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8 November 1985

# USSR Report

TRANSPORTATION

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# USSR REPORT

## TRANSPORTATION

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## CIVIL AVIATION

### IMPROVEMENTS IN AIRCRAFT PART REPAIR WORK REVIEWED

Moscow GRAZHDANSKAYA AVIATSIYA in Russian No 8, Aug 85 pp 40-41

[Article by V. Frolov, doctor of technical sciences, professor of MII GA [Moscow Institute of Civil Aviation Engineers], under the rubric "On the Course of Technical Progress": "The Second Life of Aircraft Parts"]

[Text] One of the main directions of technical progress in the performance of aircraft repair today is the rebuilding of worn parts of aircraft equipment and their reuse. The present organization of this task differs above all by a comprehensive approach to accelerated mastery of the methodology of rebuilding at aircraft repair plants and extensive use of modern technical resources. This results from a need to reduce the expenditure of spare parts, the cost of which makes up over half the cost of major overhaul of aircraft equipment and increases with an increase in the design complexity of the equipment.

The development of industrial processes is the initial and basic stage in preparation of production for the rebuilding of worn parts. Until recently, however, many performers scattered through the sector have been engaged in creating new technologies based on scientific achievements. There was a need for the coordination of all projects as well as for coordination of ties with a large number of scientific and production organizations of various departments. This led to the establishment under the Aviaremont VGPO [exact expansion unknown] of a special-purpose operations group of experts from among specialists of aircraft repair plants, scientific organizations of the sector, and other departments. Parts lists were compiled for each type of aircraft equipment, rebuilding of which had to be mastered on a priority basis. There is an overall total of some 1,300 descriptions of such parts. The number of rejected parts of these descriptions exceeds two million annually (the cumulative cost is over R55 million).

It has been established that the bulk of the parts (79 percent of the total number) is rejected because of the wear of their working surfaces. This determined the choice of rebuilding methods. The principal ones are the application of additional layers on the surface using electrochemical and thermal gas processes, as well as welding and soldering using electron-beam, laser and other methods of heating. Various electrochemical methods apparently are the most practicable.

Plants presently are introducing more and more widely technology developed by the specialists of GosNII GA [Order of Labor Red Banner State Scientific Research Institute of Civil Aviation] for the multiple, thick-layered chrome-plating of parts made of high-tensile steels. This permits rebuilding parts many times during each subsequent repair. The chrome covering has a thickness to 0.2 mm. Before its application, a part's surface is strengthened by surface-plastic deformation. Plant No 410 has mastered the rebuilding of 29 descriptions of parts for the AI-25 engine by this method (the combustion-chamber casing, rear shaft of the high-pressure compressor, front shaft and low-pressure turbine shaft, hydraulic pump drive gear, and others), as well as more than 120 descriptions of parts for the An-24, An-26 and An-30 aircraft. This provided an annual saving of over R290,000. Plant No 402 rebuilds parts of 54 descriptions for the Mi-8 helicopter and the Il-18 aircraft, and the total number of rebuilt parts in a year exceeded 7,000. Thick-layered chrome-plating also is being successfully used at Plant No 400, which has mastered the rebuilding of over 80 descriptions of parts for the Tu-154 aircraft.

A method of chrome-plating in circulating electrolyte, also developed by GosNII GA specialists, is promising. It permits rebuilding special-shape parts and is distinguished by higher productivity. This method was introduced at Plant 411 for rebuilding such costly parts as the fixed pinion of a reduction gear, the flange of a crankcase point and the main connecting rod of the ASh-62IR engine, as well as some parts for the Tu-154. In 1984 the plant used this method to rebuild more than 4,000 parts and the cost of spare parts used for repair dropped by R770,000.

The plant is also working to master technologies for chrome-plating parts made of titanium alloys and for bronzing parts in a noncyanide electrolyte. Next in turn is an acutely needed development of a progressive technology for chrome-plating the cylinder face of piston engines. The annual rejection of these cylinders (more than 17,000) costs R3.5 million.

