefully revised in 2009 and since August the new variant – the cars of models 81-740.4 and 81-741.4, began coming in to the Moscow Metro.

That car variant differed by availability of air conditioning, ventilation and heating system of passenger saloons ACVHS manufactured by company "Merak".

Further development of measures for improvement of comfort, reliability and engineering solutions of the metro rolling stock was reflected in the project of cars of model 81-760/761, series deliveries of which were started in 2013.

Main features of the cars of new model 81-760/761:

1. Asynchronous traction drive with the system of noise reduction from traction current effect and asynchronous traction motors with insulated bearings with power of 170 kW. 81-760/761 cars were equipped with servo regenerative-rheostatic braking mode for the purpose of ensuring of traction electric power saving.

2. New microprocessor control, traffic safety and technical diagnosis system for transmitting of commands, control and diagnosis was applied. Car and train CAN-bus was applied in the 81-760/761 cars that allowed improving reliability of transmitting of electronic and electric signals of different systems, implementing comprehensive equipment diagnosis system and essential decreasing the number of control wires.

3. Air conditioning, ventilation and heating system of passenger saloons ACVHS based on saloon air conditioner by Faiveley (France) and Transkon (Russia) was installed. The conditioner consists of two single blocks that allowed simplifying equipment installation (there are no additional control and power wires, there is no a pipeline connecting the conditioner and the compressor, which were located under the car before). The saloons of 81-760/761 cars are equipped with air UV-radiation disinfection system.

As well with the purpose of improvement of working conditions of the locomotive crews:

- cabin of the cars of model 81-760 is equipped with the climate control system with ventilation, air conditioning and heating;

- cabin doors of the cars of model 81-760 are on both sides for convenience of exit to station platforms and gangways;

4. video surveillance system with option of information online transmitting to the underground situation center was installed in the car saloons.

5. New construction of sliding plug door with individual grip-prevention system was applied in the car saloons with respect to each door of the passenger saloon.

6. Evacuation stairway that allows the passengers quick and safe leaving the rolling stock and stepping on track in case of emergency and impossibility of movement continuing was mounted

in the head cars at the ends of front masks.

7. New primary and central air suspension improving the passenger carriage comfort was applied.

8. Special spaces for passengers in wheelchairs are provided for in the head cars of model 81-760.

Variant 81-760.A/761.A/763.A of the cars of model 81-760/761 became the next stage of their development.

The main distinguishing feature of new train variant is its equipping with inter-car gangways that allow providing passengers walk-through in the train and availability, in the train, of two intermediate non-motored cars of model 81-763.A, in which, compared with the cars of model 81-761:

A) the following equipment is not used:

- 4 asynchronous traction electrical motors;
- set of traction electric equipment;
- motor-driven compressor;
- auxiliary converter AC;
- battery;
- switchgear unit;
- motor bogies;
- geared wheel sets.

B) the following equipment is used:

- non-motored bogies;
- gearless wheel sets;
- inter-car sealed gangway (2 pcs.).

In connection with application of inter-car gangways and change of construction of butt ends in the cars of model 81-760.A/761.A/763.A, additional technical measures aimed to reinforcement of the body bearing structures were taken for preservation of car body roughness.

In the construction of new rolling stock of model 81-765/766/767, supplies of which will start in 2017, all best practices used before and the latest modern engineering solutions in the field of safety, provision of passengers comfort and improvement of work conditions of the locomotive crews, as well as maintainability, will be used.

Organizations and science and research institutes, such as VNIIZhT, VNIIZhG, OPZhT, which were specially accredited in that field, were engaged in preparation of Technical Requirements to new rolling stock for the Moscow Metro.

Key differences:

- Widened door apertures and reduced floor height for improvement of comfort and rate of passenger pick-up and drop-off;

- Passenger information system with option of video broadcasting;

- Increased seat width, additional rising seats in the spaces for disabled persons in wheelchairs;

- Special seats for persons with reduced mobility (disabled persons in wheelchairs);

- Strict requirements to noise insulation and interior lighting system.

Direct current trains are designed for operation in tunnels and open spaces of operating electrified metro lines with track gage of 1,520 mm, nominal voltage of 750 V, supply from conductor rail, movement speed up to 90 km/h and passengers exit to raised platforms.

The following equipment is also used as a component of the electric train:

- motored head cars with control cabin located on the train ends;
- intermediate motored cars;
- intermediate non-motored cars.

The following train control modes are provided for: manual mode (with assistance of the locomotive crew); automatic mode (the driver closes the doors and starts the train from a station), computer-aided mode (without presence of the locomotive crew) may be applied.

O.E. Zaytsev
SUE "Moscow Metro", Moscow

Yerevan subway: 45 years in operation

Yerevan, one of the oldest cities in the world with the history of over 2,800 years, is spread out in a flat hollow crossed by the deep canyon of the Razdan River. The city is situated in the beautiful Ararat Valley at the intersection of flourishing trade routes between Europe and Asia.

Due to explosive growth of the city and swell in its population, the transportation problem has become aggravated sharply by the year 1970. After careful economical and technical calculation and justification in the specialized Union organizations and agencies, scientific and design institutions, the reconstruction variant of the tramway system with passing the high-speed tram trains through the center of the city of Yerevan in the tunnels for municipal transport in accordance with the overall dimensions (Regulation of the Council of Ministers of the Armenian SSR No. 481 dated 4 of August 1971) was selected.

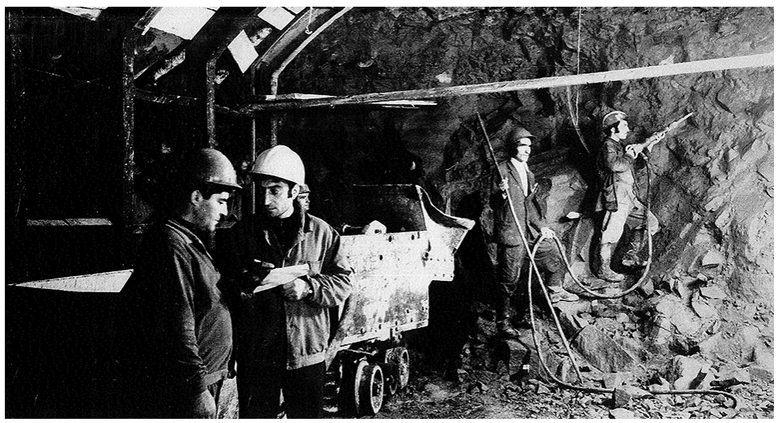
Detailed design of high-speed transport in Yerevan was drafted by the Kavkaz State Design and Survey Institute "Kavgiprotrans". The project chief engineers are Mr. V. Dandurov, Mr. K. Stepanyan and Mr. A. Kurisko.

The unique design of rail road Idzhevan-Razdan with the longest tunnel (8 km) in the Soviet Union were constructed in the territory of the Republic and for the first time in the Soviet Union the work on designing of passenger and transport electromagnetic suspension system was conducted and it was necessary to establish a design organization for this purpose and it was done according to Regulation of the Council of Ministers of the Armenian SSR No. 365 dated 16 of June 1971 and Order of the Ministry of Transport of the Armenian SSR No. 176 dated 28 of July 1971. Institute "Armgiprotrans" headed by Mr. V. Dandurov and Chief Engineer, Mr. S. Antonyan, was established on the basis of Yerevan Branch of SDI "Soyuzdorproekt". The Institute implemented the high-speed underground tramway design and the Metro design later.

In 5 years of the construction, the population of the city of Yerevan has multiplied sevenfold and has reached 1 million inhabitants. Besides, the complex terrain with height difference 550 meters made it difficult and sometimes impossible to develop ground transportation.

The high-speed tramway under construction could not meet the passenger transportation requirements anymore. Taking into account the necessity of long-term municipal transportation development, the Council of Ministers of the Armenian SSR applied to the Council of Ministers of the USSR for starting the construction of the metro in Yerevan on the basis of the high-speed tramway under construction.

Having considered the request of the Council of Ministers of the Armenian SSR and the feasibility study, the Central Committee of the Communist Party of the USSR and the Council of Ministers of the USSR adopted Regulation No. 2221P dated 06 of October 1977 "On the Construction of the metro in the city of Yerevan".



Alongside with establishing of the design organizations, the Directorate of the Metro under Construction was assigned and Mr. I. Papiev, later the first director of the Yerevan Metro, who made a great contribution into both the construction and operation of the Metro, was appointed as its Director.

The detailed design was made by Institute "Armgiprotrans" and the architectural stations designs were made by Institute "Yerevanproekt".

The following task was set during selection of line route of the metro first Stage: connect the densely populated residential areas with the railway station and the city industrial zone. It was planned to build the first 10.5 km long line with 9 stations.

The metro builders faced with the great difficulties in their path. The rout turned out to be rich in basalt in the form of single lava flows with the depth from 5.0 to 20.0 m, which separated from each other by slag horizontals with the depth from 2 to 6 m. The rocks are presented by lacustrine - alluvial deposits, sand clay and silty sands intermitting with clay, clay loam and sand pockets and bands, above which the pebble gravels transforming to the daylight surface of boulder and cobble deposits of the Getar River fan.

In the hydrological context, the metro route is heterogeneous.

Extra abundance of water is observed in 2.5 km long section from station "Yeritasardakan" to station "Zoravar Andranik", where the aqueous rocks are presented by alluvial-proluvial deposits of the Getar River. The general direction of groundwater movement is from the North to the South.

Average hydraulic water-table gradient is 0.016 meters. Hydraulic pressure head above the groundwater penstock varies from 2 to 18 meters. Coefficient of enclosing rock permeability varies from 20 to 60 m3/day, that characterizes the complexity of dewatering system in that route section.

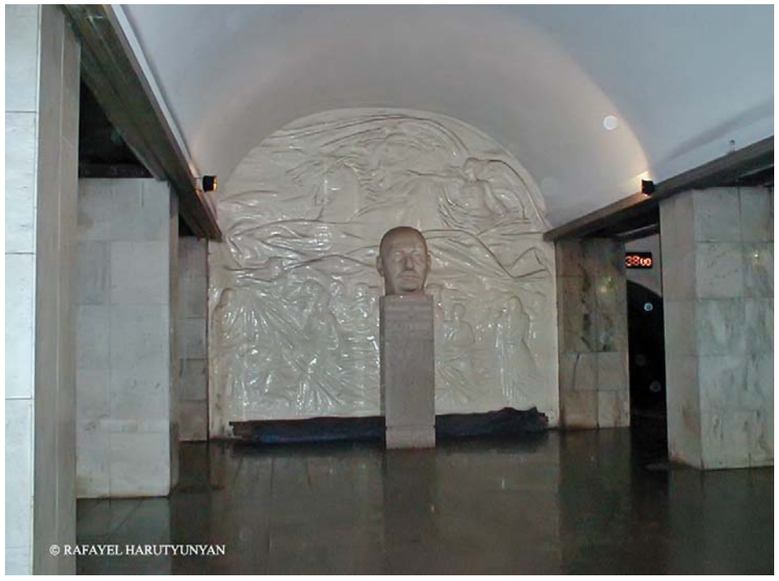
50 deep-level pumps were installed along the route from station "Yeritasardakan" to station "Zoravar Andranik" for dewatering.

The Metro route lane from station "Zoravar Andranik" to station "Garegin Nzhde Square" is situated on a depositional plain formed by the fans of the Getar and Dzhrvezh Rivers and on a terrace plain of the Razdan River.

In the section under consideration, the water-table aquifer circulating in fragmental soils and basalt cavities with general south westward water-table gradient and high coefficient of permeability was opened.

Construction of the Yerevan metro was assigned to Administration "Armtonnelstroy" of the Ministry of Transport Construction of the USSR.

As well, the staff members of "Armtransstroy", "Arpa-Sevanstroy", construction and installation organizations of the Ministry of Industrial Construction of the Republic, "Erhimstroy", "Glavmontazhspetsstroy", "Armsvyazstroy" and other organizations were engaged in the Metro construction.



Structural solutions and the metro tunneling methods were designed and implemented depending on geological and hydrogeological conditions represented by massive, basalt and friable water-flooded rocks containing pebble, gravel, break-stone and basalt float stones.

The tunneling was carried out through counter headways. First the upper part, and then the lower part, of the tunnel was mined.

The tunnels at stations "Yeritasardakan" and "Square of Republic" were holed by pick hammers across the full cross-section.

Drilling and blasting work by using hammer drills drilling the blast holes, in which the charges with blasting agents were put, was widely used on the main line tunnels. In the course of mining and rock removal, the jacketing (lining) of the mined tunnel section was carried out by using cast-iron tubing and precast concrete units.

During construction of the Yerevan metro, 44 thousand tons of cast-iron and 19 thousand cubic meters of precast reinforced concrete jacketing was mounted.

With the purpose of hardening and stabilizing of the tunnel crowns and walls, the cement slurry was pumped behind their jacketing and the water proof shield was provided. The construction was complicated by the fact that during blasting work, it was necessary to take special precautions and safety measures due to close proximity of shabby residential houses of the old city and complex network of underground utilities to the Metro route.

