UNION OF INDUSTRIES OF RAILWAY EQUIPMENT

RAILWAY® EQUIPMENT

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CONTENTS

Dear colleagues!

Global economy has been experiencing fundamental changes over the recent years. A totally new geopolitical and macroeconomic environment is emerging, with new poles of economic activity. However, even in the new circumstances, rail transport remains a crucial infrastructural element of the economic growth, and the engineering industry, consequently, becomes a key player in business regeneration. It is especially important in the new economic environment that state-run infrastructural projects maintain steady demand in railway equipment. The government's efforts in this area keep us confident about ongoing stable progress in our industry.

Russia has achieved a lot over the last years, restructuring and setting priorities for railways and railway engineering development. The Railway Transport Development Strategy of the Russian Federation up to 2030 lays out the key tasks based on an innovative breakthrough philosophy. Innovations and high-tech – these are the two main points that Russian railway engineering should rely upon in its future development.

To use effectively its engineering potential, Russia has set up cooperation with leaders of European engineering – Siemens (Germany), Knorr-Bremse (Germany), Alstom (France), Talgo (Italy), Tatravagonka (Slovakia). Today, state-of-the-art plants using technologies of the world's best manufacturers are being constructed in Russia. We highly appreciate the moves taken by our partners, and aim to make our cooperation as comfortable and beneficial for everyone as possible.

Private businesses will be further motivated to invest in innovations if the rights and responsibilities of each participant are legislatively shared on the basis of public-private partnership. These and other problems should be addressed by a special new law on innovations. Work in this area is underway.

Today, we can state that the Russian railway engineering industry has successfully retained its potential despite the complicated environment, and is steadily moving on from surviving to evolving.

Valentin Gapanovich
President of Union of Industries
of Railway Equipment

UNION OF INDUSTRIES OF RAILWAY EQUIPMENT: THREE YEARS OF DEVELOPMENT

Since its formation in June 2007, non-commercial Partnership «Union of Industries of Railway Equipment» (UIRE) has been actively involved in implementing goals and objectives adopted at the Partnership's inaugural meeting.

From the outset UIRE specified its main objectives as following: qualitative improvement of railway equipment, increase of railway engineering production competitiveness, creation of a new system of normative and technical regulation and certification of manufactured railway production, and domestic market protection against unfair competition. These objectives became the basis of the two government-approved documents: "Russia's Railway Transport Development Strategy up to 2030" (regarding its upgrade and modernization) and "Russia's Railway Engineering Development Strategy up to 2015". The Partnership's ideology proved vital: in 2009 36 companies joined UIRE bringing its membership to 94. Since then 10 more domestic and foreign companies applied to join UIRE.

UIRE is actively involved in generating new legislature — a basis for any further development. Among the new draft laws the Partnership developed are the following: "On Standardization", "On Accreditation in the Field of Conformity Estimation", "On Amendments to the Law of the Russian Federation "On Technical Regulation", "On Energy Saving and Energy Efficiency", "On Amendments to the Law of the Russian Federation "On Industrial Safety of Dangerous Industrial Objects". Besides, the Partnership took an active part in discussion of the basic technical regulations:

- On Safety of Railway Infrastructure;
- On Railway Rolling Stock Safety;
- On High-Speed Railway Transport Safety.

The proposals for these draft laws were submitted to the State Duma, the Council of Federation, the Government of Russia and some of them were taken into consideration.

Recent financial and economic crisis urged the Partnership to work even more actively generating a series of ideas and initiatives aimed to support development of the railway industry. Our proposals (on support of city-forming railway engineering enterprises; on return of two thirds of discount rate for the credits received on manufacture technical upgrade; on accommodation of the additional order for freight cars) were included into government programmes and realized.

Innovative development of the country is impossible without technological modernization of industrial production on the basis of advanced foreign technologies. Such approach is practiced by all UIRE member industries. These issues are an object of careful attention at conferences, meetings, assemblies and committees of the Partnership. Localisation parameters (essential for any upgrade) have become a mandatory component for any purchase of the foreign made equipment or technologies. The Partnership member enterprises actively establish business relations with Siemens, Alstom, Bombardier, Knorr-Bremse, Tatravagonka and other world leaders in railway engineering. It is quite common for the Partnership members (Transmashholding, Sinara — Transport Vehicles, "Tractor plants", "Tikhvin Car-Building Plant" and others) to share acquired advanced technologies.

The Partnership enterprises actively participate in the Localisation Programme of components production for "Lastochka" ("Swallow") EMUs within the territory of Russia, which will be used for transportation of participants and visitors of Sochi Winter Olympics in 2014. Later these EMUs will be used in other regions of the country.

Legal conditions stimulating new, modern-technologies-based competitive production is a necessary precondition for any innovative industrial activity. They will also facilitate regulating new products development and their introduction into mass production. To address these issues UIRE (first in Russia) has developed a set of innovative standards.

These standards — conducive to establishing a new nationwide legislative foundation — have been submitted to federal legislative and executive authorities with the proposal to accelerate development of the state innovative policy and its necessary regulatory basis.

To assist UIRE members in realization of requirements of the federal law "On energy-saving and improvement of energy efficiency" in June 2010 non-commercial Partnership "The Inter-regional organization of UIRE in the field of energy inspection» was created. In the future it will obtain the status of a self-regulating organization and will carry out the whole set of actions in the field of energy inspection of the enterprises and introduction of energy management.

The self-regulating organization will be able to provide coordination of industrial enterprises relations with executive authorities in the fields of realization of state energy-saving policy, introduction of new technological solutions and equipment which will raise fuel and energy efficiency. It will also facilitate development of energy efficiency programmes and additional fundraising from budgets of all levels, including international organizations.

The long-term policy of the Partnership regarding interaction with the regions is based on principles of mutual cooperation, association and coordination of efforts in railway engineering development, realization of the state structural and investment policy, enhancement of domestic economy competitiveness and provision of equal economic and legal opportunities for businesses. The result of this policy is the following agreements signed in 2010:

- The Agreement on interaction between Industry and Trade Ministry of Republic of Tatarstan and UIRE concerning cooperation of industrial enterprises of Republic of Tatarstan and railway engineering enterprises, that are members of UIRE;
- The Agreement on interaction and cooperation between Industry and Power Ministry of the Chuvash Republic and UIRE.

In 2009 the Partnership in cooperation with the Russian Union of Industrialists and Entrepreneurs (RSPP) worked out amendments to the federal law “On technical regulation”, which are intended to give an essential impulse for railway engineering innovative development. Throughout the year (and finally in early December 2009, at a meeting with the representative of Administration of the President of the Russian Federation) UIRE was introducing amendments to the federal law “On technical regulation”.

The amendments submitted to the State Duma on 16 December, 2009 by the President Medvedev, were aimed primarily to create a legal foundation for the use of up-to-date international standards in Russia. Besides, the amendments have called off the termination date of reform and acceptance of technical regulations as this process is continuous. It means that existing obligatory norms will remain valid until new corresponding rules have been accepted.

In 2010 UIRE continues to work with Russian Union of Industrialists and Entrepreneurs not only in implementation of technical regulation reform, but also to update legal documents in the field of industrial safety maintenance. In spite of their mandatory status these documents have not been updated for more than 12 years. In practice it leads to essential administrative barriers both at the stage of introduction of new types of the equipment and in operations with existing fixed capital.

Along with the Union of Mechanical Engineers of Russia UIRE has organized a number of events to exchange business information and to support special consultations and examinations. Such cooperation will continue in the future.

In June 2010 UIRE organised the first International scientific conference “Railway Industry: Priorities, Technologies, Prospects” in Moscow. This conference became a platform to share opinions on wide range of specific industry issues between heads of legislative and executive bodies of Russia, RZD’s management, UIRE members, representatives of private rolling stock operators, industrial railway transport enterprises, leasing companies, domestic and foreign railway equipment manufacturers, scientific community and mass-media. In total more than 400 representatives from more than 150 Russian and foreign companies took part in the conference. Taking into account huge positive impact of such actions, the Partnership is going to make this conference annual.

With the development of a civil society in Russia public organisations, associations and unions will become increasingly involved in political and economic life of the country. UIRE is ready for this involvement. Cooperation between UIRE and UNIFE, launched in 2007 with the signing of the License agreement and the Memorandum on cooperation in the field of IRIS standard expansion, is actively realized in practice. Today Russian “Version 02” of IRIS standard is widely used by the Partnership members. In 2009-2010 four series of training seminars with IRIS experts were organized to facilitate practical introduction of the standard. More than 80 experts have been trained by now. They all have been qualified as trainers and will be involved in the further IRIS standard cascade introduction at the enterprises.

Izhevsk Radio Plant became the first Russian enterprise certified in accordance with IRIS international standard. Later in 2010 managers of Russian railway engineering enterprises certified in accordance with IRIS requirements will convene at a conference at AnsaldoBreda plant in Pistalo, Italy. The purpose of the conference is to acquaint Russian experts with details of IRIS introduction. AnsaldoBreda management and IRIS General Manager Bernard Kaufman are actively involved in preparation of the conference programme. Its main emphasis will be on maximum possible practical application of the received experience. The Partnership actively develops its own optional certification system and has opened 15 test centers with accreditation in the system. Now practically all railway production can be tested in our system.

According to the programme of standardization, 15 standards of the Partnership were developed in 2009, and more than 20 standards are planned to be developed in 2010.

The Partnership has initiated a number of major events.

The first of these was a conference in St.-Petersburg, devoted to application of light-emitting diode equipment in railway transport. The conference participants had an opportunity to assess and appreciate advantages of up-to-date technology in real production. Their introduction requires certain expenses, which are very quickly paid back. Besides, today UIRE members have no much of an alternative.

The Partnership designers are busy with application of polymeric fibrous materials on railway transport (in cooperation with Lirsot OJSC , Mytishchi), modern approaches to railway equipment design on the basis of innovative LMS technologies.

Another important meeting, “Innovative railway engineering production for industrial enterprises and rolling stock owners”, featured shunting diesel locomotives, gondola cars and railway production for railway maintenance. This event was a first step towards more active use of this attractive niche in railway engineering and was meant to support the interest of railway equipment producers in growing demand for modern rolling stock. The meeting proved an efficient instrument in maintaining dialogue and cooperation between various railways, and it was decided to turn it into a regular event.

UIRE organized another event in St. Petersburg: concerning lifecycle and servicing cost estimation, introduction of lean production principles, energy-saving and improvements in energy efficiency of production at railway engineering enterprises.

New principles of railway equipment pricing will enhance responsibility of manufacturers for quality and reliability of their production, and responsibility of consumers for qualitative and timely equipment maintenance. Such approach will promote transition of railway industry to European standards of performance and will allow consumers to estimate necessary rolling stock characteristics from their economic expediency viewpoint.

Besides, this method of pricing implies that the improved functional performance of the equipment is (its productivity, run between repairs, maintainability, etc.) means its higher economical impact and hence its higher price. Thus, pricing on the basis of LCC estimation initially contains stimulus for manufacturers to improve quality and operational characteristics of their product.

These new approaches in pricing, lean production and energy-saving are decisive for the Partnership work in 2010 and following years.

UIRE understands that it is important to preserve united railway area with 1520-mm gauge and to coordinate internationally technical regulation of railway transport and it makes regular efforts in this direction. In cooperation with RZD the Partnership has considered proposals on updating single lists of production subject to obligatory certification and compatibility. The following draft documents were developed with direct participation of the Partnership experts:

- The Agreement to coordinate policy of railway production compatibility assessment in 1520-mm gauge area;
- The Agreement on rolling stock access to the infrastructure in international traffic.

These documents will be reviewed by the Council for Rail Transport of the CIS member states CIS.

The Partnership plans to finalize projects of unified technical regulations of the Euro-Asian economic community and also standards and codes supporting them, taking into account possible transfer of national standards of the CIS member states into interstate ones.

The newly founded Expert Institute is meant to ensure objectiveness and openness in solution of various controversial problems within UIRE. Its primary goals are:

- preparation of expert judgements on examination objects;
- coordination and balancing the interests of society, the government and business in the examination process;
- ensuring objectivity and reliability of examination results with respect to their accordance to norms and positions of technical regulations, methods, national standards, and also to the international norms and rules.

Performance results of the Expert Institute are regularly published in UIRE periodicals and other publications.

Apart from the UIRE’s Supervisory Board members The Expert Institute includes representatives of UIRE member organisations, experts in the field of railway transport, innovative business, and competent representatives of public organizations.

The Partnership activities are reflected in its website and in the "Railway Equipment" quarterly. So far 10 issues of the quarterly have been published.

We feel confident that the Partnership stands firmly on its feet and has exercised great impact on railway industry development. It has proved its efficiency as systemic integrator of efforts to improve railway equipment quality and competitiveness, its capability to facilitate the growth of new-generation rolling stock and satisfy railway transportation needs in new innovative way. ■

BASIS FOR COOPERATION

On April 27, 2009, a meeting was held in Verkhnaya Pyshma (Sverdlovsk region) concerning the implementation of RZD's investment programme and tasks for the Ural region enterprises regarding railway equipment supply.

Summarizing the results of the meeting RZD president V. Yakunin and the heads of leading holding companies, CEO of Transmashholding A. Andreev and CEO of "Sinara – Transport Machines" A. Saltaev concluded a Charter on fundamental principles of collaboration in the railway engineering sphere.

According to V. Yakunin, "the Charter directs towards the competitive growth and production of the high-quality products. The main direction of the Charter is to prompt the enterprises to voluntarily undertake commitments to implement railway engineering standards".

The achievement of balance of interests between RZD and Russian railway engineering companies is a guarantee of sustainable development of rail transport in Russia until 2030. According to participants of the meeting, the concluded Charter might go beyond the limits of the relations between RZD and its suppliers and become an example and a guideline for other industries.

Railway engineering development will be driven by improvement of pricing mechanism, including the switch from cost plus pricing of new railway equipment to life cycle cost pricing, widely used in international practice. It will give powerful incentive to the innovative development of Russian railway engineering companies.

On behalf of UIRE, which is authorized to organise the registration, accounting and monitoring of actions of the affiliated organisations, the Charter was signed by the Partnership President, V. Gapanovich.

In April 2009 the Charter was signed by 18 enterprises, and by July 2010 its membership reached 79.

Initial reports from the enterprises on the observance of the Charter principles allow us to conclude that essential changes took place at many of the enterprises. More railway engineering enterprises are striving for production engineering modification, update of the product nomenclature and improvement in the quality of output products, reduction of their energy intensity and increase in energy efficiency. ■

CHARTER

"Russian Railways" open joint-stock company, "Union of Industries of Railway Equipment" non-commercial partnership and Russian railway engineering enterprises, manufacturers of railway equipment, assemblies and components

City of Yekaterinburg April 27, 2009

THE PRINCIPLES OF BUSINESS PRACTICE RESPONSIBILITY

Open Joint-Stock Company "Russian Railways" (RZD) and other buyers of railway engineering equipment, Non-Commercial Partnership "Union of Industries of Railway Equipment" (UIRE) and the heads of the Russian railway engineering enterprises, manufacturers of railway equipment, assemblies and components,

taking into account the current unfavourable conditions of the global financial crisis,

facilitating the anti-crisis measures, taken by the Government of the Russian Federation, including measures for supporting the railway engineering enterprises,

realising the necessity of improving the quality and the reliability of railway equipment, including assemblies and components, as well as the necessity of conversion of the railway engineering enterprises to the innovative and energy-saving technologies,

considering the impossibility of rail transport successful development without sustainable development of national railway engineering sphere,

taking into consideration the Concept of Social and Economical Development of the Russian Federation up to 2020, particularly to the extent concerning the comfort and affordability of passenger rail service,

concluded the present Charter on fundamental principles of responsible business conduct in the railway engineering sphere, which we voluntary intend to adhere to.

RESPONSIBLE MISSION OF RZD, UIRE AND THE RUSSIAN RAILWAY ENGINEERING ENTERPRISES, MANUFACTURERS OF RAILWAY EQUIPMENT, ASSEMBLIES AND COMPONENTS IN THE SPHERE OF SAFETY, QUALITY AND RELIABILITY IMPROVEMENT

We, the heads of RZD and the Russian railway engineering enterprises, manufacturers of railway equipment, assemblies and components, believe that our key mission is to ensure the sustainable development of rail transport in the Russian Federation with due consideration of the Transport strategy of the Russian Federation up to 2030.

We realise that the consequences of the decisions taken within our organisations go beyond the limits of the companies and have direct influence on ensuring the economic and transport safety of the Russian Federation.

Considering the fact that RZD is the biggest buyer of the railway engineering products, we, the heads of the Russian railway engineering enterprises, manufacturers of railway equipment, assemblies and components, undertake permanently to take measures concerning optimisation of production costs and improvement in product quality.

We, the heads of the Russian railway engineering enterprises - the manufacturers of railway equipment, assemblies and components, undertake to unconditionally implement provisions and requirements of the agreements and contracts with RZD within the agreed price limits.

We acknowledge the main role of the Russian manufacturers of railway equipment is the continuous development and improvement of output, development of innovative, high-quality products in the railway engineering sphere. Innovations should be directed not only towards the reduction of production cost, but also towards the reduction of expenditures throughout the product life-cycle.

We appreciate that the development of the railway engineering should be driven by the improvement of product pricing mechanism, including the switch by 2011 from the cost plus pricing of new railway equipment to life cycle cost pricing, widely used in international practice. It will give a powerful incentive to the innovative development of Russian railway engineering industry, manufacturers of railway equipment, assemblies and components.

We believe the safety and quality improvement of output products to be inextricably linked to the state-set nationwide technical regulation. Technology and materials applied in the development of innovations in the railway engineering sphere should satisfy not only the requirements of technical regulations and national safety and quality standards, but also the requirements in the sphere of energy-saving and energy efficiency.

We strive for achieving good long-term economic and social results on the basis of the balance of interests of RZD and the Russian railway engineering enterprises, manufacturers of railway equipment, assemblies and components.

We are convinced that the relations between RZD, UIRE and the Russian companies, manufacturers of railway equipment and components should be built on the basis of openness and economic equality.

RESPONSIBLE MISSION OF RZD AND THE RUSSIAN RAILWAY ENGINEERING ENTERPRISES, MANUFACTURERS OF RAILWAY EQUIPMENT, ASSEMBLIES AND COMPONENTS ON THE DEVELOPMENT OF THE REGIONS OF THE RUSSIAN FEDERATION.

We realize that our companies and our employees are an integral part of the society.

We support the efforts of the government and civic initiatives in the field of economic, social and cultural development of the areas where our plants are located, as well as in the field of preserving cultural heritage and diversity.

We take part in decision-making on the socially significant issues at the regional level.

We strive for establishing efficient partnership with regional and local authorities as well as civil society institutions for the purpose of joint participation in pursuing common objectives in the community development.

PURPOSES OF THE CHARTER

The Charter presupposes voluntary sharing of information on the results of various activities in accordance with the principles, stated in the Charter.

The decision on selecting the method of reporting data might be taken on independent basis with consideration of readiness, practicability and correspondence to the own interests.

Participation in voluntary information sharing of UIRE is a successive logical step for the organisations sharing the principles of the Charter.

The Charter does not stipulate any external control of the observation of its principles by the affiliated organisations.

THE ORDER OF AFFILIATION TO THE CHARTER

The Charter on the responsible cooperation between RZD and the Russian manufacturers of railway equipment and components is a voluntary initiative, based on the fact that the representatives of business community understand and acknowledge the active role of business in the community development, the importance to observe the norms of responsible business practice with due consideration of balance of interests of the concerned parties.

The Charter is directed to favour the following:

- the proclaimed principles should become a part of corporative strategies and routine business life of every affiliated organisation;
- partnership, cooperation and collaboration of the main interested parties in pursuing the objectives of the community should become more efficient.

The Charter is a document open for affiliation by any Russian railway engineering enterprise, manufacturer of railway equipment, assemblies and components.

UIRE arranges registration, accounting and monitoring of actions of the affiliated organisations:

- publishes the information concerning affiliation of companies to the Charter on its web-site;
- keeps register of participating companies, issues the Certificates of Affiliation;
- generalises information concerning the scope of Charter application by the enterprises and organisations and publishes it on its web-site;
- provides information support to enterprises by organising events (business meetings, seminars, round table discussions, expert groups etc.) aimed at sharing experience and distribution of information about best practice and guidance materials, etc.

Admission to the Charter is free. The participants of the Charter obtain an UIRE Membership Certificate.

KEY PROBLEMS OF RAILWAY ENGINEERING AND POSSIBLE SOLUTIONS

Vladimir Yakunin
President of RZD

In the 1880s, in his "Claudius Bombarnac" novel, classic French author Jules Verne wrote about the construction of the Caspian Railway: "We often hear of the extraordinary rapidity with which the Americans have thrown their railways across the plains of the Far West. But the Russians are in no whit behind them, if they have not surpassed them in rapidity as well as in industrial audacity".

The Caspian Railway was indeed constructed in a record time. it played an important role in strengthening the defensive ability of Russia, and became one of the key trade routes — the North-South Corridor, as it is called now. And although Jules Verne was a science fiction author, there is no fiction in it. At that time, Russia had the industrial audacity it could boast. Today, achieving similar results needs will — political will of the national government to make audacious decisions, and the will of railway workers to put them into action. it is of supreme importance that the development of today's railways keeps up the level which impressed the French writer.

Rail transport is one of the structural industries which give an impulse to the various adjacent sectors and a large number of companies across the country. This is why its development should be one of the nation-wide priorities. Stronger global competition, especially during the financial and economic crisis, demands looking for new ways to improve the competitiveness of the Russian economy based on an innovative breakthrough in its real sector development.

One of the ways to promote development is to create "growth points" to stimulate innovative development, first of all in industries with the highest return on investment. State investment will not only help the real sector and create tens of thousands of new jobs but will also form the basis for the improved competitiveness of the Russian economy.

One of the growth points is rail transport.

Problems of rolling stock upgrading

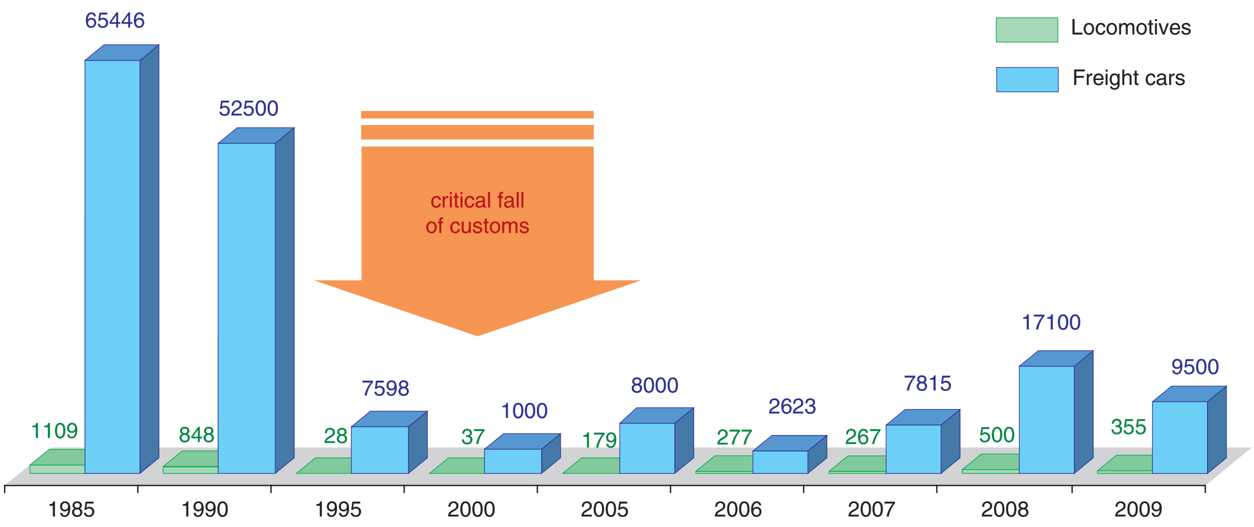
Before 1991, the rate of rolling stock upgrading in Russia used to reach 4.5% a year. This helped to maintain an acceptable level of the wear and tear of the rail transport's fixed assets and ensured stable workload and development for the country's railway engineering.

Demand for products of railway engineering companies began to decline in 1993 as a result of the significant reduction in investment. Investing in fixed assets remained extremely low almost until 2007 (Figure 1).

A contributing factor was the rigid tariff regulation for rail transport coupled with freight tariffs lagging behind the price growth in the main sectors of industry and power generation. Between 1991 and 2008, railway tariffs were adjusted only 76-fold, while prices in industrial production grew 102-fold, in iron and steel industry — 173-fold, in fuel production — 198-fold, in coal production — 229-fold, and in power generation — 129-fold.

It was only in 2007-2008 that Russian Railways achieved a significant increase in investment and switched to expanded reproduction of its fixed assets (Figure 2).

Over this short period of time, the company was able to significantly upgrade its fleets of locomotives, passenger cars, and EMUs. in contrast to many other companies, RZD covers almost all of its demand for new equipment using supplies of Russian engineering companies. it once again highlights the great influence that rail transport has on adjacent industries, and the industry's multiplier effect on the whole Russian economy.



* 2009: procurement of freight cars including subsidiaries and associates of RZD

Figure 1. New rolling stock supplies, 1985—2009, units

However, in the complicated macroeconomic environment of 2009, the RZD's investment programme was limited to only depreciation expense, which heavily constrained the development of Russian railways. The lack of financing for the investment programme not only imposes limitations on the development of railway transportation but also leads to direct risks of poorer transportation safety. in particular, an estimate showed that the absence of infrastructural upgrade can result in a critical level of the failure rate on railways as early as by 2013, and on electrical equipment — by 2015.

Alongside with this, outdated equipment also leads to significant additional costs due to the need for its unscheduled repair.

The financial and economic downturn resulted in a sharp decrease in rolling stock procurement in 2009 compared to 2008: the decline for locomotives totalled almost 22.0%, for passenger cars — 38.3%, for EMUs — 14.1%. in the future, reduced purchase of new equipment will lead to a new wave

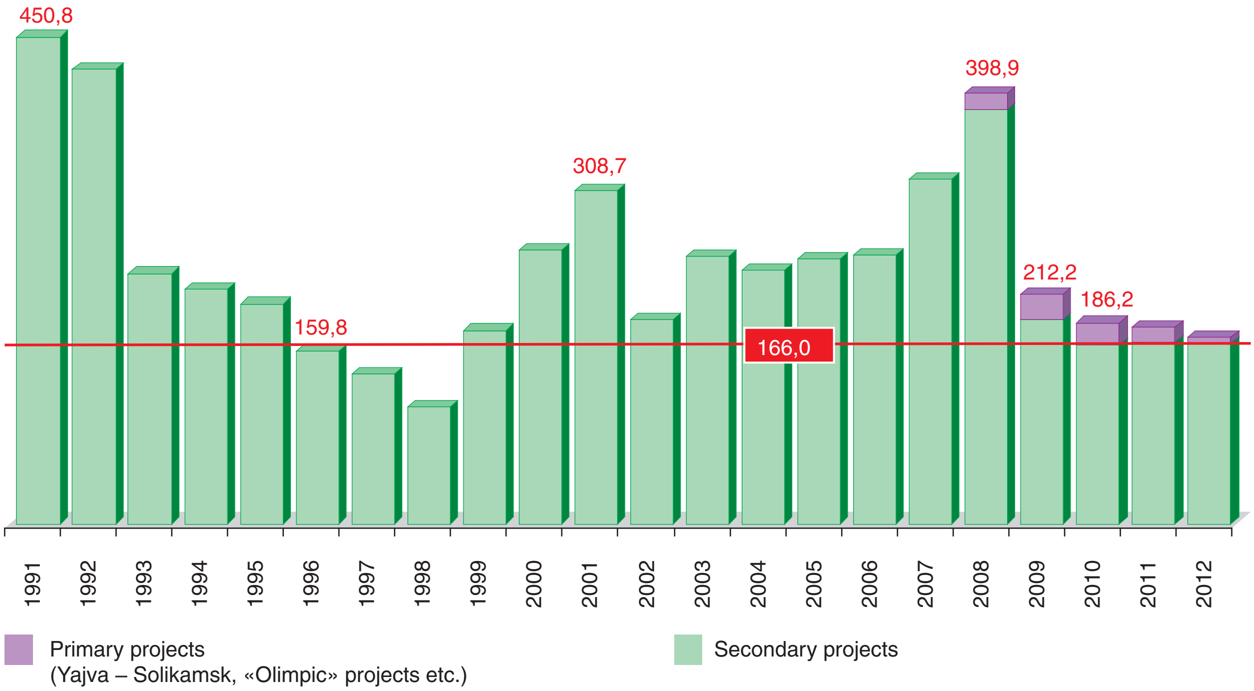


Figure 2. Investment budget of JSC RZD in 1991-2012 (excluding the Adler — Krasnaya Polyana project) at 2009 value, bln RUR exclusive of VAT

of stagnation in the railway engineering sector and a shortage of rolling stock in rail transport.

This gives grounds to say that the state policy of limiting tariff growth of natural monopolies should be based on a balanced approach, which, on the one hand, should stimulate economic development while limiting tariff growth, and on the other hand — support the RZD's investment programme as a consumer of a large amount of engineering products made in Russia. This proposal from RZD was implemented in 2009, when the Russian Government introduced a 50 bn rubles compensation for revenues RZD failed to receive as a result of the tariff regulation. it is extremely important that a well-balanced approach like this remains as the basis for tariff decisions in the future.

Alongside with the state subsidies of the revenue losses from the tariff regulation, the expanded upgrading of RZD's rolling stock in 2010 also needs state support for the implementation of the company's investment programme. Without this support, the procurement of locomotives in 2010 will fall to 361 units (a more than 26% decline compared to 2008), of passenger cars — to 524 units (a 50% decline compared to 2008 and 19% compared to 2009), of EMUs — to 671 units (a 17% decline compared to 2008 and 4% compared to 2009). (Figure 3, Figure 4, Figure 5)

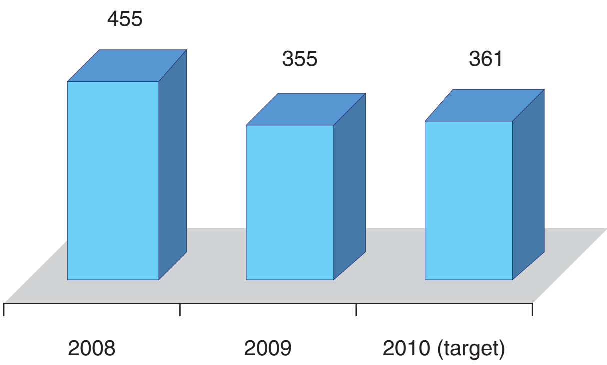


Figure 3. RZD's procurement of locomotives in 2008-2010, units

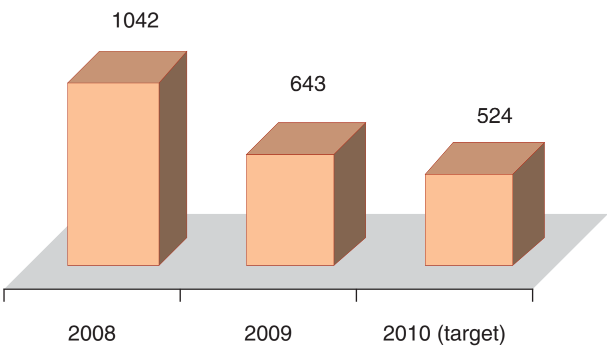


Figure 4. RZD's procurement of passenger coaches in 2008-2010, units (including additional funding allocated from the federal budget in 2009 to support Tver Car-Building Plant, 2010 — planned purchasing volume of the Federal Passenger Company)

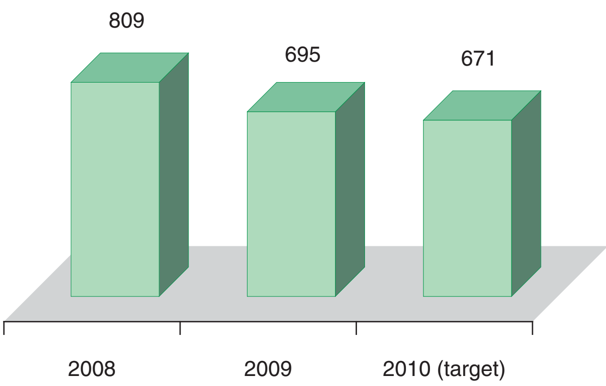


Figure 5. RZD's procurement of EMUs in 2008-2010, units

An estimate of the consequences of reductions in the RZD's investment programme showed that cutting orders for locomotives alone by 6 bn rubles a year will lead to an approximately 2 bn ruble decline in tax revenues to budgets of all levels, with the number of production employees falling by more than 2,500 people.

Moreover, in this case a number of plants will face the need to halt their production completely. Even if the use of these emergency measures is limited to only one year, companies will need significant effort and time to restore their normal operations in the future.

Problem of technical backwardness of engineering companies

In accordance with the government-ally approved Railway Transport Development Strategy of the Russian Federation up to 2030, the maximum scenario will need replacement of almost 24,000 locomotives, approximately 1 million freight cars, more than 23,000 passenger coaches, more than 24,000 cars of EMUs and DMUs (Table 1), meaning virtually complete upgrading of the entire rolling stock of RZD.

An innovative breakthrough also demands the development and launch into production of a new lineup of modern locomotives as soon as possible: double-current electric locomotives, energy efficient AC and DC freight electric locomotives with asynchronous traction drive, etc.

Unfortunately, faster production of new promising railway equipment is impossible due to the technological lag of Russian railway engineering. Another serious problem faced by not only rail transport but also by military production industry and power generation is the absence of diesel production in Russia. RZD and manufacturers should unite their efforts and become allies in this area. A unified approach and a unified policy are needed to expect support from both the executive and legislative branches.

Table 1. Rolling stock replacement needed in accordance with the Railway Transport Development Strategy of the Russian Federation up to 2030.

Rolling stock type	Maximum scenario		Minimum scenario	
	by 2015	by 2030	by 2015	by 2030
Locomotive fleet, units	11 ,750	23,397	11,675	21,753
Freight cars, thousands of units	485.5	996.0	485.5	777.3
Passenger coaches, units	1, 347	23,064	10,347	21,854
EMUs and DMUs, units	8,710	24,450	8,710	21,502

A strong impact in this environment could be delivered by the **Programme for Domestic Engineering Development.** However, it has so far not become an all-state programme.

Addressing the problem of technological lag also needs active use of unique opportunities to transfer cutting edge technologies from abroad, with a high extent of production localisation in Russia. To do so, attention should be paid to the following areas:

It makes sense for the state to use customs incentives in imports of equipment needed for making modern technology based products with no Russian analogues;

- Together with foreign manufactures, Russian engineering companies should expand new machinery engineering by creating centres for production of components and equipment with localising of breakthrough solutions.

There are examples of such centres currently emerging. However, further action should be taken: Russian engineering companies face the tasks of setting up production of modern microelectronic machinery, LED machinery, nanomaterials, new-generation rolling stock equipment, and much more.

A comprehensive transfer to the innovative scenario of rail transport development is impossible without a thorough revision of the regulatory base of railway transport: it includes more than 5,000 national and industry standards in this area. Even today, it is sometimes necessary to use documents dated as early as 1936.

Technical regulations for rail transport will soon be approved. These main documents require the establishment of an entire system — more than 300 supportive standards.

In particular, there is a pressing need to standardise requirements for freight cars and their components.

There have been precedents of owners not approving technical specifications with RZD when ordering new rolling stock. This can potentially lead to the use of rolling stock failing to meet requirements of infrastructure compatibility and safety.

These problems should be addressed by clauses to the federal law “On Railway Transport” on mandatory approvals of new rolling stock requirements with RZD as the infrastructure owner.

A crucial task is improving the federal law “On Technical Regulation” with consideration of the new operating entities, massively emerging in the railway transportation market, and of the need for the development of norms and rules to use breakthrough technical solutions. Worries about manufacturers facing excessively steep requirements are, from RZD’s point of view, unfounded. RZD is more interested in freight and passenger operations by railways than anyone else. What is needed is to stimulate rolling stock development and to cut overall maintenance costs — not only within a specific company but across the country in general. Without innovative approaches, it is impossible.

The existing system of mandatory certification in rail transport is not simply outdated — it blocks its innovative development. At the moment joint efforts are made with the Ministry of Transport to improve the system. In particular, the long-lasting and expensive certification procedures today do not meet the standards of innovative business development, and, as practice shows, the certificate does not always guarantee the quality and safety of products. It is a serious issue which needs urgent attention with involvement of machinery manufacturers and state-run structures, with the focus on railway engineering products to be launched in the international market.

Another necessary factor is multi-focused harmonization of the Russian regulatory base with the acts of EU and Asian countries. One of the ways to overcome legislative discrepancies is signing inter-governmental agreements covering technical aspects of transportation. Translating and unifying all standards is impossible, because in each country railway transport has followed different evolution ways over long years. However, aiming at standards’ correlation with each other is possible, and such efforts are already being made with companies such as Siemens, Bombardier, Alstom.

Human resourcing for railway engineering

Our efforts in the area of innovative solutions revealed another very important problem — the

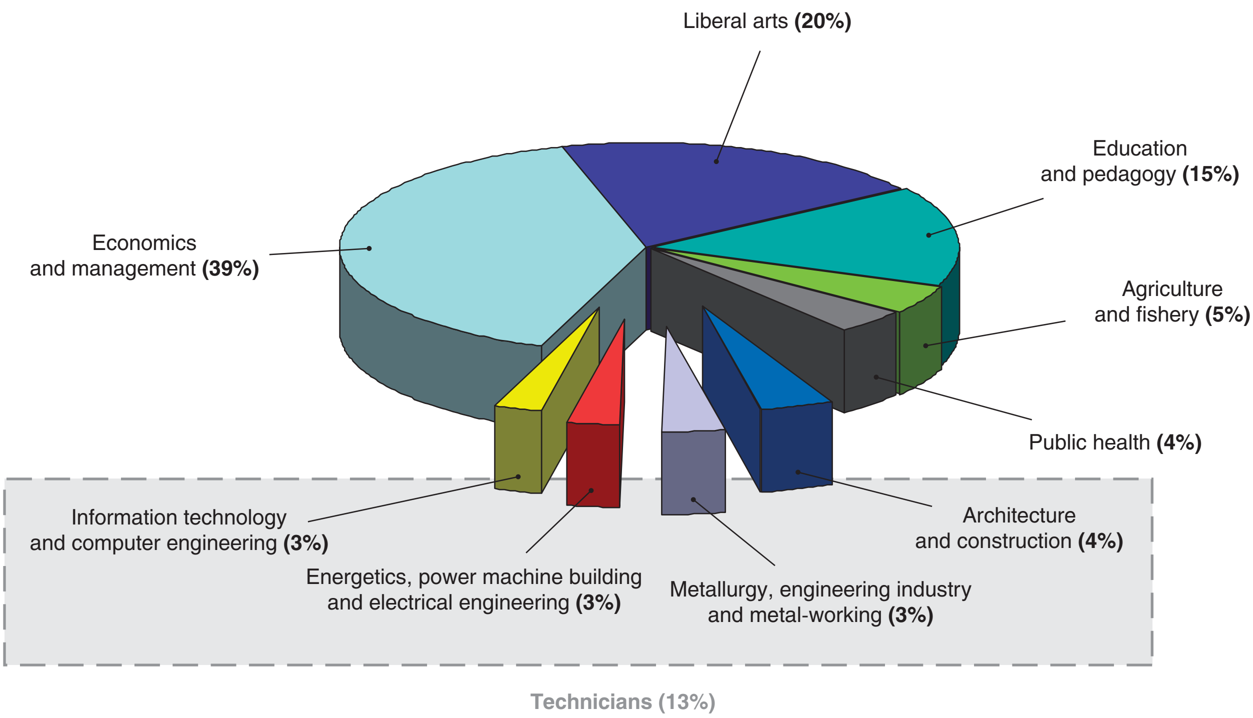


Figure 6. Structure of university education in Russia

problem of human resources for rail transport. The implementation of projects such as high speed services on the Saint-Petersburg — Moscow route unveiled the absence of trained personnel to use and maintain new-generation trains.

Meanwhile, it is not only about legislation, technologies, or technological culture — it is also about people who need to be trained the right way.

The stagnation in the Russian engineering sector over the last two decades caused heavy shortage of skilled design and production engineers at companies manufacturing new equipment. At the same time Russia has a wide range of macro-technologies which form the basis of fundamental evolution of engineering, with our engineering traditions renowned worldwide.

Conclusions

Railway engineering is currently becoming the main driver of the high-tech sector of the Russian economy. Its support and successful development demands, firstly, the establishment of a modern normative and legal base for innovations, and secondly, state support for railway engineering companies through:

- financial support for basic R&D aimed at creating new-generation rolling stock;
- best environment for integrated innovative projects on a public private partnership basis;
- long-term state lending for innovative projects;
- tax incentives for scientific and design organizations to promote new railway machinery;
- accelerated depreciation opportunities for high tech products.

No significant successes in engineering sector development are possible without a stable large sales market. As a result, demand for products of Russian engineering companies should be stimulated by increasing the RZD's investment programme using funding from the federal budget.

Today, we already have positive experience of direct state support for the Tver Car-Building Plant by providing RZD with 3 billion ruble budget funding to purchase passenger cars.

It is only consolidated efforts of RZD, other transportation companies, industrial enterprises and the state that can ensure the environment to preserve and further develop the R&D and intellectual potential of the country's railway engineering and create a firm basis to bridge the technological gap between Russia and developed economies, and to emerge from the crisis with as little losses as possible. ■

JSC "RZD": INNOVATION-BASED DEVELOPMENT

Valentin Gapanovich,
Vice-President JSC "RZD"
President NP "UIRE"

The President of the Russian Federation Dmitry Medvedyev in his message to the Federal Assembly on November 12th of 2009 set a mission of system-based, integrated modernization and technological updating both of production industry and the country's economy at large.

The ambitious targets aimed at the railway transport modernization, technical updating and safety procurement are defined by the fundamental documents of the Russian Federation such as:

- Strategy of the railway transport development in the Russian Federation up to 2030;
- Concept of Russian Federation's long-term socio-economic development for the period up to 2020;
- Basics of the Russian Federation's policy in R&D field for the period up to 2010 and further prospects.
- List of priority science and technology trends and strategically vital technologies.

One of the basic principles of the Russian Federation's railway transport development up to 2030 is that it should be orientated towards innovative breakthrough.

JSC "RZD" innovative development is underpinned by the following documents:

- "Russian Railways" Holding's integrated technical policy, defining the main goals, tasks, main principles, implementation tools of the engineering activities in the field of technical and technological development, providing for the efficient multi-target oriented transport services;
- Strategic trends of RZD's scientific and technical development for the period of 2015 (JSC "RZD" White Paper), defining the goals, tasks and milestones of RZD's innovative development.
- JSC "RZD"'s energy strategy for the period of 2010—2030, which provides practical tools to reduce the negative impact of the Company's activity on the environment.
- For the purpose of regulating the innovative development the Company has developed and approved six industrial standards defining the main essence of innovative activity, its efficiency indices, requirements to innovative projects in the railway field and procedures for the independent expertise.

Current structural reforms in the company necessitated steps for the purpose of procuring consolidated innovative approaches in all structural subdivisions and subsidiaries.

During 2007—2009 the management structure of RZD's innovative activity was aimed at maintaining coherent links on all management levels, procedural approach to creating and implementing RZD's science and technology plans anticipating the technical and technological expediency and socio-economic efficiency of innovative proposals, evaluation, selection and approval of innovative projects at the scientific-technical councils, completion of the work in the form of presenting a finalized innovative product with obligatory execution of right for the intellectual property.

It paves the way for creating the provisions easing the implementation of strategically important goals facing the Russian Railways, progress of innovations in transport operations and breakthrough of scientific-technical findings in the field of railway transport development and operation. As a consequence the Company should become one of the most active players in the area of innovative development among the other branches of Russia's transportation industry.