The area of application of thermal gas methods is diverse, from the application of wear-resistant coatings on working surfaces to the rebuilding of complex and precision parts. For example, the development and introduction of the technology of flame spraying at Plant No 402 allowed the rebuilding of inner ducts, cylinders, drive casings, compressor rings, working rings and other parts for the D-30 engine totaling around 5,000 parts per year. Successful mastery of the methods of plasma jet and detonation spraying made it possible to bring the number of parts rebuilt annually to 13,000, reducing the expenditure of spare parts by almost R600,000.

On the whole, repair plants in the sector have mastered the rebuilding of various parts for 16 types of aircraft, helicopters and aircraft engines with the help of the progressive technologies, and the products list has exceeded 200 descriptions. In 1984 the total number of rebuilt parts was some 60,000, which is one-third more than in the previous year, and the expenditure of spare parts for the repair of aircraft equipment was cut by more than four million rubles.

A system of accelerated development of production intended for a broad products list of parts has been developed and is being introduced for further implementation of the Interdepartmental (MAP-MCA [Ministry of the Aviation Industry-Ministry of Civil Aviation]) Comprehensive Special Program of Work for Rebuilding Parts for the Period up to 1990. Laboratories have been organized at base plants along the following directions: electrochemical and thermochemical processes, welding, flame spraying, riveting and paint-and-varnish coatings, plasma jet spraying, surface-plastic deformation, detonation spraying, magnetoionic spraying, microplasma welding, and laser technology. This system provides in particular for the sector's development of specialized work. One of them, for example, may be a specialized plant for major shops at one of the sector's leading (base) plants. The production unit here must be equipped with mechanized flow lines and the latest industrial equipment and must serve for technologically complex rebuilding of parts of a limited products list but of large series. This will allow mechanizing the majority of operations, improving product quality, cutting costs and reducing the need for production area. The most suitable among such parts are aircraft engine blades which have a products list of 123 descriptions (taking into account that the repair of new types will be mastered, this will increase to approximately 170 over the next two or three years). More than 4,500 blades are rejected at the plants daily, and this number will approach 6,000 in the 12th Five-Year Plan. And so there are objective conditions for setting up a mass centralized rebuilding of blades. It must be taken into account, however, that there are more than 30 principal blade defects, and each rejected blade has an average of four defects in a varying combination which is not predictable in advance. Moreover, the blades are made of tens of materials (alloys) which vary in chemical composition. Specialists believe that several tens of different technological operations must be performed in succession to rebuild a single blade. Then it will be necessary to perform several hundred thousand operations daily to rebuild all rejected blades. This is why the production unit must be mechanized and automated to the maximum.

As with many major initiatives, the mastery of progressive technological processes for rebuilding parts placed new problems on the agenda and demanded new solutions. The scientific support to this direction of aircraft repair work must be strengthened. A system of classification and coding of the entire products list of parts, their working surfaces, and rebuilding paths must be developed to reduce the duration and labor-intensiveness of developing new technologies and to standardize technological processes. This also will reduce the inputs of labor and resources for technological preparation of the production unit.

Norm setting of the expenditure of materials for rebuilding worn parts is much more complicated than for manufacturing new parts (the worn parts differ within significant limits in dimensions, shapes, and properties of working surfaces). The need to develop specific norms for material expenditures will become obvious when we consider that the principal wear-resistant materials being used for rebuilding parts are considerably more expensive than ordinary metal.

Specialized resources having high productivity and a given measurement accuracy will be required for a comprehensive, objective quality control of rebuilt parts.

Theoretical and applied research should be activated, aimed at the development of scientifically grounded recommendations for the development of production units for rebuilding, since the insufficient level of concentration and specialization and the use of general-purpose equipment do not allow achieving high productivity.