Geological and hydrological conditions, physical and mechanical properties of mined massive rocks had a great impact on the rate of progress of the construction work. As was already mentioned above, more than half of the metro line passed through the water-saturated sections. Cumulative water influx was about 6 thousand cubic meters per hour. For its containment and creation of normal working conditions at the faces, the effective methods of forced dewatering of the system of deep wells running up to 50 m were applied.

3.6 km long section from station "Zoravar Andranik" to station "Gortsaranain" was overpassed by the ground route.

Rails with mass of 50 kg/lin.m. on timber sleepers were buried into the track concrete in the tunnels and laid on break-stone on the ground sections.

There is the following expression: "You will never build the metro, if you are alone".

Just the entire country participated in the construction of the underground trunk line in Yerevan. By that time, Armenia, the country of mountains, had already possessed its own big enough highly-experienced team of tunnel builders. But the first skilled instructors on the construction and installation of special equipment of the Metro were highly-skilled tunnellers, installers, rail track workers and finishers from Moscow, Leningrad, Minsk, Tashkent, Tbilisi and Kharkov.

The metro construction workers gratefully remember the names of famous tunnellers, heroes of Socialist Labor, Mr. A. Suhanov, Mr. A. Tihanovich and their coworkers, who signed their labor autographs in the construction of the first tunnels of underground trunk line.

With the purpose of training of personnel, its recruiting, work management and commissioning of the Metro facilities, the Order signed by the Minister of Railway Transport of the USSR regarding establishing of the Yerevan Metro Administration was issued (February 1980, staffing schedule – 23 persons).

2-3 persons engaged in organizing of the service and supervising of erection work of the metro facilities were taken on to each service.

For qualitative organization of the metro operation, the interim staffing schedule in quantity of 200 persons was approved in July 1980. Training of many staff members was organized on the basis of the Tbilisi metro: for engine drivers and assistant engine drivers, escalator operators, as well as in vocational and technical school TУ-19 of the city of Yerevan – for employees of train, signals and interlocking and communications services.

The first 7.6 km long section of the line Stage 1 from station "Barekamutyun" to station "Sasuntsi David" was commissioned on 7 March 1981.

In 1989, the construction of Stage 1 was completed: the following stations appeared in addition to the existing five stations: "Gortsaranain", "Shengavit", "Garegin Nzhde Square", and "Zoravar Andranik".

Later, one more station "Charbah" was constructed on the extension of the depot branch line in 1996.

1993-1994 was the most difficult period for the metro, when the Republic was in power crisis and the population received the power within 2 hours per day. In practice, the ground municipal passenger transport was out of service and the load on the Metro increased threefold. The metro transported 200-250 thousand passengers per day. There was lack of the cars.

Unreliable electric power supply, low current frequency 45 Hz and low voltage resulted in frequent failures in operation of the Yerevan metro and signals and interlocking failures. To find a way out of that situation, the metro in cooperation with NPO "Tranzistor" developed and implemented voltage and frequency supply regulators for signals and interlocking and communication devices. But the most complicated problem of the Yerevan Metro was dewatering and water trapping. The section of station "Zoravar Andranik", where in case of emergency 20 dewatering wells and 7 water trapping pumps operated, was the most dangerous in that regard. With the purpose of lowering of water table level, the 1.5 km long drainage gallery from station "Zoravar Andranik" to the gap of the Razdan River (Stage 1 was deployed in 1998) was constructed and it allowed disabling 15 dewatering wells and 7 water trapping pumps. In practice, the possibility of tunnels flooding of the block of stations "Zoravar Andranik" - "Square of Republic" was eliminated. But the aim was not attained completely. To lower the water table level maximally, it was necessary to elongate the existing gallery for about 1 km in the direction of station "Yeritasardakan" to ODP of station "Square of Republic". Currently, the construction of the abovementioned drainage gallery was started.

After the launch of the metro the operator faced the problem of the metro cars repair and maintenance, as the car shed was commissioned in 5 years, only in 1986. The trains were repaired at the adopted auxiliary station, where there were 2 tracks: one of them was equipped with inspection pit and the inspections were carried out on the stub tracks of station "Barekamutyun". Night storage of trains was executed on the station tracks and on the stub tracks.

Unavailability of machinery equipment and repair stations made many difficulties for normal operation of the metro.

Despite all difficulties and problems, the metro has already operated for 35 years without crashes and faults, demonstrating therewith a good practice of passenger service.

Currently, the Yerevan metro includes 10 stations and its track length is 12.1 km. About 50 thousand passengers are transported daily.

Each station of the Yerevan metro has its own individual architectural look. The stations have a long scale of colors. The valuable natural stones such as marble, granite, gabbro, basalt, travertine and tuff were used for their finishing. Together with distinctive architectural forms, the decorative panel pictures and bas reliefs representing the pages of the Armenian national epic were used for the station decorating that makes the underground palaces magnificent and beautiful. The authors of the designs of architectural appearance of the underground stations are the best Armenian architects.

Station "Barekamutyun" ("Druzhba") is situated in Square "Druzhba", where the streets connecting the Northern and the Southern part of the city intersect. This is the three-leaved column station. The back wall is decorated with bar relief "Peoples' Friendship". The Station architect was Mr. F. Darbinyan.

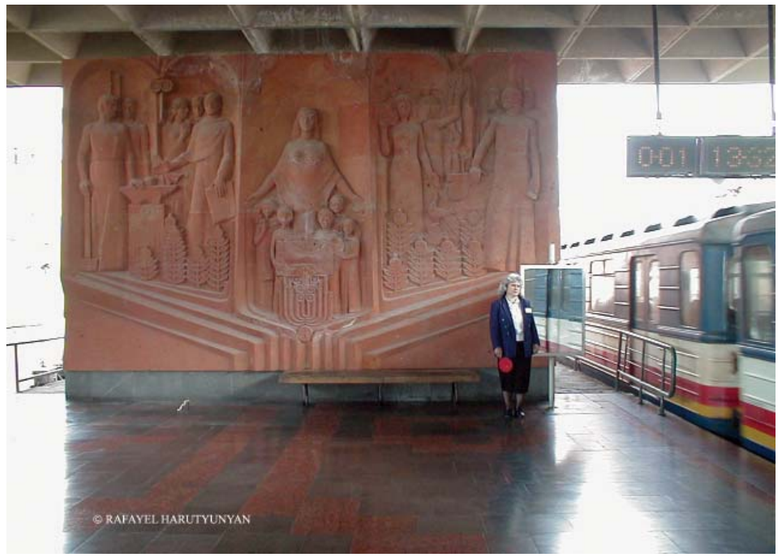
Station "Marshal Bagramyan" is situated in the Lovers Park opposite to the residency building of the RA President next to the buildings of the RA National Assembly and the RA Academy of Science. This is the three-leaved column station. At the end of the station, the bust of Marshal I.H. Bagramyan, great military commander of the Great Patriotic War, is installed. The architects are Mr. S. Kitehtsyan, Mr. A. Zurabyan and Mr. A. Azatyan.

Station "Yeritasardakan" (Molodezhnaya) is situated in the ring boulevard, where the most of higher education institutions of Yerevan are located. This is the three-leaved pylon station. The back walls are decorated with bar relief. The architect is Mr. S. Kyurkchyan.

Station "Square of Republic" is constructed in the same name square, where the building of the RA Government, hotels and other administration buildings are located. The square is the place of all-people's open-air celebrations and festive events. This is the three-leaved station. The back wall is covered by mirror glasses, which create an illusion of the magnificent station hall stretching off into the distance. The architects are Mr. J. Torosyan and Mr. M. Minasyan.

Station "Zoravar Andranik" is situated at the junction of three districts, where the big traffic flows intersect and large retail facilities, such as shopping mall "Tashir", market, etc., are concentrated. Currently, the large shopping mall "Russia Mall" is under construction. This is the three-leaved column station. The architects are Mr. S. Burhadzhyan and Mr. R. Dzhulgakyan.

Station "Sasuntsi David" is a ground station situated next to the railway station and equipped with the underground passage to it. Theme of the ancient Armenian epic "Sasuntsi David" was used in the architectural decoration of the entrance hall. The architects are Mr. B. Arzumanyan, Mr. S. Nersisyan and Mr. A. Israelyan.



Station "Gortsaranain" (Zavodskaya) is a ground station situated in the Southern industrial district of the capital. The station ceiling is made of caisson elements supported only by the columns placed along the station tracks. Such decision was taken for the first time during construction of the Yerevan metro. The architect is Mr. G. Gukasyan.

Station "Shengavit" is a single-vault subsurface station situated in a residential district. The shed branch line, on the extension of which Station "Charbah" is situated, is taken off from it. The architect is Mr. R. Dzhulgakyan.

Station "Charbah" is a single-track ground station designed as single-story station. The architect is Mr. V. Mnatsakanyan.

Station "Garegin Nzhde Square" is situated in the center of the Southern industrial district of the city of Yerevan. This is a three-leaved pylon station with the station entrance located in the specially built space under the square, where there are variety venue, fountains and numerous retail facilities, as well as the Metro Theatre. The architect is Mr. L. Gevorgyan.

The station tunnels are equipped with the forced ventilation through tunnel shafts on the station-to-station blocks and air ducts located under escalators.

Inventory stock of railway equipment includes 45 cars of type 81-717 and 81-714 manufactured by Mytishchi and Yegorovsk car works.

The power is supplied to the Metro via decentralized system from the external sources 6 kV, which is converted on the traction substation into direct current with voltage 825 V used for hauling operations. The rolling equipment is powered via the third conductor rail.

The line is equipped with automatic interlocking with signals and Automatic Train Signaling with Automatic Speed Regulation devices. The traffic is controlled from the central control room located next to station "Barekamutyun".

Minimum traffic interval during peak hours is 5-6 minutes. Working hours of the metro are from 7.00 am to 11.00 pm.

Flat-rate metro fare is 100 drams (about 15 rubles).

At the opening moment, the stations are accessed through automatic checkpoints. The fare was paid by 5 kopeck coins. After 1991, the stations were accessed through automatic checkpoints by using metal and then plastic tokens.

Since May 2009, the payment is executed by using plastic cards and tokens.

Technical system of fare payment and station passenger passage control by smart cards will be implemented in the nearest future.

In 1991, the Yerevan metro passed from the system of the Ministry of Railways of the USSR to The Ministry of Transport of Armenia. Currently, the Yerevan metro is subordinated to the city Mayor's Office.

Since 2010, program "Reconstruction of the Yerevan metro" is implemented successfully. Current management of the Yerevan metro with direct assistance of the Republic Government and the City Mayor's Office carried out work on the improvement of several systems by well organized joint actions.

In tunnels, 6 kV cables and jumper cables were replaced with new XLPE-insulated cables; in the shed, the cars were rebuilt, old car truck frames were replaced with new ones, advance equipment of automatic washing machine BMM-1 was purchased and put to operation, the simulator center equipped with advance equipment for training of electric train drivers was opened; fire prevention stocks were fully upgraded, etc.

Currently, construction of the drainage gallery is in progress (First Stage of it was deployed in 1998) with the purpose of complete lowering of water table level to the design point.

All mentioned above says nothing about that fact that all tasks set before us are fully completed. The Yerevan metro is also hopeful for solving of major problems in the near future. The metro staff members are ready to bring the tasks set before them into life selflessly, enthusiastically and with assistance of the Government and the Mayor's Office for the good of solving of transport problems of Yerevan's population.

In 35 years of operation, the metro directors were the following persons in different periods:

April 1980 – November 1980
Marlen Grigoryevich Arutyunov
1980-1983
Ivan Georgievich Papiev
1983-1991
Rafael Stepanovich Kaltahchyan
1991-1998
Grant Grigoryevich Beglaryan

1998-2001
Tigran Zograbovich Mushegyan
2003-2007
Vaagn Vladimirovich Akopyan
2001–2003; 2007- till now
Paylak Garnikovich Yayloyan.

In February 2004, the Board of Directors headed by the following persons was established in the metro:

2004-2007
Areg Apavenovich Barsegyan
2007-2014
Valeriy Norayrovich Arutyunyan
2014 – until now
David Movsesovich Grigoryan.

Prospect for further development of the Yerevan metro

Institute "Armgiprotrans" prepared the feasibility study and the design of extension of Stage 1 of the Metro in the direction of Achapnyak district, where it is planned to construct 2 deep-level stations at intersection of Alabyan and Abelyan streets (first station), in G. Chaush Square (second station). It will connect Achapnyak district with the center and other city districts.

Currently, negotiations with the Government regarding construction of abovementioned stations are in progress.

In the long run, the underground line will be extended in the Northern direction as well. Construction of four stations is planned here. This line will connect Arabkirskiy district and Davidashen with the Southern industrial district through the city center.