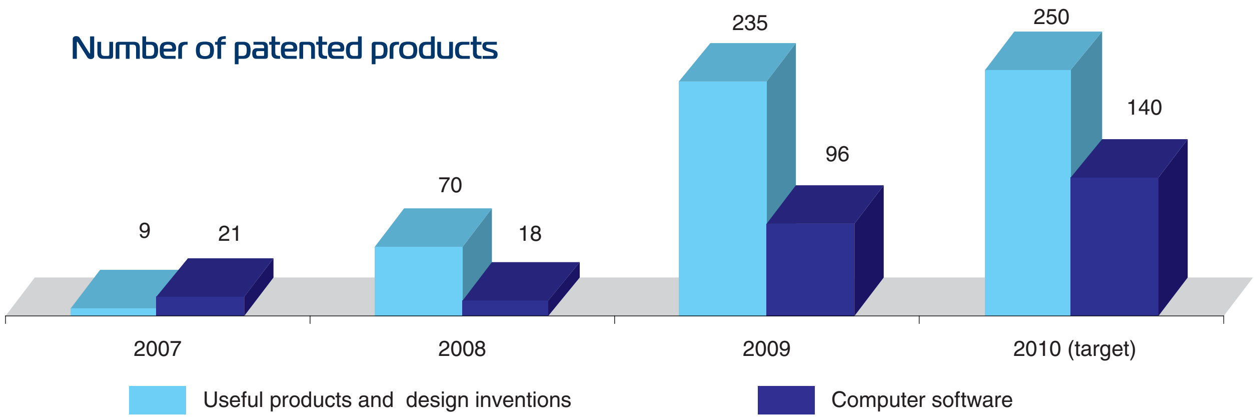
JSC "RZD" in cooperation with its strategic partners at the present time occupies the leading positions in the following areas:

Technologies of using the natural liquefied gas as fuel for the traction rolling stock.

1. Systems of high-speed trains automatic operations with provisions of energy saving functions.
2. Traffic operation management technologies on large networks of combined traffic.
3. Satellite technologies for monitoring the infrastructure objects and set up of operations for technical maintenance and repair and other activities.

Domestic electronic management systems based on "quality-cost" indices and train operation safety provisions may be quite competitive in the world market.

The transfer of technologies is vitally important for patching up the technological and technical backlog. The contract between JSC "RZD" and the company "Siemens" on organizing the production process in Russia of "Lastochka" (Desiro train version) electric trains covered by plans of creating the transport infrastructure "Sochi-2014" is a good example of this cooperation. New generation electric locos of Class 2ES10 will be manufactured by the joint enterprise "Sinara-Siemens" organised on the "Ural railway machine-building" premises. Jointly with "Alstom" company high-speed passenger traffic Saint-Petersburg –Helsinki is being organized. Cooperation



Indicators of leadership in technologies

with the company "Finmeccanica" — world's leader in high-definition processing of space photos is an example of cooperation in the field of satellite technologies. The Company handles also a number of other joint projects in design and manufacture of future-oriented rolling stock and infrastructure.

The agreements with the state corporations "Rosnanoteh" and "Rostehnologiya", "Central Aerohydrodynamic Institute" and other leading companies are concluded within the frames of interaction with the big domestic target-oriented companies and organizations thus enabling to enhance the exchange of information and support of applied innovation projects.

The Company also initiated the project of the dynamic testing national center. This unique center is designated for modeling the impact of different dynamic loads and temperature modes, so specific for the Russian climate, on the rolling stock components, permanent way base and elements of railways/highways, air-strips. All these targets are planned to be implemented applying modern measuring equipment and software support. These proposals are considered at the expert council of the Russian Federation President's Administration.

The €50 mln EBRR loan for financing the so called "intellectual railway station" in Murmansk, Saratov and Tver is being currently discussed. At the present time the program of projects technical audit submitted by the bank is being evaluated.

NEW FINDINGS IN PASSENGER TRAFFIC

Carrying out the policy of modernizing the national economy JSC "RZD" in 2009 introduced a radically new product of the international level — high-speed traffic between Moscow and Saint-Petersburg (650 km — travel time 3h 45min) in the market of transport services.

During the December 2009 - August 2010 period "Sapsan" trains transported 900 000 passengers and the train haulage equaled 1,3 mln.km. The demand in high-speed traffic is extremely high; on the 85% of their seat are occupied. "Sapsan" train design, its operation and infrastructure specifications fully answer the requirements of Russian regulatory environment.

The implementation of this project is a bright example of RZD successful cooperation with world famous companies and opens up the access of national companies to progressive technologies. In the course of the joint work with "Siemens AG" on "Sapsan" train, more than 50 inventions and industrial patterns have been patented.

The construction of new high-speed line between the two capitals is foreseen in the near future and with this purpose in mind RZD has allocated funding for regulatory procedures and pre-projects activities. Among them are the Special technical specifications for design works, construction and operation of Moscow-Saint-Petersburg high-speed line. In October 2009 the explanation for investments was completed.

On March 16th 2010 the President of the Russian Federation signed the Decree on "Measures aimed at organizing high-speed railway traffic in the Russian Federation" which defined high-speed perspectives in Russia.

On the eve of the professional holiday of railways, on July 30th 2010 new high-speed Moscow-Nizhniy Novgorod link for "Sapsan" operations was opened (442 km — travel time 3 h 55 min).

In December 2010 it is planned to bring into life our joint project with the Finnish railways (VR) and significantly upgrade the international passenger transportation on Saint-Petersburg-Helsinki link. Jointly with relevant ministries RZD handles the activities aimed at customs and passport control en route optimization. The "Allegro" electric train which

Development of High Speed Rail in Russia

is currently going through certifications tests, is accordingly assembled and equipped (415 km — travel time reduced from 5 h to 3 h 30 min).

According to the project it is planned to supply 4 dual system train consisting of 7 cars with design speed of 220 km/h and 342 seating capacity (+2 seats for disabled people). All certification tests are planned to be completed by November 2010.

Links which are viable for fast passenger traffic on international links are Moscow-Kiev, Moscow-Kharkov-Adler and Moscow-Crimea. Joint activities in this regard are confirmed by the agreements between RZD and the State Ukrainian railway administration.

Operation of permanent formation passenger trains on international links connecting the Russian Federation with the European countries is one of the innovative solutions.

Thus, for example, for raising the attractiveness of Moscow-Berlin international route connecting the capitals of Russia, Belarus, Poland and Germany, JSC “RZD” initiated the alternative of using Talgo type trains. Talgo type trains and dual system locomotives and application of automatic gauge change installations at Brest-Central station, according to preliminary estimations, will reduce the travel time from 27 h 10 min to 18 h. Considerable time reductions on this route can be achieved by reducing the number of technical stops and increasing the speed.

Within the joint protocol of intentions between RZD and “Patents Talgo S.L.” concluded on October 2008, RZD and JSC “All-Union scientific-technical institute of railway transport” during January-April of 2010 handled a number of tests on the Experimental Loop at Scherbinka, October railroad network and Moscow-Brest link dedicated to bench running and performance tests of passenger trains equipped with the gauge automatic change systems. The rolling stock of this type technical viability for the Russian climatic and operation conditions was defined.

At the present time the feasibility studies for fast passenger traffic on this link are being handled alongside with preparing the technical requirements for passenger cars of this type.

To solve the task of servicing the Olympic and Para-Olympic games in Sochi in 2014, in December 2009 RZD and Siemens AG concluded the contract on the development and supply of 38 electric trains for suburban passenger operations. Russian and German specialists are engaged in developing robust and comfortable “Desiro” based electric trains. Engineering and designing specifications will put these trains in line with the best international counterparts. The trains are supposed to be dual-system targeting for 160 km/h speed. The seating capacity of 5-car electric train will exceed 850 passengers including 4 seats for disabled people. Brake automatic system and traction specifications will secure safe operations both on flat lands and mountainous areas with gradients up to 40%.

According to the contract provisions the first electric train will be supplied in the first half of 2012 and all 38 trains will be delivered by October 2013.

At the present time the schematic design stage has been completed.

Simultaneously with the contract for the supply of 38 trains RZD signed in December of 2009, another preliminary contract was signed for delivery of 16 electric trains for suburban passenger traffic with the view to settling their production in the Russian Federation.

Now RZD with Siemens AG are making preparations for the production of electric trains on the basis of Desiro version trains.

In selecting the sites for future wagons production plant the parties are guided by considerations of economic expediency — availability of necessary communications and qualified personnel, logistical possibilities and relationships with the suppliers and others.

Proposals of regional administrations will also play an important role in making the decision of initiating the production as the practical implementation of these tasks requires a favorable investment climate for a new wagon construction plant.

In compliance with the target-oriented Federal Program “Development and manufacture of new-generation passenger rolling stock in Russia” the production of the prototype ET4A electric train with asynchronous traction drive was started in 2010 at JSC “Torzhokskiy wagon construction plant”.

ET4A design and engineering findings in regard for operation parameters, reliability, economic efficiency and comfort will surpass the existing trains used in suburban traffic.

NEW ROLLING STOCK

JSC “RZD” is the largest Russian consumer of machine manufacturing products. Therefore the company is reasonably interested in speeding up the development of the national machine-building complex. Through a well-defined innovation policy the company’s development program is oriented to the procurement of the hardware tools notable for high performance, technical-operational and technical-economic parameters in line with the best world counterparts.

Currently JSC “RZD” is making the transition to new principles of relationships with the railway manufactures which are closer to European standards. Integrated safety indices, operation availability and the technical resources life cycle costs are the basis of this approach and they will guide the technical policy of the company in its relationships with designers and manufacturers. These requirements are stricter than before and suppose that the manufacturers will feel bigger responsibility for the final product. These approaches have found their practical application in creating new generation electric locos.

New generation diesel loco 2TE25A “Vityaz’” with asynchronous traction drive 7000 hp capacity was created. The diesel loco for the first time is equipped with the electronic injection system manufactured by the Kolomenskiy plant enabling the loco to correspond to “EURO 3” standard regulations. The loco is equipped with the bogies having radial adjustable wheel-sets. The tests proved that this diesel loco corresponds to the best world prototypes in relation to track impacts.

The fact that the Russian industry for the first time established the production of newly developed electric EP2K dc is a result of significant efforts.

The development and serial production of new generation locos — perspective dual power system EP20 passenger loco with design speed 200 km/h and others will be completed during 2010-2011 years.

EP2K

Main line passenger DC electric locomotive with 6 axles (Kolomna Plant)
Start of series production: **May 2008**

2ES6

Freight electric locomotive with 8 axles and collector drives
(Ural Railway Engineering Plant)
Start of series production: **July 2008**

2TE25A

freight two-section diesel locomotive
(Bryansk Engineering Plant)
Start of series production: **March 2009**

New locomotives

Freight dc electric loco 2ES6 is viewed as an example of successful cooperation in the field of state-of-the-art developments. The work for this loco design and manufacture had been carried within a year and a half in Uralskiy railway machinery plant.

RZD and JSC Siemens "Ural locomotives" are engaged in developing freight dc electric loco 2EC10 with asynchronous traction drive which in double section alternative is able to replace the existing three-section electric locos VL11.

Conjointly with space air specialists the company has developed world's first gas turbine 8300 kW capacity loco. This loco is viewed as most perspective in terms of alternative fuel types and enhanced independent traction environmental indices.

Even stricter requirements to the quality of transport services necessitated fleet replenishing with only new generation locos notable for extended in-between-overhaul runs. These requirements are the following:

- intellectual locomotives which is capable to make up its best optimal movement path depending on infrastructure conditions, safety and train moving parameters and operation schedule
- modular type locomotives where each model is viewed as a technically completed product with built-in control and diagnostic systems all united by means of data transmission special standards into one integrated system;
- broad unification of arrangement units and systems enabling new locomotive creation/introduction, utilization of special-purpose equipment for the production of modules and, as a consequence, increase of reliability and rolling stock life cycle cost reduction;
- locomotive reliable in operation and management;
- easy in maintenance and repair based on subsystem technical inspection;
- economically viable providing for energy and fuel saving by 10-15%.

The technical viability ratio of new generation locomotives must be no less than 0,98. The locomotive design must make provisions for longer runs in between hauls.

New generation locomotive specified life time must be not less than 40 years. They should be targeted for one-man drive both for working in multiple and with distributed power and through radio channel control.

To reduce the dynamic impacts on the track new bogie types were developed to be installed in the locomotive underframe. New designs of power transmission system must provide 1-1,2 mln. km haul without repair. Traction drive main arrangement units rated life (bearings, gear) should be no less than 3 mln. km.

High level of comfort and reduced travel time are key objective, motivating the passenger traffic progressive development.

The quality of traffic is directly dependent on characteristics of rolling stock and especially on freight cars performance. In this connection top-priority goals lie in the realm of development of cars with advanced technical performance are the following:

- increased run between repairs;
- increased carrying load;
- higher reliability of parts and components.

A whole new family of perspective cars has been developed: both general-purpose, and specialized with advanced technical performance. The experience of foreign designers and suppliers of freight cars and their units and details is widely used in these research works.

In realizing the joint project of JSC "RZD" and Tatravagónka Poprad multiple-unit flatcar was developed and the prototype car was built for large-capacity containers transportation, including 45-pound containers. Certification Register of Federal Railway Transport (CR FRT) has assigned the certificate of conformity on preproduction of 400 units. The order on these flat cars was placed by JSC “Transcontainer”.

JSC “Freight One” among others is conducting engineering works for development of general-purpose boxcar with axle-load of 245 kN for packaged, pallet and piece freight which is to be covered from rainfall. The body of the car will be equipped with sliding side sections.

The design of the car will allow:

- increasing the efficiency by 15-20% at the expense of advanced capacity, reduced loading-unloading wait time and car turnaround time accelerating;
- reducing life cycle cost by 11.9%.

Within the framework of CJSC “Tikhvin Wagon Construction Plant” cooperation with Starfire Engineering & Technologies, USA, is preparing for trigging the production the following car models:

- gondola cars 12-9833 (with 18-100 bogies) and 19-9835-01(with 18-9810 bogies);
- hopper cars for mineral fertilizers transportation 19-9835(with 18-100 bogies) and 19-9835-01(with 18-9810 bogies);
- flat-cars for large-capacity containers transportation with loading length of 80 ft 13-9834 (with 18-100 bogies) and 13-9834-01 (with 18-9810 bogies).

Articulated flat car

Covered car with 25 tonne-force axle load

Within the framework of the mentioned projects realization CJSC “Tikhvin Wagon Construction Plant” is developing bogies Barber S-2-R (18-9810) with 23.5 t wheel-set axle load on rails. The bogie has passed the acceptance commission and certification procedure is going on in Certification Register of Federal Railway Transport (CR FRT).

Amsted Rail Company in cooperation with its Russian partner CJSC “Promtractor-wagon” has adapted freight bogie 18-9836 Motion Control with 25 t axle load to Russia’s 1520 mm gage track traffic.

To reduce operation cost and cost value of scheduled repair and to increase runs between repairs in-service freight car fleet it has been decided to refit the freight cars with case bearings.

Suppliers of case bearings SKF (Sweden) and Brenco (USA) have got the certificate of conformity from CR FRT. Bearings of this type are mounted in commercial car box body and offer the following advantages over cylindrical bearing:

- possibility of rolling stock operation with axle loading up to 294 kN and even more;
- the increased run between repairs up to 800,000 km and more;
- bearings repair in the dedicated service centers, reducing the quantity of wheel-roller workshops at car-maintenance sheds.

On 08.06.2010 a new SKF plant was officially opened in Tver. The plant’s current annual production capacity is 150,000 CTBU bearings of various unit sizes. Launching the second step of the facility can increase its annual production capacities up to 300,000 details.

Within the framework of the ‘SKF Tver’ production project scientific research center with testing facilities and measuring laboratory with CR FRT certification is planned to be created. The dedicated workshop of case bearings repair and renewal will be opened on the site of the ‘SKF Tver’ plant.

The agreement between the companies Amsted Rail and JSC "European Bearing Corporation" was signed. According to the agreement a joint venture is to be created on the site of Saratov bearing plant for case bearings production. Brenco Company will monitor the project realization. The planned production capacity is 100,000-120,000 bearings per year.

Russian manufacturers of brake equipment, including JSC "RITM", JSC MTZ Transmash, JSC "Transpneumatic", set a course for equipment development and production that meet up-to-date requirements.

JSC "RZD" provides innovation-based pilot projects including participation in trial tests, trial boards, monitoring the under-control operation of the developed and installed brake equipment.

INNOVATION-BASED SOLUTIONS IN RAIL TRAFFIC MANAGEMENT TECHNOLOGIES

Creation of a new technological platform — "intelligent rail transport" basing on the up-to-date digital telecommunication and satellite technologies and dedicated management information systems is the promising direction of innovation-based development. Modern telecommunication infrastructure integrated with the corresponding communication nets of European and Asian railways has been built at Russian Railways. Information technologies are provided at railway directions that are the part of international transport corridors.

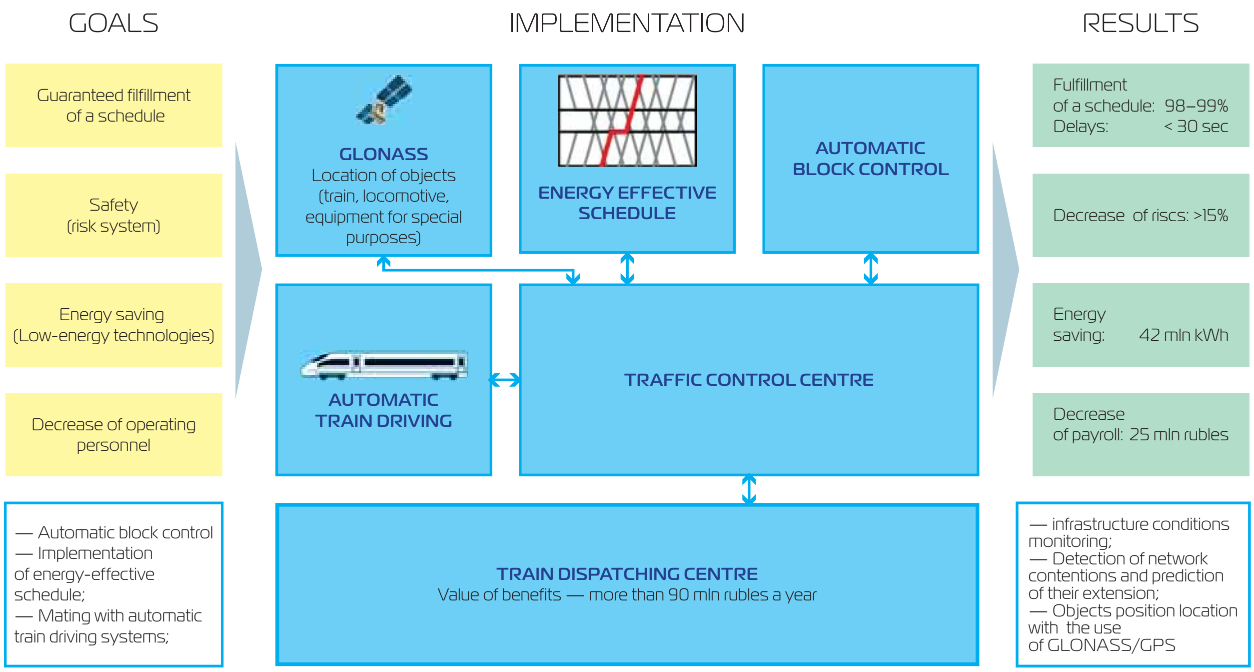
At present Russian Railways turn to creation of traffic end-to-end integrated management technologies of traffic management and its safety control in conformity to the definite trends and forms of the Holding activities.

For the high-speed route Moscow — St. Petersburg automated hardware and software train control complex "Auto dispatch" is being designed.

In the framework of this complex, system solutions are tried out for centralized train control with functions of prognosis and managerial solutions aimed at eliminating conflict situations. These will provide time-schedule stability at the level of worldwide regulations: deviation not exceeding 30 sec. Consequently the train control system functionality will totally correspond to ERTMS Level 2 and the transfer of confidential information will correspond to SINELEC security norms.

Functionality of train auto driving has already been realized; infrastructure and rolling stock state diagnostics and monitoring are being provided: as well as centralized job management of the staff of all maintenance and technological divisions.

The new approaches to traffic management system organization are realized in dispatch control center in Tcheliabinsk. At control area of more than 3,000 km 10 train dispatchers simultaneously control more than 250 freight and passenger trains. Its control efficiency is compliant with the European level. Herewith the transition to power-efficient schedules of freight trains running is carried out with the maximal effect of power saving. Innovation-based control technology of integrated



Automated traffic control system on St. Petersburg — Moscow line locomotive stock of 4 railways is implemented. The same project is carried out in Yaroslavl.

Simultaneously the company actively introduces the complex of advanced technologies based on satellite system GLONASS and on digital communication systems. These technologies provide additional multiplicative effect.

In the framework of the 2008 RZD Concept and Programme of Satellite Technologies development up to 2015 a method of satellite monitoring of heavy equipment operation at track time has been introduced. The method allows real-time control of this important and high cost-based kind of operations both with follow-up of procedures for repair infrastructure.

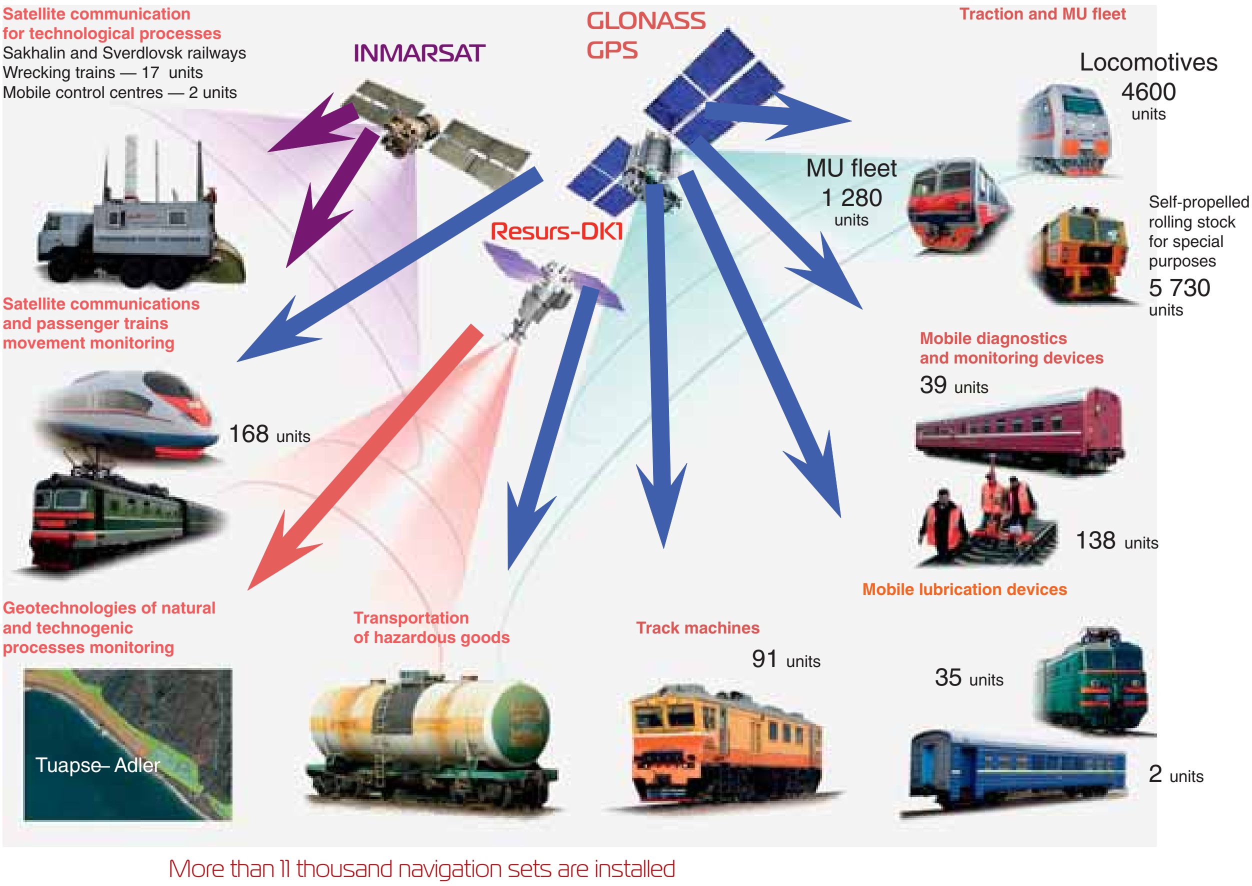
Satellite technology was implemented for monitoring repair trains operation at the sites of emergency, for hazmat and specialized freight transportation control, and other kinds of technological work monitoring.

The most important element of the system of train separation and traffic safety provision is the complex on-board safety device CLUB-U. The distinctive feature of the device is the possibility of interaction with the other on-board automatic systems, availability of digital wireless link for data exchange, and application of satellite navigation systems GPS/GLONASS/GALILEO and electronic maps of railways for locomotive positioning. In Russia more than 10,000 locomotives, EMUs and the whole fleet of dedicated self-propelled rolling stock are equipped with such systems. In total 14,000 sets of CLUB have been installed.

Particular emphasis in the new technological platform of the Company is placed on development of intelligent system for complex diagnostics of rolling stock technical conditions, based on the following principles:

- axle box temperature absolute measuring. Experience of this facility exploitation at four railways (Oktyabrskaya, Zapadno-Sibirskaya, Gorkovskaya, Sverdlovskaya) demonstrates the reduction of train stops quantity by fifty percent without a threat to traffic safety.
- axle box acoustic control developed in cooperation with JSC "V.P. Makeev State Rocket Center". Facility operation at Oktyabrskaya and Severnaya railways proved 100%-validation of bearing imperfections revealed at early stages long before overheating process initiation. The system is being rolled over the whole railway network.
- rolling stock vertical dynamic loads control. Prototype installation is being tested at Oktyabrskaya railway.

One of the most important ways of reducing costs and duration of design works was the application of various methods of mathematical simulation. The use of these methods gradually reduced construc-



Introduction of satellite technologies on Russian Railways tion expenses in projecting transportation system "Sochi-2014" and railway stations Luzskaya and Karyimskaya. These methods become obligatory for working out the projects of infrastructure development including newly built and retrofitted railroad yards. At present the Company began to turn to mathematical modeling when designing various units and assembles.

Another important area of the Company's activity is switching the passenger and freight trains to schedules optimal in terms of power consumption. More than 300 passenger trains are running according to such schedules which resulted in annual power saving exceeding 3.5 mln. kW/h.

POWER SAVING

As Russia's biggest corporate energy consumer, JSC "RZD" attaches particular significance to power saving and increasing power efficiency. These problems are also of great significance as the most important element of the Company's environmental policy.

In the first year of its existence JSC "RZD" developed and adopted its Energy Strategy to 2010 and to 2020. In 2008 this Strategy was updated taking in view of the recent changes in economics.

As a result of the Strategy realization, power efficiency of rail traffic reached the highest level in entire history of Russian Railways. Since 2004 the power consumption of the freight traffic has been reduced by 4.2%, 1.3 mlrd. kW/h of electric power and more than 100.000 t of diesel oil has been saved.

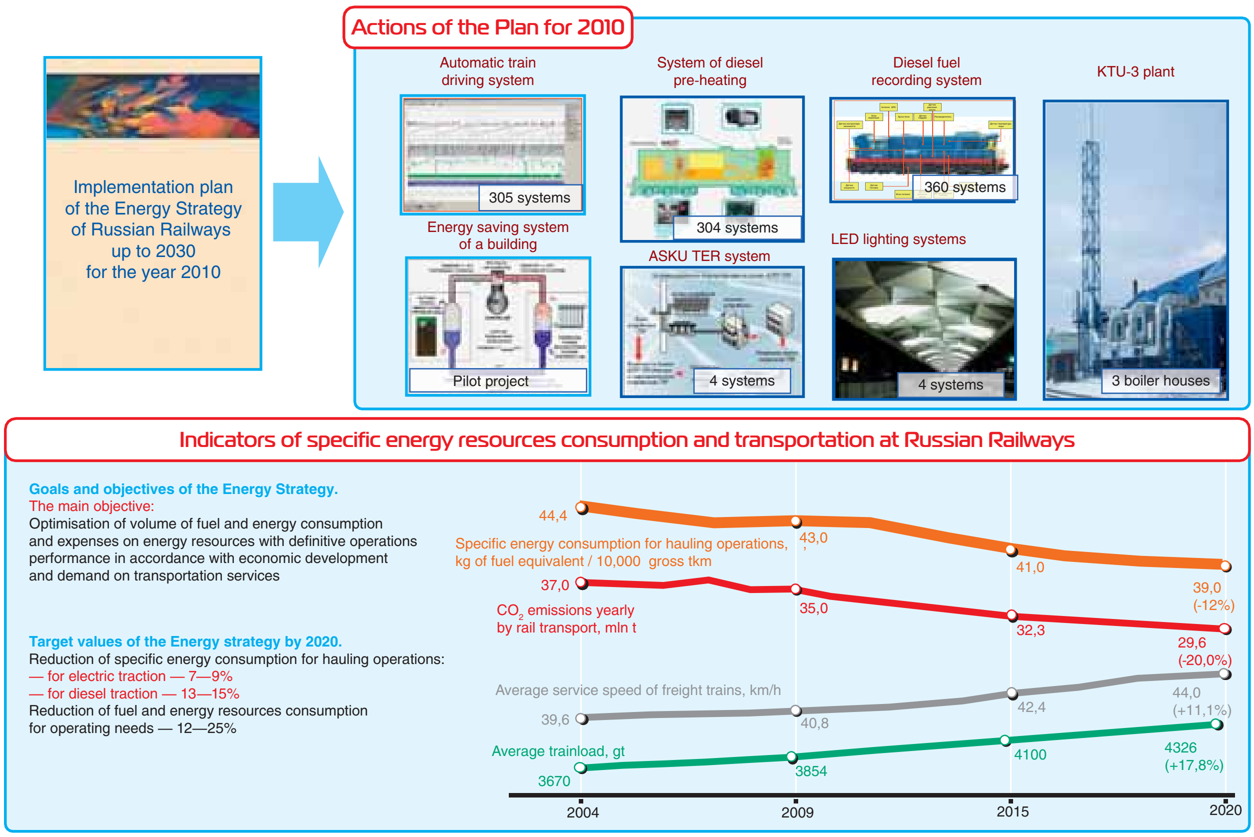
These correspond to reducing green-house gases emission by more than 625,000 t per year.

In 2009 during the recession and temporal drop of electric traction (exceeding 10%) and diesel locomotive traction (exceeding 17%) operations unit costs were approximately equal to those in 2008 as a result of the arranged antirecessionary program.

JSC "RZD" actively participates in realization of the Federal Act "On Power Saving and Power Efficiency Increasing".

In 2009 the Program of measures on power saving and power efficiency increasing in JSC "RZD" in 2010 was adopted.

The Program includes the general complex of the main trends of the Company's energy-saving activity. Among others it includes switching the passen-



Improvement of energy efficiency of Russian Railways ger trains to schedules optimal in terms of power consumption. This measure will lead to additional savings exceeding 50 mln. kW/h per year.

Several pilot projects related to introduction of LED object light systems and LED light units of railway automation have been launched. As a result power consumption at some facilities reduced to 60%. Investments in LED devices introduction in 2010 will increase 7-fold and reach €23 mln. in 2010—2011.

Since 2010 power saving efficiency estimation (of the Company as a whole and its subsidiaries and associated companies) is conducted in terms of integral indicators of their productive activity power intensity. Development of these integral indicators was finalized in the first half of 2010.

In view of the further railway reforms Russian Railways' Energy strategy to 2015 and in long term to 2030 will be developed in 2010. It is a follow-up of the corresponding "Energy Strategy of Russia and JSC "RZD"". At the same time the 3-year program of the Strategy implementation will be developed.

LEAN PRODUCTION

Among multiple consequences of the global financial and economic crisis that aggravated the JSC "RZD" situation are the following:

- rise of inter-industry competition in freight and passenger traffic (at the expense of highway transportation and aviation);
- state regulation of tariffs on rail traffic;
- capital assets cutback.

The above mentioned problems were relevant to the Company even in the previous relatively trouble-free pre-recession years. For example, service competitive recovery and Company's internal efficiency increasing were stated as top-priority tasks for development and introduction of the corporate integrated system of quality management in "Russian Railways' functional strategy of quality management", adopted in early 2007.

Innovation-based managerial technologies jointly referred to as 'lean production' are dedicated to solving the above listed tasks.

A 'lean' company should first and foremost find an answer to the following question: what is of particular value to the end customer, what is really important in rail traffic services provided to customers?

By 2010 business units and branches of JSC "RZD" accumulated experience related to introduction of 'lean production' instruments.

However to be efficient for the Company as a whole these 'lean production' instruments should be integrated into systematic coordinated actions on development of branded production system of Russian Railways. For this purpose the task was stated at the end-of-year meeting of the RZD Administrative Board in December, 2009 to introduce the 'lean production' programme into activities of the Company.

Currently the Framework of lean production application in JSC "RZD" is being developed. It states the main principles and near-term outlook of lean production introduction into activities of the Company's subsidiaries.

YOUTH POLICY

One of the key directions of innovation-based activity is setting-up the scientific and technological creative work of the rising generation. It is based on the principle of systematic training of engineering and technical skilled workers formulated as "From hobby to profession". Beginning from hobby groups of technical creativity and children's railways, through university or college, a specialist enters the production site equipped not only with deep professional knowledge but also with the drive to creative work, keen brain, and being able to turn his (her) ideas into reality.

Now the Company has under its auspices more than 40 functioning hobby groups of technical creative work. 21 of these groups work with children's railways. In 2009 more than 13,000 teenagers have gone through training in these groups.

Young professionals play an especially significant role in development and introduction of innovations. The Company has introduced a special "Youth of JSC "RZD" programme. An integral part of this programme is a specially developed mechanism of managing and encouraging scientific and technological creativity of the young generation. The program is governed by the Youth Council headed by the Company President.

More than 500 grants for graduation theses and 15 grants to young post-graduate students are provided annually. 10 grants on scientific research and development were established for young scientists. Themes of this research are included in R&D - 2010 program. Youth scientific groups on upcoming scientific trends have been set up in all major research institutes. International target-oriented traineeships are organized for young scientists and engineers.

5 best works of the annual competition of innovative projects "New Link" have been included into the programmes of scientific and technological development and cost-effective use of resources for 2010.

CONCLUSION

Target values of innovation activity results by 2015

Indicator	Measure	2009 (in fact)	2015 (forecast)	Variation to 2009, %
ECONOMY				
Labour productiveness	1000 equated tkm	2795,9	3997,3	+43,0
Average daily production of a locomotive in freight operations	1000 gross tkm per day	1786	2020	+13,1
ENERGY EFFICIENCY				
Specific energy consumption for hauling operations	Kg of fuel equivalent/10,000 gross tkm	42,6	41,7	–2,1
Consumption of fuel and energy resources for operating needs	1000 t of fuel equivalent	6546	5563	–15
SAFETY OF OPERATION				
Probability of critical failures, not more than	1/1 mln gross tkm	$1{,}04 \times 10^{-5}$	$7{,}6 \times 10^{-6}$	–26,9
SERVICES QUALITY				
Speed of freight delivery	km per day	290	305	+5,2
ENVIRONMENT				
Airborne emission	1000 t	113,3	102,3	–9,7
Wastewater disposal into surface water bodies	mln m^3	14,0	9,0	–35,7

Russian Railways has ambitious plans, and we'll do everything to fulfill them.

We are sure that effective development of Russian Railways is an accelerator of national economics development and international economic cooperation. Balance of participants' interests and mutually beneficial coordination accumulations of resources will give the opportunity to realize science-driven researches, create advanced rolling stock models and new generation infrastructure , implement projects of railway transport technical upgrading on the basis of breakthrough technologies.

Russian Railways are open for mutually beneficial cooperation and ready to consider different forms of interaction in all areas of innovation-based development.

1ST INTERNATIONAL CONFERENCE "RAILWAY INDUSTRY: PRIORITIES, TECHNOLOGIES, OUTLOOK"

On June 29, 2010, the 1st International Conference "Railway Industry: Priorities, Technologies, Outlook" organized by the non-commercial partnership "Union of Industries of Railway Equipment" (UIRE) was held in Moscow.

For bodies of Russia's executive and legislative branches, executives of RZD and UIRE, UIRE members, private rolling stock operators, industrial railway companies, leasing companies, Russian and foreign railway equipment producers and the scientific community, the conference proved a discussion platform to share opinions on various aspects of the industry's performance. The conference's participants included over 400 representatives from more than 150 companies and institutions, from Russia and abroad.

The conference discussed the pressing issues of innovative development, state support for railway engineering, technical regulations, quality improvement in railway engineering, personnel development, etc. A special focus was made on one of the most important tasks in innovative development — transfer of state-of-the-art foreign technologies and their localization experience, first of all in railway engineering. All of the mentioned subjects were discussed as part of plenary sessions, panel discussion, and three round tables.

The panel discussion **"Transfer of Foreign Technologies and Their Localization Experience"** discussed problems of railway engineering upgrading, involvement of foreign technologies, localization experience of Russian companies, ways to address the problem of service maintenance for equipment produced on the basis of foreign experience. Speakers of the panel discussion paid special attention to examples of cooperation between Russian and foreign companies — those currently existing as well as those that are to be launched in the near future. Discussion participants admitted that a number of problems exist, especially in new projects, but pointed out that problems of this kind are quite acceptable for new projects and there are no grounds to dramatise the situation.

The round table discussion **"Technical, Tariff and Customs Regulation in Railway Engineering"**, which involved more than 90 participants, decided that legislative amendments pertaining to technical regulations should later continue to be jointly discussed by UIRE and the Russian Union of Industrialists and Entrepreneurs. In particular, Technical Policy Director of Transmashholding Vladimir Schneidmuller emphasized the fact that the company is lagging far behind its foreign counterparts even on the stage of launching new equipment into operation — primarily because 80% of equipment failures are caused by low quality components.

Discussion that proved universally interesting was the round table **"Personnel in Railway Industry: Understaffed or Overstaffed?"** which discussed problems of science and the lack of demand for personnel. Participants of the rather heated discussion more than once expressed their puzzlement over the weak link between industrial companies and educational institutions, which is the reason for staffing problems. The decision was made to soon hold a conference focused on this problem, to attract attention to it.

An interesting discussion was held as part of the round table **"Problems of Investing in Railway Equipment Production".** It focused on investment and product quality improvement. The round table also discussed existing contradictions between innovative producers and consumers who oppose its large-scale introduction, leading to problems with raising investment. Special attention was paid to the development of proposals aimed at resolving the situation. Announcing the results of the round table, its moderator, Vice President of UIRE and Director General of the Institute for Natural Monopolies Research Yury Saakyan said that a contributing factor to addressing investment problems could be the formation of a long-term order by RZD, the largest railway equipment consumer, to specify what equipment and in what year it will need. As for the investment needed for the development and launch of the equipment into production, and for the technical upgrading of facilities, at the moment it is impossible without support from the state.

After discussing the prospects and outlook, the conference approved specific measures to implement joint production projects of up-to-date EMUs together with foreign companies, and production of commuter EMUs of the new generation to provide transport services to the 2014 Sochi Winter Olympic Games. Participants commented on the strong need of companies to improve the efficiency of product development processes, including cost reductions throughout the whole supply chain, by using tools of the International Railway Industry Standard (IRIS). President of UIRE Valentin Gapanovich and Vice President of Bureau Veritas Certification Rus David Fardel awarded the IRIS compliance certificate to the first Russian company, Izhevsk Radio Plant.

In his speech, President of RZD Vladimir Yakunin said that both the technical and technological level in the production of machinery and equipment used by the company is currently a large problem. "An innovative breakthrough demands the development and launch into production of a new lineup of modern locomotives as soon as possible: modern freight electric locomotives, dual-power electric locomotives, and AC and DC freight electric locomotives with asynchronous traction drive," Mr. Yakunin said. "This is why we support all joint projects with foreign producers. This applies to Siemens, Alstom, and Bombardier. Addressing the problem of technological gap needs active use of unique opportunities to transfer cutting edge technologies from abroad, with a high extent of production localization in Russia."

According to the RZD President, certain preferences should be provided both to producers introducing innovative technologies and those who purchase their products. "I believe it is perfectly fair," he stressed, "that, for example, transportation using freight cars based on new trucks which are favourable for the infrastructure, i. e. which reduce its wear and tear, should be provided a favourable tariff rate." Mr. Yakunin also pointed out that a lot of work is needed in the area of legislation and industry standards in order to bring them in line with today's industry environment. "All this demands consistent ongoing work, which should be the responsibility of the UIRE. I am convinced that only consolidation of railway equipment producers and their interaction with state authorities and UIRE will help to solve the problems accumulated to date," he concluded.

The end of the Conference was marked by the approval of the Resolution instructing UIRE to contact the Government of Russia with specific proposals aimed at stimulating the industry's development. In particular, it pertains to support for technical regulations specifics in the rail transport industry developed by railway equipment producers, development of a set of state-run measures to stimulate energy efficiency of railway equipment and its manufacture, creation of a state subsidy mechanism and establishment of government orders for products made by joint companies introducing and localizing up-to-date foreign technologies in the transport industry.

SIGNIFICANT EXAMPLES OF COOPERATION

Russian railway engineering industry is going through an innovation-based period. A long investment-dry period since the early 1990s, put it significantly behind the world level. Recent efforts are aimed at overcoming this lag. One of the quickest and most effective ways to solve this problem is establishing joint projects with the leading world manufacturers, based on localization of the production in Russia and transfer of technologies. Below we would like to bring to your attention most significant examples of cooperation between Russian and foreign manufacturers in the last two years.

In June, 2008, SKF (Sweden) signed an investment agreement with the Tver region administration on construction of the plant for production of compact cone-shaped axle boxes.

The first stone in the plant foundation in the Borovlevo-2 industrial area was laid on September 2, 2008. This was the joint investment project of the region administration and SKF. The new production's annual capacity is expected to be 150 thousand bearing kits, and SKF invested 235 million Swedish kronas into the project. 95 million covered the cost of the machine tools and the equipment, and the rest was used for the payment for the land, premises, infrastructure and maintenance systems.

On June 23, 2008, in Berlin, the President of Russian Railways (RZD) Vladimir Yakunin and the President of the Board of Supervisors of Knorr-Bremse Heinz Hermann Thiele signed the memorandum of intentions that provided for the creation of joint venture for production of braking gears in Russia.

Controlling block of shares in the nominal capital of the new joint venture will belong to the German company. Knorr-Bremse will take up management of the new enterprise, organise production, be responsible for purchases, logistics and quality control. It is envisaged in the long view to extend the capacities of the enterprise for production of automatic doors and air conditioning systems.

On September 25, 2008, in Bratislava, RZD and Tatravagonka a.s. (Slovakia) signed the Memorandum on Cooperation in the field of development and production of new types of freight rolling stock.

In February 2009, an agreement was signed between Tatravagonka a.s., RZD and First Freight Company, which provided for development, production and delivery of 1000 11-9861 series covered cars after their certification in Russia. Now two cars have been already manufactured and sent for testing. These cars are equipped with Russian-made bogies with the axle load of 25 tonne-force and the lifting capacity 72 tonnes.

On May 24, 2009, a ceremony was held in Trebishov (Slovakia) on handing over the Sggmrss 90' cars produced by Tatravagonka a.s., the trial model of six-axle articulated platform designed for transportation of 13-9851 series containers. Agreement between Transcontainer and Tatravagonka a.s. signed in September 2008 provides that 300 such platforms will be delivered during the period from September 2010 to May 2011.

On October 23, 2008, RZD and Patentes Talgo s.a. (Spain) signed the protocol of intentions to develop cooperation in the field of high-speed rolling stock. The document was signed by

RZD's President Vladimir Yakunin and the President of Patentes Talgo s.a. Carlos Oriol. The parties arranged to study jointly the possibility of using Talgo train sets (Tren hotel Series 7) equipped with the automatic rail gauge switch system, for the organisation of high-speed passenger service on the Moscow – Berlin line.

For official certification of technical possibility to use Talgo rolling-stock on Moscow – Berlin route, the Spanish cars will be tested on the testing ground in Shcherbinka. For these purposes, Talgo will provide RZD with 3 passenger coaches for temporary use at no expense. The appropriate contract for transfer of rolling stock with Talgo was signed by the Roszheldorsnab, a subsidiary of RZD. If the contract on the delivery of Spanish rolling stock is signed, the first train will be delivered to Moscow two years after signing of the contract. According to the prior assessment of RZD's experts, at least three Talgo trains will be needed for the organisation of the passenger operations between Moscow and Berlin, and Talgo's depot in Berlin can be used as a service base.