There must be a generalization of the experience of foremost machinebuilding and repair plants and of scientific research institutes of other departments engaged in rebuilding parts, and recommendations must be drawn up for planning specialized shops, sections, and work stations.

The plants of Aviaremont are faced with the task of bringing the total number of rebuilt parts to two million per year by the end of the 12th Five-Year Plan. This will make it possible to free some 6,000 of the industrial production staff. In addition, in the specialists' opinion, the repeat use of rebuilt parts will permit saving a large number of spare parts for each million rubles. Up to 1990 this will provide a saving of costly nonferrous metal, high-grade steels and special alloys used for manufacturing new parts. A saving of considerable amounts of fuel-energy resources also will be assured.

The economic expediency of rebuilding parts is confirmed by the balanced nature of capital expenditures and economic effectiveness. In fact, average annual expenditures for acquiring, installing and adjusting special and auxiliary equipment, manufacturing industrial tooling, and renovating spaces are less than five percent of the expected average annual economic effectiveness (expenditures of R650,000 and over R14 million respectively).

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## MOTOR VEHICLES AND HIGHWAYS

### RSFSR MOTOR TRANSPORT DEPUTY MINISTER ON HARVEST SUPPORT

Moscow SELSKAYA ZHIZN in Russian 7 Aug 85 p 1

[Article by G. Tarakanov, SELSKAYA ZHIZN correspondent: "Transport and the Harvest"]

[Text] Every year when the busy harvest season sets in, up to 600,000 trucks are sent to the kolkhoses and sovkholes of the Russian Federation, a large number of them being detailed from other sectors of the national economy. And all the same, there are not enough vehicles. Experience shows that this shortage can be explained primarily by the unskillful organization of freight shipments, the bureaucratic disunity in motor vehicle transport and the use of obsolete forms and methods of vehicle operation.

How can the efficient use of motor vehicle transport during harvest operations be increased while reducing the urgency of the vehicle shortage? At the request of our correspondent, V.D. Medvedev, RSFSR deputy minister of motor transport, responds to this question.

Motor vehicle transport occupies an important role in the area of agricultural production. It moves about 80 percent of all shipments. Vehicles from various authorities participate in the harvest: agriculture and motor vehicle transport ministries, USSR Goskomsel'khoztekhniki enterprises and other organizations. Every one of these authorities first actually worked on its own plans and schedules. Disunity in their work weakened, and indeed continues to weaken the harvest-transport production line.

Experience shows that converting the gathering, shipment and laying-in of the harvest into a unified and uninterrupted technological process can be accomplished with the aid of centralized control of motor vehicle transport by means of automated systems. A decisive role here is played by the so-called shipment control centers (TsUP) that are being set up in every rayon of one or another oblast, kray and republic.

The greatest success in applying centralized shipment control in the harvest over the course of the last ten years has been achieved by motor transport workers

in cooperation with village laborers in the Saratov Oblast. Here this advanced method was first applied and tested in practice. Now centralized export is operating successfully in all of the oblast's rayons. Before, crowds of vehicles with grain from the new harvest gathered at elevators was a common occurrence. Trucks, which were in such short supply, were standing half a day at a time in line, waiting to be unloaded.

In order to change the situation for the better, an attempt was made to develop vehicle work schedules for the entire harvest period. But as a rule they turned out to be unrealistic due to fast-changing conditions in the reaping and threshing of the grain. Neither did ten-day plans help matters any. The solution was found in making up schedules for each vehicle individually.

The Saratov vehicle workers successfully carried out centralized motor transport control within the limits of each kolkhoz and sovkhoz. The dispatching point plans shipments for the successive day, controls the fulfillment of shift assignments by drivers and, when necessary, carries out the rearrangement of vehicles. Operatively, this point is under the authority of the rayon control center.

Centralization of transport control allowed an increase in discipline on all shipment lines and helped reduce the demand for vehicles. This method facilitated a broad transition to brigade contract and fast shipment schedules.