New underground line West-East will connect the South-West residential area with Norkskiy one. Thanks to this line, the residents of the Western and Norkskiy districts will have convenient and quick link to the city center. The rout of underground high-speed transport will lay from North-East to South, from Kievyan Street through the Nor Aresh city center, Erebuni to the South industrial district.

In the new line designs, the employees of "Armgiprotrans" applied new advanced design solutions, which gave a good account of themselves during construction of the Yerevan Metro Stage 1: high-efficiency seismic communications in the lining of underground structures, boring bonding with anchors instead of ordinary metallic stay bolts, new type of high-performance columns at station "Garegin Nzhde Square" and a range of other exciting developments.

Yerevan metro will go on growth together with city. In years to come, the trains will appear in new districts of the capital of Armenia, but the day of start-up of the first underground line – 7 of March 1981 – will sink into imagination of Yerevan's population forever as a national day, which presented Speed, Comfort and Beauty to them.

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Director General of CJSC
"Karen Demirchyan Yerevan metro"
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New simulators designed by Logos

The production company Logos is one of the leading domestic companies in the computerized simulators market. Its experience is over 25 years. During this period the company has developed simulators for almost the entire range of armored vehicles manufactured in Russia at the moment. In recent years, there has been active development of simulators for civil equipment and automation systems.

If you drive a car, you probably remember how nervous you were the first time you sat behind the wheel without an instructor; your palms were sweating when you first fit into a dense stream of cars on the highway. Now imagine what a newly-qualified metro train driver experiences when he drives a train of eight metro cars in a rush hour! There are professions that can be mastered only in practice. Metro train driver is one of these specialities. Today the training process can be made easier, safer and more efficient than just a few years ago.

No margin for error

In 2006, not far from station «Voikovskaya» there was a terrible accident: the tunnel was pierced by a concrete pile – right before an approaching train. The metro train driver Mr. Andrey Ulyanov noticed the danger and shortly applied the emergency brake. He didn't manage to avoid hitting it: the head car ran into the pile and was badly damaged, and then pieces of the concrete lining of the tunnel and two more piles fell on the front cars. The driver had enough time for leaving his cabin and running to the back of the car, to warn the passengers and organize emergency evacuation. Later he was awarded with an order: The commission concluded that only thanks to the proper and quick actions of Mr. Andrey Ulyanov casualties were avoided.

In tunnel anything can happen, and the driver has no right for error. But how can we teach drivers to practice train driving skills? I'm talking about a real train in the real world, with real people who are sometimes in such a hurry that they forget about their own safety.

The teachers at the Production-and-Training Centre (PTC) of Moscow Metro said that before the appearance of simulators they used simple posters with drawn electric circuit diagrams and devices. They explained the theoretical material and ways out of emergency situations literally in hand-waving terms. The students had practically no opportunity to familiarize themselves with the control devices of a train, except for the lessons that were held directly in the electric engine house. This caused some difficulties in learning of the material and an increase in the duration of training.

Simulators for train drivers

Currently, Logos has delivered more than a dozen simulators for drivers of different types of cars in Moscow Metro and Yerevan Metro. When using a simulator by Logos a student experiences the illusion of being in the driver's cab. In front of him and in the mirrors he can see the same things that a driver sees when he drives a real train. The entire interior of the simulator looks exactly the same as the driver's cab: the control panel with all the controls, the auxiliary board, pneumatic valves, circuit breakers and other equipment. Just like in a real train, the surveillance monitor enables the driver to see the passengers. The audio system reproduces the sound of the wheels, the sound of operation of the pneumatic system and electric motors, the noise of opening and closing doors and all other sounds and noises that can be heard by the driver. The dynamic platform simulates the longitudinal and lateral accelerations of the car – you can feel the car run on rail joints and switches, experience acceleration and braking.

The student at the control panel of the simulator can communicate with a virtual train dispatcher whose role is performed by the instructor and to carry out his instructions. The instructor's place enables him to observe the actions of the driver. The instructor can monitor the status of all the controls in the cab. On one of his monitors the instructor sees the same thing as the driver.

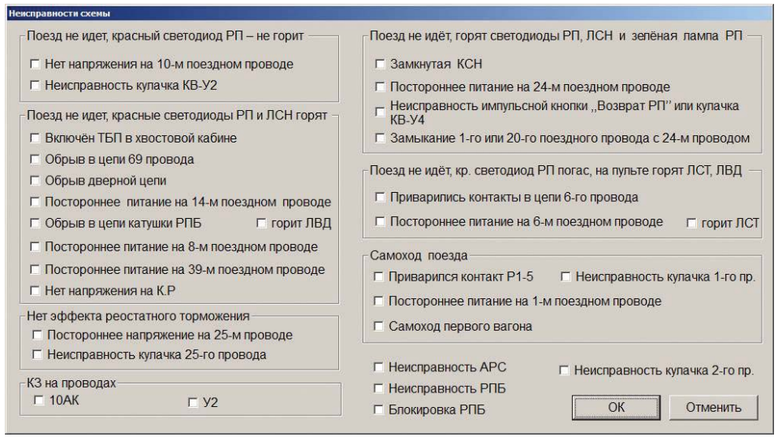
The advantages of using 3D visualization

3D visualization allows you to most accurately simulate the movement of a train on random routes at various speeds, including those close to zero, as well as the realistic movement of other trains and passengers, the change in the status of the track side facilities irrespective of the speed of the train. Three-dimensional visualization enables the simulation of all possible changes in the dynamic lighting at random locations, including switching the brightness of headlights, lighting in cars and tunnels, changing of settings according to the instructor's command (different time of day and weather conditions in open areas).

And the most important thing: when making the virtual route the specialists used videos shot while moving along the lines of Moscow Metro, as well as architectural plans, photographs, diagrams, detailed maps which reflect all the features of the landscape: ascents, drops, slopes, turns. Traffic lights, signs and plates in the virtual space are arranged exactly the same as in the real routes. The future driver can study the line in which he is going to work, practice the skills until they become automatic.

The simulator uses three-dimension computerized imaging. All stations, track and the engine house of the route are reproduced in the virtual three-dimensional space. This enables to work on the driving skills both in daylight and in the dark, like in a tunnel, and in open areas, with a sharp change in illumination, as well as in heavy rain, fog, snow. Each station was recreated in detail: they all have their structure (a different location of the station mirrors, clocks and other automatic systems of the station), and the driver is able to get used to the movement of the flow of people, when they board the train and get off. In the simulation of passenger traffic innovative technologies were used to achieve the realistic behavior of passengers at stations and at the entrance/exit of the cars.

The program provides for all typical faults and emergencies that may occur in the way: smoke or fire, flooding of the track, falling of a man on the rails, tunnel collapse, etc.



With all these features, training on the Logos simulator becomes interesting and even exciting. According to the teachers of the PTC, the use of the simulators greatly improved the efficiency of training. At the practical classes in the engine house the students handle many emergency cases faster than professional train drivers.

A new approach to training on simulators

An important task for the metro is fast training of new employees and upgrading of skills of train drivers. Operation of simulators is many times more economical than the use of real trains in the engine house. Furthermore, when the «emergency games» start on a real train, high voltage is supplied, this reduces safety. In the simulator you can perform many actions that cannot be performed on a real train. For example, how can we train the driver to act properly when a man falls on the rails, or in case of fire and flooding in the tunnel?

Previously, the procedure for emergency situations was discussed verbally in the classroom.

The use of simulators greatly improves the results of training of drivers. After all, theoretical knowledge with «good» or «excellent» marks does not provide the correct action in various situations in real life. Another good example from the experience of the teachers at the PTC of Moscow Metro is a situation where a student perfectly fulfills all the actions on the simulator, but when solving the same problem in theory (talking, not acting) he makes mistakes.

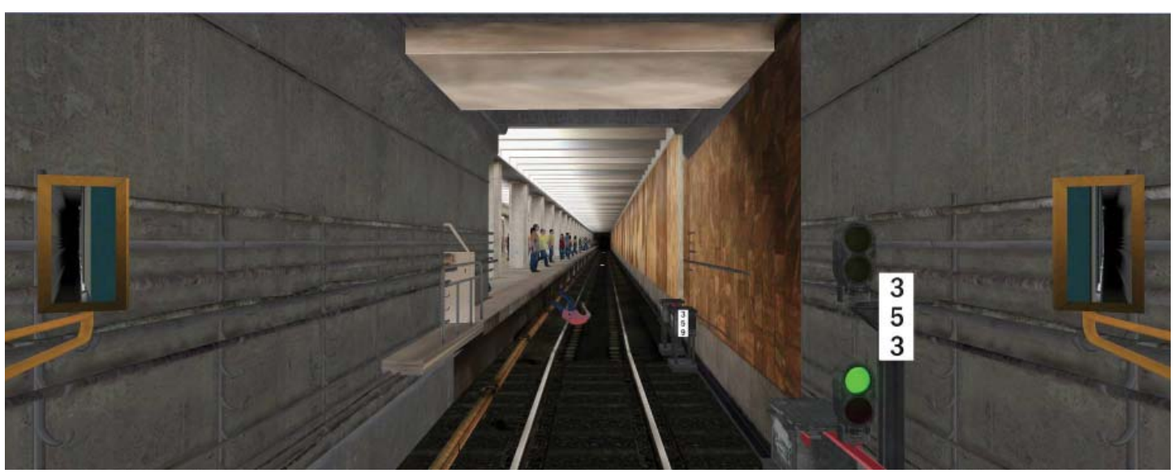
Today simulator training takes place in a different way. The student is in the simulator which is installed in the classroom. The instructor sets the faults and enters the emergency situations without prompting the student, so that he can get his bearings himself. For example, the train suddenly begins to stop. The student tries to find the faults and settle the problem, to determine what is inoperative. This learning process is very evident. All the mistakes can be immediately seen. The instructor is not in the cabin but near, on the outside. The simulator enables the student to experience independence and responsibility in the learning process.

Using the video camera mounted inside the cab and a projector which transmits the video signal to the screen in the classroom, the other students can watch their colleague passing routes and working out difficult situations. That is the way group learning is carried out in a class of about 20 people. Such system enables them to see and discuss the solutions of the future driver who is in the simulator. The teacher in the classroom may indicate errors and comment on the correctness of the student's actions.

At the PTC the simulators are so popular among the students that the scheduled lessons are not enough. Queues to the simulators begin to form at about 7-8 o'clock in the morning, despite the fact that the classes start from 9 o'clock. And after the classes the future drivers do not leave the classes equipped with simulators.

For big and small

Currently, Logos is the only organization whose simulators are successfully operated in Moscow Metro. A huge contribution to the current appearance and functional characteristics of the simulators was made by the experienced teachers of the PTC and the experts of Moscow Metro.



The simulators are installed in the Production-and-Training Centre for training of new employees, as well as in almost every metro engine house where the drivers regularly have training in the form of «emergency games» for maintaining their skills. Parameters of Moscow Metro: 12 lines, 197 stations and 329 km of tracks. According to the website of Moscow Metro, the fleet includes 5,500 cars. There are plans to build 160 km of metro lines and 78 stations in Moscow by 2020. Such intense operation may naturally lead to a large number of different emergency situations during train operation. Thanks to the cooperation with Moscow Metro, Logos simulators ensure the opportunity to work on more than a hundred different emergency situations based on real experience in operation of metro trains.

At the same time, in most small metros similar situations occur much less frequently, and the drivers are trained to deal with only 30-40 cases that are most widespread. The implementation of these situations in the simulators will enable to share the accumulated abundant experience of Moscow Metro with other metros and to prepare the drivers to handle a greater number of situations.

The latest development of Logos is a simulator for Yerevan Metro. Yerevan Metro consists of only 1 line, 10 stations, 1 engine house. The metro has open areas with views of Yerevan. All this has also been modeled in 3D. Yerevan operates a special car – the modernization of the old car initially produced by the Mytishchi plant. The modernization was performed in Tbilisi (8171M). The simulator is installed on a dynamic 2-stage platform at the engine house. The development was performed under a contract in 7 months.

In Yerevan, a new program of training drivers already includes training on the simulator. Simulators are treated as an option for significant reduction in the duration of the current long-term training program and for improvement of the efficiency of selection of future drivers.

You can familiarize yourself with the simulator for metro train drivers by addressing Logos. We invite our readers to try it!

Situations that are reproduced in the Logos simulator:

- real movement of the train with a random number of cars;
- presence of other trains on the line;
- «live» passenger traffic entering and exiting;
- operation of track side facilities on the line and the ability to operate them from the instructor's working place (traffic lights, power supply, switches, automatic train stops, etc.);
- abnormal and emergency situations in any location on the line;
- organization of movement between different metro lines;
- arrival at the engine house;
- failures of the rolling stock.

Annual Council and round table held by Association in Yerevan

The session of the Council of the International Association «Metro» and the International Round Table Meeting on the current problems of metro systems were held in Yerevan on April 14, 2016.

The events took place during the celebration of a significant date for Yerevan Metro – the 35th anniversary of putting the first order into operation.