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Spanish engineering company Patentes Talgo s.a. specialises in development, production and maintenance of the locomotive-hauled trains or trains with the multiple-unit traction for high-speed, long-distance and regional traffic, as well as equipment for railway rolling stock maintenance and automatic track gauge changeover systems.

The special switching gear of the automatic track gauge change system provides automatic rearrangement of wheels to another gauge width with the train running at the speed up to 15 km/h. It provides the possibility to use rolling stock for both passenger and cargo transportation in the international traffic with the tracks of different gauge, including switches from Spanish (1668 mm) to European (1435 mm) gauge and from Russian (1520 mm) to European gauge.

FINMECCANICA

On April 6, 2009, in Moscow, a contract was signed between NIIAS, RZD Research Institute, and Ansaldo STS S.p.A, a subsidiary of Finmeccanica on equipping of the trial site with the ITARUS-ATS system, and on April 7, 2009, the contract was approved by both presidents of RZD and Finmeccanica.

The relationships between RZD and Finmeccanica Group are particularly close and cover a wide range of activities in the Russian Federation, which are likely to be expanded to the whole 1520 mm gauge railway systems abroad. On the trial site outside Sochi, NIIAS and Ansaldo STS are jointly developing an innovative railway signalling system called ITARUS-ATS. NIIAS and Ansaldo STS — together with the high-speed railway lines JSC — have started the process of building up a joint venture to develop on RZD's railway lines train control, signalling and automation systems based on microprocessor and satellite technologies. Ansaldo STS, Selex SI, Selex Comms, Elsag Datamat and RZD have established a working group to develop technological proposals about signalling TLC and Security railway systems for the 2014 Winter Olympic in Sochi.

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The ITARUS-ATS railway safety and control system is based on the leading-edge Russian and Italian technologies, such as KLUB-U on-board system developed by NIIAS, and Radio Block Centre developed and produced by Ansaldo STS S.p.A. It includes Ansaldo STS technologies for creating the elements of the European ERTMS-2 system, in particular, the application of GSM-R digital radio communication management, and Russian technologies of ABTC-M computer-based automatic block signal system and KLUB-U integrated locomotive safety device. The key feature of the project, and more specifically its Russian part, is the application of GLONASS/GPS satellite technologies.

SIEMENS

On July 30, 2009, RZD and Tver Car-Building Plant (TVZ) signed the agreement on the delivery of RIC-size passenger coaches for providing passenger transportation on the territory of Russia and the international traffic, including Central and Western Europe. According to the specified document, RZD will purchase 200 RIC-size coaches produced by TVZ in the course of five years.

In accordance with the contract provisions, Siemens AG (Germany) will be the main subcontractor, who will supply bogies for the 1435 mm European track, parts of car bodies and inner equipment elements. It will also carry out certification for using the given type of the rolling stock in the international transportation. TVZ will produce bogies for 1520 mm gauge and carry out the series assembly of wagons.

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The RIC-size coaches (Regolamento Internationale Carrozze) are used as passenger coaches in international railway transportation in all European and Asian countries. Until now they have not been produced in Russia.

The RIC-size coach produced by TVZ will meet all the requirements of the International Union of Railways connected with ecological indices, passenger comfort, fire safety, safety of operation, etc. The coaches will accelerate up to 200 km/h, after the makeover the speed could be increased up to 250 km/h. The expected lifetime of the coaches is 40 years.

SIEMENS

On December 17, 2009, the Sapsan, a special Russian adaptation of Siemens-Velaro high-speed train was launched into operation for passenger transportation between Moscow and St. Petersburg.

RZD and Siemens signed the contract on the delivery of 8 high-speed EMUs priced at EUR 276 million on May 18, 2006 in Sochi. In April 2007 the contract was supplemented by the agreement on technical maintenance of trains in the course of 30 years at the price of EUR 354.1 million. Sapsan (Velaro RUS) was launched at InnoTrans 2008 in Berlin. Service maintenance is provided by "Metallostroy" EMU depot (St. Petersburg, Russia).

On July 30, 2010, Sapsan trains were introduced on the Moscow – Nizhniy Novgorod line.

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Sapsan high-speed trains can accelerate up to 250 km/h. The train design provides the maximum speed increase up to 330 km/h after a slight makeover.

Each electrical train has the length of 250 meters and consists of 10 cars. Sapsan cars have two-class design, the tourist class and the business class. The cabins are equipped with the up-to-date air conditioning system and ergonomic seats, there are also seats for passengers with disabilities. The total capacity of one train is 604 passengers. The rolling stock is specially designed for Russian 1520 mm broad gauge. Sapsan is produced in two modifications, 3 kV DC single-system and 25 kV/50 Hz AC dual-system. The advantage of the Velaro platform is in the technology that enables to place all the hauling equipment into the train underbody, which allows to increase the number of seats by 20%.

SIEMENS

On December 30, 2009, RZD and Siemens AG signed the contract on delivery of 54 suburban trains for the 2014 Winter Olympic Games in Sochi. The cost of the contract is around EUR 580 million. The firm order priced at EUR 410 million was made on delivery of the first 38 Desiro class trains, which will be completely produced at Siemens works in Krefeld, Germany. Collateral contract was signed about the other 16 trains. It is supposed that these trains will be partly produced in Russia.

Desiro suburban trains can accelerate up to 160 km/h. They will carry athletes, spectators and guests from Sochi airport and railway station to competition sites, as well as en route between Tuapse and Adler. They are expected to be launched into operation in autumn 2013.

In furtherance of this contract, on May 27, 2010 a Memorandum on production, development and maintenance of the modern Russian electric trains was signed at the Fifth International Railway Business-Forum "Strategic Partnership 1520" in Sochi by RZD's President Vladimir Yakunin, Vice President of Siemens AG Hans-Jörg Grundmann and member of the Board of Directors of Aeroexpress Maksim Liksutov.

According to this Memorandum, RZD, Siemens AG and Aeroexpress should organise a joint venture in Russia for the production of new-generation electric trains with Desiro RUS-series asynchronous hauling system. They will be produced by the joint venture in the territory of the Russian Federation on the base of Desiro electric trains designed for the Olympic Games in Sochi, which Siemens AG will supply to RZD in 2012-2013 in compliance with the contract between RZD and Siemens AG concluded in December 2009.

ALSTOM

On March 01, 2010, in the presence of the President of the Russian Federation Dmitry Medvedev and the President of France Nicolas Sarkozy, Alstom (France) and Transmashholding signed the documents that specified the agreement on strategic cooperation between the companies, which was in turn signed on March 31, 2009. In accordance with the agreement reached, Alstom will get the share of 25% + 1 stock in the capital of the parent company of Transmashholding. In the assessment of the stock of shares, the financial results of Transmashholding activities in 2008-2011 will be taken into account.

Alstom Transport representative has been appointed Deputy Director General of Transmashholding. Besides, a group of French experts in the field of production, construction, recruitment policy and financial control also joined the work in the holding company.

The newly established "Rail Transport Technologies" joint engineering company is engaged in the organisation of railway equipment design and production centres with the use of Alstom Transport and Transmashholding latest technologies. The Engineering centre has already been working on the creation of the new EP20 dual-system electric passenger locomotive. The joint venture is expected to develop extra types of rolling stock parts, especially metro cars, local trains and passenger coaches.

BOMBARDIER

In May 2010, Bombardier Transportation (Signal) together with Teleautomatics Service of the Moscow Railway equipped the classroom of the newly established training centre of the Moscow Railway situated at Perovo classification yard with EBI Lock 950 microprocessor locking system. The installed equipment can be used for the personnel (station duty officers and the electricians) training. In the course of training, any situation concerning train or route and point setting or passing of the train may be modelled and troubleshooting algorithms during the maintenance of the EBI Lock 950 microprocessor locking systems may be practiced.

Equipping railway sections by EBI Lock 950 system allows to increase the train operation safety level; the stations in the section may be controlled both locally and from any remote centre. For the whole period of its activity (as of the end of May 2010) Bombardier Transportation (Signal) has introduced EBI Lock 950 at 92 Russian railway stations. Today EBI Lock 950 system is available at 15 railways of Russia from Kaliningrad to the Russian Far East. It involves 2.8 thousand points and over three hundred km of integrated autoblocking. At the end of this year, 100th station equipped with EBI Lock 950 will be put into operation at Russian railways. The first start-up took place at Kalashnikovo station of the Oktyabrskaya Railway more than ten years ago, in June 1999.

SIEMENS **On May 27, 2010,** within the frame of Fifth International Railway Business-Forum "Strategic Partnership 1520" (Sochi, Russia) the President of RZD Vladimir Yakunin, the Vice President of Siemens AG Hans-Jörg Grundmann and the President of Sinara Group Dmitry Pumpyanskiy signed the contract on the supply of 221 electric freight locomotives. According to the agreement, "Ural Locomotives" joint venture established by Siemens AG and Sinara Group on the base of Ural Railway Engineering Plant (Verkhnaya Pyshma, Sverdlovsk region) should produce and deliver 221 2ES10 series two-unit electric freight locomotives to RZD in the period from 2011 and 2016. The first trial model is expected to be presented to RZD in December 2010.

The joint venture, owned by Siemens AG (49% of shares) and Sinara Group — (51%), will manufacture the 2ES10 electric freight locomotives that are presently not manufactured in Russia. The company will also proceed with serial production of the 2ES6 electric freight locomotives. Embodying up to 60% engineering solutions that are brand-new for Russian industry, 2ES6 will be equipped with the latest know-how's in the field of driving units and control technology from Siemens AG. The electrical drive component for the new locomotives will be supplied by Siemens-Elektroprivod Ltd. (St. Petersburg).

ALSTOM **On May 27, 2010,** RZD and Transmashholding concluded the contract on the supply of 200 EP20 new generation dual-system passenger electric locomotives in 2012-2020, the general scope of the contract making approximately EUR 1 billion. The agreement was concluded in Sochi, within the frame of "Strategic Partnership 1520" Fifth International Railway Business-Forum.

In terms of development and specification of co-operation, on June 29, 2010, Alstom and Transmashholding signed the contract on the development and production of key components of EP20 electric locomotive in Russia. Production of EP20 electric locomotive will be provided by Transmashholding with the technical support of Alstom at the plant in Novocherkassk (Russia). Production of EP20 electric locomotives hauling systems based on the Alstom's latest technologies will be localised in Russia on the base of Transmashholding and Alstom Transport joint company.

With the capacity of 7200 kW EP20 can accelerate up to 200 km/h running at temperatures down to -50°C. It will be equipped with the facilities of gathering and transformation of the contact voltage, which allows it to operate with dual-voltage systems used in Russia. The EP20 will become the first in the new series of electric locomotives manufactured for the countries with 1520 mm gauge width.

ALSTOM **On June 26, 2010,** an agreement was signed between Alstom, Transmashholding and the National Company "Kazakhstan Temir Zholy" on the establishment of a joint venture for production of passenger and freight electric locomotives. The joint venture will be established by KTZ and Alstom-Transmashholding consortium on a parity basis and will manufacture electric locomotives on the basis of Alstom and Transmashholding technologies and with the usage of vehicle sets for manufacturing locomotives procured from the Russian-French consortium and from Alstom plant in Belfort (France). In the future, the localisation of component parts manufacture is planned for Kazakhstan. The products manufactured by the joint venture will primarily be supplied to Kazakhstan railways. Eventually these products are supposed to be exported to other countries as well.

The construction of the new plant will be carried out by Kazakhstan railways and is supposed to be completed by 2012, for the transfer of assembly works and, at a later stage, for full production of the electric locomotives in-house. Alstom-Transmashholding consortium will in return supply equipment for the manufacturing line with estimated annual capacity of 50-80 electric locomotives. Alstom technologies will be used in production of these locomotives, particularly hauling system and some components which will be produced by the joint venture of Alstom-Transmashholding consortium in Russia.

SKF **On July 7, 2010,** SKF Solution Factory was launched in Moscow. Their lines of activity includes restoration of roller bearings and spindles maintenance, development of solutions in the field of lubrication systems, manufacture of custom-design seals, mechanical processing equipment adjustment services, design and maintenance of status monitoring systems, repair of tooling for maintenance, reliability control centre, bearing failure cause analysis, manufacture of the custom-design bearing and other services.

SKF Solution Factory in Moscow is situated on 1 500 m2 production area, where, since 2004, SKF has been carrying out activities on the restoration of big roller bearings and maintenance of spindle block of metal- and wood-working machines.

On July 28-29, 2010, Conference "New approaches to product quality standards in the Railway Transport Development Strategy" was held in Moscow, organised by Union of Industries of Railway Equipment (UIRE) and "Bureau of Quality "Technotest" with the support of RZD.

Among others the conference discussed the issue IRIS introduction in Russia. The discussion was attended by IRIS President U. de Blais, Director General B. Kaufmann and its leading auditors on the one hand, and Senior Vice-President of RZD, the President of UIRE V. Gapanovich, UIRE members, representatives of Russian manufacturers and consumers of the railway equipment, on the other hand. In total, the conference was attended by 150 representatives from more than 100 Russian companies and organisations.

In the opinion of the participants of the conference, implementation of IRIS will help Russian railway engineering enterprises to improve business efficiency, enhance the quality and reliability of railway products, change the existing system of inspection and acceptance testing and multilayered audits, increase effectiveness of product development processes including cost reduction in the whole supply chain.

ALSTOM **By the end of 2010,** four high-speed Pendolino series train sets produced by Alstom will be set in operation en route between St. Petersburg and Helsinki. The new trains named Allegro will run on the 450 km high-speed line between the two cities. The journey time will be reduced to 3 hours (today it takes 5.5 hours) with the maximum speed of 220 km/h. Currently, the trains are undergoing certification testing in the Russian Federation and Finland.

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The contract on the supply of four dual-system Pendolino train at the cost of EUR 120 million was signed in September 2007 between the Russian-Finnish Oy Karelian Trans Ltd. (the joint venture of RZD and VR-Group) and Alstom.

Allegro electric train is designed and manufactured on the base of New Pendolino line and is a successor of Pendolino rolling stock that has been running on the Finnish railways since 1995. The active car body tilt system used in these trains is the cutting-edge technological solution which is unique in its way and provides significant increase of speed during curving, compared with conventional trains in terms of complete safety and comfort and does not require changes in geometry and configuration of the existing tracks.

The above-mentioned high-speed train is designed for operation both on Finnish and Russian networks due to dual-system energy supply and radio signal systems. The rolling stock is also adapted for operation in winter conditions. All the bogies are equipped with safety devices that prevent ice and snow ingress. A new heating and air conditioning system has been installed.

Each Allegro train consists of seven cars, which accommodate 344 passengers.

EFFECTS OF THE VOLUME AND STRUCTURE OF THE RZD'S INVESTMENT PROGRAMME ON THE SITUATION IN RAILWAY ENGINEERING AND RELATED ECONOMY SECTORS

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Introduction

The previous year 2009 has become the first year in the recent history of the Russian railway engineering when the demand for the sector production decreased. The production volumes in natural units dropped by 35% if compared to 2008, which has been unheard-of since the mid 1990-s. In this situation, one of the key factors for the industry was the size of RZD's investment programme for 2010 as RZD is the major buyer of industry production.

Amongst the fall-off in rail freight transportation, it was RZD, which remained nearly the only customer of railway engineering products, as the demand of private companies for freight cars was virtually non-existent. It happened primarily due to the existing business model of private operators, aimed mostly at servicing high-yield[1] cargoes (raw materials and metallurgical, petrochemical and chemical finished products), the demand for which drastically dropped during the crisis.

RZD also faced tough times. The large share in the cost structure of the fixed expenses (infrastructure, G&A, auxiliary types of business) and decline in the income, which has already been limited by the government, had negatively affected implementation of the investment projects.

Given the exceptional importance of investments performed by RZD both for the railway transport and for railway engineering enterprises, as well as the necessity to take actions specified in the Strategy of Railway Engineering Development in the Russian Federation between 2007 and 2010 and up to 2015, the Institute for Natural Monopolies Research has studied the effects of the volume and structure of RZD's investment programme on the situation in railway engineering and related economy sectors. This article outlines the study progress and obtained results.

Variants of the of the volume and the structure of RZD's investment programme

The starting point for the analysis was the expected freight turnover in 2010 in the amount of 2,074 bn. t-km. To ensure this turnover RZD's expenses have to be 1,050.7 bn. rubles (€26.3 bn.[2]). The investment programme volume is defined as a part of the net income of the company.

Depending on the level of rates indexation for freight transportation and the volume of state subsidies, the total volume and structure of the company's investment programme may vary considerably. As a result of the study, it was found that every percentage point of the increase in the rate for the transportation of freight will on average lead to the increase of the investment programme by 6.9 bn. rubles, while every billion rubles of governmental subsidies increases the investment programme by approximately 950 mln. rubles. It was also taken into account that with no subsidies and the same rates RZD would invest into the recovery of capital

1 The rates for the transportation of freight by rail in Russia depend on the final freight cost. For example, the rate for the transportation of a tonne of oil is higher than for the transportation of a tonne of coal. This is the way the cross-subsidisation between cargoes takes place in order to compensate for the social and economic situation.

2 Editorial note: In the original study, all the calculations are given in Russian rubles. For the reader to better understand the scale of RZD's investment programme, we give you the annual average euro exchange rates: 2008 – 36.44, 2009 – 44.19, forecast for the years 2010 and 2011 and for the indices, which are not related to any specific year – 40 rubles per euro.

assets at the expense of current depreciation (it was about 190 bn. rubles for the year 2010). Otherwise, the company may expect deterioration of the capital assets and decline in capitalization, which may produce a negative impact on the credit and investment ratings of RZD. In turn, it will lead to higher debt servicing costs and worse financial figures. On the other hand, the growth of rates is limited by the inflationary expectations of the consignors: if the growth of rates considerably exceeds the inflation forecast (by approximately 3 percentage points), it is possible to redirect a part of the freight turnover to other types of transport, which will affect the expected volume of the freight turnover and would require recalculation of the entire model.

Some funds, which are used for the rolling-stock fleet renewal, nonlinearly depend on the size of the investment programme. The reason for the above is the independent amount of expenses, making up 71.8 bn. rubles, on the construction of facilities for the Olympic Games in Sochi in 2014 and development of the Olympics-related infrastructure and changes in the relation of the funds spent on the upgrade and purchase of the new rolling-stock.

Given the total volume of the investment programme, exceeding 240 bn. rubles, the change (both increase and decrease) in the indexation level of the rates by one percent will entail changes in funds allocated to renew the rolling-stock by an average of 1.87 bn. rubles. Meanwhile, the change in subsidies by 1 bn. rubles will entail the change in funds allocated to purchase the rolling-stock by 260 mln. rubles.

Given the total volume of the investment programme of more than 240 bn. rubles, every additional percent of the rate growth will increase the funds to be spent on the purchase of new rolling stock by 9.3 bn. rubles, while every additional billion of governmental subsidies will increase the funds to be spent on the purchase of new rolling-stock by 1.27 bn. rubles. Meanwhile, there is a change in the structure of the investment programme, namely – the increase in the share of funds to be spent on the rolling stock fleet renewal by decreasing the share of expenses on the infrastructure and upgrade of the rolling-stock.

Based on the acquired empirical dependences, we have considered five variants of changes in the rate for the year 2010 and subsidy amount:

Variant 1 — 11.4% indexation, 55 bn. rubles subsidies;

Variant 2 — 9.4% indexation, 50 bn. rubles subsidies;

Variant 3 — 9.4% indexation, no subsidies;

Variant 4 — 5% indexation, no subsidies;

Variant 5 — 0% indexation, no subsidies.

Pursuant to the parameters of the chosen variants, we formed the forecasts regarding the total volume of the investment programme and share of funds to be spent on the rolling stock renewal for the year 2010 (see Table 1. and Fig. 1).

The forecast of the RZD order size and structure for the year 2010 for different variants of RZD's investment programme is given in Table 2. and Fig. 2.

Table 1 Dependence of the parameters of the RZD's investment programme for the year 2010 on the growth of the rates and the governmental subsidy volume.

Investments, bn. rubles	Variant 1	Variant 2	Variant 3	Variant 4	Variant 5
Total investments, excluding Sochi Olympic Games 2014	194.6	180.2	130.2	99.3	60.7
including rolling stock renewal	67.7	48.4	35.1	26.6	15.8

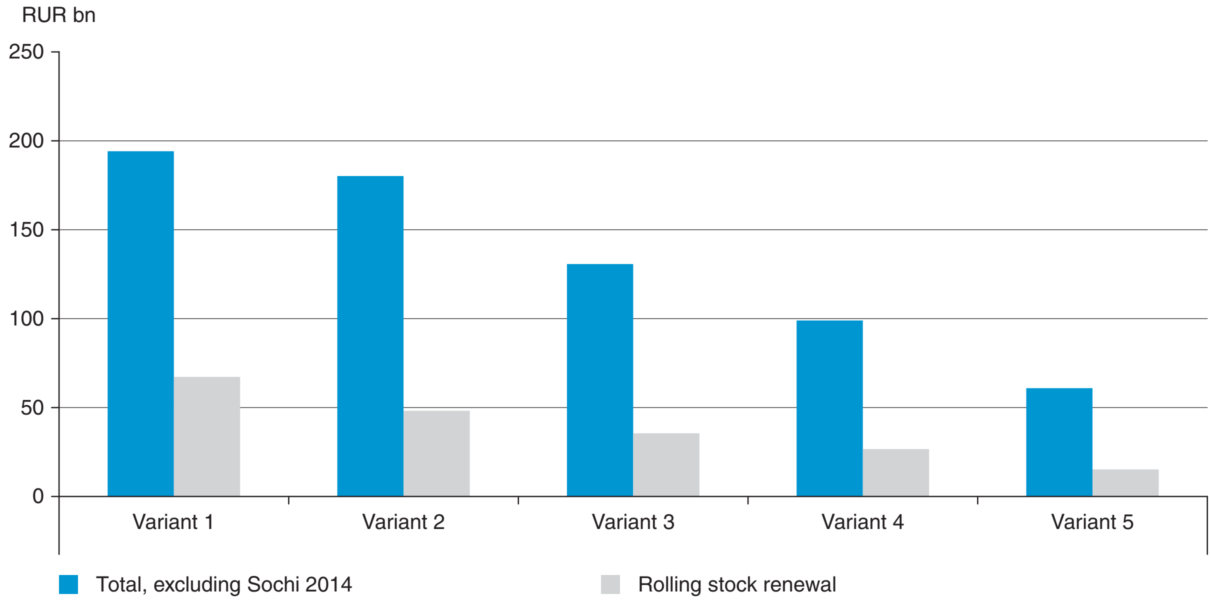

Fig. 1. Investments of RZD and different variants of the investment programme formation.

Table 2 Expected volume of the order for rolling stock for different variants.

Rolling-stock, units	Variant 1	Variant 2	Variant 3	Variant 4	Variant 5
Locomotives, incl.:	245	227	156	125	101
main line diesel locomotives	25	25	15	10	10
shunting diesel locomotives	80	70	50	40	30
main line electric locomotives	140	132	91	75	61
Passenger cars	471	358	259	197	167
MUs	567	411	298	227	138

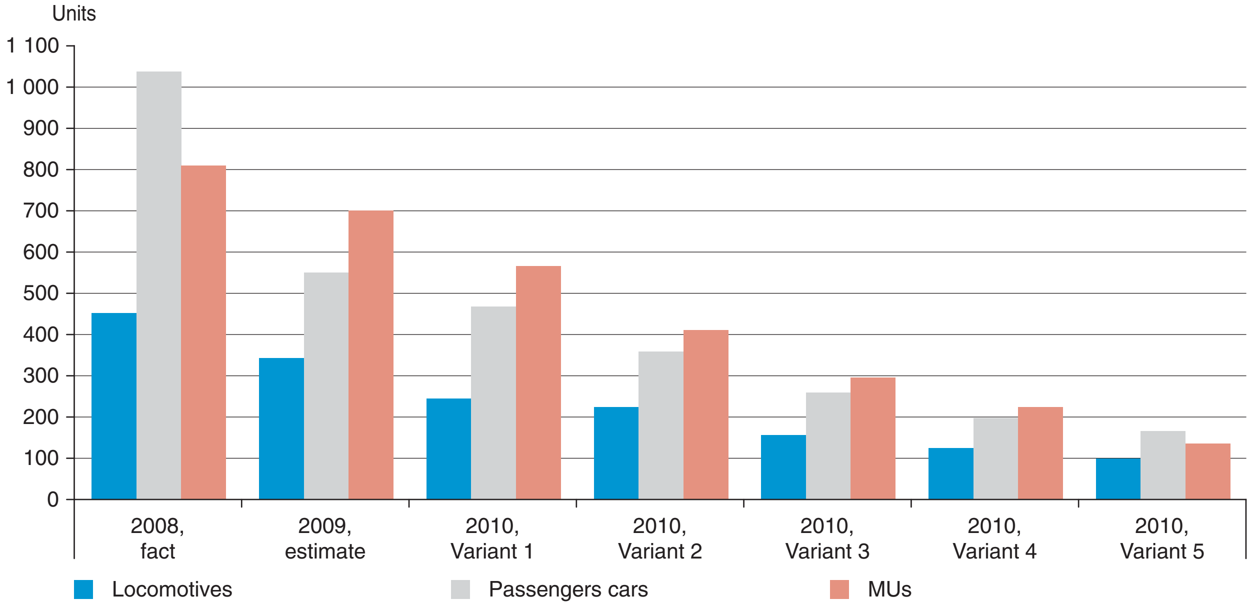

Fig. 2. Purchase of rolling stock.

Evaluation of the effects on railway engineering and related industries

We have analyzed the sector performance in 2009 for the quantitative evaluation of the effects of RZD's investment programme on railway engineering. The volume of railway engineering production shipment for the above period amounted to 173.9 bn. rubles, which is 67.1% of the 2008 volumes. 36% of this volume was the new rolling stock purchase. The deepest drop was observed in the freight car market: in 2009 companies shipped products to the total amount of 24.3 bn. rubles, which is 36.7% of the 2008 volumes.

Since the beginning of the year, the industry production manufacturing dropped by 34.3% in natural terms with this index fixed at 10.8% across the industry, in general. Comparison of the sector production volumes in 2008 and 2009 is given in Table 3.

Given the considerable decrease in the production order in 2009, some railway engineering companies were forced to suspend manufacturing and grant temporary administrative leaves to the employees.

The evaluation of effects of changes in RZD's investment programme on railway engineering manufacturing companies took into account the sector's significant social importance: many railway engineering companies are city-forming ones and in their business, the sector enterprises generate the order for some other industries, such as production of electric machines and electric equipment (including diesel engines), telecommunications products, electronic and optical equipment, ready-made metal products, chemicals, home appliances for rolling stock.

According to the Centre for Macroeconomic Analysis and Short-Term Forecasting, railway engineering takes the second place among the major industries in terms of multiplicative effect and the third place in terms of impact on the manufacturing growth. The growth of the sector production volumes by 1% leads to the growth of the similar index in the related sectors by 1.51% and manufacturing growth by 0.009% (see Table 4.).

The index of the multiplicative effect is defined as the relation of the production volume in the related sectors, accounted for 1 ruble of the products manufactured by the industry. This index is defined by the structure of raw materials and spare parts purchases but does not depend on the share of the sector in the industry. The more complex high-added value parts and components are purchased by the companies from this sector the longer the production chain and the higher the index of the multiplicative effect are.

Table 3 Volume of railway engineering production manufacturing in 2008 and 2009, units.

Production types	2008	2009	Growth: 2009 / 2008
Locomotives			
Main line diesel locomotives	49	35	-29%
Main line electric locomotives	261	232	-11%
Shunting locomotives and electric industrial broad gauge line locomotives	264	124	-53%
Electric mining locomotives	76	23	-70%
Cars			
Main line freight cars	42,681	23,584	-45%
Main line passenger coaches	1,321	711	-46%
EMU cars	822	673	-18%
Metro cars	246	254	3%
Tram cars	277	149	-46%
Track machines			
Track construction and routine maintenance machines	192	82	-57%
Track maintenance machines	113	56	-50%

The manufacturing growth accounted for 1% of the production growth in the industry depends both on the multiplier and the share of the industry in manufacturing. Thus, although the multiplier of the iron industry is by 75 times lower than the multiplier of the railway engineering, the factor of effects produced by the iron industry on the general manufacturing growth is only by 4.5 times lower than that of railway engineering.

We also evaluated the consequences for different implementation variants of RZD's investment programme for the largest production manufacturers in the industry. Evaluation results are given in Table 5 and Fig. 3 as the change in the respective indices compared to 2009.

Conclusions

If the variants 2-5 succeed, some industrial enterprises may suffer from considerable staff reductions and prolonged suspensions of the core operations. According to the estimates of the producers, given such measures are applied within one year only, the recovery of normal operations of the companies would require huge financial expenses and besides would not be possible on a tight schedule.

The current decline in the freight transportation volumes and economy in general should not lead to the drastic volume reduction in RZD's investment programme. The railway transport system has a significant inertia of processes, both technical and economic. The railway transport should by all means react to the systemic changes in the needs of the economy but it should still mitigate fluctuations, which become stronger and harsher as long as globalization grows on. Reductions in the investment programme pursuant to the short-term market situation are accompanied with considerable risks both for railway transport and railway engineering and any other related industries and sectors.

Any crisis ends sooner or later and if we slow down the fleet renewal rates now, RZD might have no rolling stock fleet reserves by the time the crisis is over, which will virtually immediately become an infrastructure impediment factor in the economy development.

Reductions in the order for the railway engineering production may lead to irreversible effects in the companies of the industry. It will affect staff issues, state of the business assets and lag in technology behind the world level.

Table 4 Effects of certain industries on the related sectors and manufacturing growth

	Multiplier on the related sectors	Manufacturing growth if sector grows by 1%
Home appliances	1.95	0.01
Railway engineering	1.51	0.009
Automotive industry	1.38	0.062
Metallurgical engineering industry	1.03	0.001
Handling engineering industry	0.94	0.003
Machine tool building	0.87	0.001
Mining equipment production	0.72	0.001
Power engineering industry	0.49	0.002
Synthetic resins and plastics	0.3	0.004
Iron industry	0.03	0.002
Nonferrous industry	0.02	0.001

Data: Centre for Macroeconomic Analysis and Short-Term Forecasting

Table 5 Estimates of the multiplicative effect from the change in the investment program of RZD for the year 2010 (compared to 2009).

Index	Variant 1	Variant 2	Variant 3	Variant 4	Variant 5
Investments of RZD into rolling stock renewal, bn. rubles	67.7	48.4	35.1	26.6	15.8
Change in tax revenues into all-level budgets, bn. rubles	–0.65	–1.17	–2.03	–2.33	–2.59
Change in the volume of the industrial order on the part of rolling stock producers to the suppliers, bn. rubles	–1.53	–3.21	–6.03	–7.28	–8.32
Change in the number of employees, 000' people	–4.2	–6.5	–9.8	–11.8	–13.2

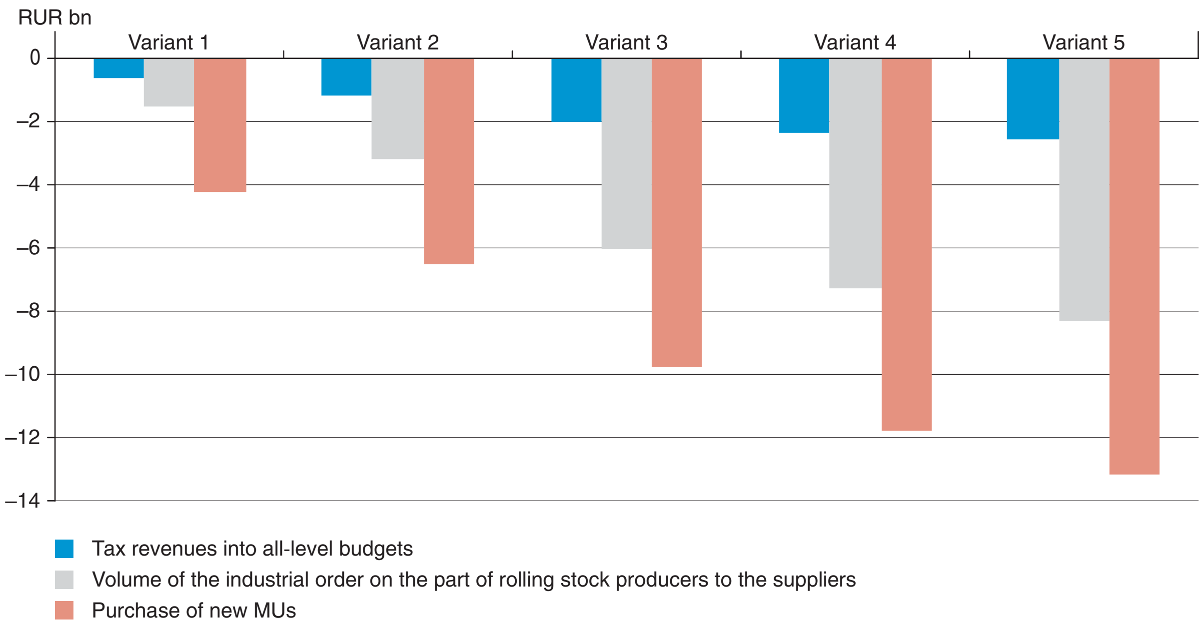

Fig. 3. Multiplicative effect from the RZD's investment programme reduction.

On December 10, 2009, the Russian Government approved the investment programme and financial plan of Russian Railways for the year 2010 and planning period between 2011 and 2012. After adjustments made in February and April 2010, the investment programme of the company will exceed 295 bn. rubles. The total volume of the funds provided for by the draft investment budget of RZD for the year 2010 for the implementation of the company's projects (excluding those related to the Olympic Games), is 223.2 bn. rubles. RZD plans to spend about 33 bn. rubles on locomotive fleet renewal.

The increase in the investment programme took place as a result of the reviewed forecasts regarding freight transportation volumes, and, consequently, takes into account the increase in the expected income of RZD. Noteworthy to say though that over 9 bn. rubles of 14 bn. rubles additionally planned in investments will be spent on the preparation of the projects for the future periods, which will not directly affect railway engineering in the next 2 or 3 years.

Given the formation of the Federal Passenger Company, the purchase of the locomotive hauled passenger coaches were removed from the investment programme of RZD, while the key programme figures and, consequently, the expected consequences for the economy are close to the Variant 2 figures as a result of the study undertaken.

ACCORDING TO THE LATEST UPDATE, THE SIZE OF RZD'S INVESTMENT PROGRAMME FOR 2011 HAS NOT BEEN APPROVED YET. THE PRELIMINARY RESOLUTIONS ON THE 8% INDEXATION OF THE RATES FOR FREIGHT TRANSPORTATIONS IN 2011 AND ALLOCATION OF 50 BN. RUBLES OF FEDERAL SUBSIDY (€1.25 BLN.) HAVE NOT BEEN CONFIRMED BY THE RESPECTIVE RESOLUTIONS OF THE RUSSIAN GOVERNMENT YET EITHER. THE PRELIMINARY FINANCIAL PLAN OF THE COMPANY PROVIDED FOR THE INVESTMENTS TO THE AMOUNT OF 285.0 BLN. RUBLES (€7.125 BLN.), WHICH BY 5.4% EXCEEDS THE EXPECTED IMPLEMENTATION OF THE INVESTMENT PROGRAM FOR 2010.

In general, in 2010 railway engineering companies in cooperation with RZD have real basis to stop the production slowdown. But the production volume growth is not expected either, so the companies should consider it expedient to keep on working on the programmes to cut expenses and improve production quality they have started before.

Opinion

Given RZD is going through the structural transformation, any further development of this model should be made subject to the above. The newly formed Federal Passenger Company, Second Freight Company, spin-off of certain business types require amendments to the model itself and model expansion by having it incorporated forecasts of the investment programs developed by the largest consumers of the industry production.

OVERVIEW OF THE PRELIMINARY RESULTS OF RAILWAY ENGINEERING PERFORMANCE IN 2009

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Introduction

In 2009, the Russian economy faced effects of the economic crisis — decline in the demand and manufacturing industry, decrease in the freight and passenger transportation volumes, unemployment growth. These events have inevitably affected the railway engineering as well, as the demand for the industry production directly depends on the financial capabilities of the railway companies, including the volumes of freight transportation by rail. We may make one conclusion right away – the year 2009 has become the first year of the drastic decline in the railway engineering for the last decade. How did the industry react to the crisis, what changes did the industry undergo compared to the production sector in general, what perspectives will the sector companies have during the current year? This overview will outline all of the above.

Dynamics of the sector production volumes

The index of the actual railway engineering production volume made up 0.657, i.e. the drop of the railway engineering production volumes in 2009 compared to the previous year was 34.3%. The deepest decline was observed in the manufacture of railway equipment and shunting locomotives (by 62.3% and 53%, respectively), as well as the freight and passenger cars: by 44.6% and 44.1%, respectively. The mainline diesel locomotive (by 28.6%), EMUs (by 18.6%) and mainline electric locomotive (by 11.1%) production volumes suffered from the decline the least.

For reference, according to the Federal State Statistic Service, the general industrial decline totaled 10.8%. It is a reminder that according to the Rosstat methods, the industry includes the following sections of the Russian National Classifier of Economic Activities (types of economic activities): Section C “Mining operations”, Section D “Processing and manufacturing” and Section E “Power, gas and water generation and distribution”. The decline in production volumes in 2009 compared to 2008 made up 1.2% in mining operations, 4.8% in power, gas and water generation and distribution, 16% in processing and manufacturing, respectively. Below, we will compare the railway engineering and manufacturing as a whole figures.

Comparison of the production dynamics across the industry in manufacturing and railway engineering for the period between 2007 and 2009 is provided on Fig. 1.

The production dynamics analysis showed that prior to Q3 2008 the railway engineering shared same trends as manufacturing activities. Then, prior to Q2 2009, the decline was somewhat slower but deeper in the end. The railway engineering recovery rates in the second half of 2009 proved to be higher than in the processing and manufacturing activities but at the year end the railway engineering production level amounted to 0.85 of the basic level despite the fact that the manufacturing activities hit 0.93.

The key explanation, which can be given to such inequality in the decline and recovery levels, is that the export-oriented low-added value products with the short operating cycle hold a considerable share in the structure of the Russian manufacturing (metallurgic, chemical, wood using and paper industries). After adjustments to prices, such product trade volumes in the world market started to recover fairly quickly. Unlike these industries, the railway engineering is characterized by the prolonged operating cycle and, as a rule, shipment contracting in the end of the previous year for the year to come. In many cases, companies sign long-term contracts. Owing to the order portfolio for the period until the end of the year 2008, the industry did not suffer from such a considerable decline.

Figure 1. Production dynamics in different industry sectors (Q4 2006 = 1).

The key factors, shaping the decline in the demand for the railway engineering production, include the changes in the transportation services market and investment opportunities of the key market players, first of all – RZD.

In 2009, the total decline in the market of the freight cars amounted to about 40% if compared to 2008, while the decline in the demand on the part of the private freight car operators proved to be deeper than on the part of RZD and its subsidiaries. If in 2008 the purchases of RZD and its subsidiaries made up 21% of the general amount of the purchased freight cars, in 2009 they hit 29%. Last year, only First Freight Company purchased 8,000 cars of 37,500 cars produced. Meanwhile, in 2009 the Russian companies produced only 23,500 cars. Other cars were imported mostly from Ukraine. Noteworthy to say that there was a change in the structure of the car types produced: if in 2008 the tank car production made up 3,163 or 7.4% of the total amount, in 2009 there were 8,331 tank cars produced, which was 35.3% of the total production amount.

In 2009, RZD secured its role of the major consumer of the industry production. Despite the fact that in recent years the company slowed down the fixed asset deterioration rates, the level of their tear and wear (of the rolling-stock in the first place) is still high. However, the investment capabilities of RZD are limited by the reduction in the shipment volumes (in 2009 freight turnover dropped by 11.8% if compared to 2008, while freight carried dropped by 15%) and the rate indexation level and amounts of the federal subsidies. Given the rate and subsidy indexation sizes set by the Russian Government in December 2009, the order volume of RZD this year may remain at the 2009 level. Granted the demand on the part of other consumers is intact, such an order of RZD will enable the sector to stop the decline, although the production growth is unlikely.

Production shipment dynamics

In 2009, the railway engineering production shipments made up 173.9 bn. rubles (€3.93 bn[1]) or 67.11% in Russian rubles and 44.6% in euros of the volumes of the similar period of the previous year. Furthermore, this index was affected both by the decline in volumes of the shipped production and considerable drop of prices for the sector production. The 2009 price index amounted to 113.82% across the industry in general (i.e. the prices grew up by a total of 13.82%), whereas in the railway engineering the value of this index was 79.4%. In other words, under pressure of the consumers, the railway engineering companies had to cut the prices by an average of over 20%. As a result, the share of the railway engineering production in the total production shipment volumes dropped from 1.23% in 2008 to 0.9% in 2009.

Financial standing of the railway engineering companies

The number of companies, which gained income for the reporting period, dropped from 127 to 99, or by 22%, while the number of the loss-making companies grew up from 19 to 47, i.e. by 2.5 times. The total number of companies in the industry has not changed.

The income of the profitable companies dropped by 40% in Russian rubles and by 50.5% in euros from 12,972.25 mln. rubles (€355.89 mln.) to 7,788.78 mln. rubles (€176.26 mln.). Meanwhile, the loss of the loss-making companies went up from 489.89 mln. rubles (€13.44 mln.) to 6,984.76

1 This overview employs the following average euro exchange rates: 2008 – 36.45 rubles, 2009 – 44.19 rubles. It should be taken into account that it would be wise to evaluate the real dynamics of the industry indices in Russian rubles and the scale of these indices – in euros.

mln. rubles (€158.06 mln.) or by 14.3 times in Russian rubles and by 11.8 in euros.

The balanced fiscal effect of the industry proved to be positive and amounted to 804.02 mln. rubles (€18.2 mln.), although it is by 15.5 times less in Russian rubles and by 18.8 times less in euros than the similar index of the respective period of the last year.

Based on the analysis of these scaled-up indices, one may conclude that the industry lost the profitability reserves and internal sources of investment resources for the year since the start of the crisis. The reduction in such operation for the period longer than one or two years will have a most negative effect on the Russian railway engineering potential.

ACCORDING TO THE LATEST STATISTICAL UPDATE, IN THE FIRST HALF OF 2010, THE RUSSIAN FEDERATION PRODUCED 110 MAIN LINE ELECTRIC LOCOMOTIVES — +2 (101.8% AGAINST THE SIMILAR PERIOD OF THE YEAR 2009), 16 MAIN LINE DIESEL LOCOMOTIVES — 1 (94.1), 57 SHUNTING LOCOMOTIVES AND INDUSTRIAL DIESEL LOCOMOTIVES — 16 (78.1%), 22 089 FREIGHT CARS — +13 438 (255.3%), 566 PASSENGER COACHES — +166 (141.5%) AND 273 MULTIPLE-UNIT CARS — 33 (89.2%).
FURTHERMORE, ACCORDING TO RZD AND ROSSTAT, THE VOLUME OF FREIGHT TRANSPORTATION BY RAIL FOR THE SAME PERIOD OF TIME MADE UP 977.2 BLN. TON-KILOMETERS (+12.9%), SHIPMENTS REACHED 584.6 BLN. TONS (+12.2%, RZD ONLY), PASSENGER TURNOVER — 58.6 MLN. PASSENGER-KILOMETERS (–12.1%).

Conclusion

Upon consideration of the major industry performance indicators one may conclude the following:

- The industry is one of the sectors, which suffered the most from the crisis.
- The production volume growth perspectives this year are quite petty. One expects the suspension of the decline in the actual production volumes across the industry.

In general, the railway engineering exhausted its capabilities to cut prices for its production. There are virtually no internal sources of investments. Given there are no changes in the market situation, this year there may be conversion or bankruptcy of the companies, which suffered from the crisis the most. First of all, we speak about the suppliers of the spare parts and components, as the major producer of the rolling-stock have bigger financial stability. Later, it may lead to the deficit of the spare parts and components and increase of the industry's import dependence.

As long as the economy recovers from the crisis, such an outcome may in the medium term create the deficit of the rolling-stock the railway companies are so well aware of, which is targeted by "the Strategy for the railway engineering development in the Russian Federation between 2007 and 2010 and for the period of time until 2015" and "the Strategy for the development of the railway transport of the Russian Federation until 2030" approved earlier.