Our republic Ministry of Motor Transport devotes the greatest attention to the dissemination of the advanced method. In the past year, for example, it was adopted in more than 500 rayons of 29 autonomous republics, krais and oblasts in the RSFSR. It was most widely disseminated in the Krasnodar and Stavropol krais and in the Orenburg, Omsk, Kuybyshev, Chelyabinsk, Volgograd and a number of other oblasts. The precise rhythm of harvest operations allowed idle time and empty runs to be avoided, which provided the opportunity to increase the efficiency of vehicles (in comparison with average figures) by 40 percent. The capacity of elevator lines increased 1.3-fold. The time needed for laying away grain was reduced by 5-10 days.

A system of centralized transport control using computer technology proved itself, for example, on farms in the Orenburg Oblast.

Orenburg grain fields occupy almost five million hectares. About 22,000 combines are involved in threshing or direct harvesting of the grain. And everywhere, side by side with grain-harvesting equipment, there are motor vehicles. Their total capacity is truly great. And they are trying to use it here economically.

This harvest 198 sovkhozes and 361 kolkhozes are to ship more than 25 million tons of freight various distances. All the motor transport will be assembled ahead of time in convoys, the distribution of which among rayons will be determined by vehicle carrying capacity and the distance of the shipments.

The distribution of motor transport among rayons is carried out strictly in accordance with the expected quantity of grain and the gathering of silage. Some of the large-capacity trucks are grouped in rayon detachments and some are located at grain receiving centers, to whose control centers is dispatched all information about the presence of grain on one or another farm.

Grain routes were planned ahead of time in the oblast and the corresponding signs and guides were installed. Particular attention is paid to the cities to which grain comes in from several rayons. In the oblast center, for example, grain is immediately received by seven laying-in organizations simultaneously. In order to avoid uncoordinated traffic on the main highways, departure laboratories have been set up. They conduct preliminary analysis of grain and determine for each driver the exact destination of his route.

At the same time, the advanced method has not been given the green light in the Altay Kray and the Amur, Kurgan, Orel and Voronezh oblasts. There the transport organizations have not yet given up obsolete methods of planning and utilizing motor vehicles in the harvest. On-site lacks of modern communications and means of transmitting and receiving information as well as of high-productivity loading facilities also hinder the implementation of the centralized method. There is usually an especial lack of coordination in the adoption of this method for the harvest and transport of sugar beets, potatoes and vegetables.

The primary reason for the slow dissemination of the leading experience, in our opinion, is that economic organs are not doing enough organizational work and are just letting things drift, although this year there are many opportunities for the widespread application of centralized harvest export in all of the primary agricultural rayons of the republic. We are certain that it will become a reliable guarantee for the successful completion of plans for the last year of the 11th Five-Year Plan.

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## MOTOR VEHICLES AND HIGHWAYS

### SOVIET REGENERATIVE BRAKING RESEARCH REVIEWED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 3 Aug 85 p 2

[Article by A. Chernyy, candidate of technical sciences and docent of KPI [Kursk Polytechnic Institute], and V. Mel'yantsov, engineer: "In Braking Operations"]

[Text] Kursk--On March 24 of this year under the headline "Science and Technology Abroad", SOTSIALISTICHESKAYA INDUSTRIYA published a short notice about the hydraulic device developed by Norwegian engineer G. Yspi, that allows the braking energy of motor vehicles to be stored, thanks to which fuel consumption in city driving is reduced 40 percent and the emission of harmful substances into the atmosphere is sharply reduced.

We want to tell how matters stand with regard to the solution of this problem here and what side Minavtoprom takes in this.

Work on the development of so-called regenerators of braking energy began in our country and abroad simultaneously. In the middle 1970's at the Kursk Polytechnic Institute they built and tested a flywheel type and then a hydropneumatic regenerator, which was installed on the LAZ-695 bus.