When opening the meeting of the Council, Mr. Vladimir Garyugin, Head of St. Petersburg Metro, warmly congratulated the staff of Yerevan Metro on behalf of the International Association «Metro» on the 35th anniversary.

Mr. Igor Ermolenko, Director General of the International Association «Metro» delivered a report on the activities of the Association in 2015-2016. He informed the audience on the events organized during this period in accordance with the Activity Plan and the Main Areas of Activity. Specifically, it was noted in the report that in 2015-2016 the Association held meetings, conferences and seminars in such areas as transportation security, rail traffic safety, rolling stock, signaling, IT, operation of escalators, construction of escalators, track and track facilities, tunnel facilities. In 2016 a new business stream was organized. It united PR-specialists and passenger services. The TRANSCOMMFORUM International Conference was the first event in this area. It was held in Moscow in March 2016 and was organized on the initiative and with the active assistance of Moscow Metro.

The Technical Council of Chief Engineers is organized annually by the Association. It has proved to be an important forum which attracts a large number of specialists.

In addition, the Association is actively working in the field of international cooperation by participating in the activities of the International Union of Public Transport.

The Council noted that all the items listed in the Activity Plan were carried out in a timely manner.

During the session of the Council held on April 14, two new members were admitted into the International Association «Metro»: Es-Service JSC – the company that has contributed a lot to the Russian industry of escalator construction, and the Russian Broadcasting and Alarm Reporting Networks – Federal State Unitary Enterprise.

Thus, the number of members of the International Association «Metro» has increased up to 33.

The round table meeting on the current problems of metro operation included reports on various subjects.

Thus, the important issues of technical regulation in metro systems were highlighted by Mr. O. Nazarov, Deputy Director General of JSC Railway Research Institute. Mr. S. Miroshkin, Chief Specialist of the Center for Development and Management of Projects at the State Unitary Enterprise «Research and Project Institute of General Planning for the City of Moscow», spoke about the peculiarities of development of a metro system within the framework of urban planning of development of big cities.

After the session of the Council of the International Association and the Round Table Meeting the participants congratulated the staff of Yerevan Metro represented by its Director Mr. P. Yayloyan on the 35th anniversary of the company. P.G. Yayloyan was also presented with a letter of congratulations from Mr. Alain Flausch, Secretary General of the International Union of Public Transport.

Then the representatives of the International Association «Metro» and the participants of the event were invited to a ceremonial reception at the City Hall of Yerevan to celebrate the 35th anniversary of Yerevan Metro.

After the ceremonial events the delegates and the guests saw stations of Yerevan Metro and the historic sites of Yerevan.

The International Association «Metro» expresses its gratitude to the staff of Yerevan Metro and to its Director Mr. Paylak Yayloyan for the warm welcome and the excellent management of the events.

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ES-Service supplies escalators for Moscow Metro

Over the last few months several new metro stations were opened in Moscow, and the improvement of the stations Baumanskaya and Prospekt Mira was performed. JSC «Es-service» from St. Petersburg is the supplier of escalators for most of new facilities and those being refurbished.

In 2015 Moscow Metro celebrated its 80th anniversary. Over the years it has become one of the world's largest transportation hubs. Over 8 million passengers use it on a daily basis.

«Es-service» makes its contribution to the steady and safe transportation of passengers. Today it is the only domestic supplier of escalators for the metro.

Our capital is growing rapidly. The ambitious plans of the Moscow Government include construction of 74 new metro stations by 2020 in addition to the 200 existing ones. All the new stations need escalators.

New escalators are also needed for replacement of the old ones that reached the end of its service life. Type N escalators that were produced from 1935 till the end of the 1940s have already been replaced. The last of them were removed a year ago at station Baumanskaya. 74 escalators of type EM made in the 1950s are going to be replaced. The dimensions of modern escalators by «Es-service» make it possible to install four new machines instead of three old ones, thus increasing the working capacity of the escalators. This means that the total number of escalators required for the improvement of the old stations is about 100 units by 2020.

There is another area to which the activities of «Es-service» are directly related. It is repair and upgrade of escalators – the service that is increasingly in demand in the metro. Every year about 50 overhauls of escalators are performed in Moscow Metro. Passengers are familiar with the overhaul-related announcements on the limitations of passenger throughput at the stations.

The best indicator of our cooperation with Moscow Metro is the table of delivery of escalators by «Es-service» for the metro. What can be said about these machines and their advantages?

«Es-service» escalators belong to the next, the sixth generation of domestic escalators for the metro. They were designed taking into account the long-term experience in operation of escalators of the types N, EM, LT, ET, E and in accordance with domestic escalator manufacturing traditions.

According to the requirements of the RF Federal Rules and Regulations in the field of industrial safety «Safety Rules for Escalators in Metros» and with account taken of the requests made by the specialists of the escalator services, the escalators ensure access to the mechanisms and assembly units from the servicing zone side. The ES02, ES03 and TK65-series escalators have a drive that is located in the machine room, with a total lifting range from 3 to 65 m.

In imported machines all the mechanisms and components are located inside the metal structure. They are accessible from the passenger area after stopping the passenger flow and ensuring the appropriate openings in the exterior structural components. Naturally, these machines are lighter and more compact. And it is these machines that the designers of metro stations began to consider in their projects, despite their non-compliance with the Federal Rules and Regulations.

Our experts took this circumstance in mind and developed the multipurpose heavy duty escalator ES04 for a range of lifting heights from 3 to 12 m. It can be installed both in standard escalator tunnels, with the possibility of performing maintenance from the machinery spaces and passages in the inclined part, and on the end supports with maintenance performed from the passenger area through removable floor slabs, openings in the track of the escalator and in the balustrade. Four machines of the kind have been put into operation at the newly opened station Salaryevo, six more have been mounted and will soon start the daily work on the transportation of passengers at station Ramenki.

Yet, compactness is one of the main requirements for escalators in such heavily loaded places as Moscow Metro. Four modern escalators ES03 and ES02 with lifting heights of up to 48 m can be installed in a tunnel where previously it was possible to mount only three old machines. This reduces the distance between the adjacent escalators, it can be easily seen in the passenger area by the narrow panels of the middle balustrade, but the width of the escalator track remains the same (1,000 mm), so do the convenient locations of handrails and the passages (500 mm) in the service area specified by the Federal Rules and Regulations. Compared to the old escalators, the machine rooms can be significantly reduced in size. During the replacement of escalators at station Baumanskaya the four new drives fit easily in the place of the three removed ones, moreover, their installation made it necessary to build up the old foundations by more than two meters.

Today this list is complemented by the escalator ES01 with a lifting height of up to 66 m. Unlike the similar machines (models ES02 and ES03), the escalator has a completely new compact drive on the basis of the planetary gear unit and a new step with the framework which can be either a traditional stamp-welded one, or a cast aluminum one, or an assemblable type made of stainless steel. Next year it will be possible to see a pilot model of the escalator. Its drive has already been manufactured and is being mounted on a test rig installed next to a preproduction prototype of another new escalator that is subjected to trial runs. The new escalator ES03M has a lifting height of up to 18 m. Its drive consists of series-produced high-technology parts that are easy to replace, unlike the ones of the escalator ES03.

Moving walkways (travelators) is another area in which the experts of «Es-service» work by the request of the escalator services of the metro systems of Moscow and St. Petersburg. Previously such machines were not used in the Russian metro and the need for them met through imports.

The stations of Moscow Metro have always been characterized by beauty and interesting architectural solutions. All the new escalators are beautiful modern facilities but because of the need to comply with the safety requirements, including the fire safety requirements, they all look virtually the same – the same geometric dimensions, handrails, deflectors (the brushes above the side clearances), steps with aluminum planks and danger zones marked with yellow, stainless steel balustrade. Often the manufacturer can be recognized only by the logo at the landing platform.

The experts of «Es-service» found the opportunities for adjusting the design of the escalator. Modern technologies make it possible to apply a durable flame-resistant colored coating to the stainless steel of the balustrade and thus preserve the historical appearance of old stations during the upgrade of escalators, or to install beautiful LED tape-type lighting at the level of the deflectors. Of course, this requires additional costs, but the escalators assume a unique and recognizable appearance.

«Es-service» works with all the metro systems of Russia, the CIS countries and the former socialist countries. But the main customer of the enterprise is still Moscow Metro. It is by the request of Moscow Metro that the plants of «Transmashholding» JSC, the largest company in the Russian sector of transport engineering, were involved in the production of escalators. «Transmashholding» is capable of producing more than 150 tunnel escalators annually with a lifting height of up to 65 m. This cooperation has many advantages, but there are also some disadvantages. Small-lot production of escalators is not very profitable for large plants, so whenever possible they try to simplify the production, to do without the special equipment. At the moment, the work is being done on the concentration of production in order to ensure a higher level of automation and equipment capability.

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Train automatic control system for Russian subways

Automatic control systems for metro train include the following subsystems: dispatcher control, automatic train operation and movement safety systems. The automatic train operation system is intended for proper performance of a predetermined volume of traffic under the control of the movement safety system. Proper performance of a predetermined volume of traffic is transformed into demands of strict compliance with the predetermined schedule of trains with compensating disturbances of the automatic rearrangement of the traffic schedule and demands of compliance with it in case of uncompensated disturbances.

The movement safety subsystems function either together with the automatic train operation systems, or independently in case of "manual" train operation. From the point of view of traffic control automation, safety control systems impose restrictions on control. Their commands have the highest priority.

The efficiency of the train automatic control system is determined by the following:

- increase in the use of the traffic performance and increase in the carrying capacity due to stricter compliance with the schedule of trains;
- increase in the traffic safety due to decrease in the probability of hazardous proximity of trains;
- reduction of energy consumption for haulage of the train due to the selection of optimum energy modes for train control and, according to the minimum energy consumption criterion, optimum breakdown of the travel time within the line into the travel time along the station-to-station blocks.

According to the level of centralization the automatic control systems for metro train movement are divided into centralized and autonomous systems. Centralized automatic control systems receive information on the times of arrival and departure of all trains at all stations and generate control commands for each train. These commands are implemented by the automatic train operation devices on the trains. Autonomous automatic control systems perform control of only one train in accordance with the predetermined schedule. Compensation of disturbances is implemented by the automatic control system of every train regardless of the location of other trains on the line and is determined by the control algorithms, availability of the regulation resource and the limitations imposed by the traffic safety system. Centralized systems have great capabilities, as the availability of information on the location of all the trains in the line enables to compensate various disturbances in a more flexible and efficient way. In metros with heavy traffic, with low resources for making up for delay and a high degree of utilization of the traffic capacity the centralized systems have the necessary properties to achieve the desired quality of control. The centralized automatic train operation system of the metro comprises two interconnected functional levels of control. The upper level detects a mismatch between the planned and the performed traffic schedules and in case of compensated disturbances it generates control (the stopping time and the required running time for each train of the line). In case of uncompensated disturbances the upper level calculates a new schedule of movement and performs control in accordance with the schedule. The lower level implements the control that is defined by the upper level. In terms of hardware the role of the lower level is played by the automatic train operation devices on the train. In accordance with this way of building the automatic train operation system, its development and implementation have two stages. During the first stage the automatic train operation devices on the train are tested in the autonomous mode, at the second stage – the algorithmic part, software and hardware of the upper level and the simultaneous functioning of both levels.

A brief history of train automatic control systems development in Russia

The first autonomous automatic train operation system was developed by the NII UVM (the Research and Development Establishment for Process Control Computers) of the city of Penza and was tested in Moscow Metro in 1961. The onboard devices were implemented on the basis of a control computer built with the use of ferrite-transistor modules. Immediately after that the work was started on the creation of centralized systems. In the late 1960s the following systems were developed and implemented: the software- and simulation-based automatic train operation system of the Leningrad Metro (PMSAU DPM) in the Nevsko-Vasileostrovskaya and Petrogradskaya lines (the developers were the Leningrad Metro and the Institute «Giprotranssignalsvyaz»), the automatic train operation system of Moscow Metro (SAMM), the developers were the Moscow State University of Railway Engineering (MIIT) and Moscow Metro. The SAMM was operated in the Kaluzhsko–Rizhskaya Line of Moscow Metro. The systems used hardware based on discrete semiconductor elements - transistors and diodes.