IPEM INDICES AS AN ALTERNATIVE APPROACH TO ONLINE MONITORING OF THE INDUSTRIAL PRODUCTION

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What is an alternative industrial production index?

Evaluation methods

At the time of an economic crisis, the promptness, reliability and fullness of information on the state of economy play pivotal role for the governmental authorities and business in making efficient decisions, especially on applying anti-crisis measures and their key parameters.

There are two key methods to get the basic macroeconomic indices, including the most important *industrial production index (IPI):* by way of aggregating the initial statistical information from the companies ("bottom-up") or by way of a correct analytical *calculation* based on the key integral true indices ("top-down").

In Russia, the Federal State Statistics Service (Rosstat) calculates the industrial production index based on *aggregating* the initial statistical information. The flaws of aggregation-based IPI calculation are rooted in complicated and time-consuming process of information collection and its further processing. Therefore, this method is not really prompt, while the first index calculations contain information only on the large and medium-sized companies. A more reliable IPI calculation comes much later in the form of the revised calculation. There are greater risks of the error accumulation, which arise through delays and/or low reliability of companies' data. As a result, the revised indices, accounting for the activities of the entire range of companies, are often different from the prompt indices, especially in terms of certain All-Russian Classifier of Types of Economic Activity categories.

It is important to keep in mind that according to "bottom-up" approach, the production with the lengthy operating cycle is accounted for within a month of its completion, although the production takes places for several months in a row. During steady economic growth it hardly affects the general industry development indices; however at the time of the crisis it gives belated signals about the real trends in economic development. Among other things, this approach does not allow to directly account for the shadow economy, which usually expands during the crisis.

The Institute for Natural Monopolies Research (IPEM) used an alternative approach – analytical *calculation* of the industrial sector status based on the key macroeconomic indices. A national economy is an integrated system; therefore there are steady correlation dependences between the key indices of the economy status. The correct identification of these dependences allows one to get prompt and true indicators of the production development. Having conducted a lot of studies both in the field of the natural monopolies research and in related sectors of economy IPEM gained a huge database of the basic and secondary indices, showing the status of the national economy in general and in certain sectors. The collected data was analyzed, it was equally important to reveal either existing interdependencies or their absence. Obtained results were later analyzed for identification of the causal relationships to exclude erroneous dependencies, which may appear in the event of a mathematical analysis of the short statistical arrays.

The basis of the IPEM index is formed by indirect integral indices – power consumption *(IPEM-production)* and freight traffic by rail *(IPEM-demand)*. This data is tracked virtually on a real-time basis; therefore they are both prompt and highly reliable. Besides, given that IPEM have been monitoring the status of these sectors for a couple of years, the post-event analysis allowed it to develop the method of the correct analysis of the sector status subject to the calendar, climatic and other factors in the form of the following indices: *IPEM-demand* and *IPEM-production*. Therefore, the indices based on their dynamics exclude many methodological flaws of Rosstat's IPI.

IPEM-production index

The industrial production index *(IPEM-production)* is based on the fact that *any industrial process uses electric power* as the production means.

The index calculation model is based on the fact that the electric power consumption dynamics with-

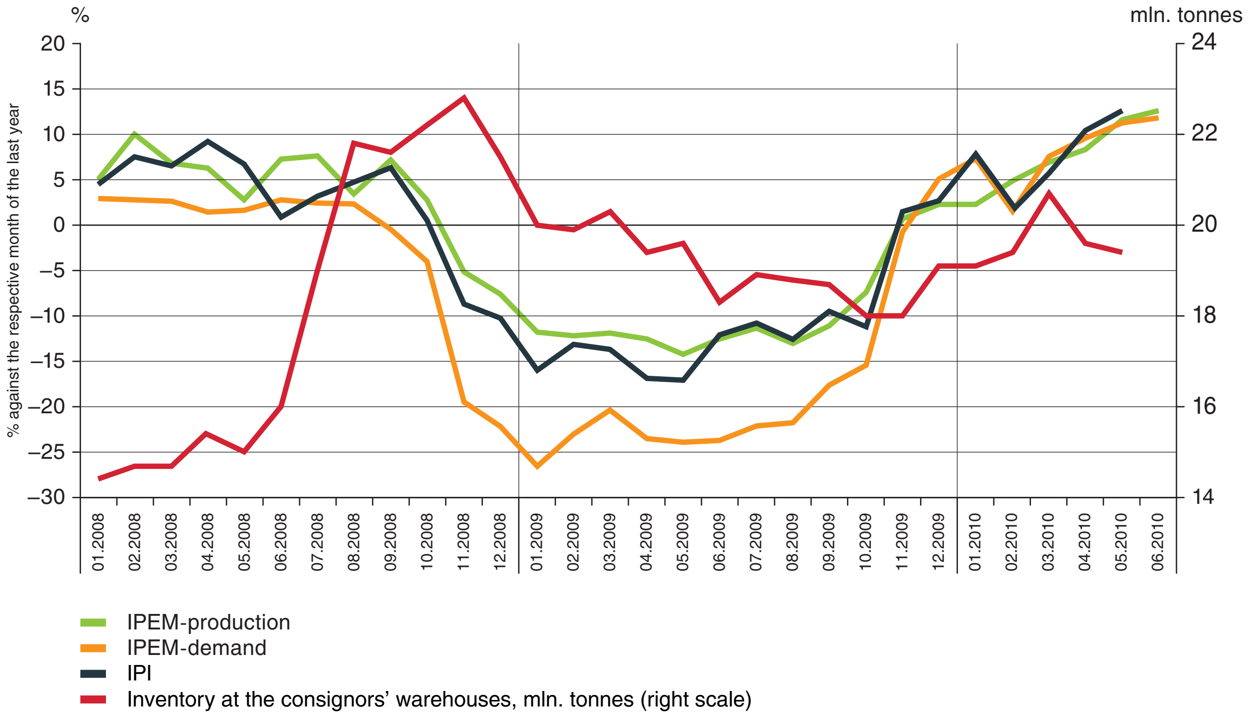

Fig. 1 Dynamics of indices between 2008 and 2010 (against the respective month of the last year)

in short period of time depends primarily on three parameters: industry performance, weather and season factors – all this data is available, prompt and reliable.

IPEM-production index allows one to get prompt and reliable information on the industry status, including informal, illegal activities. One may actually get the dynamics of the shadow economy development by comparing Rosstat's IPI and *IPEM-production index.*

IPEM-demand index

The index of the demand for the industrial production is based on the assumption that time for consumption of an industrial product corresponds to the moment of its transportation. *IPEM-demand index* is calculated mostly on the basis of the prompt data on the freight traffic of the industrial products by rail. The data on shipping at the Russian stations is clear from the effects of transit and import freights but includes export freights. In Russia, up to 80% of the industrial products and raw materials is transported by railways, therefore the railway transport activities reflect the total index of the demand for the industrial production in the economy. The calculations are based on steady correlation dependences in the dynamics of the production of different industrial products with loading of these product categories by rail. *IPEM-demand index* allows to split up, as well as take into account the *internal (inside Russia) and external demand (export)* for the production of the Russian industry.

IPEM-demand index calculation model in fact is a replica of Rosstat's IPI calculation model, where the index is also calculated by way of aggregating the data on the production changes in the sector in natural indices with the balance structure pursuant to the share in the industrial production by added value. *IPEM-demand index* calculation model uses prompter data on loading instead of data on production.

During the period of the steady economic growth, the differences between *production and demand indices* are small and ignorable. However, during the crisis their effects are drastically different and this difference is related to the growth of inventory. Consumption of products within the economy is more volatile than production in the industry. The auxiliary index *inventory* allows one to take this difference into account.

Analysis of the Russian industry status based on IPEM-indices in the first half of 2010

The decline in the high-tech and low-tech sectors turned out to be prolonged and lasted until May 2010. The drastic growth in recent months in the high-tech sectors was caused rather by the Government anti-crisis measures to stimulate the de-

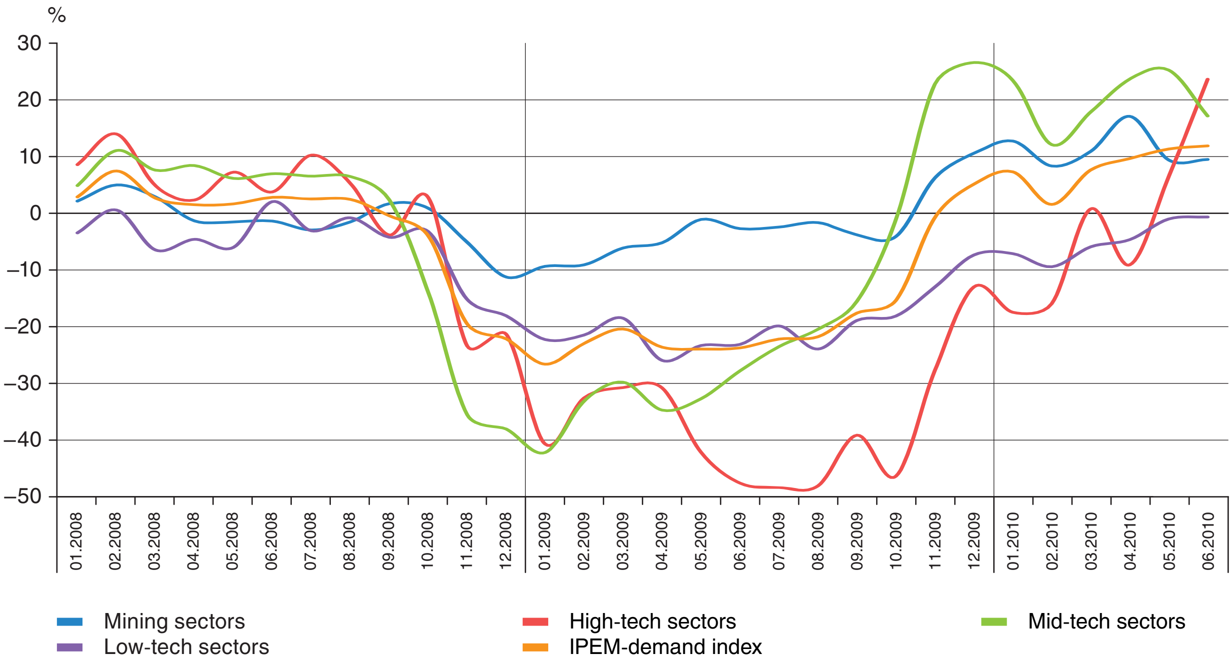

*Fig. 2 Dynamics of the IPEM-demand index by industry sectors grouped by technology of operations**

* High-tech — Production of vehicles, machines and equipment, electric equipment, electronic and optical equipment
Mid-tech — Production of coke and petrochemicals, chemicals, rubber and plastic goods, other nonmetal mineral products, metallurgical production and production of the ready-made metal products
Low-tech — Production of foodstuffs, textile and garments, leather and shoes, woodworking and wooden goods, pulp and paper production, publishing and printing

mand for the Russian industrial production rather than by low base of the year 2009.

But the risks of the high-tech sector development in Russia are very high. First of all, the Russian ruble will gradually become stronger. Secondly, at the turn of 2010-2011 the anti-crisis programs of the Government will come to an end. And thirdly, foreign producers are going through a difficult period again after incentive programs in their countries expired and will no doubt switch over to the perspective Russian market.

Until then, the situation in the Russian industry is relatively stable, which is among other things confirmed by the one-way behaviour of the demand, production and Rosstat's IPI indices between February and June 2010.

Key conclusions regarding the industry development in Russia between 2008 and 2010

The crisis in the Russian industry started not in October or November 2008 as many experts believe, it broke out in August or September when there was a drastic decrease in the demand for the industrial production and warehouse filling. IPEM-demand index showed the negative trends in the economy two months earlier than production indices did.

The major sector of the Russian industry – mining operations – started to feel the crisis effects even prior to that in April 2008. The dynamics of this export-orientated sector reflected the fact that the crisis events in the global economy appeared even earlier, as a result of which the demand for the Russian energy resources started to crumble.

The decrease in the demand for the Russian industrial production proved to be deeper than the decrease in the production. The main reason was the deeper decrease in the domestic demand compared to the external demand. In fact, until recently the key factor for production recovery has been the external demand.

The crisis produced different (in terms of depth) impact on different sectors of the Russian industry.

Thus, mining sectors showed maximum decline of 11%, but on average they have gone through the crisis with the slowdown of 5-6%.

The maximum decline of low-tech sectors was the same as the industry average decline of about 20%. The major industry of the low-tech sector was the production of foodstuffs. Such a serious decline in the production indices does not mean that people eat less, it is just the fact that the demand for expensive foodstuffs with high added value shifted towards cheaper food, which defined the depth of the decline.

Mid-tech sectors are mainly orientated on investment demand. But the investment programmes are the first to be cut by the companies during the crisis. The drastic decline in the demand for the metallurgical products and building materials predetermined the fall of the entire mid-tech sector by 35-40%.

And finally the high-tech sector suffered the most. The decline in the production volumes hit 50% and 60% in certain industries. Before the crisis, the Russian engineering, electric engineering and automotive sectors benefited mostly from the speculative demand and supply deficit. During the crisis, the market volume contracted drastically and the competition with the foreign producers became intense like never before. Only measures of the customs regulation and Russian ruble devaluation helped to halt the decline.

The fall of the Russian industry ended in November 2009 when there were first signs of the recovery growth in the mining operations and mid-tech sectors.

However, the mining sector has already almost exhausted its growth potential, as the export shipments are limited by the crisis events in European countries and growing competition with other oil and gas production regions. Further recovery of the Russian industry will mostly happen at the expense of the high-tech and mid-tech sectors.

INNOVATION IN RAILWAY ENGINEERING DEVELOPMENT

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Innovative-based development is the resultant vector and an essential condition of Russia's economic progress in the 21st century. It is reflected in President Medvedev's Annual Address and in the Government Long-term Social and Economic Development Strategy of Russia up to 2020. As it is specified in the Strategy by 2020 the innovative sector should constitute 18% of the country's GDP.

It is a very complex, ambitious and responsible goal and its realisation requires highly effective use and development of scientific and technical potential of the entire economy, including railway transport. In current complicated global economic environment innovations have become an increasingly popular instrument in overcoming recession and creating conditions for new economic growth.

Main Principles of the Programme for Locomotive-building Development in Russia.

The work of the Russian Railways today is guided by practical implementation of the Strategic Development Programme of RZD (Table 1), and the company's course to the transition to innovative management ideology. This approach is established by the Railway Transport Development Strategy of Russia up to 2030.

The basic priorities set to successfully fulfill this task are the following: formation of the RZD's investment programme directed to rolling stock improvement; signing of long-term partnership agreements between Russian Railways and railway engineering companies.

It is worth mentioning that realisation of this programme has become possible through consistent collaboration of RZD and railway engineering companies.

As a result, RZD locomotive facilities obtained over 1160 new locomotives during the period of 2006-2009.

Russian railway engineering comprises about 500 companies and entities of various business legal structures. Only 22 specialized companies produce rolling stock.

Rapid growth of new locomotives production in 2005 — 2008 has unfortunately negatively affected their quality (Table 2). The readiness coefficient of new locomotives during guarantee run is lower

Table 1. Implementation of Russian locomotive-building development programme

Type of locomotive	Models in operation by 2008	Transitive models 2008—2010	Transitive models after 2010
AC freight electric locomotives	VL80	2ES5K	2ES5
DC freight electric locomotives	VL11	2ES4K	2ES10
DC passenger electric locomotives	ChS2	EP2K	EP2
Freight diesel locomotives	2TE10V	2TE25K	2TE25A

Table 2. New locomotives failures in 2009

		Failures		
		Design defects	Technological defects	Operation
Total failures	3 570			
including system failures	1 517	409	936	172
Total idle time of new locomotives, hours,	700 000			
including those caused by system failures	450 000	120 000	280 000	50 000

than that of operating locomotives of previous series. RZD management and Technical Policy Department carry out regular technical audits of new locomotives. These actions have revealed poor quality of the following units:

- 4PD series diesel locomotive engine produced by "Penzadiezelmash";
- NBA-55 series asynchronous electric motors of supporting machines;
- Asymmetric current collectors;
- Microclimate maintenance split-systems for driver cabins, and many others.

Poor-quality equipment failures lead to new locomotives non-productive idle time that entails RZD's loss increase and lost profit and damages the company's image. System failures became a reason of up to 50 new locomotives unscheduled repairs daily in 2009. RZD's losses caused by unproductive idle time of EP10, 2ES5K, EP1 electric locomotives exceeded 113 million rubles.

Therefore now RZD sends a new message to the industry: "We buy only what we need"! That will reduce operating expenses in the future. Today technical requirements to new-generation rolling stock are as follows:

- increase of operation period;
- decrease of electric power and diesel fuel expenses;
- improvement of locomotive traction properties;
- reduction of maintenance and repair expenses;
- increase of readiness coefficient;
- increase of run between repairs;
- significant reduction of life cycle cost.

It should be mentioned that apart from production of new locomotives RZD sets one more important task for the industry — to provide the rolling stock with original spare parts for the entire life-cycle of the product. That is essential not only to ensure the rolling stock stability and reliability, but also to create an effective service system.

The key problem of Russian railway engineering is lack of sufficient capacities and its technological backwardness in comparison with its foreign competitors. Russian railway engineering fails to meet RZD's requirements in up-to-date highly efficient rolling stock in order to fully perform freight and passenger operations. Efficient development of railway engineering and increase of its export potential are impossible without solving this problem.

Decline in transportation volume along with overall budget deficit have led to reduction of new railway rolling stock purchases and consequently to poor financial situation of railway engineering companies,

Table 3. Foreign railway engineering technologies not applied in Russia

	Engineering parameters	Advantages
Aluminium car body	Length — 24.175 m Width — 3,265 mm Heightabove rail level — 3,990 mm Floor height — 1 360 mm	— Enhanced lifetime — Light weight — Plane surface — Modern varnishing, — High inoxidizability
Locomotive bogie Vmax=300 km/h	Distance between axels of wheel pair –2,600 mm Wheel rim diameter — 920/860 mm Gauge — 1,520 mm	— Comfortable primary and secondary stages of suspension — High running stability owing to drives of wheel pair and wagging damper — High traction power — High brake power
Traction transformer (TT)	Output traction power max — about 2,100 кW Output voltage (linear), max — about 2,800 V Output frequency, max — 210 Hz Weight — about 3.4 tons (two-system)	— Water cooling — Direct networking — Application of IGBT technology

reduction of expenses on R&D and capacities enhancement. Rolling stock for railway transport that has been developed during those years does not contain fundamental innovations allowing a new model to be considered new-generation equipment. These models have only marginal improvement over the previous models.

This problem of railway engineering is connected with the general economic depression in Russia in 1990s that has led to dramatic decrease in railway transportation: the freight turnover was reduced by 2.5 times, and passenger turnover — by 1.8 times in 1999 in comparison with 1990.

Railway traffic decrease together with constant budget deficit has reduced new railway rolling stock purchase. For example, volume of main line electric locomotives production was reduced by 26 times in 1998 in comparison with 1990.

As a result by 2000 technological level of Russian railway engineering was the same as it was in the 1990s, and is considered to be 15—20 years behind international standards.

Private investments aimed at the modernisation of the industry in the early 21st century helped to shorten the technological lag, but nevertheless it remains quite significant.

At the moment there's a dire shortage of Russian-made components necessary for the production of world level railway equipment. Among those not produced in Russia one can name asynchronous traction equipment on IGBT, aluminium car bodies for the passenger rolling stock, high-speed bogies (over 200 km/h) for passenger coaches and locomotives (Table 3).

Railway engineering manufacturers highly depend on deliveries of hi-tech components for rolling stock. Quite frequently, however, these components do not play any important role in their producers' sales structure. As a result third-party manufacturers do not pay enough attention to quality improvement and production development of modern components for rolling stock. On the other hand the dependence of railway engineering producers on them allows them to raise prices unreasonably.

One of the problems of railway engineering is a lack of qualified personnel of both working and managerial positions. In 1990 in the Soviet Union there were 2 R&D institutions, and 7 design bureaus with 6,300 employees. In 2009 in Russia there are 2 R&D institutions and only 4 design bureaus with a total of 2,210 employees. The continuity between generations of designers is endagered: their average age exceeds 60 years. We have just a few young active and hard-working designers at the age of 30—45. One of the main priorities therefore is making the profession of a railway designer attractive for talented young people. Technological gap is a problem railway engineering shares with related industries, including electrotechnical industry and diesel-building, and should therefore be resolved through joint efforts. Production in these industries is often inferior to their international competitors.

However, Russian railways need locomotives equipped with asynchronous traction engines, commutatorless drives of auxiliary mechanisms, modern on-board and infrastructural complex diagnostics systems capable to decrease maintenance and repair expenses and to improve technical and economic parameters of transportation process.

Joint development of new-generation locomotives by RZD and railway engineering companies

According to Russian locomotive-building development programme RZD together with railway engineering companies realize a number of projects in new-generation locomotives production.

Transmashholding is a co-developer of two-system EP20 passenger electric locomotive. Its run will be increased by up to 2.5 times in comparison with current electric locomotives and will reach 12 mln km, its average haul distance will triple up to 2,000 km, its working life will increase by up to 40 years. Its increased technical and economic parameters will enable to replace no less than four electric locomotives of transition models during its operating life.

These machines will become a basis for new-generation electric locomotives development, including locomotives with asynchronous traction engines.

According to the rolling stock modernization programme the development of 2ES10 DC freight locomotive with asynchronous traction engines was launched in 2008. This electric locomotive compatible with RZD's technical requirements is planned to be unified as much as possible with the 2008

EP20 passenger double-current electric locomotive with asynchronous traction drive (Novocherkassk Electric Locomotive Plant — Alstom)

Being developed since 2008
Life cycle cost — 1.5 bn rubles
Integrated effect in comparison with electric locomotive EP1 — 104.7 mln rubles
Pay-off period — 12.3 years

2ES10 DC freight locomotive with asynchronous traction drives (Ural Railway Engineering Plant — Siemens)

Being developed since 2008
No quick-wearing components
High power-to-weight ratio
Individual adjustment of traction engines

Characteristic comparison of VL11 and 2ES10 freight locomotives

Main characteristics	VL11	2ES10	Difference, %
Hauling capacity in long-term mode, ton-force	32	60	88
Life cycle cost, bln rub.	650	510	-21

2ES6 DC freight locomotive with collector traction engines of independent excitation.

The asynchronous traction drive for 2ES10 electric locomotive is being developed by Siemens for the purpose of development terms reduction and high technologies introduction in the field of engineering.

They will be produced by the newly established JV between Sinara and Siemens on the basis of Ural Railway Engineering Plant (Verkhnyaya Pyshma).

New 2TE25A "Vityaz" freight diesel locomotive with asynchronous traction engines and Euro-3 diesel engine possessing high traction and power properties has been developed quite rapidly. Diesel locomotive having the parameters of minimal influence on track is keeping with the parameters of the world best models. 2TE25A life cycle cost is 22% less than LCC of the nearest analogue — 2TE116U freight diesel locomotive produced by Lugansk Plant. Now 2TE25A diesel locomotive is tested at the Moscow railway. The current priority is to improve its reliability parameters as fast as possible and to start its mass production.

Application of synchronous traction engines with constant magnets and gearless drive that will reduce maintenance volume during operation looks quite promising for new passenger high-speed locomotives.

In order to decrease dependence on conventional energy sources as oil and oil products, it is important to expand work on application of alternative types of fuel, in particular, natural gas and hydrogen.

Introduction of alternative gas fuel is closely connected with the use of gas turbine engines on autonomous locomotives which have specific mass-and-size characteristics than diesel reciprocating motors.

Most effectively gas can be stored in the locomotive in its liquefied form. However, several technical and organizational problems need to be resolved before natural gas can be used as locomotive fuel:

GT1 mail line gas turbine locomotive, first-ever in the world running on liquefied natural gas

Power equipment capacity — 8300 kW
Turbine type — NK-361
Turbine life — >100,000 hours
Liquefied natural gas load — 17 t
Fuel distance — 1,000 km

Life cycle cost at Sverdlovsk railway

	2TE116	GT1	Difference, %
Life cycle cost, bln rub.	1.17	0.98	-19.39

Two-diesel locomotive

Annual expenses saving — 540 thousand rubles
Fuel consumption reduction — 10%
Maximum speed capacity — 95 km/h
Diesel capacity — 2x478 kW

Shunting locomotive of low capacity

Maximum speed capacity — 80 km/h
Hauling capacity in long-term mode — 91.3 kN
Capacity — 441 kW
At a light-weight shunting operation in comparison with ChME3 locomotive:
— life cycle expenses reduction — 7.2 mln rub.
— Annual operation expenses saving — 915.3 thousand rub.
— Pay-off period — 8.2 years

- Creation of highly efficient gas turbine engine for locomotive;
- Develop algorithm of regulation systems to provide interaction of gas turbine engines with electric transmission;
- Development of locomotive on-board systems of refueling, storage, transmission and regasification of liquefied natural gas;
- Creation of gas turbine engine fuel system, working on liquefied natural gas.

These problems were successfully solved with the introduction of the world-first GT1 gas turbine locomotive, running on liquefied natural gas. It was used to set a world record of train weight of 15,000 tons with single traction from the head of the train. This result is registered in the Russian Records Book.

Pilot model of ChME3-1994 shunting diesel locomotive has been tested by VNIIZhT. The locomotive is powered by compressed natural gas using electronic system of gas submission into the diesel engine. This diesel locomotive is the prototype of diesel locomotives. Since 2013 they will operate on Adler railway section of Sochi-Adler-Veseloye line. Diesel fuel replacement by natural gas is 60%, and decrease in toxicity of exit gases when working on natural gas is not less than 30%. The economy of switching seven diesel locomotives to gas on the tested track section, in comparison with ChME3 diesel locomotives is about 350 thousand rubles per year per diesel locomotive.

Priorities for locomotive-building industry for the 2010 — 2012 should be the following:

2010 — Development of a mass production of 2TE25 diesel locomotives;

2011 — Development and start of mass production of EP20 double-current passenger electric locomotives;

2011 — Manufacture of 2ES10 freight electric locomotives with asynchronous traction drive;

2012 — Manufacture of new-generation diesel engines with power of 1500 and 4500 h.p.

JSC "Railway Research Institute" (JSC "VNIIZhT")

Largest scientific center of 1520 mm track gauge in the field of research and design works since 1918 that is capable to conduct all spectrum of certification tests

Scope of activities:

- Exploratory and fundamental research
- Development of new technical means and technologies for railway and other kinds of transport
- New materials development
- Automatic control system and software development
- Elaboration of technical regulations, specification and guidance documents
- Commissioning and certification tests of railway engineering and transport technologies
- Projects evaluation
- Experimental models and prototypes designing
- Standardization and metrology
- Small – scale manufacture
- New engineering prototypes production
- International projects
- Consulting services
- Scientific personnel training

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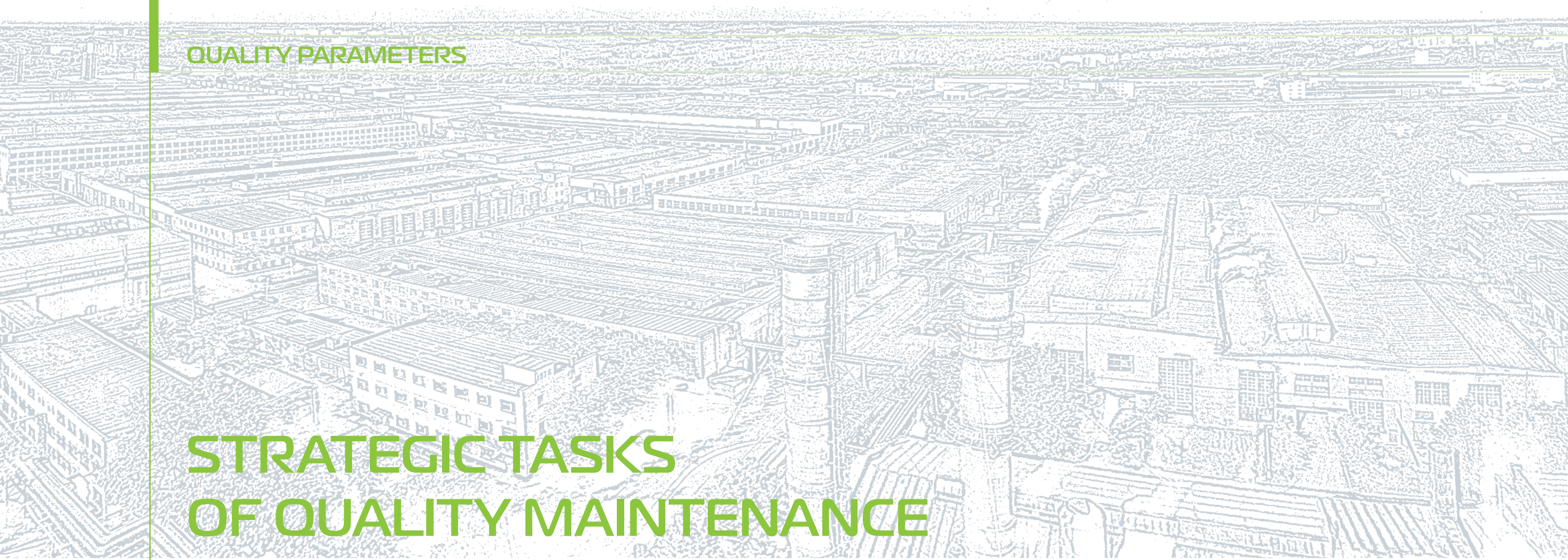
Russian Railways



STRATEGIC TASKS OF QUALITY MAINTENANCE

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Much has been done in the last few years for production quality improvement at Russian railway engineering companies, and its level has noticeably risen. If we were to single out only two main components: design of products with higher quality and introduction of quality management systems, we could give lots of examples.

Thus, realisation of innovative development strategy contributed to introduction of new technologies and improved quality production in Russian railway engineering plants.

For example, to improve the quality of moulded pieces in freight car bogies, car-building companies have adopted new technologies of steel casting. Today Promtractor-Promlit plant in Cheboksary casts these details using vacuum-membranous technology. Other plants have started to use cold-hardening mixtures.

In recent years, rapid development of Russian railway car-building allowed to create new casting capacities in Usolye (Irkutsk region) and Rubtsovsk (Altai). Introduction of high technologies is carried out in Tikhvin and Ruzaevka. The casting complex in Rubtsovsk is notable for its most advanced technologies of heavy casting and high quality production.

At the same time sturdy construction of solebars for freight car bogies were designed, the mass production of bogies with increased axle load was introduced. Bogies with one million-kilometre-run between repairs are being created.

Production of a range of new models of freight cars with the increased quality parameters and commercial use was launched. These cars feature increased dimensions, increased axle load, aluminium body, etc. The most advanced models of freight cars are produced by Uralvagonzavod, Roslavl Car-Repair Plant and Promvagon plant in Kanash.

Locomotive building companies have started to produce new contactors with increased reliability. They have created new microprocessor control systems, more reliable traction engines, traction generators, converting systems, safety of operation and automatic driving systems. Frictionless bearings in traction drive suspension are introduced; traction diesel engines and a range of locomotive major elements have been modernized.

These innovations allowed to develop new locomotives:

- 2ES5K and 3ES5K freight AC electric locomotives
- 2ES6, 2ES4K freight DC electric locomotives
- EP10, EP1, EP2K passenger electric locomotives
- TEP70BS, 2TE25K diesel locomotives

A wide range of railway equipment producers (Transmashholding plants in Kolomna, Bryansk and Novocherkassk as well as the Ural Railway Engineering Plant of Sinara Group) were involved in development of all the above mentioned locomotives.

Two entirely new models were introduced for the first time in Russia: a new-generation 2TE25A diesel locomotive with an asynchronous drive, (its quality parameters do not in any way inferior to foreign counterparts), and a gas-turbine locomotive with unprecedented unit power of 11 300 h. p. running on liquefied natural gas.

In passenger car-building new air-conditioning systems are introduced, passenger coach bogie with improved dynamic characteristics is manufactured, and interior and comfort in coaches are considerably improved. The production line of new passenger coaches which are used in deluxe long-distance trains is created.

Quality of interior, mechanical and electric properties of MU fleet is improved. Production of the rail bus which proved to have good operation characteristics and comfort was launched.

At the same time, foreign railway engineering is promptly developing while Russian industry lags behind the rest of the class in some types of rolling stock. Railway operators require more advanced rolling stock for large-capacity freight container transportation. There is no freight rolling stock with operating speed of 120-140 km/h.

It should be mentioned that today not only the necessity of quality management effective systems is fully understood, but a wide range of projects in this field is realised. Producers have introduced learning and training systems in quality management. For the first time the IRIS standard of the European railway industry was translated into Russian and distributed among UIRE members to develop implementation programmes. The industry system of voluntary certification and quality engineering system at the enterprises are introduced. Lean production was introduced at Novocherkassk Electric Locomotive Plant. All the plants actively use the newest quality maintenance instruments like FMEA, RAMS and others. Productivity of quality management systems has greatly improved. At the same time there is clear awareness that a lot still has to be done.

A lot is being done to create a new system of supplier quality assessment; producers have expressed great interest in this new system. Many producers have already applied to UIRE's Technotest Quality Bureau to participate in approval and estimation of quality of supply, technical audit and help in organisation of work with suppliers. Certainly, the result will immediately change quality of supplies used in the rolling stock production.

Pre-1990s railway engineering potential has been completely restored during the last five years, while some plants have upgraded their production facilities. Former leaders of railway engineering: Transmashholding, Sinara Group, Siberian Business Union Holding Company, Russian Transport Engineering Corporation and others are back in form. The attitude to quality maintenance has radically changed. Working for quality is not a formality anymore. It has become a vital necessity on the road to success. In the shortest terms, it has allowed to create a new rolling stock production line which characteristics surpass those built during the Soviet period.

Meanwhile, today the enterprises should optimize their costs in new economic conditions of production decline. Unfortunately, most have opted for the simplest and easiest way of inertia and try to react adequately to volatility in demand. They have to introduce volume decrease, personnel reduction, and part time shifts. Certainly, such measures negatively affect production quality. Plants work according to condensed version of plan, the interrelation of technological processes becomes broken; manufacture engineering support and quality control becomes worse.

This has brought the fall in quality: RUR 375 mln worth of products was rejected by quality control. As a result, instead of cost reduction, these factories faced raising costs to eliminate defects, and made their situation even more complicated. The amount of failures of equipment purchased by RZD due to quality reasons has increased, and non-production costs of the company for idle time and off-schedule repairs have risen. Quality level reduction has required extra costs to the sum of approximately RUR 1 billion which could have been invested to purchase additional rolling stock.

Quite noteworthy is the idea of some plants to use the balanced optimization of costs in order to save as much as it is possible the achieved productive potential, to reduce investments and to concentrate them on start-up complexes for production of innovative and highly competitive product in short terms.

Much can be achieved through efforts in reduction of direct material costs, power consumption, as well as non-production costs and labour input, introduction of automated manufacturing, etc.

This April UIRE approved a version of production facilities upgrade and new innovative product launch, which will generate new demand and will allow exiting the crisis much earlier.

There are the examples to be mentioned. IST Group in Tikhvin actively continues reconstruction so that in 2010-2011 it could supply the Russian market with increased carrying capacity freight cars with 1mln km run between repairs. Reconstruction of Altaivagon continues, as well as at Uralvagonzavod. Tractor Plants Concern creates a new flexible production of specialized rolling stock. The investment program of Transmashholding meets all these requirements.

Proactive approach to the crisis issues solution allows to significantly minimize negative effects, to form positive trends in production stability and quality maintenance. It accumulates potential necessary for successful competition once the crisis is over.

The main issue is not so much the effect the crisis has upon the production (certainly, the impact will be negative). The main thing is how to work during the crisis in order to achieve a positive effect both now and in the future. In our opinion, the most effective way is modernization aimed at manufacturing new products of higher quality.

In these conditions actualization of normative and technical base becomes vitally important. Enormous files of standards have grown out of date and require reviewing and updating. They include more than 8 thousand standards of a national and industry level, thousands of standards used by railway engineering companies. Technical rules of railway transport will be approved soon. These basic documents require hundreds of supporting standards for their implementation. It would be naive to believe that railway engineering plants on their own without proper budget allocations will be able to create new standard-based legal foundation. Even during stable times the plants are not able to pay for the development of such huge quantity of standards independently. Unfortunately, this problem has not been solved on the government level yet.

One of the main tasks of standardization is to create a correct "quality pyramid" on the basis of standard requirements. Obviously, requirements of many standards are taken as a basis in developing safety norms. There's an opinion that it would be better to move several requirements into supportive technical regulations. But in fact safety requirements are minimal. There is a problem that the majority of the enterprises while executing requirements also use rules of the same standards. Thus, they work with the minimum standard of quality providing only safety conditions. But customers require higher quality.

The purpose of standardization therefore is to create a correct pyramid of quality requirements. The main point of this "pyramid" is that safety requirements should be the minimal, requirements of national standards would be above minimal safety requirements, industrial ones would be above national ones, and requirements of standards of the organizations would be above industrial ones. It is necessary that the national standards requirements should exceed the international ones to be internationally competitive. Certainly, it is difficult, but this is the only right direction.

UIRE has not worked out the mechanisms of realization of such a mighty task yet, no ideas as to possible sources of financing have been submitted to the state structures yet. All UIRE committees together with manufacturers and, first of all, with UIRE standard committee must work in this field.

There are other, no less important issues. These are questions of standardization within the integrated railway space. It is becoming increasingly dissociated due to independent development of national and industrial standards, which explains the lack of harmonization with the neighbour states railway space. It makes the work of a unified freight cars fleet complicated, and in the future transport corridors for transit trains might become necessary.

Certainly, the priority in the decision to this problem belongs to the Railway Transportation Council of the CIS countries. But UIRE cannot ignore the issue of railway equipment technical requirements harmonization. The solution of this important problem will facilitate the speed of innovative technologies introduction into various national railway systems.

It should be noted that most of the CIS countries share constructive understanding of this problem and have come up with creative initiatives to solve it on the basis of compromises. But decisions of Railway Transportation Council do not influence development and harmonization of existing national standards yet.

The reasons are rather political, than technical, they are beyond UIRE's competence, but they make resolving standardization problems even more difficult. Appropriate decisions on intergovernmental level could remove many unreasonable obstacles and stimulate the railway engineering interstate standardization process.

The problems of quality parameters standardization and quality management system are also under control of UIRE. The series of standards supporting functioning of quality management system of the enterprises are designed. These standards allow organizing estimation of a production processes, certification of technological systems, systems and methods of design, compliance estimation and control.

The most complex and most difficult to introduce but at the time the most advanced standard in this area is the International Railway Industry Standard (IRIS) based on the industrial specifics not presented in ISO 9000 standards. It's an entirely new and comprehensive standard which embraces accumulated experience quality management system requirements in other industries. It represents a number of requirements to control systems, including quality. It is otherwise known as the business management system standard.

The standard structure considers not only industrial features but also other specific requirements. This standard therefore does not conflict with existing national standardization system, including state and industrial standards. In fact product quality depends on the technical requirements and on how they are observed during the production process.

Implementation of IRIS requirements approved by management system certification provides high degree of product technical compatibility. Obviously, if technical standards are not compatible with international IRIS standards, the product even if certified by quality management system will not be competitive. To provide a high competitive level of national railway engineering IRIS implementation is necessary but not sufficient. It is essential to harmonize certain technical requirements of state and industry standards, and other technical requirements to products, production process, and control methods with corresponding technical requirements of international standards.

If national technical requirements are higher than international requirements, production quality will be quite competitive internationally. And compliance of quality management system with international standards requirements will provide high technological stability, qualitative results and guarantee of qualitative product manufacturing. Therefore there are no contradictions but a necessity to provide conformity of technical requirements to the highest standards alongside with introduction of IRIS.

Over the last three years RZD has created incentives for manufacturers to improve quality of their products. First of all, the company consistently fulfils all its obligations regarding quality taken up in the 2006 Memorandum of Cooperation. Since then the purchases of new rolling stock have considerably grown. The company consistently provides its specialists, expertise and technologies to support manufacturers in their development of new railway equipment. It helps to organize operational tests, certification, mass production launch, acceptance procedures etc. on a regular basis and at its own expense. Recent radical changes in contractual relations prioritized quality issues, defined responsibilities and conditions of long-term relations. Manufacturers will agree that without RZD's active organizational and technical support the results would have been much more modest.

The important step in further strengthening of cooperation in the field of new equipment development and technological modernization of railway transportation and engineering is the Charter signed by RZD together with a number of leading railway engineering companies in April of 2010.

This document becomes even more important, because it was signed in the period of economic instability. Russian railway engineering industries are more confident in realization of their plans for purchase of a new rolling stock, so companies can implement the investment programmes without any fear. All the products complying with the requirements of innovative development and produced by the railway engineering factories will definitely find their buyer. This document determines the conditions of transition from a resource pricing method to life cycle cost-based pricing approach. This approach will increase producers' interest in innovations and will provide RZD with the highest-quality products.

This is a huge impetus for creation of the new railway equipment which will support stable development of railway engineering, and improve the quality of RZD commissioned products.

According to RZD's quality policy the company is preparing to transfer commissioning of new products exclusively to IRIS certified industries. The reasoning behind this preparation is to introduce a new effective strategic quality management system. The specified system assumes creation of effective suppliers system, managing suppliers in terms of understanding core requirements of the company, creating new producers, evaluating current technologies and factories, tracking results of innovative development and technological modernization, creating new conditions of quality improvement motivation based on company participation in major investment projects, etc.

Some elements of this system already work and bring results (e. g., Ural Railway Engineering Plant and Promvagon are founded with participation of RZD during the last years).

The most vivid example is cooperation arrangements with a strategic partner – Transmashholding. RZD invested in the development of the company by purchasing 25% of its shares, it supervises the investment programmes implementation, takes part in rolling stock production planning, determines future technical requirements for locomotives, carries out quality management, assists in launching mass production and in implementation of advanced quality tools.

The aim of these is to help producers to be compliant with the IRIS standards. If for any reasons a plant can't reach the IRIS level it will lose some preferences of RZD including order volumes.

But if the enterprise introduces a clearly defined programme of reaching the IRIS level and supports its intentions with practical results and regular audit, it will preserve its relationships with RZD. It may even receive the company's support regarding preparation and certification processes. Otherwise RZD will eventually stop cooperation with the enterprise.

To avoid this problem, UIRE has founded Technotest quality bureau, which provides essential methodological and practical assistance to help companies get minimal necessary points to satisfy compliance of quality management system with the IRIS requirements.

Contacts with the European Association of Railway Industry (UNIFE) are fully established, and corresponding cooperation memorandum was already signed. The memo has become a basis for the licensing agreement giving UIRE the exclusive right on translation and distribution of the IRIS standard in Russia and CIS countries. It has already been translated and the official version approved by UNIFE and IRIS management was sent to all UIRE members. It should be emphasized that English is the standard's official language. The UIRE version is the first experience of the IRIS standard translation into a national language. Even initiators of its creation – France, Germany, Spain and other countries – still do not have the standard in their national languages.

It determines that UIRE is a legal owner of the Russian version of the standard. UIRE carries out all necessary work on promotion of the standard to the Russian companies. All day-to-day work on standard introduction is performed by Technotest, which is responsible for personnel training, capable to implement standard on plants, assisting companies in determining the status and compliance with IRIS, preparing plants quality management system to preliminary and certification audits.

UIRE provides maintenance of the Russian version of the standard, actualizing it and defining a group of the Russian consulting organizations on training and implementation of this standard, etc. In other words it provides the enterprises with everything necessary to develop their own implementation plans, to realize them, and to prepare for certification.

Given great disparity in different plants readiness level, it is increasingly important to create an intermediate variant applicable to Russia. It will reflect several different levels of requirements up to total IRIS conformity. Development of this variant is on the stage of approving of the basic approaches now. Especially interesting is the idea of a gradual ascent to the top of IRIS requirements. Relevant experience was accumulated by RZD and it should be used by other enterprises.

IRIS training by foreign experts scheduled for February 2009 failed due to many reasons, partially economic. But this should not delay the process of IRIS requirements introduction. UIRE certified consultancies have actively started to provide appropriate training. This is even more convenient for the enterprises because training is organized directly at the plants.