Tests confirmed the high efficiency of recovering energy for the city traffic cycle: fuel economy comprised 27-40 percent and the volume of exhaust gases was reduced 39-49 percent. However, the efficiency of regenerators is not limited to this. They sharply, almost 20-fold, reduce the wear on wheel brakes and extend the life of the engine. The studies conducted also indicated that the installation of the hydropneumatic type of regenerator requires a fundamentally new approach to the design of a city bus, since there is a new, centralized source of energy in the vehicle. It may be used not only as an addition to the energy of the engine, but also utilized in various of the bus's equipment. As modern studies abroad have now shown, the energy of that type of regenerator is used particularly efficiently for wheel and parking brakes and the differential interlock, for the brake delay mechanism, hydropneumatic suspension and hydraulic steering booster. Having a store of energy contained in the hydropneumatic accumulator, it is possible to stop the engine and then start it at the necessary moment, that is, to use the regenerator as a hydrostarter. This allows, for example, the engine to be switched off during stops and, according to the foreign data, by this means alone a fuel savings of 8-10 percent on city buses.

In 1979-1980 a hydropneumatic regenerator was built for LAZ-4202 buses, but it was not tested, since the country's chief design-experimental organization for bus building, the VKEI [All-Union Design Experimental Institute] for Bus Building, curtailed further work in this direction with a directive on their complexity and the absence of hydraulic equipment. Actually, up to now Minavtoprom has not had specialized enterprises for the production of hydrostatic equipment suitable for installation on motor vehicles. Repeated appeals to Minavtoprom with the suggestion of planning projects to introduce regenerator devices on city buses did not lead to a positive result. And this in spite of the fact that, according to a number of position statements, our country has a priority to develop similar systems that has been reaffirmed by many inventions.

Meanwhile, as experience abroad shows, studies in regenerative braking were highly prospective. The leading motor vehicle engineering firms of FRG, France and Sweden are conducting intensive projects in this direction, although public transportation in these countries is much more poorly developed than here. In that case it should be us worrying about this! After all, our public transportation is already without equal in the world and continues to be intensively developed. In these conditions it seems that it goes without saying--it is us that ought to occupy the leading positions in the utilization of technical innovations on public transport vehicles.

However, the point of view of Minavtoprom with regard to regenerators is entirely opposite. At the ministry they took the part of observers from the periphery. The answers of Minavtoprom workers to our addresses speaks eloquently of this. Here, for example, is the answer of the chief institute in this branch of industry, NAMI [Central Motor Vehicle and Engine Scientific Research Institute], from March 19, 1985:

"The use of a hydropneumatic energy regenerator by KPI on the LAZ bus series with mechanical and hydromechanical transmissions is technically (!) and economically unfounded... According to calculations, as a result of the installation of a regenerator the mass of the bus is increased by 700 kilograms. Owing to this, the bus will have a 3-percent operational overexpenditure of fuel. The dynamics will also be worsened as will the toxicity of exhaust gases".

There you are! Not fuel economy, but overexpenditure. Not reduction of toxicity, but increase. With a wave of the hand they have dismissed the published data of foreign firms just like the results of the tests conducted here back in the 1970's. Their further answer puts an end to domestic experimentation once and for all: "At KPI at the present time there is not a regenerator design that could be recommended for testing and evaluation of potential".

Instead of actively participating in ongoing work and in operational development of a design, the industry's chief scientific center removes itself from the conduct of projects and hinders the work of others. And this opinion of the institute reflects the position of the ministry. This is apparent from the letters of the chief of the directorate of design and experimental projects of Minavtoprom, A. Titkov:

"The model energy regenerator developed by KPI cannot be installed in a bus for testing, since it has not been brought to the required degree of readiness". Is this not a familiar argument?

And further, A. Titkov writes: "The problem touched on in your letter is essentially important and has economic significance, however, at the present time it is still within the realm of theoretical and mock-up studies, therefore its solution in the branch subdivisions of Minavtoprom, which have specific applied tasks, is so far premature".