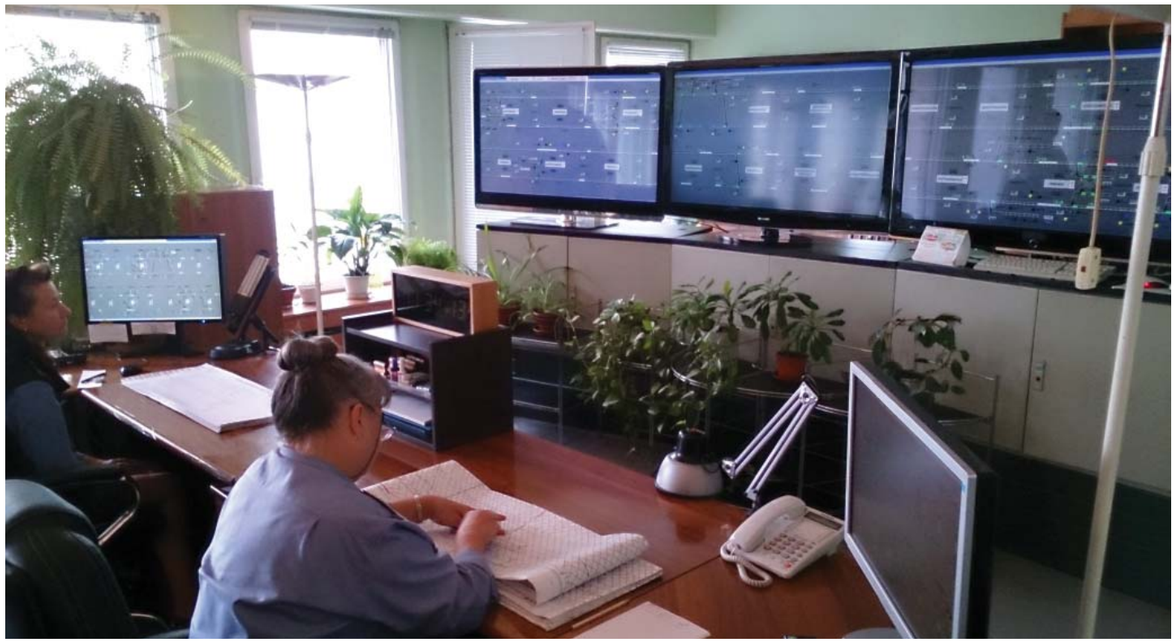
The braking program in the PMSAU DPM was implemented using a wire loop located on the track. The travel time control at a station-to-station block was carried out by means of selection of the time of additional movement in the haulage mode with respect to the reference point. The selection of the travel time along the station-to-station block was calculated by comparing the planned and accomplished schedules of movement (the schedule-based control algorithm). The centralized automatic train operation system of the SAMM that was based on the transistor-diode system of elements of the series «Spektr» had a three-level structure (the central control station, station facilities and onboard devices). In this system the location of the train on the track was determined by inductive sensors located on the track. When a train passed the sensors, the station facilities received pulses and the sum of these pulses determined the coordinates of the train. The switch-off time of the traction motors was calculated by the station device, and the switch-off command sent to the traction motors for the purpose of meeting the predetermined travel time along the station-to-station block was transmitted to the train also via the inductive sensors located in the traction switch-off zone. The braking program for the train was implemented on the basis of inductive sensors located on the track. Centralized control was implemented by comparing the planned and accomplished intervals of train movement (the interval-based control algorithm).

In 1979-1980 complex automatic control systems for train movement were developed and implemented at the Moscow, Leningrad, Kharkov and Tashkent metro systems. The distinctive features of these systems include the presence of a supervisory computer control system at the central control station and the functional integration of the automatic train operation systems with the traffic safety systems (automatic speed regulation systems). The term "complex" indicated this integration. The MIIT, the VNIIZhT (All-Russian Scientific Research Institute of Railway Transport), and Moscow Metro were the developers of the complex systems for the Moscow, Kharkov and Tashkent metro systems, while for the Leningrad Metro – «Giprotranssignalsvyaz» (GTSS) and the Leningrad Metro. A lot of work on the improvement of the complex automatic train operation systems was performed by the Kharkov Metro.

The complex automatic control system for metro train movement (KSAUP DP) was implemented at the Zhdanovsko-Krasnopresnenskaya and Kalininskaya lines of Moscow Metro. At the Kirovsko-Vyborgskaya line of the Leningrad Metro the KSAUP system (complex automatic train control system) was implemented. Its modernized version is the KSAUPM system which has a distinguishing feature consisting in the hardware implementation based on IC chips.

The development of microprocessor technology, improvement of the reliability and efficiency of computing systems increased the relevance of development of a new generation of automatic control systems for train movement. By 1989, the MIIT developed the automated control system for metro train movement (ASU DPM). All the levels of the system use microprocessor-based means of computer technology. The latter enabled to use more sophisticated and efficient control algorithms, to improve the reliability and the «liveness» of the system due to reasonable redundancy, to remove the wire loops and inductive sensors from the track. The MIIT and the Research and Manufacturing Association "Almaz" developed the onboard device ASU DPM. In 1990 operational tests of onboard devices were held on trains with passengers in the Kharkov Metro. The tests were held in the autonomous automatic train operation mode. The error in the performance of the specified travel times along the station-to-station block within the entire range of their measurement did not exceed ± 2.5 s, the error of stopping of the train at a station did not exceed 30 cm. In this case the rate of target braking amounted to about 0.75 – 0.8 m/s .

The collapse of the Soviet Union left no opportunity to continue this work. However, its results were used in a joint project of the MIIT and the Research and Development Establishment for Precision Mechanics (the city of St. Petersburg) for designing an onboard device of the automatic train operation system. The device was designed for operation in the autonomous mode. It was planned to be used in the metro system of St. Petersburg. The results of the work were implemented within the framework of the system «Dvizheniye» in the metro systems of St. Petersburg



and Kazan. In the 90s the MIIT started to cooperate with the V.Tikhomirov Scientific-Research Institute of Instrument Design (NIIP) from the town of Zhukovsky for designing automatic train operation systems for metros.

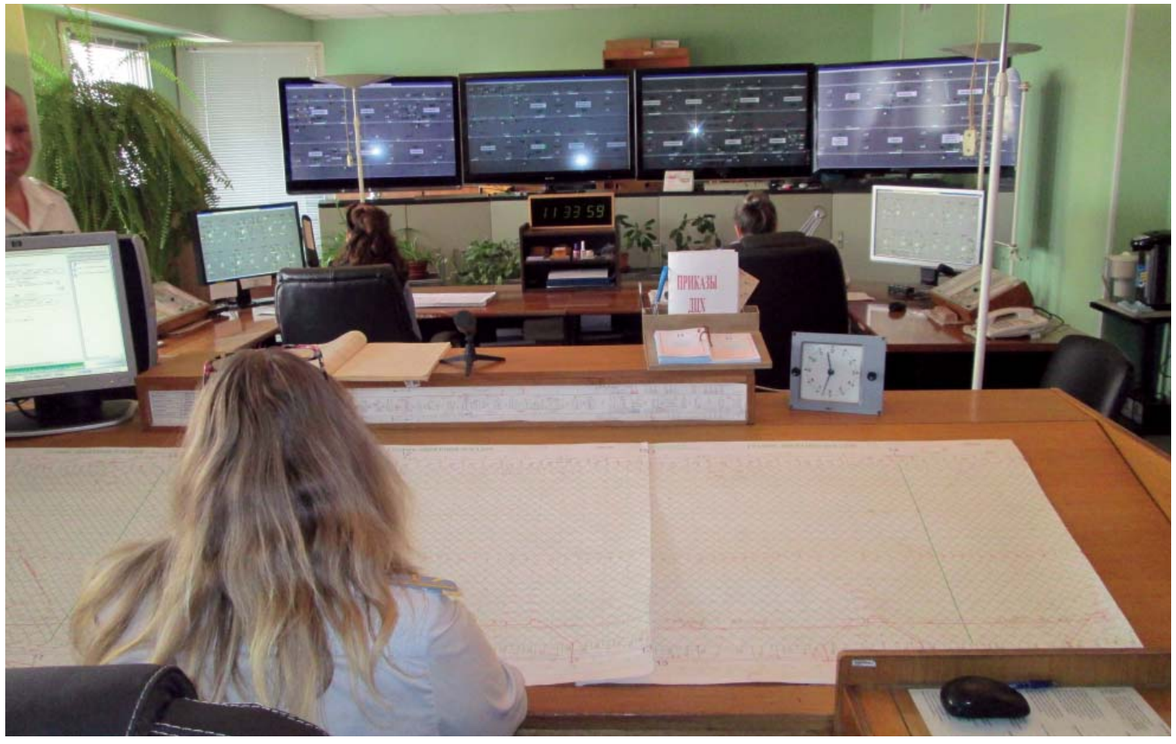
Steps of growth of Russian train automatic control systems

During the period 2012-2015 Moscow Metro received 1184 new cars. Modern cars are equipped with a more powerful traction drive based on induction motors. There were changes in the control system for the equipment of the car and the train. NIIP developed and implemented the new-generation automated system «Vityaz» for control, diagnostics and traffic safety. When developing this system, the designers used advanced modern technologies. The logical continuation of this development was the creation of onboard automatic train operation devices that work in an autonomous mode during the first stage. The onboard devices of the automatic train operation system enable the following: automatic starting of the train, the choice of traction control modes in order to meet the specified time of travel of the train along the station-to-station block, target braking of the train at the platform, slowdown of the train in accordance with speed limits, automatic door control. The principle of acquisition and algorithms of functioning of the onboard automatic train operation device are based on the experience obtained during the creation of the ASU DPM. The onboard device receives the information about the distance traveled by the train from the moment of starting and its speed from the frequency-modulated rotation sensor for the wheel pair. For compensation of measurement errors at fixed points within the track there are RFID sensors that do not require a power supply connection. The energy for the operation of the RFID is received from the high-frequency signal generated on the train when passing the sensor. In its turn, the RFID generates a signal that transmits a message to the train on its location and the number of the station-to-station block. The capacity of the message enables to transmit additional information on the characteristics of the station-to-station block. The reply signal generated by the sensor has a bell-shaped directional diagram. This is a positive feature, in terms of the need to transfer large amounts of data at high speeds. However, the «blur» of fixing the correcting point in the track has a negative impact on improving the accuracy of the measurement of the distance traveled by the train. Additional location of RFID sensors at the station, with lower speeds of the train, enables to reduce the effect of «blurring» of the correcting point. As shown by the tests carried out in Moscow metro, the required stopping accuracy can be achieved today.

From the point of view of the author of this article, it is advantageous to apply integrated use of RFID and infrared track correction sensors which consist of a transceiver mounted on the train and passive reflectors attached to the wall of the tunnel. The transmitter operating in the infrared range generates a signal - an IR beam directed toward the side wall of the tunnel. When passing a passive multi-element optical corner reflector (a cataphot), the beam is reflected and it reaches the receiver where passing of the correcting point is registered. The advantage of the track correction sensors consists in the accuracy of determining the coordinates of the correcting point. There is a positive experience in the use of this sensor during tests of ASU DPM in the Kharkov metro system and during long-term operation of track correction sensors in the automatic train operation system of the St. Petersburg Metro.

Integrated use of RFID and track correction sensors enables to apply the advantages of both sensors: the ability to transfer a large amount of information from the track and the accuracy of fixing the correcting point. At the same time it is possible to increase the functional reliability of the channel for path measurement and measurement of the train speed.

The onboard devices of the automatic train operation system developed by the Scientific-Research Institute of Instrument Design provide for radio connection with stationary systems, which is necessary in constructing the upper level of a centralized system. The adopted principles of building an onboard automatic train operation device and the automated control system that is integrated with it and also ensures technical diagnostics and traffic safety of metro cars of the new generation (system called "Vityaz") – these are the means that enable to implement the new capabilities which go beyond the limits of traffic control automation. It is possible to transmit diagnostic and statistical information on the train to the control center



via radio channel, the use of such information makes it possible to significantly improve the efficiency of the metro. The tests of the onboard automatic train operation devices designed in the Scientific-Research Institute of Instrument Design (Zhukovsky city) were carried out in Moscow Metro. The tests provided positive results.

To date, algorithms of the upper level have been substantially developed – the centralized traffic control algorithms for all trains in a line. MIIT developed schedule-interval traffic control algorithms with compensated disturbances. In case of small mismatches of the planned and implemented schedules the required durations of stops and travel times of the trains in the line are calculated in accordance with the schedule-based algorithm. Transition to the interval-based control is carried out when the resource of the line is not sufficient for compensating the disturbances. After adjustment of the interval the transition to the schedule-based control algorithm takes place.

A special place is occupied by control algorithms during major failures of movement and algorithms that implement control after the elimination of the causes of a failure (a development by the MIIT). The performed simulation of these algorithms in the models of the lines of Moscow Metro with different types of failures and the comparison of the results of automatic control to the stories of control by dispatchers taken from the archive have demonstrated the possibility of the use of algorithms in an automated mode under the control of dispatchers.

The developed centralized traffic control algorithms use the methods of artificial intelligence for decision-making in case of uncertainty. An example of this is the need to determine the allowable interval for departure of the (n+1)th train with known calculated travel times of the nth and the (n+1)th trains. The allowable interval for moving in the same direction, where the (n+1) th train that follows can travel without speed limitations in accordance with the safety system, is linearly dependent on the duration of the stop of the nth train at the station ahead. At the time of calculating the allowable interval for the departure we only know the planned duration of the stop, there is no information about the deviation of the actual duration from the planned duration due to the disturbances. In this case it is necessary to predict the unknown deviations on the basis of automatic self-learning of the system. Application of artificial intelligence methods enables to use the name «intelligent centralized system for automatic control of metro train movement». The term «intelligent» is associated not so much with the creation of a complex integrated control system, but with the application of artificial intelligence methods in control algorithms.