In order to realise plans on IRIS standard introduction in Russia, UIRE and Technotest together with IRIS group management have provided preparation of 60 experts on Russian plants in 2009-2010. The specialists should be able to continue training and standard introduction at all multistage levels of Russian railway engineering in the future.

The first group of 20 Russian experts were trained and successfully passed the examinations established by the international European association for "trainer" degree in the field of IRIS standard and internal auditing during the period of 7-9 July, 2009.

This event is significant for the Russian railway engineering as it actually starts practical implementation of the standard requirements at the plants. This process will provide considerable quality improvement, operating costs reduction, and increase RZD's efficiency.

URGENT ISSUES OF TECHNICAL REGULATION IN RAIL TRANSPORT LEGISLATION

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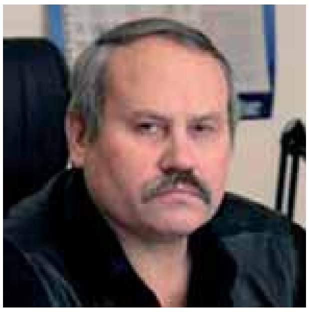

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The purpose of technical regulation in legislation is to avoid operating a product which is dangerous for human life and health, or can damage the environment. At the same time it should avoid any excessive (unnecessary from the security point of view) intrusion into the market processes associated with product manufacturing, shipping, operating, storage and recovery, as well as to provide unobstructed product turnover without excessive technical barriers.

With regard to rail transport it means prevention of release and operating dangerous railway equipment non-compliant with statutory security requirements, as well as prevention of using dangerous objects and railway infrastructure installations.

Current stage of market economy development, along with deficiency of the judiciary system in Russia cannot provide reliable background for market self-regulation. It is therefore impossible to implement full scale control over prevention of release of dangerous objects with subsequent dangerous accidents, without specific technical regulations such as obligatory compliance approval, tests, evaluation, control and monitoring.

Product danger used to be measured by the level of dangerous situation risk. Risk level for desired operating conditions is measured by a set of physical and/or chemical parameters and their values.

Products with the same function, but with different structure may have different parameter sets to define their security. It is especially true of innovative, fundamentally new products.

To complete the task of providing security, it is first and foremost necessary to set a list of potentially dangerous products, including their elements. Then we should define and provide an acceptable risk level for such a product, therefore:

- estimate risk levels;
- identify a set of parameters determining and providing such operating risk levels;
- set the values of operating parameters;
- define inspection methods for operating parameters and for verification of product's compliance with assigned risk levels.

Regulatory compliance assessment

Assigned security parameter values, methods of their inspection and verification have to be included into appropriate regulatory documentation — technical regulations and maintaining standards; compliance therewith serves as confirmation of the product's compliance with technical regulation.

Product safety can be provided only by a very strong connection between strong aggregate of the risk level, technical requirements and inspection methods and the check system to assess the product's compliance with these requirements. After working out such a regulatory system, risk assessment can be effectuated by the way of regulatory requirements observation control, and basically this is what compliance presumption realization really means. Meanwhile, the regulatory system should allow using an alternative documentation, with product manufacturer providing risk calculation and compliance verification with such operating risk criteria.

Thus there are two possible variants:

First: compulsory use of maintaining standards and sets of rules, identifying safety requirements and inspection methods for controlling product's compliance with these requirements, providing product regulatory presumption. A manufacturer then is not charged with working out the risk calculation and product safety verification, whereas compliance with maintaining standards and sets of rules turns as mandatory for him.

Second: using alternative documentations for product safety verification. In such a case it is necessary:

- if alternative inspection methods are used, their results should be proved compatible with the supportive standard methods;
- if alternative regulatory documentation is used, their requirements should be equivalent to supportive standard requirements;
- if documents, which do not correlate with supportive standards are used, the product safety should be proved directly, through risk calculation and risk test result verification.

All the above mentioned provisions are also true for instances of use and compliance verification of the foreign standards and sets of rule, as well as to innovative product compliance verification.

Current Railway Safety Code is basically compiled from existing practical requirements, therewith compliance provides an achieved safety level with acceptable risks, confirmed by real railway equipment operating result.

Railway technical regulations, prepared for Governmental approval, are developed in accordance with the New European approach and contain only functional and fundamental safety requirements without identifying value indices of safety parameters. Thus they are more flexible and universal, and do not require frequent amendments, which usually represent serious troubles for documentation of such a level. Specific indices are fixed only in the so-called supportive standards and sets of rules, compliance therewith provides product regulatory compliance presumption. Such documents have lower level of approval and can be promptly modified in case of science level being changed or innovative product being launched.

In the course of Russian regulatory system reform a few really important issues were ignored. Namely: responsibility for the accuracy of assigned requirements in technical regulations and supportive standards, as well as their completeness from the viewpoint of providing an acceptable risk level. We believe that responsibility for the technical regulation as a whole must be laid on an appropriate federal agency, i.e. the Ministry of Transport should be responsible for the rail transport. The main responsibility for a specific document — any technical regulation, standard, set of rules, must be laid upon its developer. A qualified developer should receive payment for his work and should be warned about his responsibility which must be stipulated in his contract. Drafts of documentation are to be submitted for an assessment by competent specialists and companies who should equally share responsibility with the developer. The process must be open and public and involve standardization technical committees.

Concerning the infrastructure objects safety, considering limited time factor, it is necessary to be guided by active construction norms and regulations, as a basis for development of the sets of rules. If necessary, foreign regulations may be implemented, but existing major differences in Russian and foreign standards should be taken into account: they may lead to instances of incompatibility. Construction designs have to be submitted to the mandatory examination by competent expert organizations, and the work-flow must be constantly controlled by customer and supervisory authorities. Compliance with appropriate requirements should be approved at the acceptance stage after all the necessary tests and examinations.

Accreditation system

One of the most important tasks of reforming the system of technical regulation in Russia is to secure the objectivity of verification process and credibility of its results, precluding the need for re-inspections and tests.

Verification should be sufficiently formalised to ensure the uniformity of work by various organs and the prevention of corruption, but at the same time it should not be an insurmountable obstacle when alternative decisions should be taken in an emergency situations.

This variability must be balanced by a clearly-defined legal responsibility of officials taking such non-routine decisions, for their objectivity and accuracy (similar to notified bodies in Europe).

The objectivity of the decisions taken is ensured by competence and independence of their host bodies, and trust – by grant of appropriate authority through the accreditation procedure.

In accordance with the legislation in the field of technical regulation in Russia the unity of accreditation system must be ensured, which provides the formation of a united national accreditation body. Identical decisions were taken in Europe in accordance with EC Regulation No. 765/2008, July 9, 2008, which defines the accreditation and market monitoring requirements. In accordance with the Regulation the accreditation body must meet certain requirements, such as:

- be the only one in the state and be duly authorized by the state (in the case of its foundation as a non-commercial organisation) or enjoy the status of the federal executive authority;
- independence;

- competence ensured by properly trained and accredited experts with a well-defined area of accreditation;
- availability of accreditation procedure at a fee;
- availability of procedure rules for accreditation works, their transparency and uniform non-discriminatory application to all applicants;
- involvement of competent organisations and experts into the work execution;
- availability of the unified register for accredited organisations and experts;
- government and public control.

Certification bodies should be independent, staffed with competent and accredited experts with well-defined area of accreditation; transparent certification procedures. They should not be discriminative towards applicants. All the information about their activities should be available. Their activities and compliance with accreditation criteria are to be controlled by the accreditation body.

Testing centres (laboratories) are to be equipped with all the necessary equipment (test means), consistent with their scope of accreditation, to have the proper testing technique and qualified experienced personnel. They should have an independent status or otherwise have procedures that will ensure their impartiality. Information about their activities should be available. Their activities and compliance with the accreditation criteria are to be under the control of the accreditation body.

Experts are to be properly trained, duly qualified and experienced, accredited and have a well-documented accreditation area. Experts can participate in the work either directly or as a part of expert organisations (centres), which must also be accredited, enjoy the independent status and documented accreditation area.

All organisations and experts are entitled to work exclusively within the limits of the set accreditation area.

On this basis, it is necessary to establish the national accreditation system in Russia, that meets the following requirements:

- existence of a single national accreditation body as a non-commercial organisation, authorized by the Government, or as a federal executive authority;
- ensuring the required competence level of the accreditation authority through the establishment of its units on separate activity branches;
- payment of the accreditation procedure with involvement of the accredited as appropriate experts and Centres of Expertise;
- openness and transparency of the accreditation body and its activity being monitored by the state and the public;
- supervision of accredited certification bodies and testing centres and prevention of monopoly in their activities.

Creating of such a national accreditation system will be a starting point in matters of mutual recognition of certification and testing in Russia and abroad.

Compliance verification procedure

Russian laws on declaration are significantly different from modules of conformity assessment, adopted in Europe. Thus, out of 16 European modules 10 of those contain procedures of granting the certificate by notified body, which is the product certificate or the certificate for the project. 5 other modules provide the manufacturer with quality system assessment by the notified body. At the same time, according to the Russian legislation, the participation of the certification body as the third party adds up only to certification of the quality system in one of the declaring schemes by the legal unsettlement of manufacturer responsibility for failing the product balance to the existing conformity declaration.

Given the growing integration between Russia and Europe, this disbalance should be eliminated and at the same time the legal gap is to be excluded in the legislation of the manufacturer liability by adopting the declaration of products conformity with safety requirements.

The procedure of registration of the conformity declarations by the certification body within three days also gives rise to doubt. Obviously, for a serious analysis of the documents provided, this period is too short, and the payment for these works, that makes two minimum monthly wages (Regulation of the Government of the Russian Federation on July 7, 1999 № 766 and Regulation of the State Committee of the Russian Federation for standardisation and metrology on August 23, 1999 № 44, agreed with the Russian Ministry of Finance), which in accordance with the federal law “On the Minimum Wage” equals 200 rubles, does not encourage such an analysis. And just a common document record does not make any sense in terms of assessing accuracy of the adoption of a declaration, then the certification body liability for this procedure is not statutory defined, whereas in Europe this declaration is adopted by the manufacturer and recorded upon notification.

Procedures and mandatory certification schemes are rather well-worked out in practice and do not cause much difficulty. A question which still requires attention is the range of certification applicants. For the compliance verification it is exhaustingly specified in the law: legal entities or an individual registered as a private entrepreneur, a manufacturer or seller: a representative of a foreign manufacturer whose contract provides the liability for the supplied products compliance to the requirements of technical regulations and for the imbalance of the supplied product to the technical regulations (person who acts as a foreign manufacturer). For mandatory certification however the legislator has failed to provide an unequivocal explanation.

Some specialists believe that the range of applicants for certification is the same as for the compliance verification. In this case no application for certification from a foreign manufacturer can be accepted and such foreign manufacturers will be forced to register in Russia as a foreign manufacturer, which apparently will not help reducing technical barriers in trade. This question requires prompt solution, because applications for certification from foreign manufacturers continue to be submitted and accepted. In total, it is expedient to begin the transition from the existing certification schemes to the modules of conformity assessment, adopted in Europe.

Several instances of foreign products certification, manufacture of which was carried out on a single design and technology documentation, but was prolonged and therefore they could not be presented for full scale certification, proved it to be expedient to develop a relevant certification scheme. This scheme would provide certification of the supplied products along with the analysis of production process. Thereupon compliance verification certificates can be issued without repeated testing but with visual examination and inspection of the accompanying documentation. In that case the production analysis is necessary to assure the certification body that manufacturing company is capable to supply products compliant with the certified samples.

Individual study is required in order to certify an innovative product. We consider the situation when the new products cannot be up to quality with the specific safety requirements, set forth in the technical regulations and maintaining standards series products based because of advanced design solutions. For example, there are no standards in Russia, specifying requirements for disc brakes of high speed trains, electronic system management of these trains, aluminum air tanks and other components, which met inconveniences by certification of Sapsan electric train.

The federal law “On technical regulation” stipulates the option of rejecting the approved list of supporting standards, but it entails the need to prove the security and acceptable degree of any risk. This alternative variant is simple, direct and clear, but easy to realise only for simple, technically unsophisticated products. For the technically sophisticated products this method can be very complicated and time consuming, not providing all the necessary reliability and confidence in providing acceptable risk.

For rail facilities such calculations of risk levels were not performed, there are no certified approved calculation methods, and there is no basis of comparison for the individual components. Under these conditions, it is possible only to compare with the factual level of risk, but not all component parts have necessary accumulated statistics here as well.

The law allows to apply foreign standards for purposes of compliance verification, and the procedure is quite simple. Since it is about complex technical facilities, their safety as a rule is defined by the whole set of standards. And the selective application of one or two documents, rather than a set of standards will most probably not ensure the “presumption of conformity” to the requirements of technical regulations, i.e. the guarantee of safety and the acceptable risk level, and it means it would be still needed to calculate the risks and make appropriate tests.

For national manufacturers for the purposes of compliance verification it is more appropriate to use the possibility of applying the so-called “pre-standards” – standards adopted for a limited time for innovation products compliance verification. Taking into account European experience in documents processing, it is required that production developer simultaneously with the development of working documentation, would develop draft standards containing safety standards (both for rolling stock and the new parts). Thus, by the time of finalisation and approval of construction documentation there should be developed safety standards in pre-standards draft form.

Pre-standard is registered by national body of standardisation – the Federal agency for Technical Regulation and Metrology – after the procedure of its study and adoption by the relevant Technical Committee for standardisation, and the possible term of its adoption and approval can take from 6 months to a year.

Considering that the process of making the major innovative components, the object itself, its set-up and pretesting would require approximately the same time, such a way would be the most acceptable.

Regarding the application of international standards, especially for the advanced modern products, it is necessary to conduct a systematic study of standards complexes, their analysis, harmonisation and adaptation under operational environment by Russian Railways. At the same time for this standardisation it is necessary to solve the problem of mathematical simulation methods application, on which the whole range of these standards is based, and also implement modern methods of inspecting product itself.

Technical regulation while operating process

All the descriptions above concern the process of evaluation and safety control of specimen product, its structure and manufacturing technology.

However, product safety parameters and potential damage to people and ecology may be revealed in the course of the operating process. Unfortunately this point has not been properly worked out and defined in the federal law “On Technical Regulation”. According to this law only government agencies have the right to approve the product compliance with technical regulatory requirements during the product turnover in the market. Of course, it is quite sufficient for products for personal individual use (except transport facilities). Official check-ups and examinations work for cars and water transport. But existing control (supervision) over complicated technical objects, such as railway rolling stock and its components is insufficient in our point of view. In the time when these objects had only one customer, and it was the state structure (Ministry of railways), there were other active control and safety provision methods. Nowadays after railways and technical regulation reforms, the situation has changed radically.

Certification verifies compliance of the selected specimen product with statutory requirements, as well as the manufacturer's technological properties to make products with such parameters serially or on the unit-by-unit basis. But the meaning of safety provision is to provide that all production coming out to operation must be compliant with safety requirements.

For mass consumption products their compliance with the tested specimens, and therefore with the prescribed safety requirements is verified through selective product checking and through scheduled and unscheduled control by certification bodies. It can also be implemented through product testing in the volume of periodical or acceptance tests, as well as through manufacture condition analysis.

For aircrafts, sea crafts, and river crafts, besides the type certification, the fitness certification is provided for each craft manufactured.

In case of complicated railway equipment the first inspection method is not effective, whereas the second one, meaning certificate for each specimen, is too costly — particularly for rolling stock, manufactured by tens thousands units yearly.

In the federal law “On technical regulation” the purpose of the product surveillance is its safety verification on the stage of circulation from coming out in use and in operating process till the write-off, whereas the stage of operation includes both intended use and all kinds of maintenance and repair.

Operating safety control is extremely important and difficult for the area of railway equipment. The direct “total control” approach is unsuitable, since it is too expensive both for the government and for private business.

We consider as appropriate the control and surveillance in two directions:

- verification of the safety documentary confirmation by manufacturer (supplier), operator and repair offices;
- immediate control and surveillance (through object technical condition check) of providing safe operating in the infrastructure owner departments, and of repair office condition.

It is the manufacturer who must provide compliance of each unit to appropriate safety requirements; for this purpose, as a system, input component control and accurate technological operation realisation must be provided, as well as effectuating all acceptance and in-cycle inspection on the appropriate level, ensuring an acceptable risk level.

Most important components and technological operations, providing conformity to safety setting requirements, must be marked out; people, responsible for compliance, control and documentation (automated as much as possible) must be assigned.

As a result, full document set will be prepared, which, together with acceptance test protocol and report enables the manufacturer to get a final document, security certificate for each unit.

Such a system of verification and safety provision system implemented through documentation analysis and questioning during local inspections must be the main task of an audit by the certification body. Its results must be included in the audit report.

The products supplied for the railway transport should also go through the acceptance and verification procedure. Such an acceptance, in accordance with the laws, can be effectuated only under customer's conditions stipulated in delivery contract.

In Germany the Federal Authorities have set up the list of important products that once manufactured have to go through a similar acceptance procedure; there's also a list of recommendation for control.

Rights and liability of acceptance experts are identified, as well as an order of their training, verification and documentary certification of their competence with specified area of accreditation. The contract of expert involvement stipulates necessary work conditions and liability for a result.

Customers have to stipulate such an acceptance in their delivery contracts and to provide its realisation. For such a work customers often make a contract to involve experts or expert organisation.

Implementation of such a system would be reasonable for Russia as well.

On the stage of operation, the owner (user) must provide safe product condition, with a risk level within normative, during the whole period of operating till the write-off. It can be provided only through correct operating, maintenance (control), and repair.

From both technical and legal points of view such a system should be developed and offered by manufacturer and developer. Only the developer is able to foresee wear and aging process, and on that basis to set a maintenance and repair system. This documentation must include recommendation of repair technology and requirements concerning the control procedures frequency, inspection methods, and equipment accuracy requirements. By the way, basing on such documents, and considering following reliability indexes, product life cycle cost can be calculated.

Document existence and adequacy verification must be controlled by certification body experts, and customers should stipulate in the contract delivering them all the necessary documentation.

If necessary, a user can modify maintenance system, providing required safety level.

Following all these conditions enables improving surveillance efficiency. Supervisory authority officers then can concentrate on verifying compliance with repair and operation documents, including checking required control and technological equipment existence, personnel skills, performance control system.

Obviously immediate control and surveillance remain for technical condition of the equipment, which is subject to mandatory compliance verification while operating.

Summary

On the basis of the above, the following basic conclusions can be made:

1. The purpose of mandatory compliance verification in the field of rail transport is the prevention of permit-to-work for unsafe railway equipment, and the procedure cannot be replaced by other mechanisms even in the market conditions.

2. There should be mandatory compliance verification on a minimal number of and their implementation is to ensure the acceptable risk level.

3. The actual acceptable risk level under existing operating conditions is stated by current safety standards for rail transport and the presumption of compliance of railway equipment to technical regulations' requirements may be ensured only by those standards or of supporting standards and set of rules developed on their basis. Any amendments to these regulations, including foreign regulations application, demand the safety check.

4. Under these circumstances, in connection with the tight deadlines for a single economic space formation, the development of supporting standards and set of rules like "safety regulations" by means of including the content of safety standards can provide significant time and capital savings, also because the risk and evidence of safety won't have to be calculated.

5. Russian legislation must be supplemented with the rules regarding setting the liability for correctness and sufficiency in ensuring the security of requirements stating in technical regulations, standards and set of rules, also in the case of foreign standards and set of rules application. These measures of liability are to be mentioned in contracts for carrying out such regulations document development.

6. For innovative and technically complicated products compliance verification, the special order is to be established, including the use of "pre-standards" and the establishment of more flexible procedures, stipulating the right of the certification body for adoption of non-standard solutions by setting its liability respectively the correctness of these decisions.

7. To ensure transparency in the compliance verification procedure and credibility to conformity assessment bodies, it is necessary to create a single system and a single national body for accreditation. This accreditation body must keep accredited experts, competent units in branch activities, and the external experts and centres of expertise are to be involved in work on contract basis.

8. Declaring schemes stipulated by Russian legislation demand the adjustment to schemes for conformity assessment adopted in Europe, also in the field of more considerable participation in certification authority declaration schemes (certification of the type of declared goods), as well as the order correction in recording the declarations of conformity by certification body in area of the expert examination of the documents in support on the contract basis, or changing it for the declarative order for declarations adoption as in Europe.

9. It is required to define clearly in the law on technical regulation the possible applicants spectrum for mandatory certification in the area of the possibility of filing and obtaining a compliance certificate by foreign manufacturer directly.

10. The manufacturer must have the system to monitor the adherence to established manufacturing technique and compliance of every item manufactured with the safety requirements, providing documentary confirmation of this in the form of first party document, and products labeling with a conformity mark only after the document execution. The existence and functioning of such a system is to be confirmed by certification body in the document of analysis of the manufacture state.

11. The manufacturer must develop the necessary set of operating and repair documentation, adherence to which should ensure safe operation within a specified period of service. The presence of such documentation must be verified by certification body, and its adherence - by organ of state control and supervision.

12. In order to improve the quality of potentially dangerous product and its main components it is necessary to introduce the institution of independent approval. In this case, the list of such products is to be established by the state, as well as the approval experts' rights, the preparation procedure, verification and documentary confirmation of their competence. Approval is to be carried out on contract basis with the liability establishment in the contract.

13. Maintenance and repair of railway equipment control and supervision during the operation are to be exercised by checking the adherence to the repair documentation, presence of operable technology and control equipment at the repair facility, which is stipulated by the repair documentation, and the compliance of the maintained and repaired items, and products which are operated by owners, to the safety requirements.

If overhaul plants use technology or control equipment, which is not covered by documentation, in, the evidence of its compliance with the security requirements it must be presented.

14. The body of state control and supervision should have authority for the following:

- suspense of operation of dangerous products;
- making prescriptions to manufacturer in connection with revelation of products non-compliant with safety requirements;
- demand from the manufacturer to present the action plan of eliminating revealed breaches in adherence with safety requirement or the voluntary product recall;
- mandatory recall of unsafe products through courts action. ■

DEVELOPMENT OF LIMIT PRICE CALCULATION METHODOLOGY FOR ROLLING STOCK

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Nowadays pricing of various types of rolling stock purchased by RZD is carried out on "costs plus" principle, in other words assuming the cost of this rolling stock manufacture with allowance for manufacturer's profitability. This pricing method is inadequate primarily because it does not imply any stimulus for the manufacturer to increase quality and/or decrease the production cost. Manufacturers do not feel it necessity to make additional investments in this area because they are not very likely to change their profit margin. Besides with the cost-plus pricing the buyer has no instruments necessary to analyze the expediency of purchasing rolling stock with particular specifications which in fact define the rolling stock price in cost-plus pricing. Practical advantages of using the purchased rolling stock may not be significant enough to justify the price which the buyer had paid for it. However today within the framework of pricing it is impossible to analyze this issue.

Why has the pricing based on costs appeared in the first place? At first sight, this mechanism is a heritage of planned economy. Besides, today the situation on railway engineering market, except for the freight cars, is seen as industrial monopsony of a unique buyer represented by RZD. Following the railway transport structural reform other buyers can appear in this market. However, in any case, their number will be limited, and the share of RZD will remain rather high. It means that the pricing principle applied by RZD will always influence this market by virtue of RZD leading position.

On the other hand, there is no competition between manufacturers on the rolling stock market (in view of a small number of rolling stock manufacturers, except in the freight cars sector). This theoretically could encourage production quality improvement. This situation is unlikely to undergo major changes in the future.

It is therefore irrelevant what kind of pricing scheme is used in railway engineering market. In any case this scheme will represent different forms of arrangement between buyer and seller. It always happens in a situation when we have both a dominating buyer and a dominating seller. The purpose of the suggested change is to base these arrangements on criteria of economic efficiency of product operation rather than its manufacture. The situation in the freight cars market with its successful transition market pricing, is a result of presence of several sellers and buyers in this market. In other types of rolling stock markets it will be hardly possible in the near future to avoid this or that form of arrangements between seller and buyer.

The pricing that allows consumers to estimate necessary rolling stock specifications from the point of view of their economic feasibility, and also encourages manufacturers to improve their products quality eventually connects the final price of a rolling stock with the parameters and economy of its future operation. Such approach is used in majority of developed countries. And we will be able to take all these factors into consideration, making the transition from “costs plus” pricing principle to the pricing on the life cycle cost (LCC) basis.

RZD'S METHODOLOGY

Foundation for this new approach, radically different from the production cost orientated price were laid in December, 2007 by the RZD approved “Basic Regulations of a Methodology of Determining LCC and Price Limit of Rolling Stock and Complex Technical Systems of Rail Transport”. This document was the first to introduce the concept of LCC understood as the consumer's combined expenses for the equipment purchase and maintenance which until then had been discounted. Thus, it was the first attempt to connect the price paid by a rolling stock buyer with parameters of its future operation. It's worth mentioning that the LCC limits offered by RZD take into account maintenance expenses per rolling stock unit which to an extent brings together the concept of life cycle cost with the former approach based on a rolling stock cost price.

Above all the methodology introduced the concept of limit (marginal) price. The limit price of a new or a modern rolling stock is suggested to be calculated as a sum of the price of the base equipment corrected by obsolescence coefficient and useful effect after the introduction of new equipment corrected by useful effect coefficient included in the price of new equipment. The useful effect in a methodology is considered to be in the form of productivity growth parameters, decrease of operation costs, increase of service life and other significant parameters.

The approach offered in the RZD's methodology is quite good as a first step. Now there is a need to develop this idea in several very important directions.

Firstly, in transition to pricing on the basis of rolling stock activity parameters during its life cycle, it is important to make the following step after introduction of useful effect accounting method through natural parameters of productivity offered by RZD. Namely, it is necessary to start considering cost of the rolling stock operation indices. Besides it is expedient to consider life cycle not only as a cost stream for a unit of a rolling stock during its operation, but also as a stream of incomes and charges.

Secondly, life cycle cost is considered to be separated from the limit (marginal) price in RZD's methodology. Thus, to decide if the innovative actions connected with development and introduction of new type of a rolling stock are expedient or not, it is necessary to carry out two separate analyses. First of all it is necessary to compare separately life cycle costs for a base and a new (innovative) unit of a rolling stock and then to calculate useful effect and to estimate the limit (marginal) price for a new (innovative) rolling stock. Going further in this direction, it is logical to make the next step to the global analysis in which lifecycle parameters would be considered at limit price calculation.

Thirdly, as a matter of fact the methodology offered by RZD is directed to calculating economically reasonable price of a new rolling stock that has never been used in operation before. The next step is to develop a design procedure of calculating economically reasonable prices not only for a new rolling stock, but also for the modernized samples of existing models.

ECONOMICALLY REASONABLE PRICE OF A ROLLING STOCK AS A RESULT OF LIFE CYCLE COST ESTIMATION (LCE): GENERAL IDEAS.

Hereafter we represent the approach to define economically reasonable prices on the basis of life cycle cost estimation developed by the Institute for Natural Monopolies Research. This approach is the logical continuation of the RZD offered methodology and it considers all the above mentioned aspects, which in our opinion need to be included into this methodology.

If we connect economically reasonable price with life cycle cost analyzing economically reasonable prices of rolling stock, the essence of the offered approach is in summing up **net incomes flow** (difference between incomes and costs) from operation of a rolling stock unit during the whole operational period discounted to the current moment. It is possible to explain such an approach in the following way. Purchase of a new rolling stock unit — irrelevant of the fact whether it's of a new, innovative or already used type — should be seen the investment of a buyer who will maintain the rolling stock in the future. It means, that the buyer making a decision about investment should think about the benefit he will receive later using this unit of rolling stock. And this in turn means that the price should be measured against the net income from rolling stock operation. The similar approach looks much more logical than in a situation when the price reflects the cost of rolling stock unit.

Rolling stock in operation and new types of rolling stock

The offered methodology allows to calculate economically reasonable price for types of a rolling stock used in operation and for types put into operation again.

In the first case the limit price of one unit of already operated type of a rolling stock represents the sum of net incomes (difference between incomes and costs) during operation of a unit of rolling stock discounted to the current moment.

In the second case it is expedient to act in the following way. Let's assume there is a new type of rolling stock. To define its economically reasonable prices it is reasonable to compare incomes and costs during its lifecycle with incomes and costs of operated type of a rolling stock that is similar with a new type from the point of view of functions and specifications. Then the limit price of a new type unit of rolling stock will equal the price of unit of a similar type corrected by the difference between net incomes from old and new types of a rolling stock operation discounted to the current moment. Thus the specified difference in the net profits represents, as a matter of fact, a useful effect of a new rolling stock type introduction in money terms.

The types of rolling stock which do not have existing counterparts need to be analyzed separately. These are, for example, the first gas turbine locomotive and a high-speed train 'Sapsan' or double-deck passenger coaches that are planned to be used on different lines. In the latter case, however, they can be compared with single-deck passenger coaches. In calculating the economic advantages of these projects it is necessary to consider more factors: required investment in railway infrastructure, required personnel training etc. It is necessary to consider minor factors as well: ranges of the use of a new rolling stock, effect of increased infrastructure transportation capacity, decrease of rolling stock destroying influence on the infrastructure.

Actually, these projects should have high-grade business-plan. But the main regulations of the offered methodology remain permanent: for equipment that has no counterparts among maintained rolling stock, the limit price should also be based on economic benefit of its operation.

The limit price and economically reasonable price

If we take the value reflecting cost of the capital (for example, WACC — Weighted Average Cost of Capital) as a discounting factor to discount net income stream to the current moment, the calculation described earlier will allow to receive value representing price of indifference for the buyer, or limit (marginal) price using RZD definitions. Indeed, both at price calculation for unit of rolling stock used in operation and at price calculation for unit of the rolling stock put into operation again, investments (the price of unit of rolling stock) are equal to the net incomes stream. In this case from the economical viewpoint it becomes irrelevant for the buyer (investor) to invest in purchasing new rolling stock (excepting, for example, social importance of new rolling stock purchasing).

Here it is necessary to observe that in analyzing the future net profits there is an inevitable question of future price volatility. However the capital value takes into account possible future price changes, as in any case whatever the rate is used in discount-factor it will be the nominal rate by implication. This rate includes inflation.

There are two possible ways to move from the limit price to economically reasonable price. Firstly, Internal Rate of Return (IRR) for the investor (rolling stock buyer) can be considered as a discount-factor instead of the capital value. IRR, certainly, will exceed the capital cost. Thus the final price will be lower than the limit price and at the coordinated Internal Rate of Return it will economically represent a reasonable price of a purchased rolling stock. Secondly, it is possible to consider the capital cost in net income flow for the operation period of a rolling stock, but we have to set up an account coefficient of the economic benefit which will be necessary to increase this stream of incomes. This coefficient will show by implication how economic benefit of the rolling stock operation will be distributed between buyer and manufacturer: coefficient value represents a part of the net incomes flow coming to the producer.

Each of the two described ways of transition from the limit price to economically reasonable price has its advantages. As for IRR, if we look at the price of rolling stock as the investments and if we connect pricing with the investment decision-making, this way is considered to be standard, more logical and economically justifiable in this context. On the other hand, IRR reflects only profitability of a rolling stock buyer, and it shows nothing about the manufacturer who receives an available economic benefit of operation of a purchased rolling stock. But it is possible to answer this question applying an economic benefit account coefficient. It can be said though it is in no way relevant when making decisions about possible investments.

Anyway it is more expedient to use an economic benefit account coefficient. Rolling stock pricing is not at all identical to the buyer's investments: we are not talking here of an investment project as such, but, more likely, of purchasing long-term commodity that is supposed to bring annual income. In this sense within the limits of this project (rolling stock purchase) it is necessary to consider the needs not only of one party (investor), but both (manufacturer and consumer of rolling stock).

Climatic and geographical factors influencing the limit price

Another aspect that must be taken into account in calculating reasonable price is the necessity to base your calculations on real parameters influencing incomes and OPEX. For example, in calculating economically reasonable price of a passenger coach we use data of actual tickets cost, repairs costs and so on. It may seem possible just to use common network statistical data and take them into account when calculating all the parameters for rolling stock unit price. But the same unit can be used in different geographical and climatic conditions and will therefore have different profit and expenses level. It is therefore more expedient not to use available average parameters of all network, but to separate data received from different climatic or geographical regions. The resulting limit price will in this case be a flow of the net incomes of operation of a type of a rolling stock for different climatic or geographical zone, with the net incomes depending on external conditions. And after that we have to calculate the uniform limit price.

Such an approach has a number of advantages in comparison to a situation when calculation is carried out on average network data. Firstly, it makes it possible to analyze efficiency of rolling stock redistribution to other regions since this will affect the rolling stock limit price. Secondly, such approach allows to analyze expediency of using the rolling stock in this or that region in general. Thirdly, in this situation it becomes easier to assess the necessity of technical modernization of the given type of rolling stock in general or for a particular region: when setting up parameters of upgrade the transparent limit price of the modernized rolling stock turns out automatically.

ECONOMICALLY REASONABLE PRICE OF ROLLING STOCK AS A RESULT OF ITS LIFECYCLE: DETAILED ELABORATION ON TYPES OF ROLLING STOCK

It's worth mentioning that separation of the profit from operation of some types of rolling stock from the overall income has its peculiarities. It is connected with the structure of existing railway rates. For example, the freight car component is precisely allocated in the freight car rate, and it is possible to define an approximate share of the rate for infrastructure or locomotive services. The essence of the term "infrastructure services component of the tariff" is similar with the widely used in the rest of the world concept of "charges for the use of infrastructure".

Nevertheless, we thought it possible to list a number of reasons concerning formation of a profitable part as if all the rolling stock tariff components have already been allocated.

As for the expense side of the budget the situation here is easier. The combined charges per rolling stock unit consist of the general costs (not depending on the rolling stock type), operational and repair costs. As a whole this combination of costs is correct for any rolling stock, and the problem is in using the available statistical data (usually they average for a network) for one unit of a rolling stock.

It is extremely important to note here that railway equipment or diesel shunters require absolutely special approach, as they simply do not have profitable base. For such types of rolling stock it is expedient to carry out an analysis of how a purchase of one additional unit of rolling stock will change the common buyer's costs on repairs and services of such types of a rolling stock (for example, a new diesel shunter needs less scheduled repairs than a long-time used locomotive).

Calculation of a profitable part for each type of a rolling stock has its peculiarity. Let us look at it on the examples of passenger coaches, and EMU cars.

Income producing component of passenger coaches

It is known that passenger operations at least at some lines are unprofitable. It means that if we calculate net incomes from coaches operation at these lines they will be negative.

Since many important components of passenger operations profitability: the ticket price, the infrastructure charges and others are currently defined not by an operator, but by the prescribed tariffs actual profitability or unprofitability of passengers transportation on different lines depends mainly on the volume and density of passenger traffic on this line accounted per coach. Therefore while calculating limit price and economically reasonable price on the basis of LCC it is important to consider the amount of coaches (of all types) used at this line during lifecycle of a coach for which the limit price is calculated.

In this case the limit price increasingly represents a tool for efficiency analysis of the coach types at this or that line. Let us say, a bigger capacity coach is introduced on the route with low annual passenger volume. In this case the economic benefit of replacing an old coach with a new one will unlikely cover the increased manufacture cost of the new coach and consequently economically reasonable price will be unprofitable for the manufacturer. But if we replace several old coaches with the new ones of greater capacity, with the same passenger traffic volume, an economically reasonable price can turn out to be quite acceptable for the manufacturer.

It is however necessary to bear in mind that quite frequently the bigger number of coaches are used for social rather than economic efficiency reasoning. And in this case economically effective replacement can turn out to be impossible for non-economic reasons.

Another important question is whether it is necessary to count an income producing component from passenger transportation considering state grants for passenger operations.

There are some features here. Firstly, state subsidies for passenger operations will not be able to cover the whole amount of losses from coaches operation if ticket prices are controlled. Moreover, in any case the state grants are given to operating company in general. But as it has been mentioned earlier, there are profitable and unprofitable lines. In this case losses of one line partially become covered due to cross funding of other profitable lines. And when calculating the price for open-plan coaches at lines with a low passenger traffic volume, it is necessary to consider this cross funding.

Secondly, actual incomes from this or that coach type are derived not only the ticket price, but also proceeding from the actual number of passengers in the coach. Quite frequently even on the same route the number of passengers in open-plan coach is considerably higher than, say, that in a first class sleeping-coach. As a result the actual general income of an open-plan coach and a first class coach can for some lines turn out to be comparable or even in favour of an open-plan coach, despite a significant difference of the ticket prices.

Thus, it is more correct to consider cross funding between different types of coaches at the same line and between coaches of the same types at different lines.

If we assume that the state grants for passenger transportations should be based on “economically justifiable level”, rather than on the amount of losses, it can turn out that actual incomes of different types of coaches (in view of the number of travelling passengers) are quite comparable. Then, having distributed the state grants for the whole coach fleet, it is possible to receive the positive net income from all these coaches operation. But in this case taking into account the state subsidies will distort the real incomes of each type of coaches and consequently their economically reasonable prices.

Income producing component of EMU cars

Multiple unit rolling stock consists of different types of coaches: car with driving cab, driving car and trailer car. It might seem logical to differentiate their prices according to their functional and technological distinctions. However it is more expedient to calculate economically reasonable price of an entire rolling stock. Firstly, the buyer usually does not purchase EMU cars separately, but orders EMU of a required configuration at the same time. And secondly, the income producing component is calculated considering EMU as a whole as it is hard to separate it by the type of cars.

DRAWBACKS OF THE LCC CONCEPT

The basic important point which should be noted here is the forecast of operational parameters for the whole life cycle. Service life of the products used in the industry is quite significant and is usually measured by dozens of years. As LCC pricing is based on economic benefit of a rolling stock operation during the whole life cycle period, first of all it is important to calculate the future parameters of operation: in both profits and expenses. Therefore, the calculation will be reduced either extrapolating recent operation parameters onto the future or to their hypothetical assessment. In the long term it’s no more than an assumption, more or less plausible depending on the particular product, since specific parameters of the operation will depend on future economic situation and on the general technological development (for example, repairs features). These data are obviously unknown.

An important feature is the after-sales correctness assessment of the manufacturer declared operational parameters, for example, in case when we speak about a new rolling stock that has never been produced earlier. On the other hand, in this case the operation conditions control becomes necessary. These conditions should correspond to the conditions that are declared by the manufacturer, who cannot be responsible for any change in operational parameters. And finally, apart from the economically reasonable price, there should be a compensation mechanism on the part of the manufacturer: in case the product is maintained within the limits of the declared conditions, but operational parameters do not correspond to the declared ones. In this case it turns out that the buyer “has overpaid”, and the price is not economically proved.

Above all it is necessary to highlight the problems peculiar for the current stage of LCC based pricing development in Russia. Firstly, it actually concerns a mechanism of correlating future parameters with the present situation (discounting factor). For Russia the discounting factor including different kinds of financial and insurance risks is largely a matter of assumptions.

Secondly, according to our practice parameters of operation of this or that rolling stock or complex technical systems are frequently considered as a whole, instead of counting this or that type of rolling stock. It creates certain difficulties in correct calculation of this or that operational parameter for various types of rolling stock.

Thirdly, the described method of pricing is used in order to compare operational parameters of a new product and any base product already used in operation and to correct the price of a base product for the received economic benefit. However today in Russia we use stock which was manufactured in the Soviet times and which has long been out of production. So when a Soviet made unit is used as the basis it becomes really difficult to correctly calculate the price.

As a result of all these peculiarities of LCC pricing certain parameters used in calculation become a matter of the arrangement between buyer and seller, with the precise mechanism of these arrangements virtually non-existent. Therefore methodology development of pricing for various types of rolling stock and complex technical systems should include recommendations on algorithm of the parameters adjustment, and proposals on the monitoring system for operation parameters and operation conditions.

METHODOLOGY OF ROLLING STOCK ECONOMICALLY REASONABLE PRICES CALCULATION AS A TOOL OF DECISION-MAKING

As a result of development and detailed elaboration of the methodology described here manufacturers and consumers will receive the tool for an objective estimation of economic parameters of purchased equipment. Except for creation of transparent and controlled system of rolling stock pricing, application of the offered approach allows to lower labour input and duration of the price coordination process. Manufacturers can compare the size of additional incomes of selling qualitative and advanced rolling stock with the cost of the actions directed to its improvement. Consumers can estimate whether operation of new rolling stock will be effective in the future, whether certain improvements of qualitative characteristics are expedient in general.

It is quite possible that in some cases this methodology will assess certain technical innovations as economically inexpedient: i.e. their effect does not cover the purchase expenses. In a case like this, consumers can adjust their requirements, and manufacturers can adjust their offers and concentrate their efforts on improvements which will lead to the maximum economic benefit.

As a whole, the calculation methodology of economically reasonable prices — taking into account all the above mentioned conditions and peculiarities can be a transparent and rather effective tool of economic policy both for sellers and buyers of rolling stock.

LIFE CYCLE COST (LCC) AS A BASIS FOR PRICE CALCULATION OF RAILWAY EQUIPMENT

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For decades the equipment technical parameters were a decisive factor for its purchase in all branches of Russian economy including rail transport. In these conditions until recently prices for new equipment have been set on cost-basis calculated by manufacturers.

Transition to market economy urged railway equipment manufacturers to come up with new, innovative, qualitative equipment with lower production and maintenance cost.

The 2009 Charter of cooperation between RZD, Union of Industries of Railway Equipment and equipment and components manufacturers among other things was meant to improve the pricing mechanism, including transition by 2011 to internationally accepted lifecycle pricing.

In foreign practice when concluding a contract of supply of rolling stock and during tender procedures such concepts as “life cycle cost” and “management of reliability, availability, maintainability and safety” (RAMS) [1, 2, 3] are used.

Application of LCC and RAMS concepts is the result of the change which has recently taken place in relations between railways and engineering industry. At present the industry incurs the full responsibility for products and system development. The role of railways is limited to giving technical requirements and guarantees of presenting the data concerning production system behaviour during life-cycle (i.e. life cycle cost, availability). Moreover private railways are guided by the economic benefit that is defined on the basis of integrated estimations of costs during the equipment entire lifetime.

According to recommendations of International Electrotechnical Commission (IEC) published in the form of IEC 6030-3-3 standard, a three-dimensional matrix (Fig. 1) is applied as one of the approaches for LCC estimation.

This matrix unites three aspects of product LCC estimation of rolling stock:

- lower level classification (splitting) of a product — with modules of technical or functional object structure (units, assemblies, groups of the equipment);
- time point during lifecycle when operation should be executed;

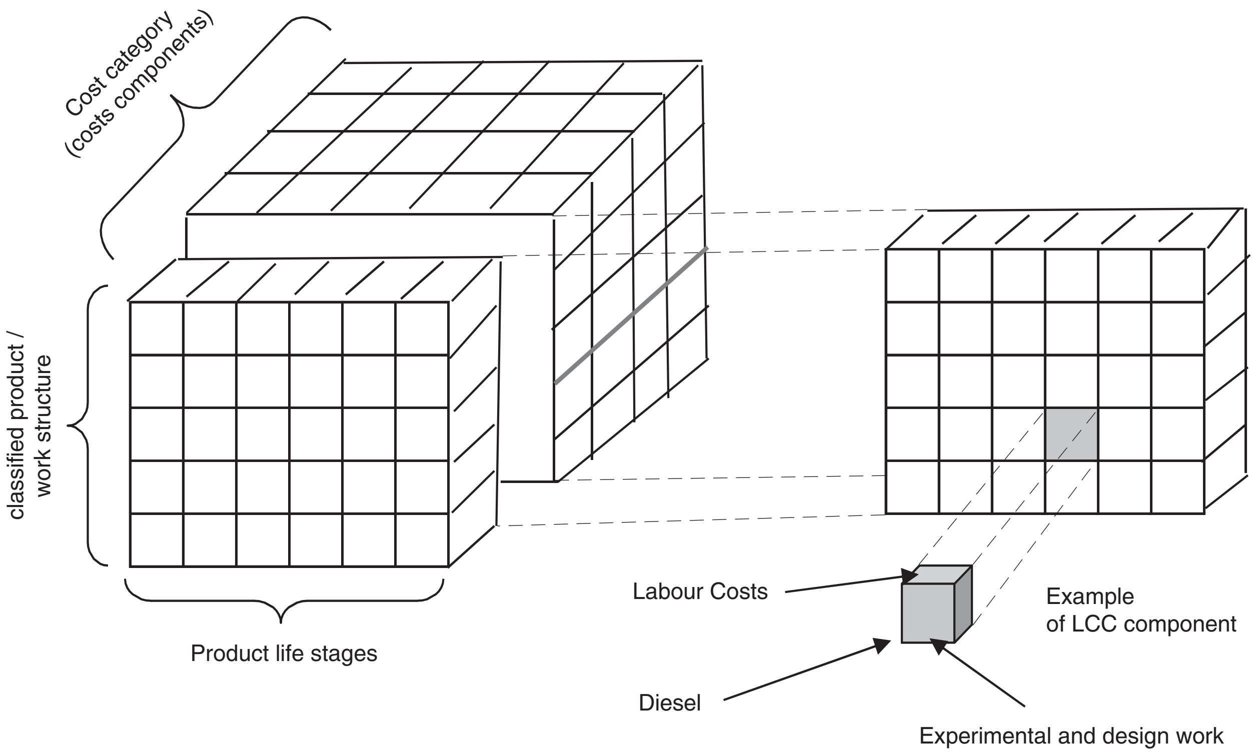


Fig. 1 Matrix of maintainance costs

- a cost category of such applied resources as labour, materials, fuel/energy, overhead expenses, transportation, etc. (cost components).