Now it is all clear! Although A. Titkov acknowledges the economic significance of the problem, he does not plan to participate in solving it in the foreseeable future, for the project is not "out of the realm". And someone else, one must suppose, should take it out of this "realm", without the participation of Minavtoprom organizations.

Apparently, it is superfluous to say that such a position does not correspond to the demands and tasks set before the entire economy by the party. If we want to save fuel in transport, we must first of all understand that both scientists and industrialists are equally responsible to the people, so that any, even theoretical, possibility of such economy may be verified, tested and instituted without delay. No one now has the right to divide this most important matter into "ours" and "theirs". And we should take as a warning signal the item in the paper where, by the way, it talked about the fact that the Swedish firm Volvo was interested in the work of the engineer G. Yspi. Because it affects our professional honor.

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## MOTOR VEHICLES AND HIGHWAYS

### UKSSR STUDIES PROS, CONS OF LNG-POWERED VEHICLES

Kiev PRAVDA UKRAINY in Russian 29 Aug 85 p 2

[Article by Ya. Oleynichenko: "Gas instead of Gasoline, Be a Diligent Manager," followed by "Commentary of UkSSR Motor Transport Minister P. Volkov"]

[Text] At first glance, this filling station in Berdichev Motor Column No 2194 (Zhitomir Oblast) was no different from the usual. The vehicles drove up to the pumps in the same way and the drivers quickly handled the rubbers hoses. And we did not immediately ascertain what in fact was missing here.

What was missing here was the smell of gasoline. The name of the filling station spoke for itself: gas supply station. One other detail: all the vehicles were equipped with cylinders located under their bodies.

"Out of the enterprise's 417 motor vehicles, about 140 are equipped with gas cylinders," motor vehicle enterprise chief V. A. Rizvanyuk told us.

Deputy Minister of Tajik SSR Motor Transport M. M. Madibrigimov, and the specialists who came with him to acquaint themselves with the experience of their Zhitomir counterparts, are interested in many things. First, the economic basis. And it is rather impressive: fuel for vehicles that have converted to gas cost 43 thousand rubles last year. If they had been using gasoline, it would have cost around 87 thousand rubles, about double. A profitable innovation? Absolutely. Moreover, there is much less environmental pollution and the engines last longer.

But there are factors holding things up. On the whole, they are connected with technical operations. Each cylinder weighs 90 kilograms. On a vehicle of the ZIL-130 type, eight of these are installed. So 720 kilograms of carrying capacity is lost. Further, one refueling lasts for 220 kilometers; consequently, the radius of a vehicle's activity is limited. Also, the engine's power is diminished with gas fuel, which means the use of trailers is questionable. And another thing: the transition to a new fuel type is impossible without constructing and equipping a whole network of gas supply stations, and this is also a serious problem.

"Let's weigh all the pros and cons," said L. N. Kolbasenko, chief of the Zhitomir Oblast motor transport administration. "Right now we are using 12 tons less gasoline daily to carry out the same volume of work. By the end of the year, the savings should exceed 3 thousand tons. And this is only the beginning of the transition to the new fuel.

"As regards the carrying capacity, you will agree that not always is the vehicle loaded, as they say, 'to the hilt,' and there are also empty runs. Here a solution has been suggested: let the vehicle be filled with both gasoline and gas. If more motor power is needed because of a heavy load, the driver switches on the gasoline. But if the load is large in size, let's say, but light-weight, gas can be used. This same fuel, as the more economical, should be used in cases of partial loads, empty runs and short-distance trips.

"Now, about the radius of activity. Here, there is also a way out, in our view. Equip not only the vehicle but also the trailer with gas cylinders, and one refueling will be enough for double the distance.