The existing experience in development and operation of automatic control systems for movement of metro trains, the results of research work, design effort and testing will help to use proper organization of the work for implementing the control system that is being developed now, which will increase the quality of the volume of transportation and the rail traffic safety.

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25 anniversary of Yekaterinburg subway

On April 27, 2016 Yekaterinburg Metro celebrated its 25th anniversary.

The city of Yekaterinburg is one of the fastest growing metropolises in Russia. The city is compact; the main part of it is elliptic in plan with dimensions of 10x20 km.

There is very close city development in the center. Outside the center density becomes less close, but, nevertheless, it remains continuous. It is only at a distance of about 5 km from the city center where the housing density decreases: the residential quarters stretch along the intercity highways.

Like most big cities, Yekaterinburg is badly in need public transport system increasing. It should meet such requirements as speed, comfort, safety and reliability. The metro system meets all these requirements. This system is the only currently existing alternative that enables to prevent the impending traffic standstill in Yekaterinburg.

We should probably take the year 1967 as a reference. In January 1967 a joyful event took place in the city of Sverdlovsk (now it is called Yekaterinburg): the millionth city dweller was born. Going beyond that one-million milestone had serious consequences at that time. Such city could be eligible for more funding for the construction of big public buildings, new parameters of the transport network development and even such an expensive facility as the metro.

It is safe to say that since 1967 it was time to act. The general plan of Sverdlovsk development with a plan of prospective metro lines was approved by Resolution No. 316 of the Council of Ministers of the RSFSR dated May 25, 1972. By the end of 1974 the long-awaited budget line appeared in the budget of the Ministry of Railways for the year 1975, it was related to funding of "metro designing in the city of Sverdlovsk". The Kharkovmetroproject Institute was selected as the design contractor.

In accordance with the Resolution of the Council of Ministers of the USSR dated December 16, 1977, the decision was made on the construction of a metro system in the city of Sverdlovsk.

In early 1978 the project feasibility study for the first phase of the metro construction project in Sverdlovsk was agreed upon.

In December 1979, the Directorate was established for the metro that was under construction, it was headed by Mr. Ivan Titov. The official date of the beginning of the metro construction is August 28, 1980, it was the day when the first scoop of earth was taken out of the fore-shaft of the working channel of the future station Uralskaya.

In November 1980, the engineering design of the first phase of the Sverdlovsk Metro (from station Prospekt Kosmonavtov to station Chkalovskaya) was approved in accordance with the Regulation of the Council of Ministers of the USSR. According to the approved construction program for metros in the USSR, the first line of the Sverdlovsk Metro was planned to be opened in 1990. In order to complete this program without scattering funds, equipment and labor power, it was decided to split the line into two start-up facilities: the first one – from station Prospekt Kosmonavtov to station Ploshchad 1905 Goda, and the second one – from station Ploshchad 1905 Goda to station Chkalovskaya.

In the summer of 1982 an independent general contracting organization was established. It was Tunnel Construction Department No.34 headed by A.M. Sapozhnikov. Later the Construction Management Sverdlovskmetrostroy was created, it included two Tunnel Construction Departments – No.34 and No.36.

During the process of construction the governing bodies of the Oblast and the city kept the construction under the spotlight and provided great help with the difficulties that arose.

The rate of construction was quite high; the task was to complete the first start-up facility by November 1989. In connection with this, a new company named «Sverdlovsk Metro» was established in May 1988 in accordance with the Directive of the Ministry of Railways of the USSR. On December 15, 1988, Mr. Titov was appointed its head.

It was the time when the history of Yekaterinburg Metro started.

However, the social and economic environment in the country was such that the rate of construction dropped considerably and putting the metro in operation in 1989 had already been put into question.

During the period before putting the metro in operation one of the main tasks of the metro management was staffing the divisions and departments with skilled personnel.

Reliable and efficient work on passenger transportation depends significantly on the motive power and rolling stock department that is why one of the priorities for the metro was to begin staffing the electric train drivers. In March 1989 and 1990, two groups of 56 and 18 drivers who had already got experience in railroad employment were sent to the Road Technical School of the Kharkov Metro to complete 5-month training.

In order to obtain practical experience in maintenance of escalator systems, in July 1989 a group of 24 people was sent to the Road Technical School of the Moscow Metro to complete 3-month training of escalator operators.

During the period from March 1989 to December 1991, over 200 people completed internships in various specialties and enhanced their professional skills. These were traffic operators, station masters, station duty officers, signal tower duty officers, power engineers and communications personnel. The internships were conducted in the metro systems of Novosibirsk, Tashkent, Kharkov, Minsk and Moscow.

Before putting the metro in operation it was fully staffed with all the specialists. The metro employees provided assistance to the subway tunnel builders and took an active part in the preparation of the stations.

16 specialists were invited from other metro systems to work in the newly opened metro:

– from the Novosibirsk Metro: 12 people (electric train drivers, chief traffic controller, communications technicians, defect detection supervisor, economists);

– from the Tashkent Metro: 2 electric train drivers;

– from the Gorky Metro: 2 electric train drivers.

The following assistance was provided during the construction of the metro:

– the Dnepropetrovsk Metallurgical Equipment Plant of the Heavy Engineering Ministry of the USSR produced and supplied cast-iron intermediate products for tunnel rings;

– since 1984 the Ural Heavy Machine Building Plant (UZTM) started to perform machining of cast-iron tunnel rings;

– since 1987 the UZTM started to perform casting of cast-iron tunnel rings in shop No. 34. Later casting of tunnel rings was performed by other enterprises of Sverdlovsk Oblast. Tunnel rings started to be delivered from the cities of Kachkanar, Kushva and Nizhny Tagil;

– since 1983 the Beryozovsky Building Structure Plant (BZSK) started to produce and deliver reinforced concrete tunnel rings.

A great contribution to the construction of the Sverdlovsk Metro was made by the Ural Turbine Works, the Uralelektrotyazhmash Plant, Uralelektroapparat Plant, the Kalinin Machine-Building Plant, the research and manufacturing association "Sverdlovsk Automatic Equipment Plant". The Uralelektrokabel Plant started to produce the special cable that was needed for the metro. Before that time this cable was produced only in Ukraine.

In the middle of 1990 the percentage of completion of the electric engine house and the surrounding three stations was quite high, but due to the fact that the installed equipment was not put into service, was not serviced and there was no control for its safety, it gradually began to fall into disrepair, and sometimes it was simply stolen.

The management of the metro made a difficult decision: to put a section with three stations into operation in 1990 while having only one terminal station with gridiron. It is hard to say whether such cases of putting metros into operation had occurred previously, but what is certain is the fact that the Operating and Maintenance Rules for the Metros of the USSR did not mention it. The approval of such putting into operation was granted by the General Office of the Metro Systems of the Ministry of Railways of the USSR.

But even in 1990 it was only possible to perform a trial run of a test train on the section from station Prospekt Kosmonavtov to station Mashinostroiteley. This historical event took place on the night of December 29th to 30th.

Putting the metro into operation was put on hold till the next year, but the test train played its role: the hope emerged that the metro would soon be opened; everyone only had to try a little harder.

Prior to putting the metro into operation the work was performed in two directions: on the one hand, staffing was in progress, on the other hand, the start-up operations were carried out with the participation of the constructors. As a result, by the time of opening the metro for transportation of passengers, staffing was complete and the employees were fully ready for work.

On April 27, 1991 the metro was opened for transportation of passengers. Three stations were opened on that day: Prospekt Kosmonavtov, Uralmash and Mashinostroiteley.

At the instigation of the media, for a long time our metro was called the smallest metro in the world. This is not true there were smaller ones, but apparently the people who spread this rumor do not read much.

In December 1992, station Uralskaya was put into operation and 2 years later the section till station Ploshchad 1905 Goda was opened for traffic: the trains went circle-wise with a turnaround at the terminal stations.

The start-up of other stations dragged on for many years. In 2002 station Geologicheskaya was put into service.

In 2011 the last section of the first line was put into operation, it reached station Botanicheskaya. After a delay of 8 months, the intermediate station Chkalovskaya was opened for passengers in the last start-up section. It was on July 28, 2012.

After the start-up of the section from station Geologicheskaya to station Botanicheskaya that took place on November 28, the construction of the first line was completed. The first metro line went from the most northerly point to the most southerly point of the closest city development and connected five of the seven districts of the city. Duration of a trip from station Prospekt Kosmonavtov to station Botanicheskaya is 19 minutes. The speed of transportation of passengers within the city that is ensured by the metro today cannot be achieved by any of the types of the above-ground transport.

One intermediate station was excluded from the start-up section and putting it into service was postponed for a long time, at the same time the work was performed on the tunnel sections of the main lines of the future station. It was station Bazhovskaya.

Over the 25 years of operation, the metro services were used by more than 840 million passengers. Today the metro services are used by 170 thousand citizens every day. During 2015 the metro transported 49.9 million passengers, which amounts to 23.9% of the citywide public transportation.

The headway between consecutive trains during the rush hours is 4 minutes, during the periods between the rush hours it is 6-8 minutes, during the weekends it is 8-11 minutes. The technical capabilities of the metro enable it to transport a lot more passengers because the minimum headway between consecutive trains defined in the project is 1.5 minutes.

The length of track in use within the line is 12.71 km. There are 9 stations in the line including the following:

- 2 subsurface stations without escalators (Botanicheskaya, Prospekt Kosmonavtov);
- 2 subsurface stations with escalators (Mashinostroiteley, Uralmash);
- 5 deep level stations with escalators (Chkalovskaya, Geologicheskaya, Ploshchad 1905 Goda, Dinamo, Uralskaya).

When passengers enter the metro, the first thing they see is the underground structures. One might as well say that the project designers put their souls into the architectural appearance of the stations. Finishing of all the stations was performed with the use of natural stone, as a rule it was the Ural stone.

The following themes are reflected in the architectural appearance of the stations: station Uralskaya is an old underground mine, station Geologicheskaya characterizes the richness of the Ural mineral resources, its walls are made in the form of stone mosaics, stations Uralmash and Mashinostroiteley illustrate the history of the domestic industry, including the wartime period, stations Prospekt Kosmonavtov and Chkalovskaya show the most important stages in the development of Russian aviation and space exploration, station Dinamo is a kind of underground stadium, station Ploshchad 1905 Goda presents stone depiction of the events of our complicated history with the social upheavals of the early 20th century, station Botanicheskaya looks like a huge beehive.

All the stations of the first line were designed with island platforms, their length ensures operation of five-car trains. Four-car trains are used within the line, they consist of type 81-717(714).5 cars. The running tests and temporary operation of the rolling stock of the first order (it included 54 units) was performed in the Novosibirsk Metro prior to the opening of Yekaterinburg Metro. Later 8 more cars of series 81 were purchased.

Today the company employs approximately 1,500 employees. Most of those who came here before the start-up retired with a sense of a job well done. And we must give credit where it is due, because they created the maintenance system for the facilities, equipment and rolling stock that was the basis for ensuring the rail traffic safety and passenger transportation safety.

In order to maintain the necessary balance of skilled employees, the company's own Training Department was established. It provides training according to the trade programs for escalator operators, electric train drivers, electrical fitters, etc.

Mr. Ivan Titov was the first to be appointed Head of the Sverdlovsk Metro on December 15, 1988. He was in charge of the company till January 2011.

Using the accumulated experience, Mr. Ivan Titov put in great efforts and knowledge during the construction and establishment of the first metro system in Ural region. Under his leadership, a well-coordinated team was formed and it ensures high passenger services culture and rail traffic safety.

Since May 31, 2011 the company has been headed by Mr. Vladimir Shafray.

Yekaterinburg Metro is now a well-equipped urban public passenger transportation enterprise.

Within the territory of the electric engine house there is a base of the department of line service and tunnel facilities, a repair shop of the electrical and mechanical services department, the shops of the signal telephone and telegraph department and the electric supply department, the warehouses of the procurement service. The first order of the combined shops was built for performing repairs of the equipment involved in the technological cycle of all the metro facilities.

Recently, Yekaterinburg Metro has completed a number of tasks for the replacement of the outmoded equipment, introduction of new equipment, as well as innovative designs for improving the reliability of the facilities and equipment and for ensuring the safety of traffic and passenger transportation.

In order to reduce the maintenance expenses the company purchased and installed new compressor plants DEN-90Sh and a control station for these plants. In 2014 and 2015 the machinery equipment was almost completely renewed for maintenance and repair of metro cars.

Over recent years, the signal telephone and telegraph department has worked hard to improve the security systems of the metro and the passenger-related automatic equipment: terminals have been installed for communication with the police, all the communication devices have been provided with self-contained uninterruptible power supply, the company has put into operation an electronic card fare system and a system for access of authorized personnel to the metro facilities. Centralized traffic control is being upgraded based on microprocessor technology.