With reference to locomotive LCC estimation the given matrix has an essential drawback: it is impossible to distribute working costs, for example, fuel or energy costs, or labour costs of locomotive crews among the components of technical structure — bogies, diesel engine, etc. However its application makes sense during maintenance and repair costs assessment.

Thus LCC is used in a foreign practice for the following issues:

- estimation and comparison of alternative strategies;
- technical requirements, evaluation of supply offers;
- risk insurances of the investments enclosed in industrial means;
- estimation of sharply increasing costs and its factors, analysis of soft spots in production optimisation;
- long-term investment planning;
- deciding the time of outdated equipment replacement.

It follows from the above that this parameter is hardly used in decision-making concerning pricing of the new equipment.

In market conditions rejection of the cost-based pricing for rolling stock and complex technical systems triggered development of the methodical approach to pricing to stimulate cost reduction per unit.

Thus, economically reasonable price should reflect technical equipment efficiency, i. e. express its value for manufacturer as well as the consumer.

In 2007 Research and Development and Design Technological Institute of Rolling Stock (VNIKTI) together with Research and Development Institute of Railway Transport (VNIIZhT) using foreign experience designed “calculation method of LCC and limit price of a rolling stock and complex technical systems of rail transport” (LCC and limit price) and the Application Regulations, approved by RZD. [4]

The Method is developed in accordance with requirements of IEC 60300-3-3 International standard “General reliability management. Part 3-3 “Application guide. Life cycle cost estimation”.

LCC of rolling stock and complex technical systems of rail transport as a cost parameter is calculated as:

$$LCC = C_o + \sum (I_t + \Delta K_t - L_t) \cdot \alpha_t$$

C_o — acquisition price of an object (initial cost);
It — annual working costs;
ΔK_t — the related lump-sum costs connected with equipment introduction;
L_t — disposal value;
α_t — discounting coefficient;
t — current operation year;
T — last operation year in accordance with technical requirements or other documentation (including accounting policies of the company that has an object on balance).

The discounting coefficient αt for constant discounting rate is calculated by years of the settlement period as:

$$_{\alpha}t = (1 + E)^{-t} = \frac{1}{(1 + E)^{t}},$$

E — discounting rate.

LCC is the most objective cost index of technical equipment. However, because of calculation complexity of all LCC components and need to account costs during life-cycle, this method has not been used as a parameter of complex production and operating analysis of rolling stock and complex technical systems of rail transport on the national level.

The integrated block diagram of LCC calculation regarding locomotives is shown on Fig. 2.

Transition to LCC pricing methodology of rolling stock and complex technical systems requires comparative calculations as part of useful effect is included in the price. This useful effect can be achieved by the Consumer during service life of the new equipment which is used instead of the base one.

The useful effect amount Eu is calculated as:

$$E_u = P_b (F_p F_{sl} - 1) + \Delta LCC' + E_s + E_e + E_q$$

P_b — the price of a unit of baseline rolling stock or complex technical system;

F_p — productivity growth of new equipment in comparison with baseline one;

F_{sl} — service life change of new rolling stock or technical system in comparison with baseline model:

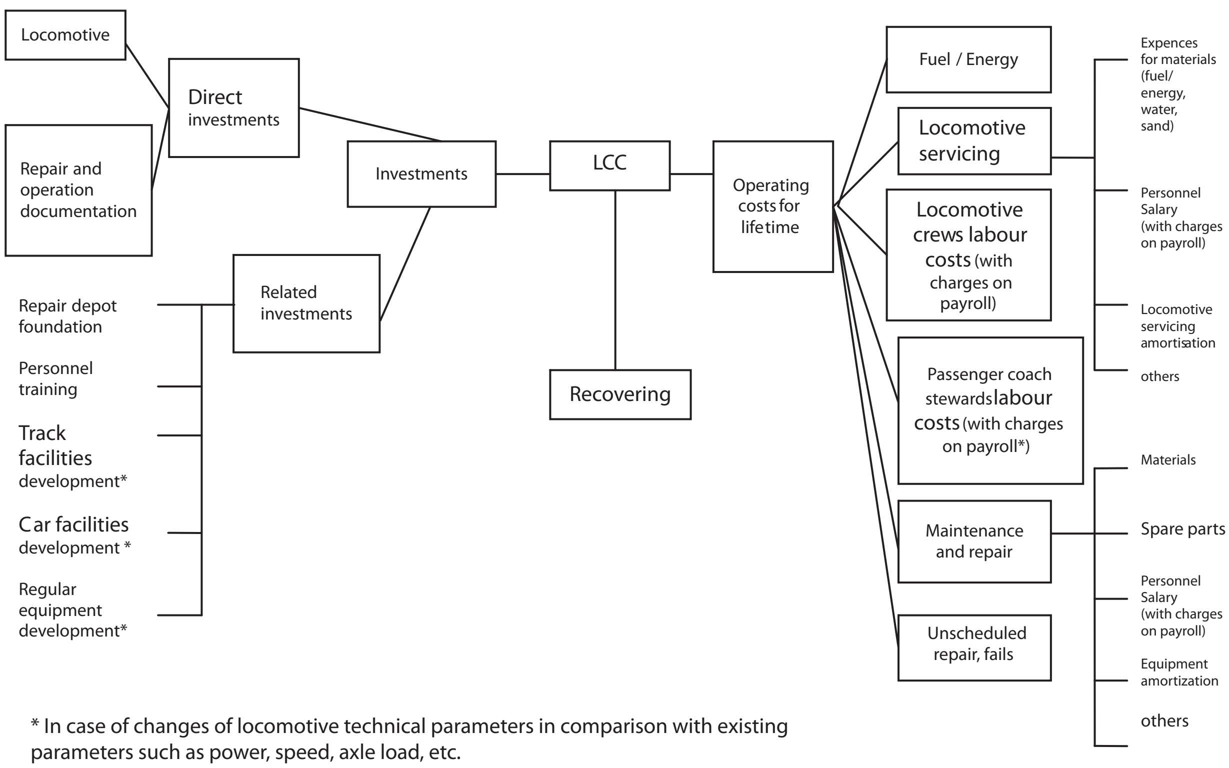
$F_{sl} = (1 / T_1 + E) / (1 / T_2 + E)$,

T_1, T_2 — service life of base and new equipment;

$\Delta LCC' = LCC_{б}' - LCC_{н}'$ — LCC economy of new equipment operation in comparison with baseline equipment without taking into account direct investments into purchase of equipment and amortised deductions in the structure of annual operational expenses. Meanwhile, the LCC calculations should be comparable for baseline and new equipment. In LCC structure of technical equipment the related lump-sum expenses on maintenance should be considered as well;

E_s, E_e, E_q — social effect, ecological effect and effect of transportation quality improvement.

The method [4] recommends to define a level of new equipment limit price with the help of useful effect parameter. In such approach the limit price expresses a maximum permissible level of the price of new technical equipment defined on the basis of consumer properties improvement in comparison with similar models, i. e. both Manufacturer and Consumer are interested in its manufacture and operation when the price is at a limit price level.



* In case of changes of locomotive technical parameters in comparison with existing parameters such as power, speed, axle load, etc.

Fig.2 The Integrated block diagram of locomotive LCC

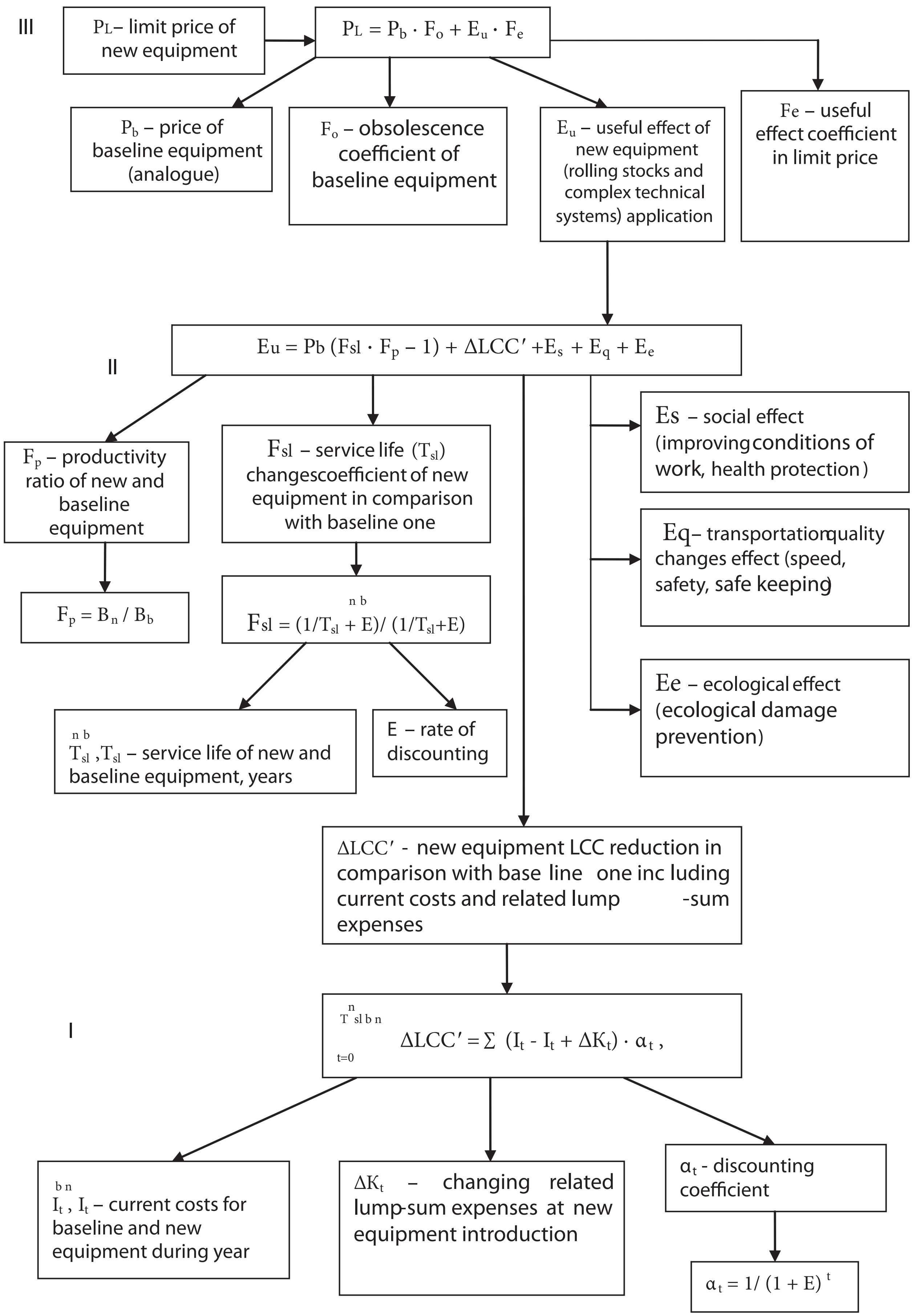


Fig. 3 Algorithm of limit price calculation.

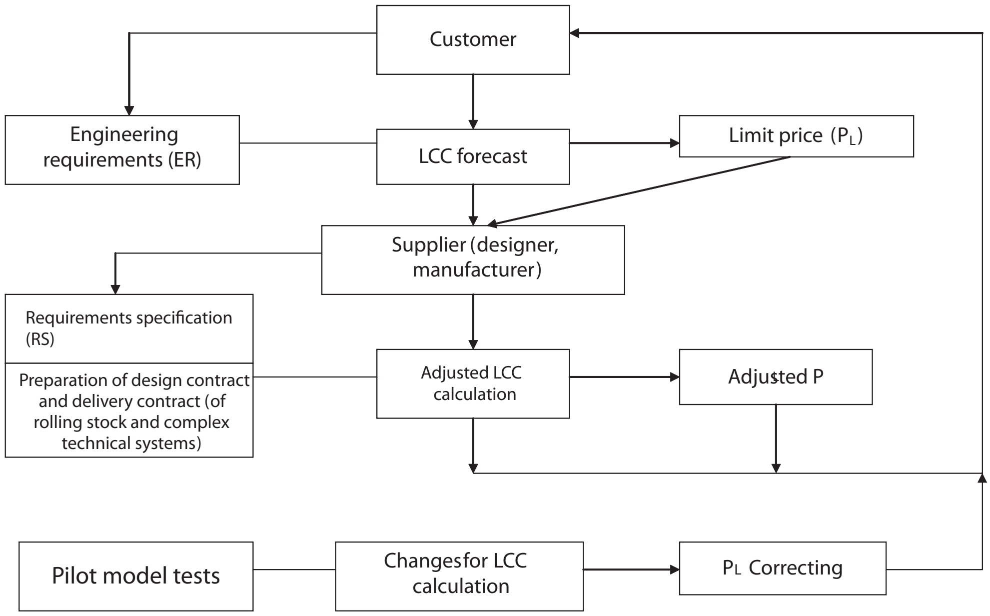


Fig.4 Arrangement for customer and supplier cooperation at limit price calculation (rolling stock and complex rail transport technical systems)

Limit price is calculated as:

$$P_L = P_b F_o + K_e E_u,$$

P_b — baseline equipment price;
F_o — obsolescence coefficient of baseline equipment;
K_e — share of effect received by Consumer while using new technical equipment instead of baseline one and included in the price;
E_u — useful effect of Consumer during technical equipment life-cycle.

F_o coefficient value and K_e coefficient value are chosen according to the Method [4].

The limit price calculation algorithm is shown on Fig. 3.

Since 1999 in accordance with the “Guidelines on a Innovations Efficiency Justifications in the Rail Transport” [5] RZD has been using limit price parameter where the economy of annual working costs of Consumer (a profitable part) is a component of useful effect without discounting its parameter by years of the settlement period.

As reliable LCC assessment can be found as a result of the complex approach to its calculation both by Consumers and Manufacturers, the Rules [6] designed and approved by RZD also defines the order of cooperation of the concerned parties at calculation (Fig. 4).

However background of experience of useful effect calculation as the basic parameter forming a level of the limit price, in our opinion, has shown the necessity of:

- the account of the time index at calculation of a durability coefficient of technical equipment (service life);
- the account of the taxation at its calculation.

In this case the formula of useful effect calculation is as follows:

$$E_u = P_b (F_p F_{sl} — 1) + \Delta LCC'(1 — j) + E_s + E_q + E_e,$$

j — profit tax rate (j = 0,2).

Transition to new pricing methods will urge Consumers and Manufacturers of railway equipment to resolve the following problems:

- to develop the organisational mechanism of LCC calculations dataware at different stages of new technical equipment manufacture;
- to define responsibility zones of Designers, Manufacturers, organisations carrying out LCC calculations, and expert companies according to the approved Rules;
- to develop methodical recommendations for calculation for all LCC components on railways, account order, option of base for comparison, discounting rates, calculation stages, normative base, etc. on the basis of Guidelines;
- to establish the order of presentation of LCC and limit price calculations by Designers, the order of their consideration by concerned Departments, and also the cooperation rules for Consumers and Manufacturers at price adoption;
- to provide the account and the analysis of expenses for operation, maintenance service and equipment repair for an actual LCC assessment of technical equipment and its deviation from calculated values, decision-making about financial

sanctions for default of the declared parameters as it is widely introduced in Western Europe and Scandinavia.

Resolving these issues will ensure gradual transition to LCC based price formation for new technical equipment .

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LIFE CYCLE COST OF RAILWAY ROLLING STOCK: FROM THEORY TO PRACTICE

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Introduction: historical information

Having appeared at the end of 1960s in a war industry, the life cycle cost concept (LCC) has been introduced into other areas. In the railway industry the LCC concept has appeared at the beginning of 1990s: at first in tendered calls from Scandinavian countries and subsequently it became one of the most important concepts of all West-European tenders connected with rolling stock.

Over fifteen years of this existing practice, requests and data application have been classified and further developed.

The point of view of the manufacturer on the contribution and limits of the application of the given tool is described below and certain prospects in the field of costs calculations are stated. These issues are substantially based on the works of the Union of the European Railway Industry (UNIFE) [1, 2] and also on various publications of my colleagues from the Alstom Transport (for example, [3, 4]).

In the widest sense LCC means the sum total of the costs connected with the possession, use and maintenance of a system from the moment it was designed to the point when it is recycled. In the railway industry, carrying out tenders and in particular, considering the cost of capital outlays as a whole is very important. Other important considerations are: components of logistical support (stock and the documentation of stock and spare parts), operating expenses and charges. Recycling expenses are considered less often, though this issue tends to be improved soon.

Therefore, the exact list of components that are included in LCC calculations depends on the intended use of the equipment and the particular operating conditions. It is useful to refer to series of Guidelines for Life Cycle Cost in publications prepared by UNIFE working group concerning LCC [1, 2]. It is also useful to know the standards of the International Electrotechnical Commission [5, 6].

LCC basic scopes

LCC calculations have been introduced to the railway industry due to the customers' pressure who made their tender requests when choosing rolling stock.

So, the middle of 1990s was marked by the changes in technical project requirements: from estimated costs calculation to legal documentation providing, and entering into a purchase decision-making stage and finally, transition to a stage of contractual obligations acceptance including check stages and penalty clauses.

However LCC application is not the only criteria for decision-making. The fact is that LCC first of all represents an auxiliary tool for assisting project management, which by means of modelling allows to take technical decision aimed at preserving and optimisation of inseparable link “LCC — equipment availability”.

Thus, LCC calculation is inseparably connected with calculation of equipment availability or unavailability and its estimated cost.

LCC application in calls for bids

The LCC requirements development was accompanied by specifications of “game rules” and therefore greater efficiency was required to obtain realistic approach. For example, the LCC request directed to a certain railway equipment manufacturer at the offer stage became concerned with controllable expenses which can vary from one manufacturer to another.

LCC calculation excludes administrative charges, operators’ charges, warehouse and logistical charges. Generally speaking, it concerns the indirect costs which do not influence the manufacturer’s option.

At the same time to avoid the influence of the components unconnected with the quality index of the equipment manufactured by competitors during the tender process the following regulations are represented in calls for bids: the usual economic forecasts, labour costs, energy costs, and discount rate.

Finally, in order to ensure competitive quotes, calls for bids include approval criteria and LCC auditing plans specifying penalties (more often than bonuses).

With regard to performance, a contract with more sophisticated customers will need to ensure that regular updating of LCC costs and design specifications is included. Nowadays it is a usual practice.

LCC does not reflect the full cost maintenance and has the technical specifications and economic data which more accurately detail rolling stock cost.

Despite the progress that has arisen in relation to the understanding of customer’s needs and the opportunities and obligations of the manufacturers, the practice of LCC still has limitations.

LCC application as a tool to improve the “LCC — equipment availability” ratio

LCC is a modelling tool and therefore the tool for “real world” simplification. Thus, an absolute value of a calculation often has a significant error margin concerning repayable costs (energy consumption, maintenance support, etc.).

The error margin prevents customers from accepting the contract obligations. However, it can still be relied upon when comparing technical aspects and taking design decisions.

LCC limitations are particularly noticeable in the areas of energy consumption and maintenance support where costs measured over time can vary significantly. This can be illustrated by the following two examples.

The first example concerns wheel wear: even if we know the optimum size of the bogie frames or the rigidity of the wheels that increases the wheel service life, it is still difficult to predict the total service life. Substantially, it depends on the maintenance support level of rail tracks and also the maintenance, service and lubrication systems. After the rolling stock has been delivered, the manufacturer cannot supervise these parameters anymore.

The second example concerns energy consumption and braking system wear. The more efficient the braking system is the less energy the system will consume. To choose and improve the hauling chain it is sufficient to calculate the ratio of power regeneration benefit and rate of braking system wear on design stage. However real energy consumption and the actual expenses caused as a result of brake wear is defined by factors that cannot be supervised or controlled by the manufacturer and sometimes even by the operator.

In both examples, the correct design solutions become simpler as a result of LCC calculation which does not focus entirely on operating costs.

LCC application for internal purposes and also in relation to suppliers has got system characteristics for the majority of Western European manufacturers as a result of development of “commodity groups” or “modular platforms”. Here LCC calculation is used for the purpose of properties improvement for these groups.

In this improvement LCC depends on the availability of the equipment, in this case, design parameters are only used (see Fig. 1). So, quality of logistical support preparation (LSP) and its early integration in the process of design and the choice of maintenance support strategies influence product improvement and we will see later, all these parameters affect development of LCC calculation methods.

Thus we see that this tool — LCC calculation — the accuracy of which is sufficient for being a design basis can require to be treated carefully in the frames of a certain agreement.

LCC calculation complexities

Let us look at one of the areas of LCC where the calculation could be improved one more time — Maintenance support costs.

Maintenance support costs are usually divided into the current repair costs established by the statistical laws (unserviceable equipment repair) and the costs for preventative technical maintenance

GLOBAL LCC/AVAILABILITY TRADE-OFF

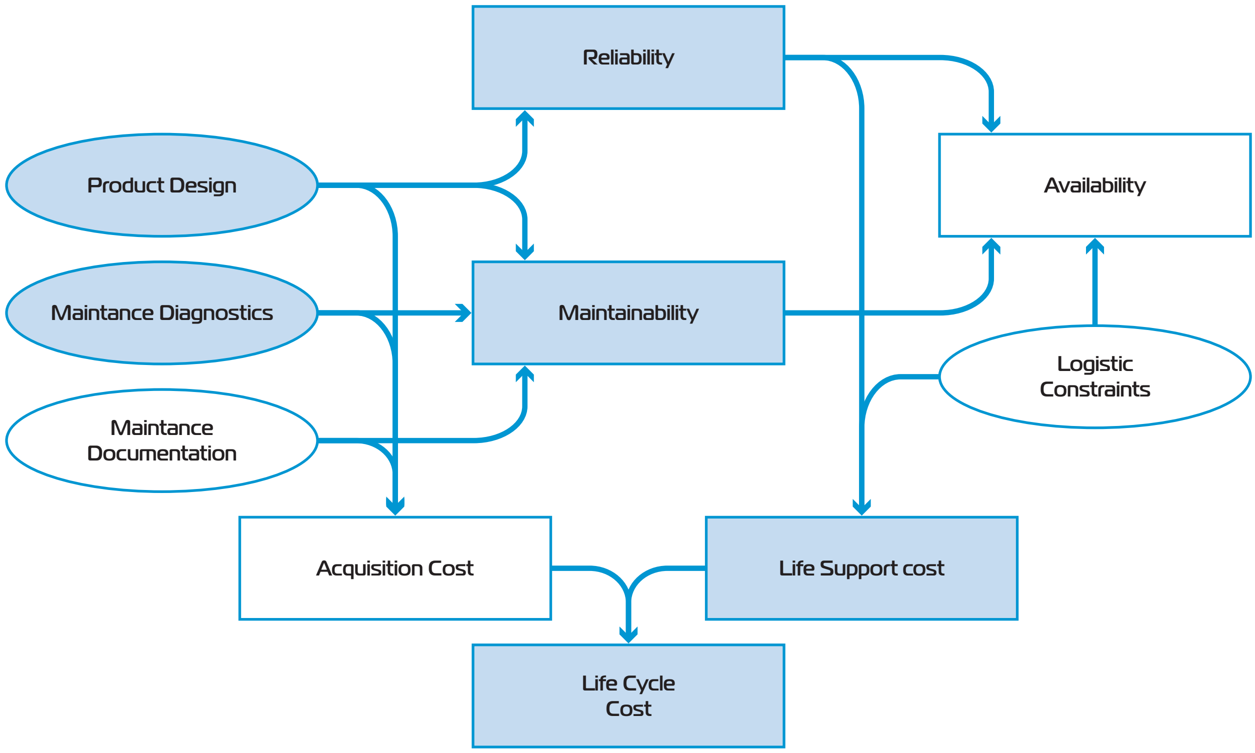

Fig. 1 This circuit pattern is kindly furnished by Electro Mechanics and Electrical Engineering Institute.

and repair (equipment failure prevention) determined by deterministic laws.

Maintenance support and repair work depend on wear rate, rail transport run, time interval for equipment operation, and the number of cycles for the equipment. However, the last component is subject to change along with introduction of new strategies and maintenance support methods.

In general, operating expenses for repairs are defined using linear models with average failure value and repair costs per unit of equipment considered as deterministic values. It is therefore easy to prove that for certain equipment failure the average failure rate and standard deviation will be very close in their values.

More advanced means of calculation based on modelling can give more satisfactory results from methodological point of view. However these methods are more cumbersome, less intuitive and require a significant amount of initial data. These means are often used for LCC improvement and availability of service for complex transport systems, not just for rolling stock.

Difficulties calculation arise with the introduction of new equipment or subsystems when there is no sufficient information from customers (REX).

With regard to new equipment, the suppliers of equipment and subsystems tend to provide the manufacturer with "conservative" LCC calculations. This data often looks pessimistic regarding equipment failure rate, repair expenses and maintenance support plans connected to it. Not all suppliers possess long term operational experience to provide more accurate LCC data that is why they are more careful in their calculations.

Such LCC planning is integrated into general LCC planning for materials and equipment and usually artificially increases their final cost.

This "pessimism" or uncertainties concerning initial data is not appropriate for subsystems suppliers, and integrating designer might not possess the sufficient means to carry out realistic calculations.

Certain significant expenses (scaled examination of railway junctions being used in operation for several years) can be taken into account only in case of great experience (many years of records) in equipment and subsystems operating and improvement of maintenance support.

In this field the LLC application is especially profitable for the manufacturers who possess long-term maintenance support experience.

Difficulties appear when we start calculating the recurring part of LCC. They are connected with the maintenance period. The same situation occurs when we deal with deprecation conditions.

Rolling stock equipment is depreciated over a period of 30 years. This term is used in the sphere of capital investments and it is contrary in the sphere of high technology such as electronics and computer science.

As a comparison: in 1979 informed forecasters only had an idea of technical equipment and communication costs coming in 2009.

Thus, the difficulties in forecasting costs for maintenance support of informational and electronic systems increase as far as operating period of component generation is decreased.

The "conservative" approach concerns the full replacement of a certain subsystem with a frequency which is compatible with the service life of several generations of electronic components. The "optimistic" approach concerns neglecting the difficulties revealed in LCC calculating. It is assumed that an economy of maintenance support costs will be sufficient for the replacements self-financing due to new technologies introduced into the sphere of out-of-date equipment replacement. The truth is between two approaches, and more accurate answer should be based on the customers' information (REX).

Proactive obsolescence risk management allows to avoid the risks and the expenses connected with them. However the manufacturer does not impact on how the operator deals with the given questions if he is not involved in services rendering on a long-term basis.

Finally, let us stop the enumeration of difficulties on a positive note, and highlight the improvement in development of maintenance support means and in equipment designing.

Therefore, expenses for different categories of equipment can show positive changes during the service life of equipment that is due to the fact that new maintenance support means or new conceptions have appeared.

When an industrial endoscope was designed it enabled to control the equipment without its dismantling, to increase diagnostics reliability and to reduce repair time. For example, the use of compact, automatic oil diffraction analyzers enabled to conduct complicated analyses in shop conditions, with total safety and without the experts' supervision. Immediate information receipt allows to change the oil in the reducer before the certain run is achieved and when certain ageing and wear indicators take place.

The last example shows the general development of maintenance support methods in relation to Condition Based Maintenance (CBM).

This maintenance support concept focuses on carrying out preventive maintenance on a planned basis taking into consideration the specific requirements to each type of equipment.

Basically, this method results in the maximum benefit being received from the various characteristics such as spread and ageing of the particular equipment. It does not only increase the average work life of equipment but also, at least theoretically, the most vulnerable equipment receives the required maintenance support before a failure occurs. Reliability of equipment noticeably increases the transformation of current repairs into preventive maintenance.

This approach partially developed by means of modern design has a promising future. It allows to improve the equipment LCC during its service life. However LCC is still substantially calculated at the design stage. Statistical data exists for the calculation of the expenses involved in each type of task carried out during preventive maintenance support. The current experience of this sphere is expected to be standardised.

Therefore, it is possible to limit the errors of LCC on a line by line basis due to the significant amount of statistical data giving the description of rolling stock characteristics (from 500 to 1500 data lines). We also note that contract regulations regarding LCC auditing are based on analyses over a period of time and limited to particular tasks. There is a problem with the statistical values of the results which are calculated on the basis of a limited number of events.

Quality maintenance support obligation as a universal tool for problem solution

Having read the above the reader might think that LCC does not represent a good value and its calculation is linked with insurmountable problems: in the best case scenario the initial data relate to the times long gone, in the worst case scenario they are just workings of imagination of people without sufficient maintenance experience. The length of time over which the calculation spans is very long indeed, 30 years and with no way of verifying the data until the end of the service life. However the minimum timescale that can be used is half of this term which is more manageable and enables verification of the initial approach.

Nevertheless, a 15-year LCC application has moved our industry forward on the way of improvement. The choice of engineers dedicated to improvement for the sake of better quality service, based on new technologies and new methodologies, has found the precise logic foundation. Developers look for innovations focused on the improvement of equipment availability and LCC besides the mere improvement of classical index such as speed, noise, and safety.

The preservation of LCC accurate application at the design stage is a complicated task and requires accuracy to ensure its consistency regarding commercial and contract characteristics.

The solution that has been evolving in Western Europe, where competition is supported by the European Commission, embrace the requirements for work quality and maintenance support obligations in a call for bids. It ensures that the manufacturer remains in touch with reality and only contractual obligations are subject to random LCC auditing.

In reality, the offer of maintenance support is not LCC. In general it differs from both the duration and the nature of considered expenses: administrative, staff, contractual obligations, hourly rates, etc. They have ceased to be notional and have become real for the maintenance support provider. They reflect their competitiveness. Directors at local level should integrate equipment outages and integrate logistical time into the maintenance process. Finally, the risk associated with maintenance support might require compensation. This compensation is usually called profit.

However if we avoid confusion between LCC concept and maintenance support offer, we can observe the LCC on the basis of the latter. The competitiveness is a reflection of the LCC quality which in turn is a reflection of the quality of rolling stock design and the elements of logistical maintenance support.

This structure is used by manufacturers such as Alstom Transport who are responsible for the development and provision of maintenance support for more than 6000 units of railway rolling stock delivered for many different countries. Alstom has built up a lot of experience based on the data they have acquired over the years. This has only become possible recently.

Therefore it has become more and more attractive to manufacturers to provide maintenance support contracts as it often leads to new business contracts:

- Firstly, the initial data of LCC calculations or RCM design are based on real use;
- Secondly, the manufacturer is the expert in the field of maintenance support. He is the driver of progress and improvements;
- Finally, the manufacturer integrates maintainability into the design works, beginning with rolling stock design, all the elements of logistical support and organizes the process of receiving information from customers.

Obviously some customers decide to do without a contract for maintenance support and do not take all the benefits from this offer but at least they are convinced that LCC calculation carried out by the manufacturer is accurate and reliable.

In conclusion

In Western Europe, with all tender offers connected with rolling stock, LCC is considered alongside the other criteria in the decision making process.

We have seen that LCC should be carefully applied; at the same time the LCC method has led to the significant improvement in the railway industry:

- Involving manufacturers into studying global problems of equipment lifecycle;
- Attaching greater significance to development of manufacturers maintenance support (using information from customers, REX);
- Effectively promoting the best rolling stocks designs.

LCC is the tool displaying comparative qualities of maintainability and controllability of rolling stock.

The work quality obligation for maintenance support is the best LCC guarantee. Thanks to LCC, Alstom Transport has become one of the leading market participants in the field of maintenance support. Alstom is able to carry out unique and accurate LCC calculations and also minimise the LCC by means of corresponding design decisions.

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LIFECYCLE. FACTS AND FACTORS

Opinion of world industry leaders on railway equipment life cycle cost.

Life cycle cost of railway rolling stock depends on a number of factors, directly or indirectly defined by the manufacturer, the rolling stock operator, the infrastructure manager and rolling stock servicing company. Besides, requirements of certification and licensing authorities, and regulatory documents can also influence life cycle cost.

To reveal the current international methodology in life cycle cost estimation and regulation, “Railway Equipment” and the Institute for Natural Monopolies Research carried out a survey of the world leading rolling stock manufacturers, namely, transport divisions of Alstom, Bombardier, General Electric (GE) and Siemens. They have been asked the following questions:

1. Which technical and operational specifications of rolling stock that have an impact on its price are guaranteed by manufacturers? 2. What responsibility do manufacturers bear in case real and declared parameters do not coincide? 3. What are the instruments of monitoring real operating conditions provided? (for example, infrastructure condition, origin and quality of spare parts, specifications of power supply for electric rolling stock, fuel quality for diesel rolling stock, lubricants quality, etc.)?

4. What responsibility do customers bear if they violate operation conditions?

5. How do you determine the cause of the rolling stock failure? How do you understand which party should bear the responsibility? And what is the form of this responsibility?

Most of those polled observed that issues like this and various disagreements between manufacturers and customers are resolved on case to case basis and there are not and cannot be universal answers to these questions. Nevertheless, we will try to reflect and compare the most interesting aspects.

In reality, a rolling stock manufacturer can predetermine life cycle cost both by means of productivity (through capacity, coefficient of efficiency, etc), and by means of reliability, availability and maintainability. These equipment qualities are determined at the design stage by the selection of engineering solutions. For example, Alstom mentions the following specifications for a locomotive: power capacity, traction effort, ecological parameters, weight, speed, clearance and width. Besides, other factors can be defined by specific needs of the client and infrastructure requirements, for example, fuel tank capacity, air pump productivity, traction mode (alternating current/direct current), harmful emissions, noise, EMI/EMC (electromagnetic interference / electromagnetic compatibility), etc.

According to Siemens, Reliability, Availability and Maintainability (or “RAM” for short) of rolling stock are the key factors, which determine quality, efficiency and profitability of the rolling stock operation and therefore influence satisfaction of operating companies and their clients. These parameters have a direct effect on life cycle cost, and also determine the amount of required investment because they are directly proportional to the quantity of the rolling stock required to meet transport needs. Significance of these parameters for life cycle cost estimation (and hence for the price of rolling stock) compels the manufacturer to make all the efforts for their improvement.

For all current and new projects Siemens realizes a set of actions to calculate and improve RAM parameters in accordance with European standard EN 50126. The key element in this process is data collection in co-operation with consumers and fine tuning of operation parameters of the already delivered rolling stock.

Use of life cycle cost estimation method to determine the rolling stock price presupposes certain mutual obligations of manufacturers and consumers concerning technical and operational parameters. The set of parameters is defined in the technical project and in the contract for each specific case separately. By default, **Alstom** guarantees the general parameters of availability, reliability and running costs.

Siemens stipulates a set of parameters in technical specifications as well as fixes RAM parameters in the contractual form. In Europe, there is a coordination of useful energy loss values within contract limits (on the basis of established efficiency values), and also a definition of possible penalties when this parameter is violated.

General Electric, as a rule, does not guarantee costs on operation service because these costs substantially depend on intensity and operation conditions of the locomotive. One of the ways of more precise cost estimation applied by General Electric for its clients is the provision of a long-term service contract according to which the company provides maintenance to meet the needs of each client for a certain fee.

It should be noted that leading manufacturers specify that, in case of any discrepancy between real and declared technical and operating parameters of rolling stock the responsibility of the manufacturer is unequivocal. Specific ways of interaction between the manufacturer and the consumer in such cases are fixed in the contract.

Manufacturers also emphasize that actual operation conditions can significantly influence life cycle cost. **Alstom** controls the compliance of maintenance, operation, infrastructure conditions, etc. **Siemens** requires that the parameters of operation conditions should be precisely fixed and agreed between the operator and the rolling stock supplier. **General Electric** chooses not to monitor actual operating conditions of rolling stock. Their position is that operation conditions are, as a rule, determined by the customer, and the manufacturer tries to comply with these conditions at an earlier stage of design. In general, manufacturers concur that the client should bear responsibility for correct operation, and these terms should be included in the contract.

Every case of rolling stock failure is followed by an investigation of its causes. **Alstom** uses readings of onboard recording devices as well as maintenance and repairs reports. The investigation in its turn is followed by sanctions and, when necessary, alterations in the rolling stock design specifications. **Siemens** and **General Electric** also mention that they take all the necessary steps to understand the causes of any failures and thereupon act in accordance with their contractual obligations.

To sum it up rolling stock pricing with the use of life cycle cost estimation method is usually accompanied with mutual obligations of the manufacturers and the customers regarding contractual technical and operating parameters. Specific features can vary considerably depending on the type of the rolling stock, local infrastructure conditions and current legislation.

In Russia, where pricing on the basis of life cycle cost estimation is still at a very early stage, there are still many questions to be answered. It should be said however that the principle as such determines only a certain price range and the individual responsibilities of the parties. As international experience proves, instances of more detailed pricing vary greatly from case to case. A higher price should be an indicator of a higher quality, and this quality should be consistent throughout the length of the contract.

According to this logic, non-commercial partnership "Union of Industries of Railway Equipment" ("UIRE") is developing its own standard "Pricing principles for railway rolling stock and other complex technical systems of railway transport on the basis of life cycle cost estimation; mandatory conditions of delivery contracts and responsibilities of railway equipment manufacturers and consumers". It is intended to provide a most detailed definition of conditions for life cycle cost estimation of railway equipment and economic benefit of its use as well as mutual rights and responsibilities of supplier and consumer. ■

STANDARDIZATION IN UIRE: ITS OBJECTIVES AND PLANS, AND THEIR IMPLEMENTATION

Vladimir Matyushin
Vice-President, UIRE

The Non-Commercial Partnership "Union of Industries of Railway Equipment" (UIRE) was founded on April 28, 2007. One of the main tasks set forth by the Partnership's Charter is creating up-to-date normative and technical basis for improving the products quality, raising their competitiveness and contributing to competition development.

The Charter also lays out operations aimed at developing certification systems, establishing requirements for product quality, quality management and personnel certification systems; it is also carried out on the basis of respective normative documents.

In December 2007, the General Meeting approved the decision to enhance work aimed at creating the Partnership's regulatory base, primarily the standards of "Rules of Interaction within the Partnership", conducting objective quality assessment and contributing to the creation of competitive environment. Since the UIRE membership includes almost all the main manufacturers of railway engineering and components, this will basically form rules for the entire railway equipment market.

One common task for all the Partnership members is products' quality improvement, which requires creating economically justified requirements to product quality parameters, rules and techniques of quality checks, and improving product quality management system. Addressing these tasks requires creation of respective normative documents in the form of the Union's standards, and national standards if needed.

New consumer requirements call for improved design and better consumer properties of the product.

Here, from our point of view, it is standardization and certification on a voluntary basis that can and should become really important. According to Western companies estimations (e.g. Siemens) standardization brings up to 15% cost reduction.

For consumers, standardization ensures interchangeability, which means they are not tied to a specific manufacturer, unequivocal understanding of characteristics included in the producer's data, simplicity of choosing the equipment needed. For manufacturers, it helps to define necessary requirements for products (and consequently have a clear picture of developing popular products and launching them into production) and simplifies product sales provided that the products are competitive.

In case of an individual order, standardisation simplifies negotiations aimed at drafting requirements to products and their quality control.

It is of supreme importance that standardisation enables manufacturers to coordinate requirements to components and materials despite the competition and jointly set tasks to produce new samples of the products. Basically, it already means creating the market of required materials and components. In other words, it is precisely standardization that links the manufacturers of all types of products — from materials to complex products — into one chain. This is the reason why so much attention is paid to standardization abroad and why businesses there order and heavily finance standard development: the share of standards developed through private capital reaches 50%.

Awareness of the importance and need for standardization development, urged the state to increase the funding of these programs, even if the necessary level has not been reached yet. Business is also involved, though not as yet very significantly. To improve the situation in the standardization area, railway machinery manufacturers should be more actively involved in the creation of state-run standardisation plans, defining the standards the focus area. Business must act as a customer and finance the development of standards necessary for manufacturers.

Since standards are used by all companies, their development should be commissioned by everybody interested. This will reduce the financial strain on development and enable each company's active involvement in discussing the documents. This approach could be implemented through special groups which would commission standards on behalf of business structures. These groups should be able to accumulate funds or issue shares for financing the standards development.

This is precisely what railway equipment producers did by forming UIRE. One of the Union's main aims is developing standardisation works, with a lot of attention being paid to this problem. The Partnership established a special Committee for Normative and Technical Support and Standardisation, which had six sessions over the last year.

Examples of effective unions of this type in the railway sector are Association of the European Rail Industry (UNIFE) in Europe and Association of American Railroads (AAR) in North America. Both organisations operate on standards developed, approved and introduced by their members.

Especially interesting in this sense is AAR, which virtually defines all areas of North American railways functioning on the basis of the normative documents it develops. The AAR fully meets the railways' demand for normative documents across all areas of their operations. Its standards define requirements for most technical equipment of the railway sector, methods for its control during production and operation, the interaction procedure between railways, between railway companies and technical equipment suppliers, and define test procedures for new products. The AAR manages the operations of Transportation Technology Center, Inc. This testing and technology centre of railway equipment has a standardisation department, the tasks of which include identifying the demand for normative documents, developing draft standardisation projects and standards and acting as a customer ordering normative documents.

The AAR standards are used not only by the Association members but by virtually the entire industry of railways products and their component manufacturers in the US, Canada and Mexico. The AAR example proves that standards of communities and associations of this type can be very important and even decisive for both members and non- members operating in the same industry. In Russian practice, such standards can act as industry-wide. The standards can also be used for regulating interaction between the Union's members and defining the rules of competition on the basis of unbiased product quality assessment. Basically, standardisation can address all issues and tasks listed in the UIRE's Charter and in "The Main Ideology Provisions" approved on December 13, 2007.

That's why UIRE in its first year apart from addressing urgent organisational needs developed and approved (on May 16, 2008), two basic standards: "Standards of the Non-Commercial Partnership. Main Provisions" and "Rules of Development, Approval, Renewal and Cancellation". This is where advantages of unified standards become obvious: they are discussed by all the Partnership members who will have to implement them. This contributes to creation of a consolidated position, making the document truly "common" at its very early development stage. The official standard approval procedure is two or three times as shorter than the one used for state standards. This significantly speeds up the process of standard approval or revision, at the same time reducing its costs by approximately 20%.

Standards are approved at the General Meeting by means of a direct personal vote. As a result, by voting for a document's approval, organisations voluntarily assume, under the law 'On Technical Regulations', the commitment to comply with the standard's requirements. The standard introduction schedule and the plan of actions for standard implementation are set independently by each company.

On September 16, 2008, the General Meeting for the first time approved UIRE's standardization plan for 2009 and approved, according to the Charter, the decision to finance standard development using special-purpose contributions.

Joint financing of standard development through special-purpose contributions helps to radically decrease its costs for each of the participants.

At the suggestions of the Union's Committees and Executive Direction the draft plan included documents which can be used by most of the Union's members.

Standardisation economic effects are characterised by the following main factors: unification and interchangeability of components and materials and their guaranteed level of quality, which enables optimisation of procurement policy and simplifies the process of choosing suppliers and replacing them when necessary.

It also simplifies new product launch to the market. Buyers have clearer view of the products on offer, unambiguously understand what products they are offered, and can obtain information about their quality.

It can improve demand for products with stronger quality parameters. To do so, a new quality standard for these products is developed at a very early stage and subsequently the products are assessed and tested for the compliance with the standard parameters and efficiency. Once the manufacturer obtains positive assessment from consumers, the volume of orders for the products begins to grow. When submitting orders, buyers will include the product's compliance with the standard as a mandatory procurement condition. Competitors are certainly free not to introduce this standard (introduction of standards is voluntary in all countries), but willing to comply with the buyers' needs will urge them to improve their products quality and confirm it by passing the standard. The information above makes it clear that manufacturers of high quality technically advanced products benefit from ordering development of standards to improve their competitiveness. It is also beneficial for the country's economy as a whole as it stimulates efforts aimed at improving the quality of products.

In order to establish rolling stock certification with UIRE in accordance with the approved decision, the Union developed standards “Certification Rules for Serviceability of Rolling Stock” and “Organisation of Service Tests of Rolling Stock”.

Serviceability certification will ensure unbiased assessment of the usability and reliability parameters of the rolling stock based on the service of the first pilot order and identification of their compliance with documentation and the buyer’s requirements.

Certification results will be used as the basis for the assessment of economic efficiency of the new rolling stock type compared to the previous models.

The problem of economic assessment of products based on life cycle costs is covered by the “Principles of Pricing for Railway Rolling Stock and Complicated Technical Systems of Railway Transport Based on Life Cycle Cost Assessment, Mandatory Conditions of Supply Agreements and Responsibility of Manufacturers and Consumers of Railway Equipment in Such Pricing” standard developed at the Institute for Natural Monopolies Research.

Establishment of modern market relations is covered by the “System of Supplier-Consumer Interaction. Main Provisions”, “Organizational Recommendations for Working with Suppliers. Choosing Supplier, Incoming Control Establishment with Trying Out Recommendations on Establishing Requirements for Product Assessment to Be Included into Supply Agreement”, “Comparison Tests Procedure in Case of Results Contestation or When Ordered by Product Owner” standards developed in 2009. The latter standard ensures the product’s unbiased assessment in case there are objections or disputes. Such assessment will involve the disputing parties by means of holding targeted tests with adjusted assessment of contested parameters. It is also possible to conduct a test to confirm the quality parameters or improve them following the manufacturer’s order. This test can also help in verifying new test methods reliability.

In accordance with the decision of the General Meeting of the Union’s members on December 22, 2008, UIRE is developing a package of standards on the new Quality Management System (QMS) for manufacturers of railway equipment. This new system, based on the ISO 9000 standards, will take into account the complete set of railway equipment specifications and encompass all stages from designing to putting to use. Their development will also incorporate the positive experience of creating systems for different sectors of economy (ISO standards have been approved for more than ten specific areas), experience of developing and applying QMS standards by railway equipment manufacturers in the USA (M-2003) and Europe (IRIS), and on the positive experience of Russian companies. The aim is to raise requirements; however, they should be compliant with the Russian industry actual capabilities. It is crucial that certification procedures ensure unbiased and comprehensive assessment of the company’s product quality and necessary control over the production process that would exclude formalistic assessment.

A stand-alone important task of standardisation faced by almost all UIRE members is developing supportive national standards needed to ensure the introduction of technical regulations. This task is of national importance and is addressed in the introduction to the federal law “On Technical Regulation” in the railway sector.

The task for the next two years is to develop several hundreds of standards on safety requirements and control methods. This problem has twice been the subject of special discussion at the Transport Committee of the State Duma. The Committee’s meetings were attended by representatives of the Ministry of Industry and Trade, Ministry of Transport, Federal Agency for Railway Transport, RZD and industrial companies. It was said during the meetings that funding allocations should be planned by the state budget and the R&D plan of RZD. Independent manufacturers of railway equipment should also make their contribution. The simplest way to ensure manufacturers’ involvement in addressing this task is by establishing a special-purpose UIRE foundation. The Union already has experience in developing standards. First of all, we believe it will be necessary to define the list of standards to be financed from each funding source, to estimate the amount of work and the timeframe for its possible implementation. Then individual jobs should be distributed among various equipment manufacturers, according to the customers interest in specific standards. Besides, it is necessary to define which standards will function as supportive. It can be General Specifications, which contain special sections “Safety Requirements” and “Conformity Assessment”, or “Safety Requirements and Conformity Assessment” (requirements and methods can be submitted as separate standards). Taking into account the lack of time and funding, as well as the scale of the future works, it is reasonable to develop the “Safety Requirements…” standards. In this case the volume of work and, consequently, costs will be 1.5-2 times lower, while the time consumed will be reduced ten-fold. The reasons for this are the fact that the standard will contain only safety requirements and not the entire range of requirements for an object, while the existing “Safety Norms” are well-prepared to be transferred into standards. Besides, standards of this type can become inter-state standards without heavy discussions and changes. Only afterwards it would be possible to start planning the work and defining the amount of special-purpose contributions. It should be preceded by all-rounded discussion of the draft project, suggestions on its implementation and their approval. ■

STATISTICS

All statistical data, provided in this section, are based on official information of federal executive bodies, ajusted in accordance with the data of Russian Railways and manufacturers.

RAILWAY ENGENEERING IN FIGURES

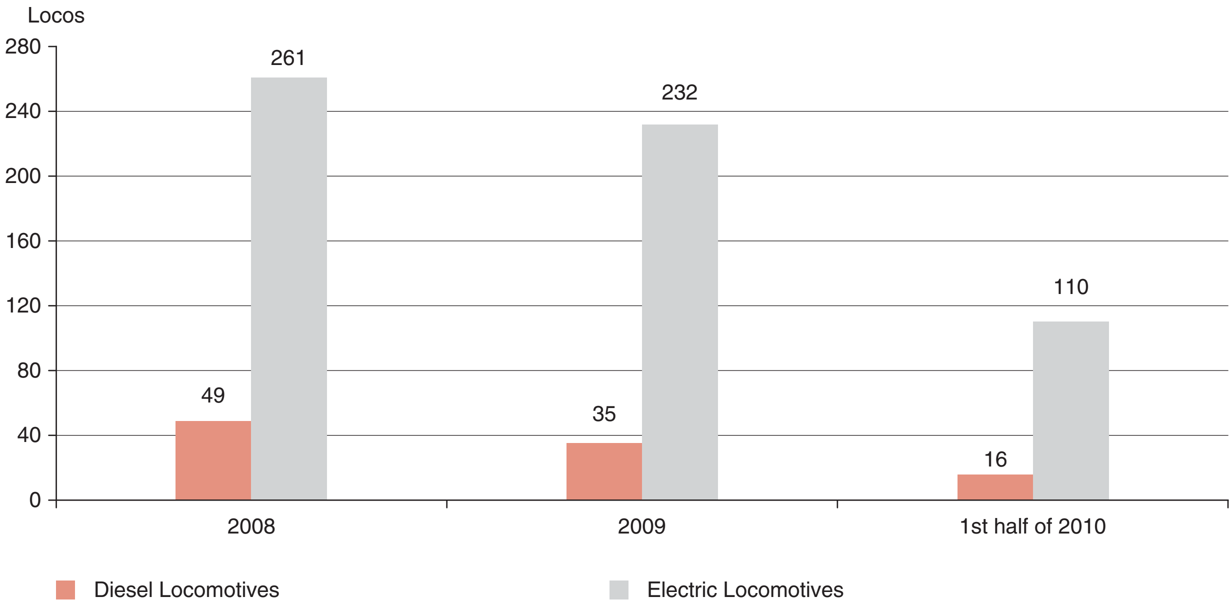
Production activities

Production of railway engineering, 2008 — 1st half of 2010

	2008	2009	1st half of 2010
Locomotives			
Main Line Electric Locomotives	261	232	110
Main Line Diesel Locomotives	49	35	16
Diesel Shunters	264	124	57
Mine Electric Locomotives	76	23	13
Cars			
Freight Cars	42 606	23 584	22 089
Passenger Coaches	1273	711	566
EMU & DMU Cars	827	673	273
Metro Cars	311	254	88
Tram Cars	276	149	21

Locomotives

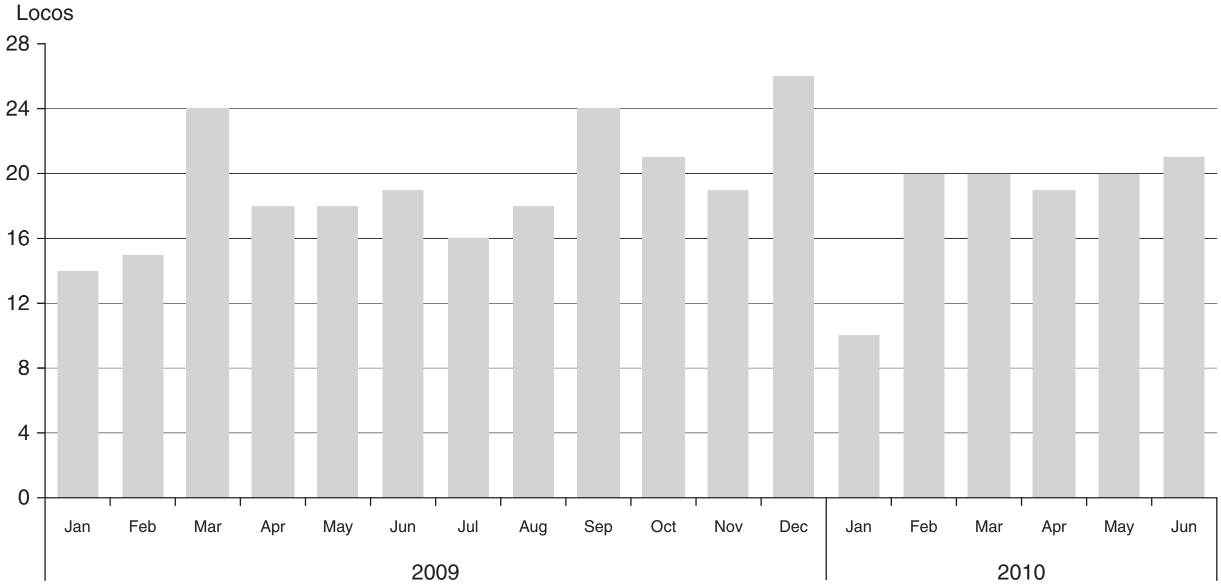
Main Line Locomotive production, 2008 — 1st half of 2010



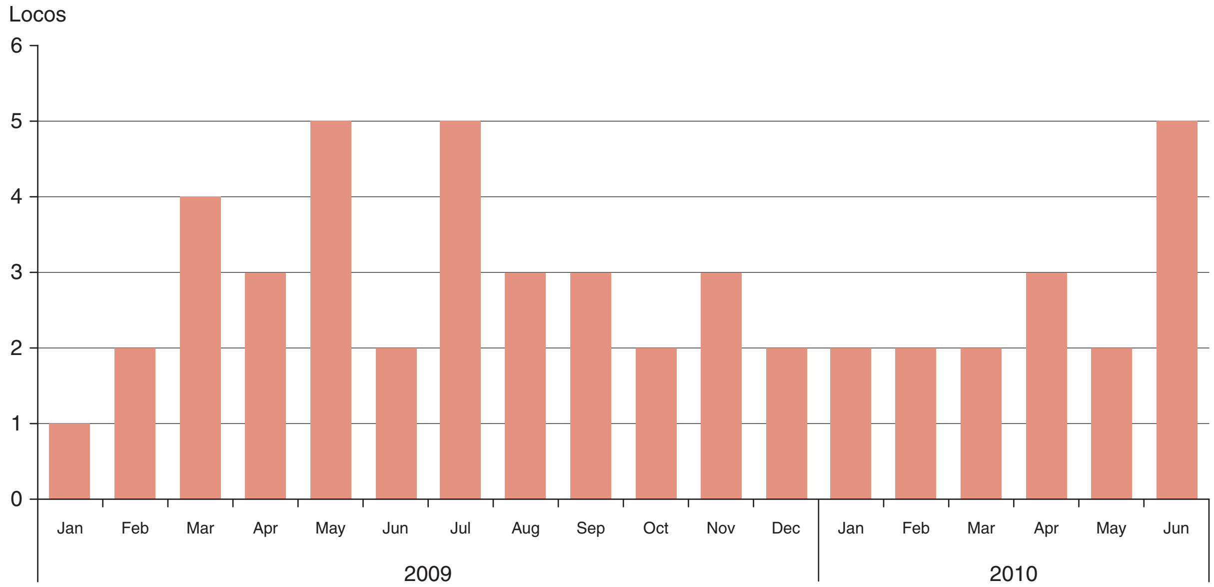
Locomotive production 2009 — 1st half of 2010

	2009												1st half of 2010					
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Main Line Electric Locomotives	14	15	24	18	18	19	16	18	24	21	19	26	10	20	20	19	20	21
Main Line Diesel Locomotives	1	2	4	3	5	2	5	3	3	2	3	2	2	2	2	3	2	5
Diesel Shunters	2	13	11	17	16	14	12	9	8	11	5	6	0	8	10	14	12	13
Mine Electric Locomotives	2	0	0	1	1	7	1	0	0	4	0	7	0	3	5	2	3	0

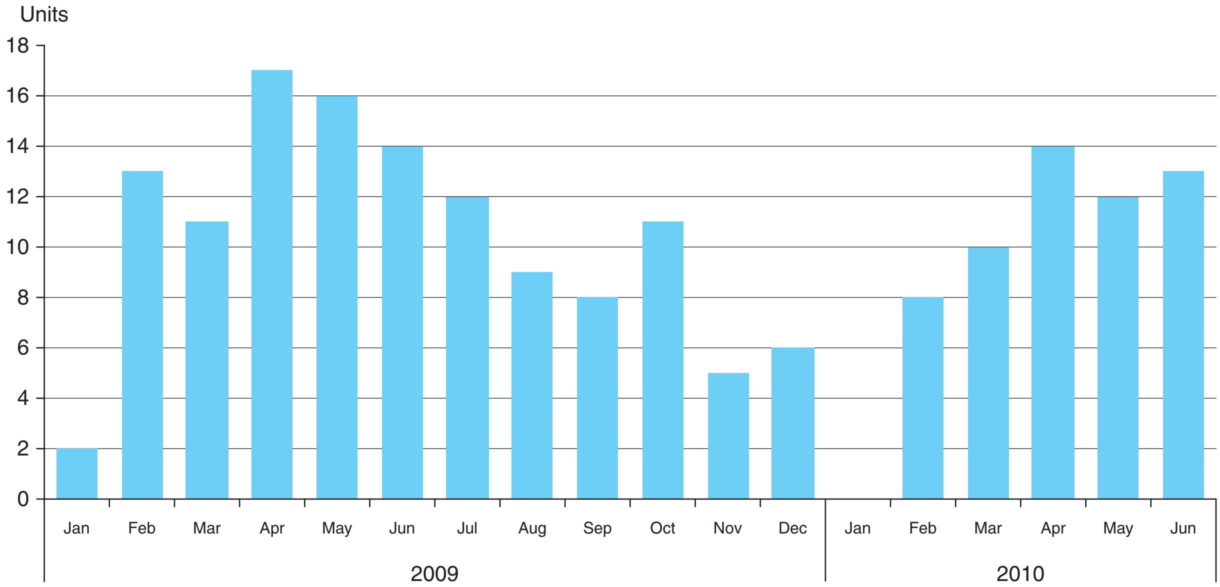
Main Line Electric Locomotive production, 2009 — 1st half of 2010



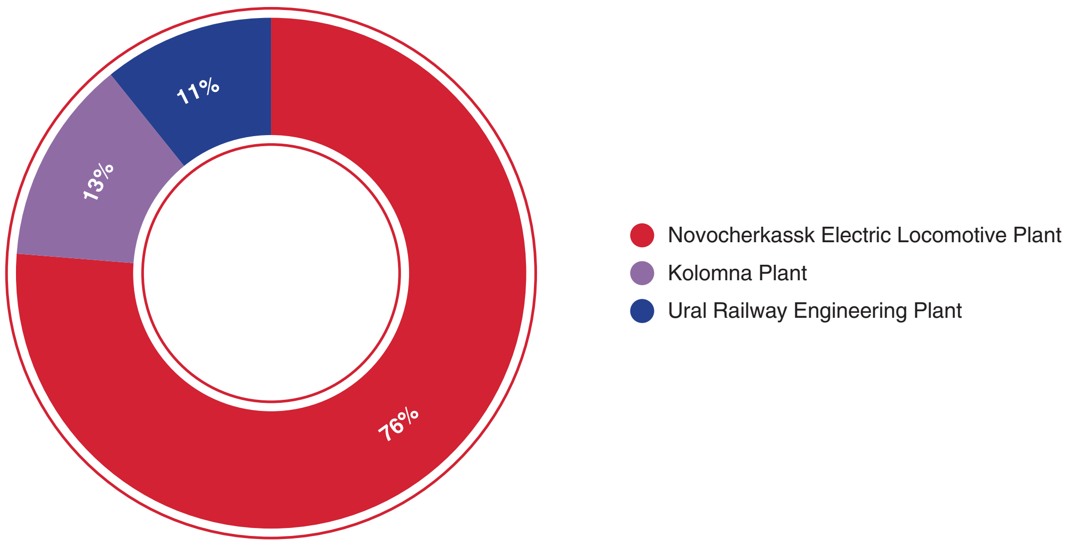
Main Line Diesel Locomotive production, 2009 — 1st half of 2010



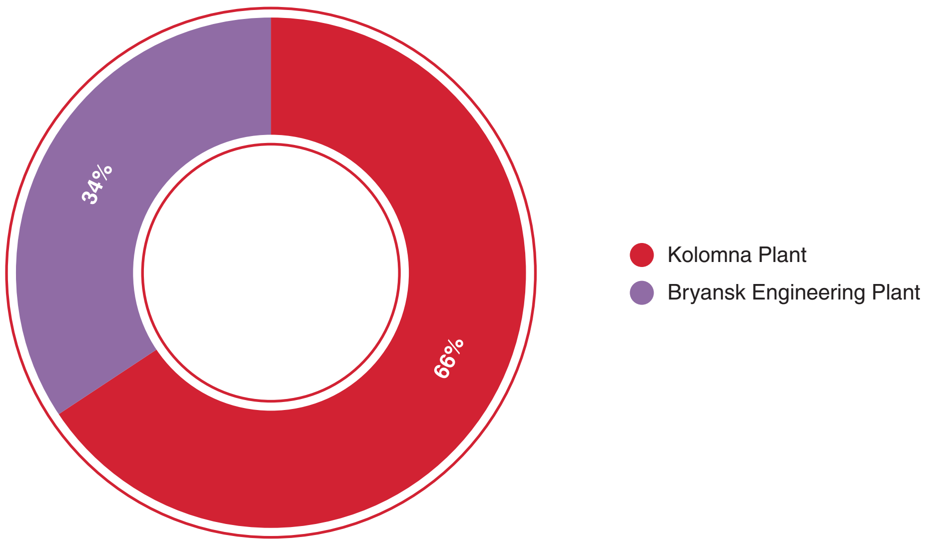
Diesel Shunter production, 2009 — 1st half of 2010



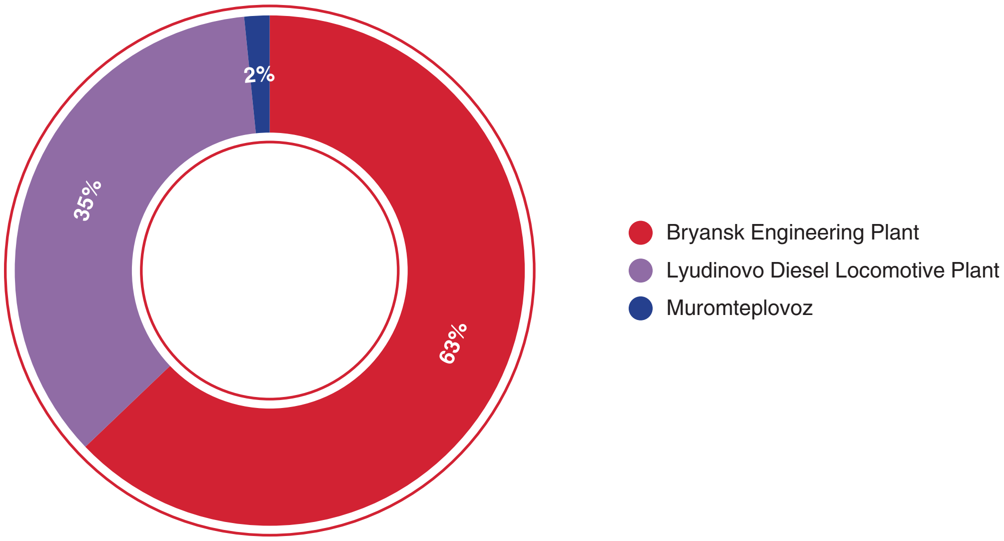
Main Line Electric Locomotive production by manufacturers, 2009



Main Line Diesel Locomotive production by manufacturers, 2009

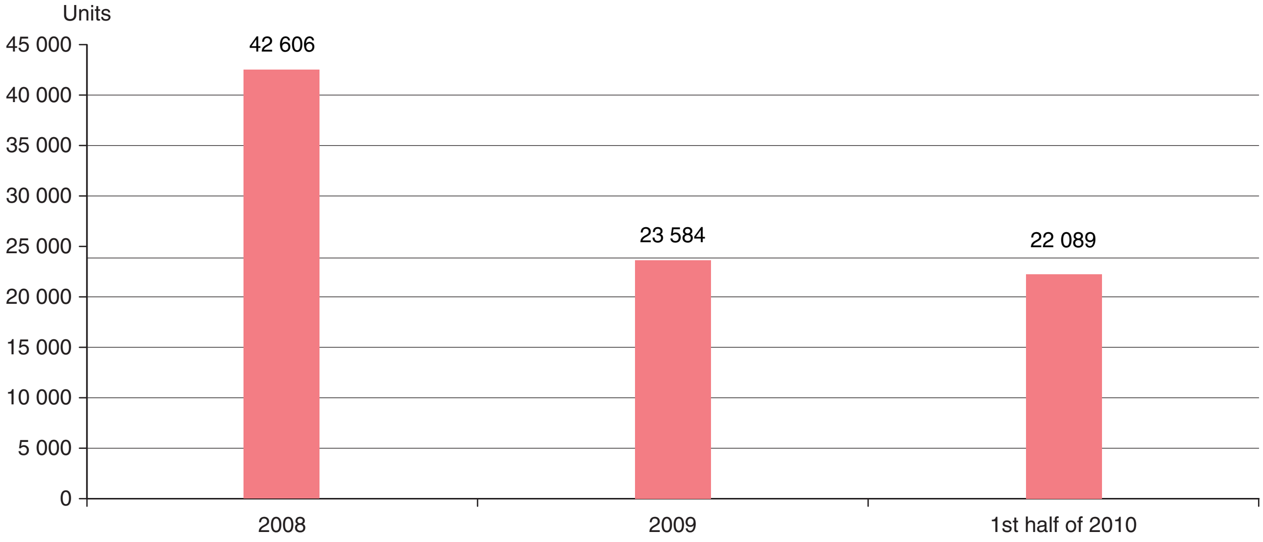


Diesel Shunter production by manufacturers, 2009

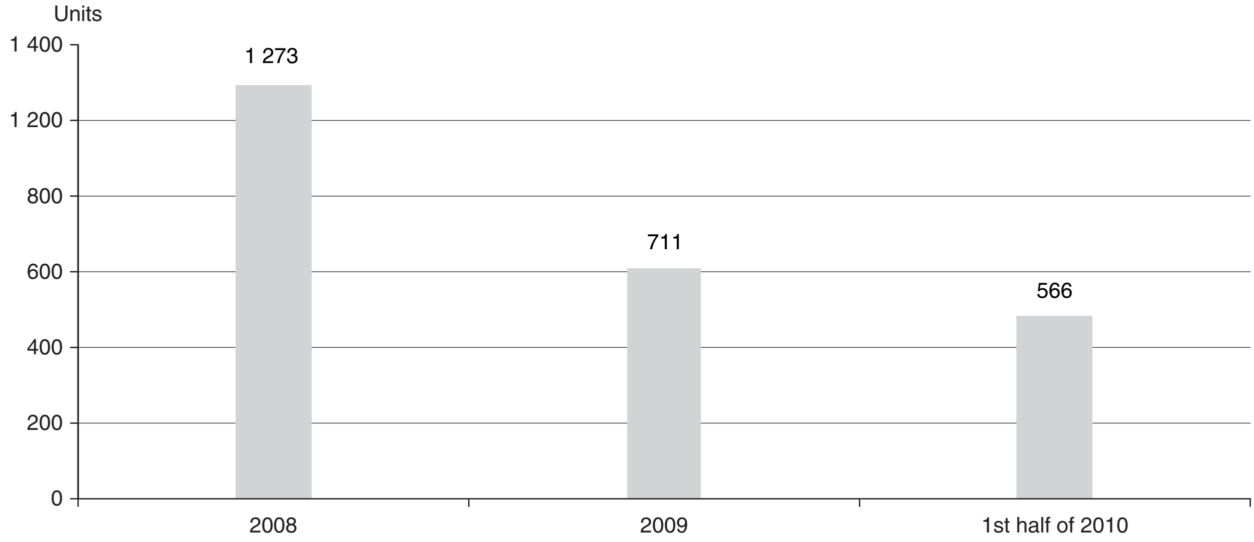


Cars

Freight Car production, 2008 — 1st half of 2010



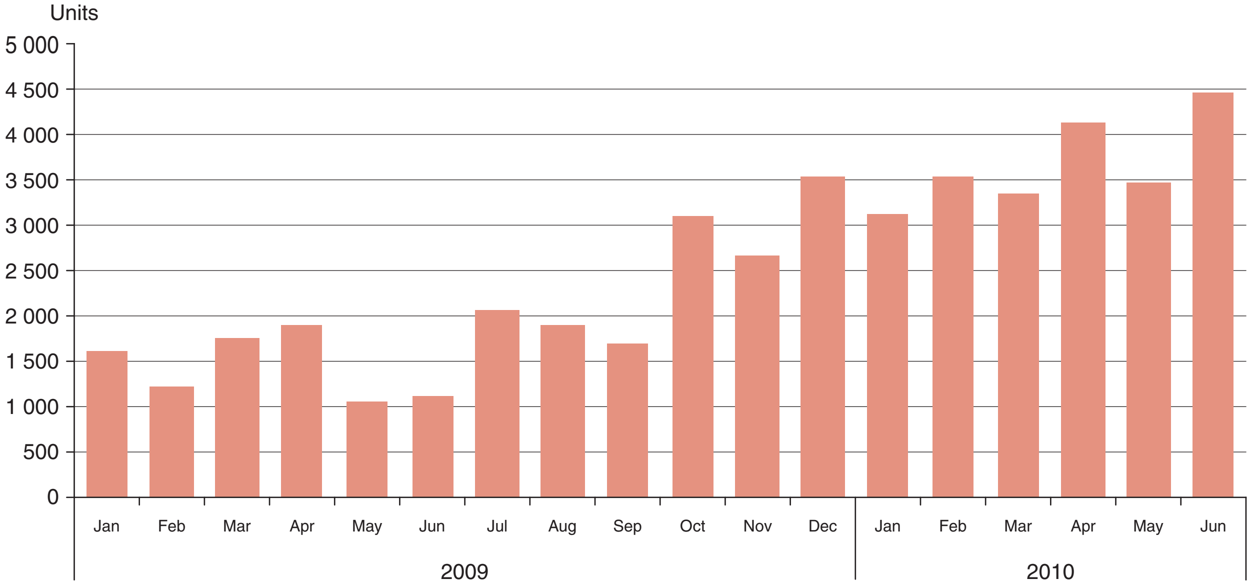
Passenger Coaches production, 2008 — 1st half of 2010



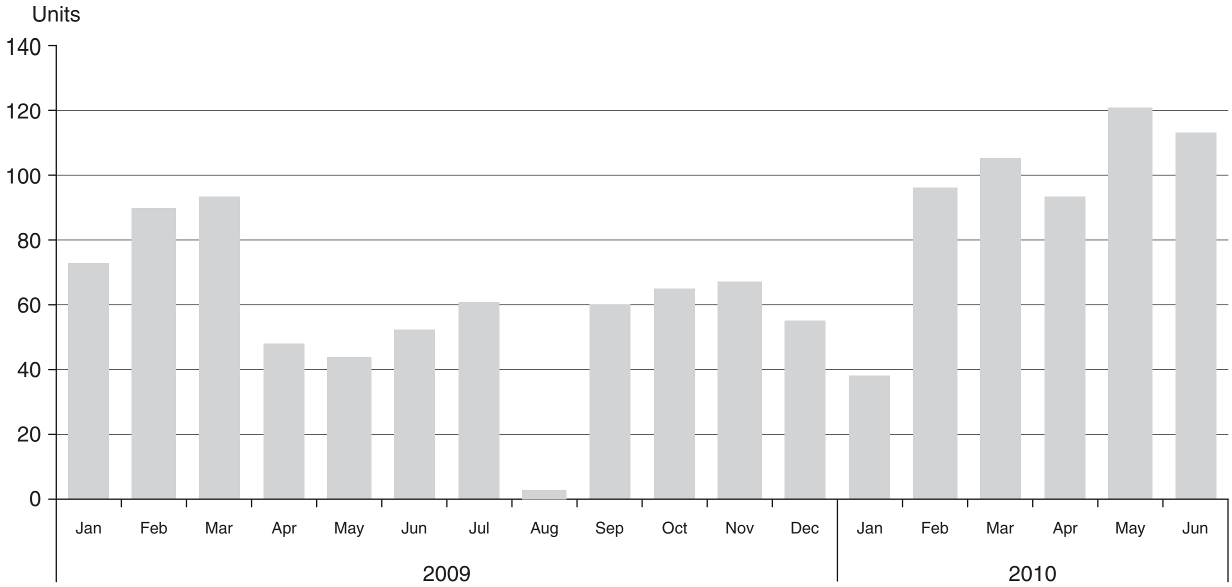
Locomotive production 2009 — 1st half of 2010

	2009												1st half of 2010					
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Freight Cars	1604	1229	1747	1905	1045	1121	2056	1896	1684	3104	2670	3523	3129	3542	3339	4134	3472	4473
Passenger Coaches	73	90	93	48	44	52	61	3	60	65	67	55	38	96	105	93	121	113
EMU & DMU Cars	10	45	61	66	63	61	88	68	65	66	46	34	35	43	50	48	43	54
Metro Cars	33	34	30	11	29	10	27	15	26	15	19	5	9	11	16	24	13	15
Tram Cars	19	10	17	15	19	17	8	8	4	6	12	14	2	3	3	3	4	6

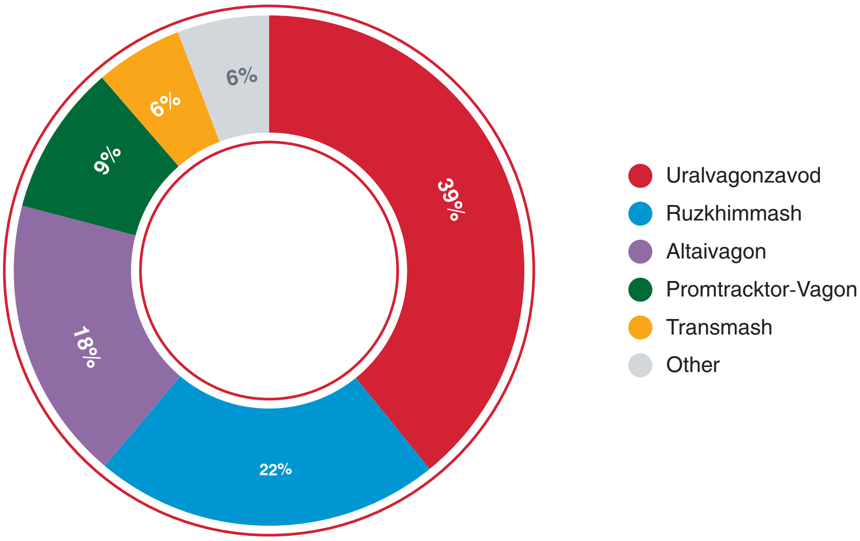
Freifght Car production, 2009 — 1st half of 2010



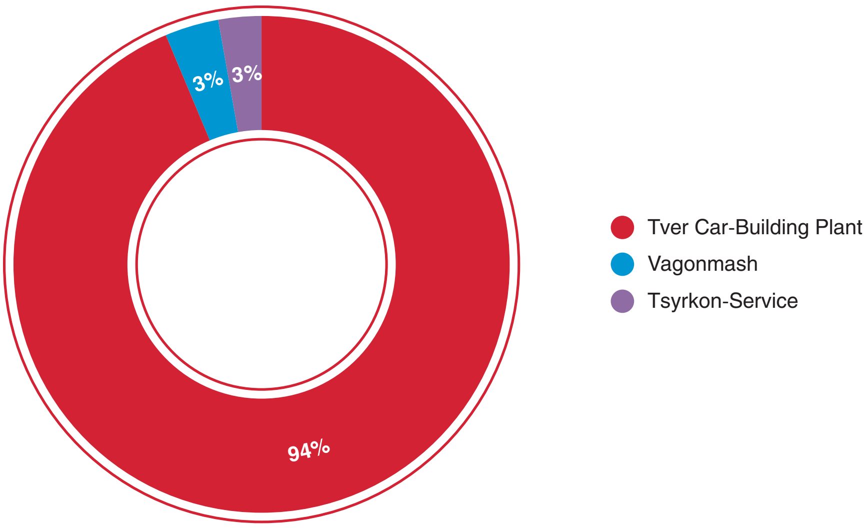
Passenger Car production, 2009 — 1st half of 2010



Freight Car production by manufacturers, 2009



Passenger Car production by manufacturers, 2009



Amount of railway engeneering production and services sold, exclusive of VAT, bn €

	2008				2009				2010	
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Production of Rolling Stock	1 427,78	1 732,76	1 996,37	1 954,14	963,47	888,46	928,01	1 156,32	1 069,48	1 594,25
Locomotives	116,94	172,44	174,92	218,31	101,88	120,53	124,81	135,50	115,91	189,14
EMU Cars, DMU Cars, Metro Cars, Tram Cars, Locotractors	122,95	135,97	188,86	219,62	126,04	87,84	135,32	99,61	85,21	125,18
Freight Cars	24,99	35,07	33,75	75,28	20,60	14,72	17,89	19,89	6,30	25,34
Passenger Coaches	182,61	222,79	282,28	245,48	183,87	132,83	113,36	155,87	77,92	132,03
Track Machines	387,04	446,90	533,34	455,82	131,69	72,22	105,36	243,88	303,14	456,64
Production of Spare Parts of Rolling Stock and Track	255,49	308,37	322,05	254,03	127,90	150,10	131,75	164,27	163,36	235,02
Repair and Maintenance of Rolling Stock	337,75	411,20	461,16	485,59	271,50	310,21	299,52	337,30	317,63	430,91
Total industry	133 741,97	150 269,17	161 491,14	132 416,14	90 437,04	105 211,33	112 718,53	127 769,93	127 893,49	155 364,46
Exchange rate	36,33	36,93	36,49	36,04	44,70	43,81	44,76	43,56	41,23	38,55

DEVELOPMENT OF SAFETY SYSTEMS AND TRAIN TRAFFIC INTERVAL CONTROL SYSTEMS BASED ON SATELLITE NAVIGATION AND DIGITAL RADIO CHANNEL TO INCREASE THE SPEED AND INTERVALS OF TRAIN TRAFFIC

Vasily Zorin,
Ph.D, head of JSC NIIAS control systems and rail traffic safety R&D department

The efficiency and competitiveness of the rail transport largely depends on the speed and intensity of train traffic. With increased speed and intensity of train traffic, safety requirements are also increased. To meet these requirements, new improved and more sophisticated technologies and principles of control systems designing and train traffic safety should be applied.

The most important task of control systems and train traffic safety is to determine the location of a train and its speed.

Traditionally, speed sensors (odometers) mounted on wheel axles of locomotives and MUs are used for this purpose.

A significant error associated with this method requires the use of external (ground-type) technical means for adjusting the location of a train or the use of other, more precise methods of measuring train motion parameters.

Specialists of our institute are constantly researching alternative methods and technical means for measuring motion parameters with increased accuracy. Doppler radio-frequency and Doppler scanning laser measuring devices were studied. We also tested inertial and other measuring instruments. All the tested devices have a significant drawback: the accumulation of measurement error, which reduces their effectiveness in determining current position of a train.

This error can be reduced through the use of stationary correction points — similarly to Eurobalises[1] introduced in foreign railways.

The most efficient way is to apply satellite navigation systems GLONASS/GPS in combination with conventional speed sensors.

The advantages of satellite navigation systems are obvious. In late 1990s, a number of leading European companies, General Electric (USA) and NIIAS (Russia) began to explore the possibility of using satellite navigation systems to control train traffic and safety. Developers of control systems for the Sokol-250 high-speed train also tried to apply satellite positioning.

Russian-made integrated locomotive safety device CLUB–U is the most widely introduced technical device for train traffic control and safety management worldwide. 'Ultra Cab' locomotive safety system by General Electric is the closest to CLUB–U, though satellite positioning is only an option of the Ultra Cab.

A ten-year experience in the operation of satellite navigation systems in train traffic control and safety systems allows developers to expand their functionality.

In particular, reduced error in railway positioning allows operators to replace the transmission of information through a rail channel of multiple-valued

1 Eurobalises are point transponders used in the ERTMS system to determine the location of trains on the railways in Europe and other countries

automatic locomotive signaling about the areas of permanent speed restrictions with an electronic database of GLONASS/GPS satellite positioning. More specifically, the implementation of this function allowed railways to reduce travel time of the Sapsan high-speed train between St. Petersburg and Moscow by 12 minutes without compromising the safety.

Another important task is to transfer necessary information from the ground-based train traffic control devices to the locomotive.

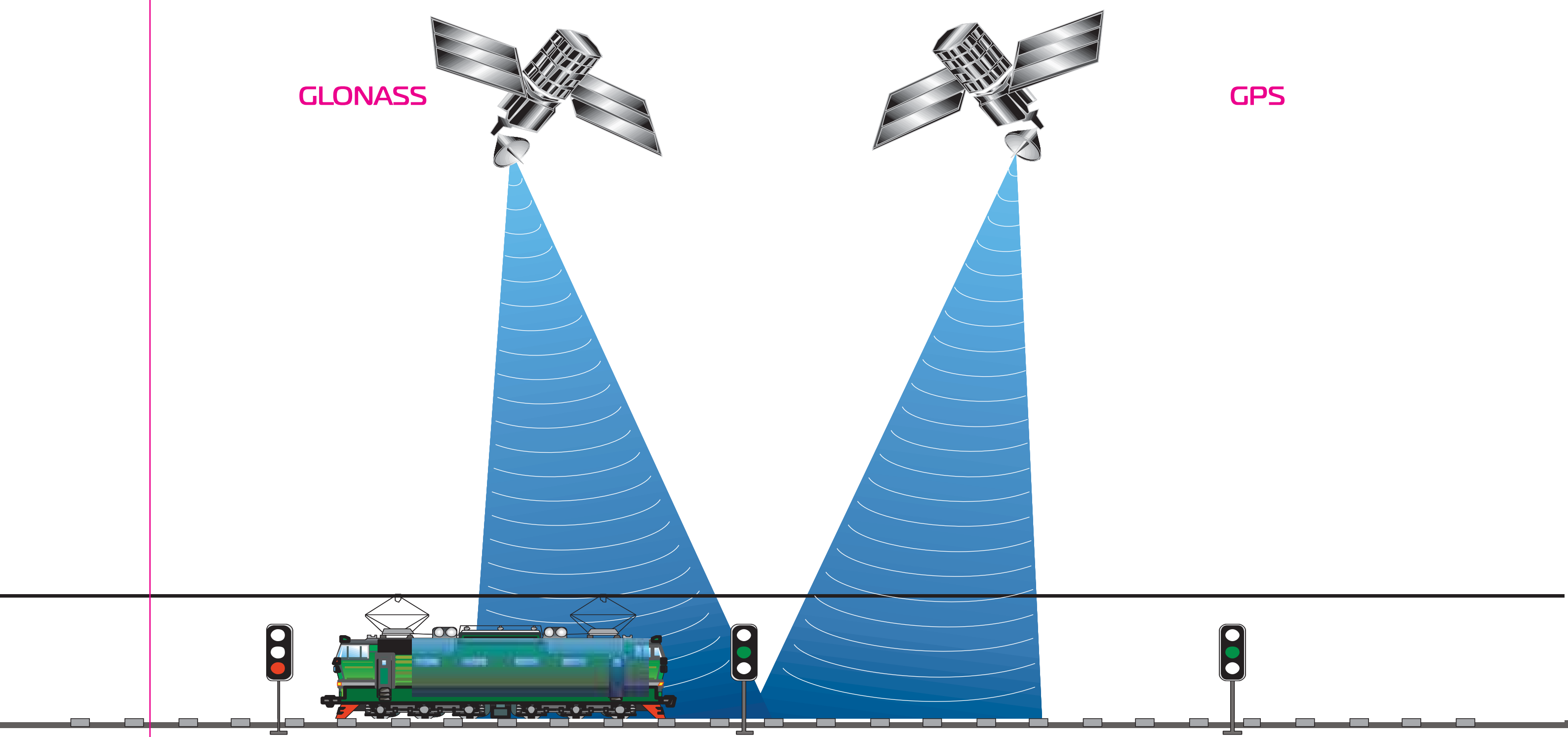
Traditionally, rail lines are used for this purpose. The signals of traffic lights and other necessary information are transmitted to the locomotive through the rail lines and received by locomotive units with the help of inductance antennas. Currently, alternative channels for information transmission, zonal or network radio devices are being intensively developed.

Based on these principles and technologies and by order of RZD, researchers are developing an integrated safety system for the new generation locomotives and MUs.

Present-day requirements for locomotive systems of train traffic safety are being realized through a number of technical means: CLUB-U, SAUT-CM/485, TS KBM. However, the installation of such a diverse complex on newly developed locomotives and multiple units looks archaic. This complex has a hardware and software redundancy, inevitable conflicts in the interaction of functions and algorithms. The development is carried out in accordance with deadlines set by RZD.

Unification of technical means and technologies of train traffic control and safety with foreign railways is particularly needed for efficient organization of international transport corridors.

To solve this issue, NIIAS and Ansaldo STS (Italy) — a subsidiary of Finmeccanica — are currently engaged in joint development of train traffic control and safety system ITARUS-ATC, functionally in line with the Level 2 ERTMS. The system will be largely based on Russian technical means and, first of all, technology for satellite navigation systems. The Italian part is about the technology for information transmission between outdoor devices and the locomotive via the GSM-R network. This system is to be used at the Olympic lines of the Sochi railway, as well as international projects. Tests of this system are to be started in 2010 at the experimental section of the North-Caucasian Railway.



GAS TURBINE LOCOMOTIVE: TIMELY AND SUCCESSFUL TESTING

Vladimir Rudenko
Ph.D, Chief Engineer, JSC "R&D Technology Institute of Rolling Stock" (VNIKTI)

Quite a bit has been written in the media about the recent record runs of the GT1 gas turbine locomotive. Nothing however was said about the hard work done of its designers. They were the first in the world to come up with an idea to power a gas turbine locomotive engine with liquefied natural gas (LNG)

A similar engine, however, was used before: on April 15, 1988 the world's first Tu-155 airliner made its first flight equipped with the experimental engine NK-88 designed by the Kuznetsov Design Bureau. The engine consumed alternative fuels (liquefied hydrogen and liquefied natural gas). Therefore, quite naturally, the gas turbine locomotive project developers commissioned the Kuznetsov Samara R&D Center with the gas turbine engine design, even though they considered several types of such engines offered by various developers.

The Tu-155 jet scheme of liquefied gas injection as such could not be used for gas turbine locomotive because unlike on board of the jet the liquefied gas container (due to its larger volume) could not be located in the same body with the gas turbine engine. This resulted in a number of new parts and elements.

A number of parts including the combustion chamber used to ensure the cold gas start were tested during the manufacturing of the gas turbine engine (which was named NK-361). In late 2006, the GTL power unit running on LNG was tested with the loading on the water rheostats. The tests were conducted under the following atmospheric conditions:

- Atmospheric pressure 733—760 mm Hg;
- Relative humidity 35—75%:
- Temperature: from -20.10C to +12.40C.