At the moment an integrated automatic dispatcher control system is being implemented for the power supply services and the electrical and mechanical services.

In 2011 a transportation security department was established for ensuring transportation security within the metro system. Today the Transportation Security Department employs about 140 employees. They operate dozens of sophisticated device complexes and systems for protection of stations, tunnels and other metro facilities from terrorists.

All the primary facilities are equipped with video surveillance systems with image recording, at specific locations the radiation monitoring equipment is located, station inspection equipment is functioning in the ticket hall, explosion-proof containers are also located there. The set of mandatory equipment at the stations and the checkpoints includes metal detectors both in the stationary and hand-held versions. All this equipment and the team of the department work to complete the main task – to ensure maximum security for the metro passengers in case of threats of acts of unlawful interference with the work of the metro.

On the occasion of the 25th anniversary of the metro the company opened a museum dedicated to the history of the metro in Yekaterinburg. The museum houses numerous stands with photos of the construction of the metro and photos of its employees, various exhibits that will grow in number over time. At the stations and underground walkways of the metro there are also displays of photographs.

Professional skill competitions have been held to commemorate the 25th anniversary of putting the metro into operation. The employees have demonstrated a high level of professional skills and profound theoretical knowledge and ability to apply it practically. The competitions were held in the traffic department, the motive power and rolling stock department, the signal telephone and telegraph department, the power supply department, the department of line service and tunnel facilities, the electrical and mechanical services department, the machinery and repair department. A total of 117 people participated in the competitions.

Particular attention is paid by the company to physical training and sports. Sports halls are rented for lovers of football and volleyball, those who like swimming can always get a pass for the swimming pool. The trade union committee actively participates in the formation of teams in many sports for taking part in the Spartakiads held by the metro systems of the CIS members and in the Spartakiad of the municipal enterprises of Yekaterinburg. The athletes defended the honor of the metro and won prizes in many sports competitions. The trade union organization held contests in futsal, volleyball, table tennis and chess as part of the celebration of the 25th anniversary of the metro.

For 25 years the personnel of the metro have properly maintained the sophisticated facilities and every morning at 6:00 sharp the doors of the halls open for the city dwellers and the guests of Yekaterinburg.

And what is more, the personnel dream of new lines, new trains, new passengers…

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15th international conference on transport security held in Moscow

On February 10-11, 2016 Moscow hosted the International Exhibition "Security Technologies – 2016". The 15th International Conference "Terrorism and Transportation Security" was held as part of the International Exhibition. The participants of the conference discussed the results achieved in the area of transportation security, disclosed and analyzed the most pressing issues and marked out the approaches to their solution.

Mr. Nicolay Zakhryapin, Deputy Minister of Transport of the Russian Federation, delivered report "On the Measures for the Implementation of the National Policy and Statutory Regulation in the Area of Ensuring Transportation Security". The speaker highlighted the fact that the issue of ensuring security is relevant to different spheres of activity of the society, but it is a matter of particular importance in the transport sphere.

The Ministry of Transport of the Russian Federation plays the key role in ensuring transportation security; it is the statutory regulation agency that carries out the formulation of the national policy in the area of transportation security. It also takes organizational steps for the implementation of the national policy in this sphere of activity. The main tasks of the Ministry in the area of ensuring transportation security are as follows:

- further improvement of the laws, including optimization of approaches to implementation of the requirements of transportation security in the context of economic constraints;
- coordination of activities for ensuring compliance with the laws in the area of transportation security at the regional, federal and international levels, taking into account the predicted and emerging threats.

One of the main outcomes of the joint effort with the federal executive bodies was Federal Law No. 15-FZ «Amendments to Certain Legislative Acts of the Russian Federation on the Issues of Transportation Security» that was adopted on February 3, 2014. For the purposes of implementation of this Federal Law, the Ministry of Transport of Russia and the involved federal executive bodies developed 16 draft regulations of the Government of the Russian Federation and 11 draft orders of government agencies. Almost all of these documents to some extent touch upon the issues of coordination of the activities of the bodies responsible for ensuring transportation security. At the same time, in the context of modern terrorist threats it is necessary to take a number of additional measures for improvement of the laws in the area of ensuring transportation security. These measures should provide for, among other things, the coordination of the activities in the area of ensuring transportation security at the regional and federal levels. For example, the Ministry of Transport of Russia is working on the issues of introducing amendments to Federal Law No. 16-FZ "Transportation Security" with regard to:

- granting powers to the Government of the Russian Federation for approval of the procedure for rating the transportation facilities and vehicles, including the time frame for its performance, for determination of the number of categories and the criteria for rating the transportation facilities and vehicles;
- harmonization with the standards of the Air Code of the Russian Federation;
- granting rights to the subordinate organizations of the Ministry of Transport of Russia in the area of ensuring transportation security for validation of the results of performing the vulnerability assessment and for approval of plans for ensuring transportation security;
- maintenance of a special register by the competent authorities in the area of ensuring transportation security for registering the transportation facilities and vehicles that are not subject to rating; elimination of the necessity for such facilities and vehicles to undergo the vulnerability assessment and of the necessity for elaboration of plans for ensuring transportation security; introduction of the notion of a certificate of ensuring transportation security for such facilities and vehicles;
- introduction of the notion of an additional vulnerability assessment for transportation facilities;
- necessity for transmission of the data from the technical facilities for ensuring the transportation security of transportation facilities and vehicles to the authorized units of the Federal Security Service, law enforcement agencies and the Federal Service for Supervision in the Sphere of Transport in accordance with the rules established by the Government of the Russian Federation;
- granting rights to the security authorities for development and approval of the standard list of questions in the field of ensuring transportation security that are used during job interviews for the purpose of ensuring transportation security.

Besides the Ministry of Transport of Russia, the system of measures for ensuring transportation security includes the following:

- the federal agencies that are within the jurisdiction of the Ministry of Transport of Russia as the competent authorities in the field of ensuring transportation security;
- the Federal Service for Supervision in the Sphere of Transport as the federal executive authority that exercises federal government control (supervision) in the area of transportation security;
- specialized organizations in the area of ensuring transportation security that are accredited by the competent authorities for carrying out vulnerability assessment at transportation facilities and on vehicles;
- the transport infrastructure subjects which own transportation facilities and (or) vehicles or use them on other legal grounds;
- law enforcement agencies, including the Federal Security Service of Russia, the Ministry of Internal Affairs of the Russian Federation; the public prosecution service;
- educational institutions;
- non-government organizations, such as the Transportation Security Association and the Transportation Security Fund, the International Association «Metro» and other associations for other modes of transport. For the purposes of accomplishment of measures for ensuring transportation security there exists an integrated national information system for ensuring transportation security which is owned by the Russian Federation.

A special place in the system of measures for ensuring transportation security is held by the departmental security service of the Ministry of Transport of Russia and the departmental security service of the railway transport. In accordance with the Federal Law, they became the first departments of transportation security that perform protection of transportation facilities and vehicles from acts of unlawful interference and for these purposes they were authorized to perform inspection, additional inspection and secondary screening.

It was highlighted at the Conference that the measures of state support for the implementation of the transportation security laws, including the implementation of Decree of the President of the Russian Federation dated March 31, 2010 No. 403 for development of a comprehensive program for ensuring transportation security, as approved by Order of the Government of the Russian Federation dated July 30, 2010 No. 1285-r, enabled to achieve the following:

- improve the laws in the area of ensuring transportation security;
- enhance the protection of passengers and personnel in transport from acts of unlawful interference;
- ensure enhancement of training, education and certification of the personnel in the area of transportation security;
- create an information support system for ensuring transportation security;
- increase the technological infrastructure level of transportation facilities to a totally new level;
- eliminate the vulnerability related to acts of unlawful interference at over 100 transportation facilities classed as category 1.

Today it is an important task to ensure the development and improvement of the Comprehensive Program. At the moment the Project of the Comprehensive Program is under consideration by the Government of the Russian Federation. There is a brief overview of the results of the work. Within the boundaries of their competence, the federal agencies for modes of transport take measures for rating, approval of vulnerability assessments and plans for ensuring transportation security at transportation facilities and on vehicles. By December 2015 a considerable amount of work was performed for enhancing transportation security.

At metro systems ratings were assigned to 790 transportation facilities; 789 vulnerability assessments were approved for transportation facilities; plans for ensuring transportation security were approved for 762 transportation facilities.

Moreover, within the framework of the business program of the exhibition a workshop was held for sharing experience in ensuring protection of metro facilities from acts of unlawful interference. The workshop was successfully conducted by Mr. V. Muratov, Security Advisor to the Head of Moscow Metro.

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Innovations for subways at Innotrans 2016

From September 20th through 23rd Berlin hosted the InnoTrans International Trade Fair which is held every two years at Messe Berlin and is the world's largest exhibition venue in the field of production and technologies for railway transport, metro and urban rail transport. InnoTrans is the event that you should visit, see and use for contacting your colleagues. Both technical experts and managers will find a lot of information there to use in their work. This article briefly describes the equipment for metros and individual engineering solutions.

InnoTrans 2016 was attended by representatives of the International Association «Metro» and such members of the Association as Transmashholding JSC, Kryukovsky Railway Car Building Plant PJSC, Bombardier, Alstom, NIIEFA-ENERGO, Pluton JSC. They presented their products and pilot projects acting in the capacity of exhibitors.

Among the variety of the exhibited models of metro rolling stock the products of JSC «Transmashholding» caught everybody's eye – those were the metro cars of the new generation 81-765/766/767 "Moskva". The cars are a combination of many years of experience and the most advanced technologies. The design was created with the use of the latest achievements of science and technology.

The distinguishing features of «Moskva» cars enable us to speak with confidence about the broad prospects for the use of such rolling stock not only in the domestic metros, but also in foreign ones. The features of the cars of model 81-765/766/767 include energy saving of up to 35% due to the introduction of new technical solutions and the use of the third-generation asynchronous traction motor which reduces the cost of operation by 40%. The rolling stock is equipped with bogies that have air suspension and a microprocessor system for control and diagnosis. The train has drawbars that include elements of a passive restraint system (crash system). To ensure maximum comfort for the passengers, the cabin was also improved. The aperture of the sliding plug doors was enlarged by 12%, accidental trapping of passengers between the doors is excluded. The passenger cabin is equipped with modern ergonomic seats and a passenger alerting system that can display television channels. Besides, the color of lighting in the salon varies from cold in the morning to warm in the evening. The number of handrails was increased by 30% and now the handrails have a «warm» coating.

The ergonomics of the control cab were designed with account taken of the wishes of underground train drivers. The control cab is equipped with an air conditioning system, a fan heater and hinged doors on both sides. The control cab doors are equipped with an additional safety function - a pneumatic lock is activated at the speed of 15 km/h.

The exhibition was also presented equipment that can ensure reliable and uninterrupted power supply for metro systems.

At the stand of NIIEFA-ENERGO LLC the visitors could learn more about the advantages of modern innovative products. The wide range of products enables the customer to order modular integrated deliveries. The equipment is divided into structurally and functionally autonomous major units - the functional units that have the form of an assembly of cells, cabinets, panels, as well as primary detectors, multiprocessor controllers that are integrated by the load-bearing structures, the common power current distributor and secondary circuits. As a result, the traction substation is built using the functional units assembled in the workshops and production departments of NIIEFA-ENERGO LLC.

The exhibition stand of NIIEFA-ENERGO LLC presented the latest equipment for railways, metros and urban electric transport:

• Cell of the double-pole input switch 1S-2x25-2-VV-UHL4 for AC traction substations for railways;

• Cell of the traction network power line switch KV-3.3-FKS-UHL4 for DC traction substations for railways;

• Rectifier unit V-MPE-D-2.0k-825-UHL4 for traction substations of metro systems;

• Unit RU-600 V for traction substations of urban electric transport, it includes: feeder cell KV-600-F-UHL4, a cable connection cabinet, rectifier unit KV-V-MPPD-2.0k-600 UHL4 of the withdrawable type;

• Substation control cabinet ShUP for application at substations of railways, metros and urban electric transport;

• Dry-type power transformer TS-100/6/0.4 for application at substations of railways, metros and urban electric transport.

The stand of Kryukovsky Railway Car Building Plant («KVSZ») PJSC presented its developments of the recent years: regional high-speed dual-system trains, diesel trains, innovative freight cars and metro trains. This machinery has already started operation and demonstrated its efficiency, reliability and popularity with the operators and passengers. The rolling stock of KVSZ PJSC is service in the in the metro systems of Kiev and Kharkov, and over the years of operation it proved its reliability. The car builders from Kryukov also welcomed their long-standing business partners – the senior officers of the Ministry of Transport of the Islamic Republic of Iran and the management of the Islamic Republic of Iran Railways. Meetings and negotiations were held with representatives of other firms and companies.

At the open area of the exhibition the visitors could examine a full-scale specimen of the rolling stock for metro systems - the automatic train Siemens Inspiro for the city of Riyadh (the capital of Saudi Arabia). The design of the train looks similar to the Dubai above-ground metro train. The passenger cabin is decorated in tones of beige and blue, with seats located singly and in twos transverse to the aisle. It makes a bright positive impression. An interesting solution is the chrome-plated vertical handrail in the middle of the cabin, in front of the doors. At the top it elegantly branches away in 4 parts. Between them there is a square-shaped light fixture. There is an abundance of information panels in cars. During the exhibition there were displayed a video about integration of metro with bus routes and even with an option of ordering a bus «on demand» using an iPhone. The German company is planning to deliver 74 trains to Riyadh.

The stand of the Chinese supplier of rolling stock CRRC (www.crrcgc.cc) presented metro trains for China and other countries. CRRC offers 3 types of rolling stock: A, B and C. They differ in their weight-and-dimensional characteristics and, consequently, in the transportation capacity (from 417 passengers in type A trains to 300 in type C trains). Type A trains are delivered to the metro systems of Mecca, Boston, Shenzhen, Shanghai, Hong Kong, Rio de Janeiro (line 1A), type B – to Tehran, Beijing, Wuhan, type C – to Chicago, Buenos Aires, Shanghai.

Metro rolling stock was presented at the stands of the companies CAF, Alstom, Stadler, Astra Vagoane Calatori (Romania, http://www.astra-passengers.ro), Hyundai Rotem, Hitachi.

Bombardier Transportation Company presented a mock-up of an innovative metro car.

Monorail as one of the type of urban transport was also present at the exhibition. Intamin Transportation (http://www.intaminworldwide.com) is a Swiss company, it has already put several monorail systems into operation: the city of Port Harcourt (Nigeria), 2013, a 34-meter long train transports up to 210 passengers at a speed of up to 80 km/h; in Calabar, another city in Nigeria there is a single-track 1.1-km line crossing the river; the city of Bologna (Italy), 2014, a 14-meter train transports 70 passengers from the airport to the city center in 7 minutes; in 2015 a 9.6-km line was opened in the city of Xi'an (China); in January 2016 the first Vietnamese monorail line was opened in the city of Da Nang, it is a 1.8-km long single-track circular monorail line which encircles the Asia Park (88 hectares). A new line will be opened for the Asian Games in 2017 in Ashgabat.

Suggestions on installation of platform doors in metros were reflected at the stands of many companies.

An interesting solution for CIS metros was suggested by Korean company SKD HI-TEC (www.skdhitec.com): the Rope Screen Door. The solution is based on screens that move down from above. They are made of 0.5 cm thick wire covered with a polymer. They consist of 3-4 horizontal sections, each 0.5 m high. Their advantages are as follows: large interval between the vertical supports (20 m), 2 electric motors lift 2 sections, narrow intermediate supports (this enables to stop a train with its doors in front of the support, because it will not hinder boarding and alighting), the possibility of lifting the screen by hand in case of a power failure (the weight of one 20 m section is only 10 kg), the installation cost is reduced by 40% and operating costs - by 80% compared to conventional designs of platform doors. There is an anti-trapping system: in case of an obstruction the cycle of closing is stopped.

Faveley Transport Corporation (www.faiveleytransport.com) offers modular sliding doors with a passive opening/closing mechanism without an electromagnet. A separate motor and a separate control module are installed on each aperture. All the mechanisms are located at the bottom, so the upper structure (height: 2.15 m) becomes virtually transparent. Such doors are used at the metro stations of Taipei, Istanbul, Shanghai, Helsinki, Lausanne.

Pluton JSC demonstrated on its booth 750 V DC electrical switchgears of advanced design. Special interest of the visitors was caused by the 750 V DC rectifier unit with a withdrawable design. The rectifier unit has a convenient design that enables easy access to the components of the rectifier and to the bus compartment. The applied design solutions enable easy movement of the power-supply unit of the rectifier. It does not require much physical effort from the personnel during maintenance and servicing. Withdrawable-type rectifiers produced by JSC «Pluton» are characterized by high power and a compact size. The stand also presented a stationary-type 12-pulse railway rectifier (DC, 3.3 kW). Within the framework of the exhibition the manufacturer also demonstrated the intelligent system for monitoring and protection of the traction network SMTN-3. It represents the third generation of safety devices based on advanced technologies. The SMTN-3 provides comprehensive protection of catenary systems from overloads and short-circuit currents. It also facilitates restoration of power supply of the energy system and the rolling stock in the shortest time possible.

As note most of the exhibitors and visitors, participation in the InnoTrans exhibition significantly strengthens the image of enterprises producing a unique product in its kind - rolling stock and equipment for railways and metros. Innotrans is the leading global platform for showcasing and selling vehicles and technologies, it determines the main development trends in this area for decades to come.

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Curiosities and prospects for Rio de Janeiro public transport

Rio de Janeiro is the second largest city in Brazil with a population of almost 7 million people. It is a major financial and tourist center. Many substantial sports and cultural facilities are located in the city. These factors determined the necessity for developing transport infrastructure that can provide services for the city dwellers and its numerous visitors.

Rio de Janeiro has a transport network that includes such types of transport as the light rail, buses and the metro. There is also a tram route, cog railway and urban electric trains that ensure the suburban rail link.

Development of public transport in the city started with the tram line that was laid in 1875 from the city center to the neighborhood of Santa Teresa located on the Santa Teresa hill. In the 19th century it was the place of residence of the urban aristocracy and then of the local Bohemia – poets and artists. Initially, the tram was horse-driven, but in 1896 it was converted to electric traction. Part of the tram line runs along the aqueduct Arcos da Lapa. The line is double-tracked along its entire length but on the aqueduct it becomes a single-track line. The route uses retro American cars made in the century before last. The control cabins are located in the cars on both sides, and there are no side walls and no aisle through the center of the cabin. The rows of wooden bench seats occupy the entire width of the car. The Bondinho tram, as the locals call it, is used mostly by tourists, but it also has minor transport function.

In 2011, an accident occurred when a car crashed with passengers and it lead to casualties and injured people. As a result, the tram route was closed. After the modernization in 2015, the historical tram Bondinho resumed its operation.

Another transport rarity of Rio de Janeiro is the cog railway that leads to Corcovado hill, the place where the famous statue of Christ the Redeemer is located. It is one of the symbols of the city. This is not a cable car, as sometimes people mistakenly call it, but a railway with multiple-unit trains, inter-stations with gridiron (passing loops) and other railway facilities. The railway with a length of 3.8 km and a rail gage of 1000 mm was built by Swiss experts in 1884. The rolling stock consists of 3 two-car trains. One-way travel lasts 20 minutes. The track was laid through real Brazilian jungle of the Tijuca National Park and is very picturesque along its entire length.

At the lowest terminal station Cosme Velho there is a museum which tells about the history of the railway. One of its exhibits is displayed near the station at St. Jude Square. It is an electric locomotive which began to operate in 1910, making Corcovado the first electrified railway in Brazil.

To return to the tram subject, it is worth mentioning the light-rail transit system project VLT Carioca that was implemented in Rio de Janeiro. This system was put into operation in June 2016, on the eve of the Summer Olympic Games. Now it consists of a single line with 16 stations, it has a length of 14 km and connects Santos Dumont Airport with Novo Rio Bus Terminal. The European rail gage of 1,435 mm was adopted. The city government plans to build two more lines, as a result the network spread will increase to 28 km, and the number of stations – to 31.

VLT Carioca was designed in 2010, while track laying commenced in 2012. According to the project designers, integration of such system into the urban infrastructure would reduce the number of the automobile transport in the transportation of passengers by means of reorienting the passengers from bus routes and private cars to the light rail lines.

The LRT system uses modern equipment and rolling stock which is powered with a direct 750V current from the contact rail, which is located within the gage at the same level with the railroad tracks. The peculiar feature consists in the electric dividing of the contact rail, due to which each of the sections is live only when the rolling stock is above it. Such power supply system ensures complete safety for pedestrians and vehicles. The cars are equipped with high-value capacitors that maintain the power supply of the engines at dead sections, and capacitors can be recharged by means of regeneration. The doors in the cars are located on both sides, the control cabins are in both head cars.

The bus is a very popular mode of transport in Rio de Janeiro, the route network encompasses the entire city, including its distant outskirts. There are more than 800 bus routes. Travelling by bus has some features that do not make the trip comfortable. For example, on-demand stops are numerous. When a bus approaches such a stop, one needs to see the route number and be quick enough to stop it by putting up one's hand. However, the route numbers and names of destinations are clearly visible on the windscreen. The most inconvenient thing is the lengthy trip time. Since Rio de Janeiro has a peculiar surface relief and the districts of the city are separated by hills, in many places there are tunnels, which limit the throughput capacity of the streets. There are also numerous traffic controlled intersections which impede traffic on the city mains. That is why in the daytime a bus trip from Cosme Velho (the lowest station of the cog railway) to Copacabana takes no less than 2 hours.

In the context of the increased transportation flow the role of the metro becomes apparent, because it is designed to solve the problem of passenger transportation.

The first line of the metro in Rio de Janeiro started to be constructed in 1970. In March 1979, the metro was opened for passengers and within the first 10 days it transported more than 1.5 million people. At that time, four trains operated in the line. They consisted of 4 cars. The interval between trains did not exceed 8 minutes. In 1980, two new stations appeared in the line and then stations were opened one by one almost every year. In 1980, the number of cars in a train was increased to 6. Today, the length of line L1 is 16 km, which includes 19 stations.

In November 1981, train operation was started in line L2. Today it has 16 stations and a length of 30.2 km.

In 2016 line L4 started to operate, it was built for the Summer Olympic Games in 2016 and it played an important role in provision of the transport services within the city. 30 thousand workers were involved in the construction of this line; it was the largest construction site in Brazil. The construction began in 2010. A concession was established for the implementation of the project, in which 80% of the capital was controlled by the State of Rio de Janeiro and 20% by private companies. The project itself existed since 1980.

The new metro line almost immediately proved its efficiency. Before the construction of line L4, a trip from Barra da Tijuka to Ipanema took 1.5 hours, and after putting the new metro line into operation the trip takes 13 minutes.

In 2013, a tunneling shield with a diameter of 11.5 m started its work. Tunneling was carried out under extremely severe conditions involving water-saturated soils, swampy underground spaces and rerouting of the branched service lines. During the tunneling process, the tunnel sections were repeatedly flooded with water. Many historical artifacts were found during the work, including items that belonged to the imperial family.

Modern rolling stock was purchased for the line. More than 250 million Reals ($72.5 mln.) were invested in the infrastructure.

During the Olympic Games, the line served only the visitors of the sporting events, the city dwellers started to use the line in September.

Today the Rio de Janeiro Metro consists of three lines, has 41 stations and a length of 48 km. The average daily passenger flow is 850 thousand people, during the Olympic Games it was around 1370 thousand passengers.

Fork-type movement is organized in lines L1 and L2, i.e. from station Botafogo to station Central the movement in both lines is carried out using one track and then the trains go separate ways according to their routes. To distinguish the trains of different lines the interiors of the cars are painted orange or green. At the stations the corresponding information is provided via the dynamic displays.

Many stations have three platforms. This measure makes it possible to organize separate boarding and alighting of passengers when the train stops at the station in order to avoid collisions of passenger flows moving in opposite directions. The cars are also designed for transportation of large numbers of people. The dimensions of the rolling stock are noticeably larger than, for example, those of the cars in the Moscow Metro. Thus, the width of a car is 2.9 m, the length – 22 m, the door width – 1.6 m.

Fare is paid by means of electronic cards and single-trip tickets that work on the principle of tokens. It means that such a ticket does not contain an electronic chip and is inserted into the special slot to open the turnstile. The ticket is not returned to the passenger. You can buy tickets at the ticket office in the hall for cash, or in a machine, but only with the help of a bank card.

A ticket for a single trip costs 4.10 Reals (1 real = 21 rubles) and has no time limitation. There is another travel option, metro+bus. The transportation company Metr Rio that operates the metro has special express buses that run from metro stations according to specific routes. Such double ticket also costs 4.10 Reals.

There are no inspection zones in the halls, but the security officers are always on duty at the turnstiles, they also maintain order in the trains.

Before finishing the report on the metro of Rio de Janeiro, it is worth mentioning one peculiarity.

In 2006, the deputies of the Legislative Assembly of the State of Rio de Janeiro passed a law on separate travel of men and women in the metro trains. Of course, that was at the discretion for the passengers. Each train had a special car marked with a pink sticker «only for women». Separate boarding was supposed to be performed on weekdays from 6 to 9 a.m. and from 5 to 8 p.m. Thus, the deputies decided to ease the women's problems related to travel conditions. In crowded cars they often felt discomfort caused by the shameless behavior of some excessively temperamental men. The law caused a mixed reaction in the society, giving rise to numerous disputes and protests, including those initiated by some women who saw signs of inequality. Today separate travel is almost not performed by passengers in the metro of Rio de Janeiro.

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