The tests included the following activities:

- Working out the technology of fuel line refrigeration from a cryogenic tank to the gas turbine engine (GTE), including fuel pump and fuel control units;
- Checkout of engine start with reaching rated rotation speed of free turbine rotor;
- Determining the basic parameters of the NK-361 gas-turbine engine and its flow rate characteristics for various capacities from idling to peaking;
- Recording characteristics of the traction and auxiliary generators;
- Evaluating vibration status of the engine and generators;
- Evaluating performance of GTE and generators' oil systems.

During the tests, GTE was started 73 times.

The tests have confirmed conformity of experimental data to theoretical calculations, but the power unit control system needed improvements in the structure and algorithms of the control unit.

Also, it was determined that nitrogen oxides, carbon oxides and hydrocarbon emissions were far below the allowable values (according to the state standard GOST 50953-96).

After gas turbine locomotive was assembled, in May 2007 rheostat tests began. These tests have revealed that developed GTE control system was inoperative. We at the VNIKTI had to re-develop the control panel and the algorithms to control the cryogenic tank, fuel supply system, gas heating, as well as the control of GTE and traction generator load modes. The rheostat tests confirmed the operability of the newly developed control system. They also revealed the need to develop a new LNG fuel supply system which could bring down the gas consumption during refueling, fuel system's cooling-down, stabilizing temperature of the cryogenic tank to ensure a reliable operation of cryogenic centrifugal pumps, as well as ensure the full consumption of the LNG stock in the cryogenic

tank. Existing fuel supply system did not ensure the full consumption of LNG — about 3.5—4.0 tons of fuel remained in the cryogenic tank.

After the rheostat tests, test drives were carried out at the RZD rail test ground.

Results of these test drives are shown in the table below:

S — length of trip, km;

Q — weight of the train, tons;

N_{av} — average power of the generator during trip, kW;

V – average speed of the locomotive, km/h;

Tt – travel time, hours.

The feasibility study based on the test drives has revealed that with the price ratio of diesel fuel and liquefied gas at 2:1 (which corresponds to European prices), the fuel costs of gas turbine locomotive were 30% lower than those of diesel-powered locomotive.

Currently, the gas turbine locomotive fuel system is being upgraded at VNIKTI. After the rheostat tests, test drives and acceptance tests the GTL will be delivered to the Sverdlovsk railway for routine operations. Regular re-fueling of the gas turbine locomotive will be carried out at the LNG production site, gas distributing station 4 in Yekaterinburg. Pilot operation of the first gas turbine locomotive GT-1 will be carried out at the line section Yekaterinburg-Sortirovochny — Polevskoy — Verkhniy Ufaley.

Test drive	Date	Trip	S, km	Q, t	N_{av}, kW	V, km/h	Tt, h
1	04.07.08	Smyshlyaevka - Kuroumcha	30	3200	3714	23.08	1.3
2	11.12.08	Bekasovo - Vekovka	315	2300	1785	74.8	4.21
3	17.12.08	Vekovka - Bekasovo	315	8300	2846	41.9	7.52
4	20.12.08	Rybnoe - Perovo	140	10000	3462	49.3	2.84
5	23.01.09	VNIIZT Ring	18	15000	1898	11.7	1.54
6	29.01.09	Vekovka - Bekasovo	180	6000	2073	37.3	4.82
7	06.02.09	Vekovka - Bekasovo	315	6000	2078	36.4	8.66

ELECTRIC LOCOMOTIVE EP20 — BASIC PLATFORM FOR NEW GENERATION ELECTRIC LOCOMOTIVES

Sergey Usvitsky
EP20 Project Manager, VELNII head of electrical engineering department

The changes that have occurred in the railway industry in recent years — improvement of the infrastructure, introduction of new information technology management and safety of the transportation process, introduction of modern standards in service and logistics, increased competition among transport operators, growing innovative capabilities of manufacturers of railway engineering components — are a powerful incentive to the creation of a new electric rolling stock that meets the modern technical and economic standards.

Based on the experience in creating electric locomotives with asynchronous drive, VELNII — under order of RZD — started designing the EP20 passenger single-section dual power supply electric locomotive with asynchronous traction motor. This work is being done in close cooperation with the leading manufacturers of rail engineering products.

The development of the electric locomotive is heavily based on innovative technologies, which are essential to achieve the required operating parameters of the electric locomotive, as well as the reliability and long lifetime.

General concept

Taking into account the prospects for the development of high-power high-speed DC and AC rolling stock, the EP20 electric locomotive is the base platform (Fig. 1) for subsequent types of locomo-

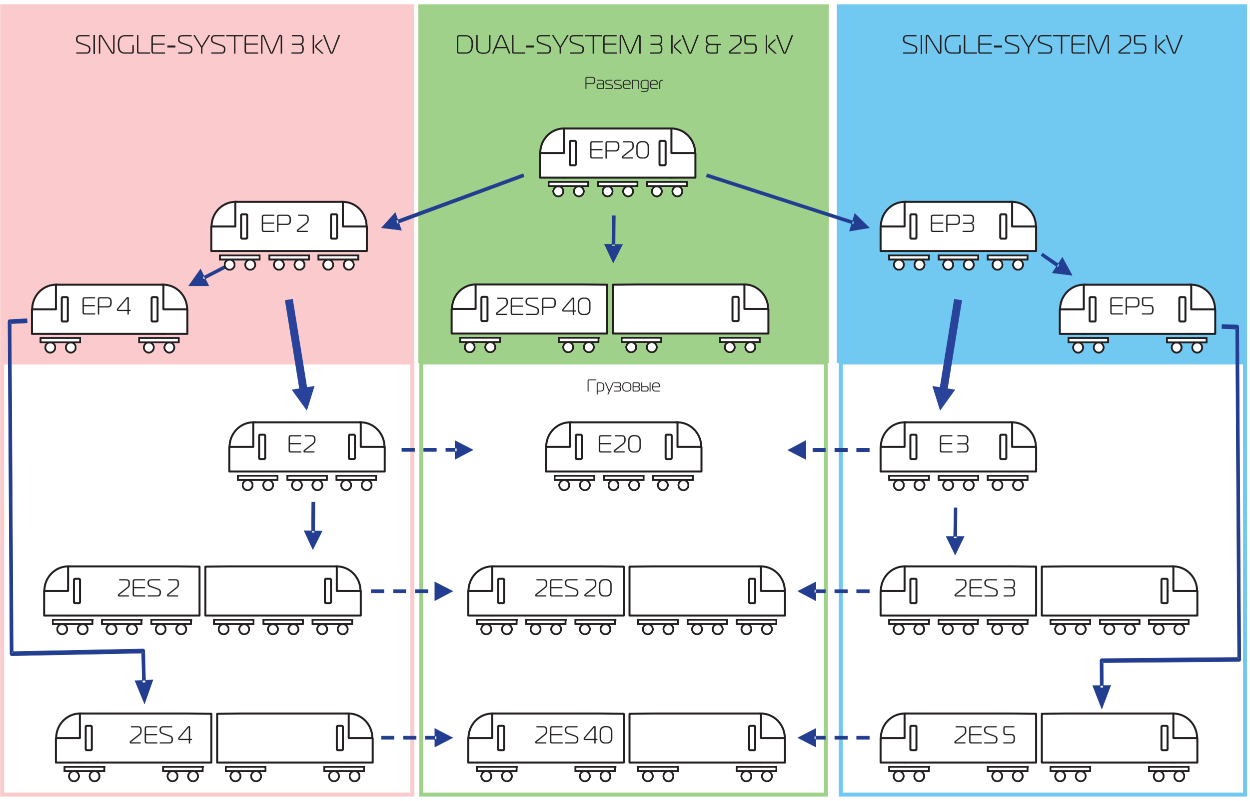


Fig. 1. EP20 is the basic model for the line of perspective electric locomotives

tives with asynchronous traction motors to be developed in accordance with the list of types and basic parameters of electric locomotives for main line railways in Russia.

The EP20 mainline dual-system passenger electric locomotive is designed for hauling passenger trains on Russian railways with the 1520-mm gauge, electrified with DC 3 kV voltage and AC 25 kV voltage with 50 Hz frequency. The electric locomotive is designed to operate on existing and

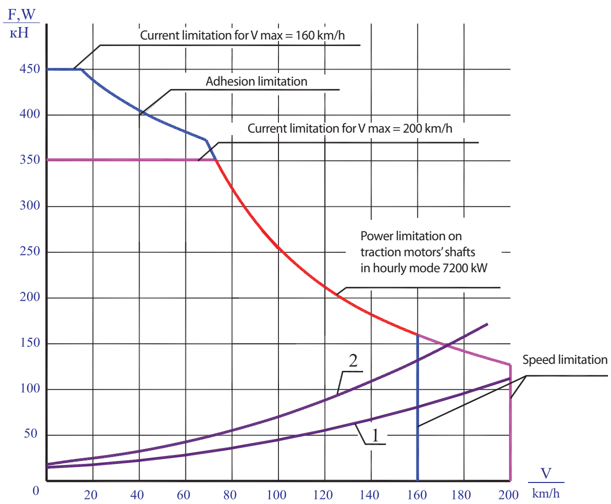


Fig. 2. EP20 haulage performance

subject-to-reconstruction high-speed railway lines with a maximum allowable speed of 160 (up to 200) km/h, as well as conventional railway lines with specified operational speeds.

In accordance with the traction characteristics (Fig. 2) the electric locomotive should haul a train of 24 cars at a speed of 160 km/h and a train of 17 cars at a speed of 200 km/h on tangent sections of the track. For comparison: commercially available electric locomotive of EP1M series has a maximum speed of 140 km/h and hauls a train of 19 cars at this speed.

Modularity

The new electric locomotive design is based on the modularity principle. According to this principle, the overall design is based on modules, components and assemblies, which are highly unified for different types of electric locomotives and every subsequent model can be built up using these modules. It is expected that due to this fact the designing timeframes for subsequent electric locomotive series will be much shorter. The principle of modular design helps in reducing costs of subsequent models and simplifies the work of operators as they will not need to study new elements and devices.

Table 1. Key parameters of the electric locomotive prototype

Parameter	Value	
Rated voltage at the current collector, kV — AC 50 Hz — DC	 25 3	
Gauge, mm	1 520	
Chassis formula	2o-2o-2o	
Adhesion weight with 2/3 sand capacity, tons	$129^{+1.8}_{-3}$	
Nominal diameter of running wheel rolling circle, mm	1 250	
Height from rail level to the working surface of pantograph pan: — In the closed position, mm, not more — In the working position, mm	 5 100 5 500-7 000	
Maximal speed, km/h	160	200
Hourly power on the shafts of traction motors, kW, not less	7 200	
Hourly speed, km/h	78	100
Traction effort in the hourly mode, kN (ton-force), not less	325 (33,1)	250 (25,4)
Prolonged mode power on the shafts of traction motors, kW, not less	6 600	
Prolonged mode speed, km/h	78	100
Prolonged mode traction force, kN (ton-force), not less	300 (30,6)	230 (23,4)
Maximum tractive force when starting, kN (ton-force), not less	450 (45,8)	350 (35,6)
Traction force at the maximum rated speed, kN (ton-force), not less	147 (15)	115 (11)
Efficiency in hourly mode, at least: — with AC power supply — with DC power supply	 0,86 0,875	
Centralized power supply parameters of passenger train: — Power, kW, not less — Nominal voltage, V	 1 200 3 000	
Electric braking	recuperative, rheostatic	
Power of electric brakes on the shafts of traction motors, kW, not less: — recuperative — rheostatic — with DC power supply — with AC power supply	 6 000 4 500 3 200	
The length of the locomotive along the coupler axes, mm, not more	22 550	

Equipment layout

The EP20 dual-system line passenger electric locomotive is a six-axle section with two driver's cabs.

The internal equipment layout is made with a central passageway. A mounting groove goes along the central passageway, where pneumatic system tubes and electric power cables are installed.

Equipment is installed at both sides of the central passageway. The equipment layout is based on the functional blocks. All blocks are closed, bay of racks.

The uniform distribution of equipment around the body of the electric locomotive ensures an equal distribution of weight loads across the electric locomotive and optimum use of the adhesion coefficient.

Driver's cab

The modular cab of the EP20 locomotive meets the modern safety, ergonomics, comfort and aesthetic requirements.

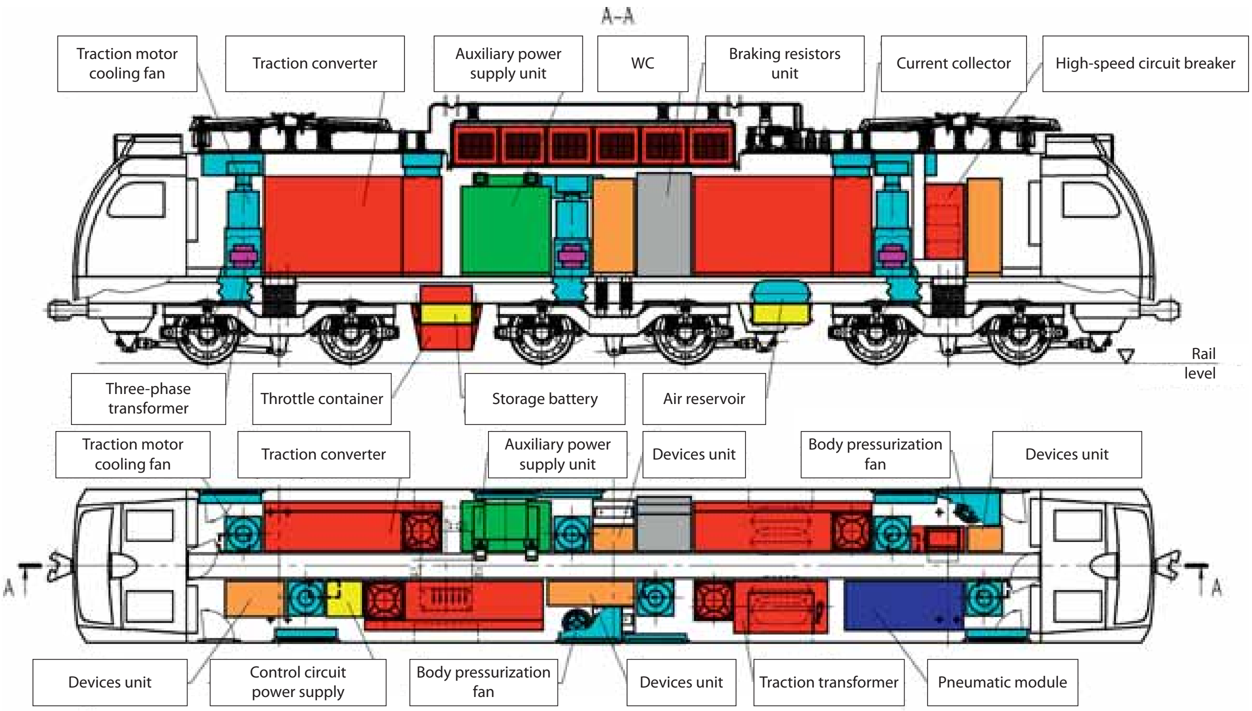


Fig. 3. Locomotive equipment layout

It should be noted that through the use of modular cabs the locomotive design gets a very important feature — the possibility of its further modular upgrade, along with the introduction of new, more effective technical solutions.

Careful attention paid to the ergonomics allowed the designers to create a modern driver's cab and the locomotive crew workplace in line with recent world trends.

A number of new technical solutions were used to design the control room. Windshields are equipped with wipers with electric drive. The side windows are equipped with a sliding mechanism and rotary safety shields. The locomotive is equipped with LED taillights and headlight, rear-view mirrors with electric defroster and distance control.

The metal frame of the cab sets the basic strength and dimensional characteristics of the cab and, most importantly, provides the required level of safety.

A passive safety system is used, which together with the body elements is aimed to absorb up to 4 MJ energy in case of the locomotive's collision with an obstacle.

The cab interior is made in warm colors.

The cab is equipped with a climate control: heating and air conditioning with automatic maintenance of the required temperature in the cab.

Information for the driver in the cab of the EP20 electric locomotive is available in visual and sound types. Sound information is available to the driver as voice messages and audio signals.

Driver's control panel

The layout of controls on the driver's control panel is based on the convenience principle. The control panel has two displays, driver's controller that is made as a joystick, whose lever moves in two planes, and power switches made as touch panels.

The layout of controls on the driver's control panel is made to allow one-driver control over the electric locomotive.

Information on the displays is available in three types:

- a basic set of parameters that characterize current state of the train (standard mode);
- on-demand information;
- additional information automatically displayed in case of abnormal and emergency situations.

Information system provides the driver with the necessary data on the functioning of all major systems of the locomotive.

Mechanical part

The locomotive body is based on three two-axle bogies (Figure 4). The electric locomotive has a two-step spring suspension. The body spring suspension is made as FlexiCoil body supports. The axle-box spring suspension is made as helical cylindrical springs. The transfer of traction and braking forces from bogie to the body is made through oblique traction. Damping of body oscillations against bogies and bogie frames against wheelsets is done by hydraulic dampers.

The electric locomotive has a third class drive. The traction motor and the traction reduction gear are combined into a single unit and have a support-frame suspension. The bogie is equipped with disc brakes and cleaners designed to clean the surface of wheel's rolling circle. To reduce the wear rate of running wheels' flanges, the bogie design includes flange lubricators.

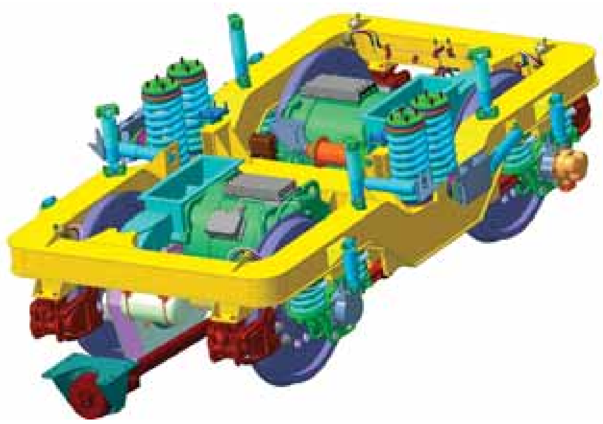


Fig. 4. Locomotive's bogie.

Pneumatic system

The pneumatic system of the electric locomotive provides functioning of pneumatic brakes of the locomotive and the train, parking brake, sand sprinkling, sound signals, current collectors, flange lubricators, cleaning of rolling wheels' surface, control circuit devices, and antiskid devices.

The locomotive's sources of compressed air are two oil-free piston compressors arranged in a single brake module. In order to ensure a reliable operation of the pneumatic system in terms of the quality of compressed air the locomotive is equipped with a compressed air drying and cleaning system.

The pneumatic brake is equipped with remote control of actuating devices, which improves working conditions of the locomotive crew and ergonomics of the workplace.

Traction drive

Each bogie has one autonomously functioning traction converter, which, in turn, contains two identical traction units. Each traction unit includes one input transducer (4qs), filter capacitor, three-phase voltage inverter for powering the traction motor, one brake chopper. IGBT transistors with isolation voltage of 6.5 kV are used as power semiconductor devices for traction converter.

In case of failure of one of the traction units, such a unit is switched off without affecting the functioning of the other equipment. In fact, the locomotive can continue motion with the power reduced by only 17%.

The traction motor (Figure 5) is made as a six-pole three-phase asynchronous motor with cage rotor. The rotor's shaft has a package of core with rotating rods, whose ends are connected with short-circuit rings. Hourly power of the traction motor is 1200 kW.

This concept of traction drive design provides high survivability of the locomotive.

Fig. 5. Traction motor

Locomotive control system

A microprocessor system controls all processes in the locomotive, performs the monitoring and diagnostics tasks. The control system consists of dispersed – in terms of location – control units.

A high-level system is the basis for the control system. It provides the overall control over the locomotive's motion.

A low-level system provides a control of the traction drive. All units of the control system are integrated to the communication network. Information and control signals are transmitted over the communication network to manage the control, regulation and diagnostics process. The communication network has a common hierarchical structure that allows for debugging, execution, maintenance, configuration, monitoring and control of all its elements.

Current collectors

Four asymmetric current collectors are used to connect the electric locomotive to the overhead contact system: two collectors for the DC power supply and two collectors for the AC power supply. The current collectors are designed to operate with locomotives running at speeds of up to 200 km/h.

Main and high-speed circuit breakers

A vacuum main switch is used to protect the locomotive's electric equipment from the AC power supply system. This switch has an electrical drive, which reduces the locomotive's warm-up time after a long lay-over because - unlike circuit breakers used on currently operated locomotives - it does not require a supply of compressed air.

A high-speed switch is used to protect the locomotive's electric equipment from the DC power supply system. Similarly to the main switch, the high-speed circuit breaker is brought into operation by an electric drive.

Traction transformer

The traction transformer has six traction and one heating winding, as well as six throttles of suppression filter.

Braking resistor

In addition to regenerative braking, the electric locomotive has rheostatic brake with a total power on the shafts of traction motors of 4500 kW. The rheostatic brake is applied in cases when the use of the regenerative braking is not possible.

Each unit of the traction converter has one braking resistor.

Auxiliary system

Auxiliary machines and other auxiliary users are powered by the auxiliary power supply unit (APSU), which is designed as a single box (Figure 6) with four auxiliary converters with independent power circuits.

Each converter in the APSU is powered by the DC voltage element of the traction converter.

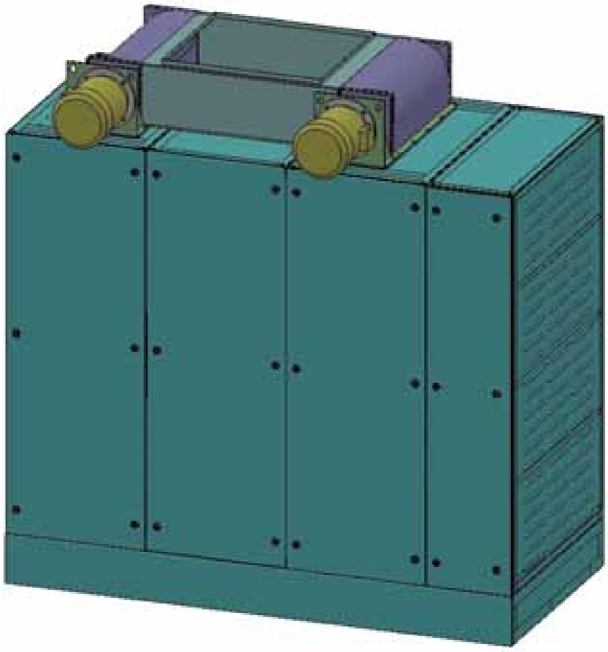


Fig. 6. Auxiliary power supply unit.

The number of output channels of the Auxiliary power supply unit is designed in accordance with the power supply load modes, power supply channels' output, and load redundancy schemes.

The presented concept of the EP20 locomotive components and systems is based on the latest technologies available in the world electric locomotive engineering.

The first locomotive prototype is intended be manufactured in 2010. After a set of tests (on electric, technical, braking, track impact, etc.) its mass production will be launched.

METALLOSTROY DEPOT

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On July 30, 2009 Metallostroy Depot complex (the Oktyabrskaya Railway) was officially opened. The complex is designed for the maintenance of Siemens produced Sapsan high-speed trains.

Along with the President of RZD Vladimir Yakunin, the event was attended by Governor of St. Petersburg Valentina Matvienko, Chairman of the Legislative Assembly of St. Petersburg Vadim Tyulpanov, representatives of the Federal Assembly of Russia.

The opening of new production sites of the depot was preceded by a long and hard work, initiated by the signing of an agreement on maintenance of new rolling stock.

On April 20, 2007 RZD and Siemens have signed the agreement on maintenance and repair of 8 high-speed electric trains for 30 years since their commissioning.

In accordance with the agreement, Siemens bears all the responsibility for the maintenance and repair of Sapsan high-speed trains. On the other hand, RZD is responsible for the operation of these trains, their cleaning and servicing.

Maintenance and repair of Sapsan trains will be performed in a renovated railcar depot TCh-10, 'St. Petersburg — Moskovskoe' (Metallostroy) of the Oktyabrskaya Railway (the general view of depot is presented on Fig.1).

The CMMS-based (Computerized Maintenance Management System) principle is becoming the top priority for Sapsan maintenance. This system allows to detect defects while the train is under operation, report these defects to the depot's control center, plan up measures to eliminate them and inform about required spare parts.

Fig.1. The general view of depot

Introduction of this system allows depots to reduce the trains idle hours during their scheduled and unscheduled maintenance and repair.

Lengiprotrans institute was the General Designer of the Metallostroy Depot reconstruction. ProKonzept (German company) was contracted to design the technological part of the project. It coordinated all the technical and technological solutions with Siemens, as the train manufacturer, and the Oktyabrskaya Railway, as the customer.

Fig. 4 Flyover

As part of the reconstruction, the depot was fit up with modern high-tech Russian and foreign manufactured equipment required for Sapsan trains maintenance. The use of such equipment is very important for the high-speed rolling stock maintenance and serving procedures, which are aimed to reduce the idle time of trains during technological operations, reduce operating costs, employ energy-saving technologies, and improve working conditions of the staff.

We should also note the automatic climate control system in the production shop, which combines ventilation, heating and air conditioning functions. This system allows the depot to create comfortable conditions for the staff, reduce fatigue and increase productivity.

The heating system of the shop is based on a closed cycle featuring energy-saving technologies. The water supply is equipped with a multistage purification and water softener system. Waste water from the maintenance site is disposed to the sewerage system only after its purification.

The maintenance site lighting system features lamps with lower power consumption and longer life cycle.

The shop is equipped with technological facilities to carry out all the work (including replacement of faulty units and individual pieces of equipment) during scheduled maintenance. The production shop is equipped with three track lines, long enough to maintain an entire 10-car train; each line is electrified with two power supply systems (3 kV DC and 25 kV AC).

The base of the track is a flyover (Fig. 4 flyover), its supports are installed on the foundation within the repair pit, and all necessary utilities (air, water, electricity) are installed between the outer faces of the flyover pillars and walls of the grillage, which enables the staff to move freely inside the repair pit. This design of the flyover makes it possible to perform maintenance and repair of undercar equipment with the help of a truck with lifting platform traveling in the pit (Fig. 5 – lifting platform). Its load capacity allows the staff to replace any components of the chassis, including wheelsets.

One of the tracks (measuring) is made with a particularly high accuracy – it is designed for the commissioning operations. It has two devices that allow the staff to replace bogies without lifting the car. Turntables ensure the transfer of bogies from the storage to installation sites. (Fig.6 – turntable). This design allows the staff to replace the traction transformer located under the body of trains.

To ensure access to the rolling stock, suspended service platforms are designed at all levels of each flyover: to enter the car – at the height of 1.36 meter from railhead level, and to exit onto the roof – at the height of 4.0 meters from railhead level. This design allows personnel to have access to the equipment of electric train anywhere. The suspended design allows free movement of staff between flyovers. The flyovers are equipped with outlets for compressed air, water and power supply. Along the train, there are three service platforms equipped with water collecting and discharging outlets, and garbage collection facilities. To secure the safety of personnel on the roof, sliding platforms are used – they slide out right up against the roof edge of the train and thus eliminate the possibility of injury to employees. The suspended platforms allow the staff to perform all work with the equipment located on the roof of the train, without moving the train to a separate line.

Fig. 5 Lifting platform

Fig.6 Turntable

Instead of the regular overhead contact line, a current collection with diverting contact bus is used (Fig. 7 – diverting contact bus). In the active position, it allows the train to enter the shop using its own traction motor. In the diverted position, it allows overhead cranes to travel about and replace equipment located on the roof of cars.

To check up the 25 kV AC 50 Hz traction electric equipment and devices of the train, the depot is equipped with a voltage conversion module, which can supply alternating current to the contact network, thus providing a full check-up of the power electric equipment of the traction drive in dual-system trains directly at the maintenance site.

To ensure electrical safety, a grounding system and contact system breakers are used to avoid injury to personnel.

Fig. 7 Diverting contact bus

A tandem-type wheelset machining unit (made by Hegensheidt-MFD, Germany) is installed in the depot. The machine can at the same time reface two wheelsets of different type bogies from rolling stock with a different base. The machine can grind wheelsets for different profiles – both on a train and as a detached bogie, which is especially important for the selection of running gear components during the repair of high-speed rolling stock.

To diagnose and measure basic parameters of wheelsets in motion, an automatic diagnostic system ARGUS (made by Hegensheidt-MFD) is used. This system allows the staff to monitor the status of wheelsets using software and ensures the timely planning of wheelsets maintenance excluding the human factor.

The positioning of trains in the depot's maintenance positions will be done with the help of a Mercedes-Benz Unimog truck (made by Daimler, Germany). The truck has a combined chassis (it can move on rail tracks and on motor roads). The use of such a truck can significantly reduce shunting in the depot for simple movements.

The sand filling system (unlike classical sand distribution system) uses a single bunker for storage of sand, which supports the desired microclimate. The train's filling with sand is carried out with the help of a special electric vehicle. This solution significantly reduces the cost of construction and maintenance of cumbersome centralized systems of sand distribution.

The rolling stock servicing system includes a set of devices for filling the rolling stock with drinking water (with its own water purification device), emptying the WC storage tanks, and a flyover made of dielectric material for personnel's access to the cars — which is especially important in areas with high humidity. The flyover is equipped with special service platforms for the supply of water and detergents, garbage collection, loading the consumables and foods.

The technological outfit of Metallostroy Depot allows it to carry out all types of maintenance, repairs and servicing. The depot does not conduct repair of certain major units and assemblies of trains, such as transformers, traction motors, axles, etc., as well as repainting. Such parts and assemblies will be replaced with operable ones; faulty parts and assemblies will be forwarded for repair to their respective manufacturers.

A set of such systems and specialized technological equipment of the depot allow the Russian railways to introduce distributed maintenance method, where medium and large maintenance is carried out during the small-scale maintenance. It ensures high reliability and operational availability of electric trains (10% higher vs. Russian rolling stock).

The 'St. Petersburg – Moskovskoe' depot (Metallostroy) with its technological outfit, trained and skilled staff and a new approach to electric train maintenance management should be a role model for others. Such technical solutions should be implemented throughout the network of railways in Russia.

EXPERIMENTAL COMPLEX AS A UNIQUE BASIS FOR SUCCESSFUL INNOVATIVE DEVELOPMENT

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The need to ensure high level of quality and safety of railway equipment, its parts, and railway infrastructure components requires experimental confirmation of compliance of their fundamental characteristics and quality parameters with the specified requirements. This is an extremely important and resource-intensive stage of the innovation process, which has a special role in the rail engineering management system.

Conducting tests under the nearly-real operation conditions requires not only a capital-intensive experimental basis, but also special knowledge-intensive and costly studies, which generate the values of necessary technical requirements and test procedures. Central to this process is a requirements verification system and procedures needed for reliable testing of items for compliance.

This is the only way to get positive results from innovative products validation in the operation process and it is quite justified by the goals of high safety and quality.

The adoption of the strategy for innovative development, modernization and technical re-equipment requires special attention to improve the experimental base and methodological support of testing.

It's not a secret that lack of attention to these problems, unnecessary haste in creating new types of rolling stock (which is typical for new players in this market), resulted in a number of serious failures. Thus, there were created failed designs of long-wheelbase flat cars for transportation of high capacity containers; a freight car bogie with a turn-around mileage of 500,000 km and a number of other projects. They are characterized by a lack of R&D approach and unjustifiable application of existing test methods to new technical solutions.

For these reasons, the role of comprehensive scientific research increases. It will result in new technical requirements in line with safety and efficiency conditions, as well as verified procedures for conformity assessment.

The development of the mandatory certification system largely contributed to the improvement of safety standards compliance tests. However, the methods to assess the compliance with the basic technical and economic parameters and integral quality indicators remained unchanged. At the moment, the newly commissioned rolling stock has no experimentally confirmed reliability, durability, maintainability, life cycle cost breakdown across cost elements, etc. Yet these are very important indicators that determine the efficiency and competitiveness.

In addressing these challenges, the role and significance of test sites and experimental base of rail transport increases, along with their manning with highly skilled and well-paid scientific and research personnel. There is no doubt that the leadership in this aspect belongs to Scientific-Research Institute of Railway Transport (VNIIZhT) and its Experimental Test Ring in Shcherbinka, the Moscow Railway.

The Experimental Ring of RZD and VNIIZhT at Shcherbinka is one of the world's largest testing sites for rolling stock, parts, assemblies of railway machinery and elements of the track structure. Under the existing procedure all commissioned machines, rails, materials, parts and components of power supply, signaling control and communication devices have to be tested in real operating conditions at the experimental ring. The founder of this procedure, Russian scientist Yury Lomonosov, as early as in 1901 introduced a verification system for locomotives characteristics at a closed test site.

In 1908, Lomonosov together with his students created the first research institution – the office to test locomotive types. In April 1918, after the October Revolution in Russia, the office was transformed

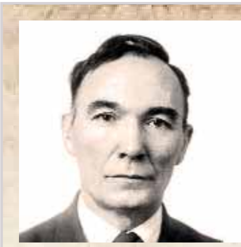
Yuri Vladimirovich Lomonosov
(1876—1952)

In 1898 he started designing and testing locomotives. In 1899 he was the inspector of the Russian state-owned and private railways. In 1905 he defended his doctoral thesis on the dynamics of locomotives and became a professor. In 1907 he was appointed the head of the traction department of the Yekaterininskaya Railway. He created a new science – the theory of locomotive traction, developed scientific foundations for railway operation. In 1908 he founded an office to test locomotive types. In 1920-1923 he supervised the purchase of German and Swedish locomotives visiting Berlin. In 1923-1924 he participated in the creation of the first domestic diesel locomotive with an electric transmission. He never returned to the Soviet Union. His professional activities abroad were unsuccessful. He died in 1952 in Canada.

into the Experimental Institute of Railways, then into the Scientific and Technical Committee of the People's Commissariat of Railways. Six institutes that worked on the basis of this Committee were merged in 1941 into a single All-Union Scientific-Research Institute of Railway Transport (VNIIZhT).

Lomonosov's ideas were fully implemented only in 1932, when the Experimental Ring for such tests was constructed at Scherbinka station, the Moscow Railway. The newly built test site had a closed track with a radius of 956 meters. Its length was 6,000 meters with all services and a locomotive depot. Professor Nikolay Belokon made a great contribution to the design and creation of the test site.

The Experimental Ring is a combination of a laboratory and operational test ground. On the one hand, the closed circular track ensures an extraordinary even and smooth tractive resistance on a



Nikolay Iovich Belokon
Ph.D., professor
(1899—1970)

In 1931-1933 he headed the designing and construction of the Experimental Ring. In 1950-1958 he participated in developing a new type of engine – gas turbine locomotive. He worked for more than 30 years in VNIIZhT, headed the Thermodynamics and Thermal Engineering chair at the Gubkin Petroleum Institute. He is the author of books: "Heat Transfer at Variable Temperatures" (1938), "Development of the Doctrine of the Basic Thermodynamics Principles" (1946), "Generalized Theoretical Cycle of Internal Combustion Engines" (1948), "Thermodynamics" (1954).

track free from any extraneous traffic during the tests. The researchers can set any desired mode of locomotive operation and keep it for as long as needed. In other words in terms of methodology and organization of experiments the ring in fact ensures ideal laboratory conditions. On the other hand, studies of the interaction between wheels and rails, the locomotive interaction with the environment are conducted under actual operating conditions. Thus, the institute has acquired a unique opportunity to conduct numerous experimental studies of a variety of rail equipment, as well as improve and develop test methods.

It was the world's first testing ground for newly designed models of railway equipment. The ring allowed researchers to determine compliance of locomotives with the safety standards and technical requirements in the shortest possible time. After successful comprehensive tests the new rolling stock could be introduced to main lines. Later, based on the enormous role of the Experimental ring to design and test new equipment, similar test sites were constructed in the USA, China and other countries.

During this period, the Experimental Ring established test labs, which could bring together laboratory test methods and results of rolling stock operation in real life.

The establishment of the Experimental Ring has brought about significant opportunities to research into the basic characteristics of rolling stock and infrastructure devices at various defined operation parameters. Tests identify the traction and power characteristics of locomotives and their compliance with the rated values, since they are the basis for establishing the weight of a train, its speed, travel time, fuel or electricity consumption. In addition, the possibility of using new parts and components for locomotives is also tested.

The EMO 710-53 steam locomotive was the first engine tested at the Experimental Ring. Professor O. Isaakyan supervised the testing – he was one of the founders of the locomotive experimental research school. Since then, each Russian locomo-

tive must be thoroughly tested at the Experimental Ring of the Institute before commissioning. As early as 1933, a group headed by T. Khokhlov conducted the world's first test of a diesel locomotive at the Experimental Ring – that was a first locomotive of the EEL series.

Later on, second and third generation diesel locomotives were tested at the Experimental ring. In 1935, the Experimental ring was electrified, which allowed to conduct the first tests of electric locomotives VL19 and S, and subsequently conducted an extensive study on the introduction of electric traction. Specialists of the Experimental Ring significantly contributed to the introduction of the AC electric traction. Based on the results of the research, the world's most powerful freight locomotives VL80T with rheostat braking, VL80R with regenerative braking and many other locomotives were created. The tests gave start for many series of electric locomotives, including VL85, EP1, dual power electric locomotives EP10 with asynchronous traction drive, electric locomotive EP2K and others. We should specially mention comprehensive studies of the electromagnetic effects of a new-generation of electric rolling stock upon the traction lines, signaling control systems and automated locomotive signaling. Experts of the Experimental Ring conducted a set of works aimed at improving the quality of power supply.

In 1936-1937 the Experimental Ring was the site for first dynamic tests of eight-wheel freight gondola cars and eight-wheel passenger cars.

The Experimental Ring is equipped with a special rheostat device for traction-and-power tests of locomotives with an automated recording and processing of the experimental data. It also has a diesel stand with the D49 diesel engine for testing various components of diesels. Combined with a mobile measuring complex it can measure the traction and thermal characteristics, as well as other important parameters of diesel generators.

Dynamic and strength tests of the locomotive under-frames are conducted at vibration stands designed for testing bogie frames and elements – at the MUP-100 machine designed for static and dynamic tests. The ring is equipped with facilities for calibration and resonance testing of springs. All of them are equipped with measuring and computing systems for high precision data acquisition and processing.

The scientific outcome of studying the basic characteristics of the rolling stock was creation of the modern theory of train traction. This theory became a basis for newly developed technical requirements to all new locomotive series.

The Experimental Ring is studying the mechanical interaction between current collectors of electric rolling stock and their interaction with different types of catenary. The ring has studied the specific features of current collection in iced conditions, carried out research on the wear of contact wires and prevention of their inadmissible heating. Traction electrical equipment is being tested at the contact network site, high-voltage laboratory, at various stands and special plants. Their reliability and safety of all the constituent elements are being assessed.

An important area of research at the moment is the transfer of locomotives to natural gas. The ring is testing the natural-gas-powered TEM18G shunting locomotive, the 2TE116G main line locomotive, a gas turbine locomotive and a prototype of a DMU train.

The lab facilities of the test ring include stands for testing electric locomotives, electric trains, traction engines, electrical equipment. Currently, a stand for testing brushless traction motors is being prepared for launch. The stands can simulate the whole range of operational impacts, and various modes of operation. The stands are equipped with computerized measuring systems. There are devices to test electric locomotives in the special power-supply conditions of extended traction lines.

Traction-and-power tests of commuter trains are held only at the Experimental ring. In the past few years, the ring tested a dozen of series of EMUs, including ED4E, ET4E, ED9E, ED4MKM, ER9E.

The Experimental Ring is a versatile testing ground for cars R&D. The addition of two more ring tracks with radii of 400 and 600 meters and straight inserts allows the researchers to reproduce any dynamic loads that may arise under operation. The first ring track is used to test cars at speeds of 120 km/h. The second and third tracks are used to test cars at speeds of up to 70-80 km/h. The test site checks up dynamic and strength characteristics of freight and passenger cars, tests brake systems, new friction materials, the interaction of cars and the track. Such tests result in comprehensive assessment of the operability of new car types. The ring addresses the problem of the longitudinal dynamics of heavy-weight freight trains, selection of rational methods for their driving, minimizing the impact of newly created rolling stock upon the track, as well as of long trains.

The available set of equipment allows researchers to test the durability of cars and their elements under different types of loads, assess their wear-resistance, and conduct longevity tests.

In recent years, the testing base of rolling stock auto-break systems has been fully upgraded. A single testing ground for parts and assemblies of auto-break systems was established. This testing ground includes an inertial stand for testing brake discs and pads at speeds of up to 350 km/h, and studying temperature conditions of the wheels under braking. The stand is equipped with computer control system, data acquisition and processing system, and real-time data retrieving.

Europe’s largest stand for testing brake equipment for 200 freight and 40 passenger cars can process the brake control modes of super-long and standard freight trains with increased weight and length, including connected trains or trains of special formation with a distributed traction. The inertia-free stand is designed for testing the designs and materials of brake pads in prolonged braking modes at temperatures from +35°C to -60°C.

The Experimental Ring has a stand to assess the stiffness of cross-links between the wheelset and bogie frame of locomotives.

The Experimental Ring is a unique base for testing designs of the permanent way. Under laboratory conditions, it carries out the static, cyclic and life tests of various rail fasteners (ZhBR, KB, ARS, etc.), isolating joints of different structures (composite, metal and others). These tests proved high efficiency of heavy-type rails, evaluated the rails thermo-strengthening technologies, tested dozens of experimental rail batches manufactured under different steel-making technologies. Thanks to these tests, manufacturers designed higher reliability rails for operations under low temperature conditions. Eventually, it increased the operational reliability and longevity of domestic rails by 1.5 times. In addition, it has determined the optimum chemical composition of the metal, heat treatment technology, rational designs for the permanent way elements. The ring is studying the interaction between track and rolling stock. It has revealed the dependencies that determine the effect of increased (from 22 tf to 27 tf and up to 30 tf) axle loads upon the emergence and development of contact-fatigue defects in the rail heads, as well as the reliability of structural elements of freight cars.

The Experimental Ring has commissioned the “test mound”, where researchers can simulate various configurations of the mound and track structure. The total length of the bench road is 2.3 km. Along the mound, there are sites with a protective layer of sand and crushed stone mixture, cemented semi-gravel sand and a three-dimensional geo-grid with the height of 100 mm. The mound is equipped with stationary hydrostatic strain gauges (precipitation gage) binding the changes to anchor frames, which allows researchers to assess the effectiveness of different types of mounds in various operating conditions.

A dynamic stand for continuous welded rail track is prepared for commissioning. It can address many issues in the organization of continuous welded rail maintenance under elevated temperatures conditions.

For the accelerated dynamic testing of parts and assemblies of rolling stock and the track structure, the Experimental Ring has commissioned the LFV-3000 multipurpose stand made by Walter+Bai AG (Switzerland) with a maximum load of 300 tf. There are no similar stands in Europe. Its performance is several times higher than that of the old stands. The ring also has a calibration metrological spur track for testing and calibration of all mobile flaw detectors and track measuring devices.

Thus, the domestic railway engineering has versatile and multifunctional experimental and testing ground with unique testing capabilities. Nevertheless, new and more advanced test systems must be created for the completion of all required test types, the experimental proof of conformity, as well as ensuring the innovative development of the rail transport. Such new test systems require a reconstruction of the existing and creation of additional resource base.

In accordance with the RZD's investment programme, 556.3 mln rubles (13.9 mln euros) were allocated in recent years for the development and modernization of the R&D and laboratory facilities of the Experimental ring, including its infrastructure and the creation (in 2003-2007) of more than 30 new stands for testing railway machinery.

A further development of the Experimental Ring to the level of the world's best test sites will require substantial capital investments. Such investments over the next five years are estimated at 1.5 bn rubles (37.5 mln euros) (even excluding the costs associated with reconstruction of the traction substation). At the expense of some profits and depreciation allowances, VNIIZhT can annually allocate up to 50-80 mln rubles (1.25–2 mln euros).

It is clear that these sources are not enough to address the issue. The structural reform in rail transport will increasingly target the interests of RZD at infrastructure projects. Accordingly, active participation of rail products manufacturers is needed for the development of resource base of this unique test site with a good scientific and experimental basis. UIRE can be a consolidated member of the necessary investment process. The establishment of VNIIZhT and its subsidiaries on the basis of the Experimental Ring will enhance the investment attractiveness of the development of this test site. Ensuring equal access to scientific and experimental base of the test ring for all design and promotional organizations, as well as manufacturers of railway products can implement the competition principle in this area, which will have beneficial effect on the innovative development of rail transport.

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