"The new gas supply stations are really a problem. In Zhitomir one such station will be build next year to handle 500 refuelings a day. But we fitted out the Berdichev station ourselves, practically with no capital outlay. Here visitors are coming from all the oblasts of the Ukraine, and now from fraternal republics as well. But stations are stations, and besides them we need refueling vehicles that can work along the routes."

["Commentary of UkSSR Motor Transport Minister P. Volkov"] [Text] We are not going to prove the necessity of converting part of the motor transport to a new type of fuel; the question has been put by the time itself. It would be better for us to think about how this can be done the most efficiently and with the least expense. In short, to weaken the activity of the negative factors mentioned above.

First, we should hardly be starting with ["bortovye"] vehicles, as our motor vehicle industry is doing. Such trucks work on piece-rate basis in the national economy, not an hourly one, and they are utilized away from their main base, in rural areas, where there are no gas supply stations. But specialized transport, working either in the city limits or within a small area, is another story -- vehicles for transporting bread, milk or foodstuffs, public utilities vehicles or vehicles used for internal transport operations at enterprises; here a transition to gas is the most profitable. And it is justified from an ecological point of view.

Because of the heavy weight of the cylinders, the vehicle's carrying capacity decreases and the material input of transport resources increases; it influences the production costs of transportation. The output of 60-kilogram cylinders is being set up, but extremely slowly.

There are already gas carriers -- traveling gas supply stations -- operating in Zhitomir Oblast, but on the whole there are few of them in the republic. Practise shows us one more interesting solution: the organization of truck trains with cylinders on their trailers. The vehicle itself, without the trailer, can work in a village in case of necessity -- and in the national



economy for piece-rate pay.

However, the most promising seems to be the use of gas for motor transport with diesel engines, not carburetors. There are already gas-diesel vehicles which burn a mixture, on the order of 80 percent gas and 20 percent diesel fuel, and the engine power is not diminished. The national economy awaits such vehicles.

Concerning the construction of new gas supply stations, right now there are 10 of them in the republic and they service almost 3 thousand gas-cylinder vehicles in our system. The construction of new stations is under way but far from everywhere at the planned rate. In Kharkov, for example, such construction has stretched out for years. As a rule, each station is designed for 500 refuelings a day. But why have such a station in, let's say, Kupyansk? Or in Vinnitsa, where at the moment a total of 230 vehicles are running on gas and one refueling is enough for two days? Here we should show flexibility and set up modular points of a container type. They are cheaper and more convenient. They should also work not one shift but around the clock, as do the vehicles.

There is a problem of another character. We can say that our system includes about 14 percent of all motor transport, while 70 percent of the gas-cylinder motor vehicles turned out by industry are sent to us. Such a bureaucratically uneven transition to the new type of fuel may give rise in many to an uninterested, sluggish attitude towards a very promising innovation.

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## MOTOR VEHICLES AND HIGHWAYS

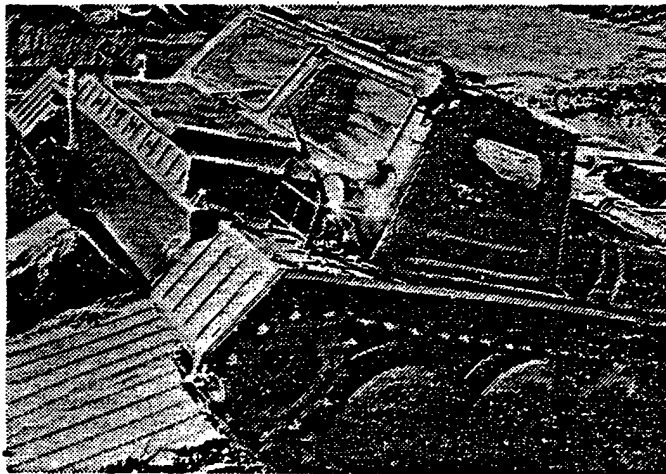
### GAZ-3403 ATV IN SERIES PRODUCTION

Moscow IZVESTIYA in Russian 29 Aug 85 p 2

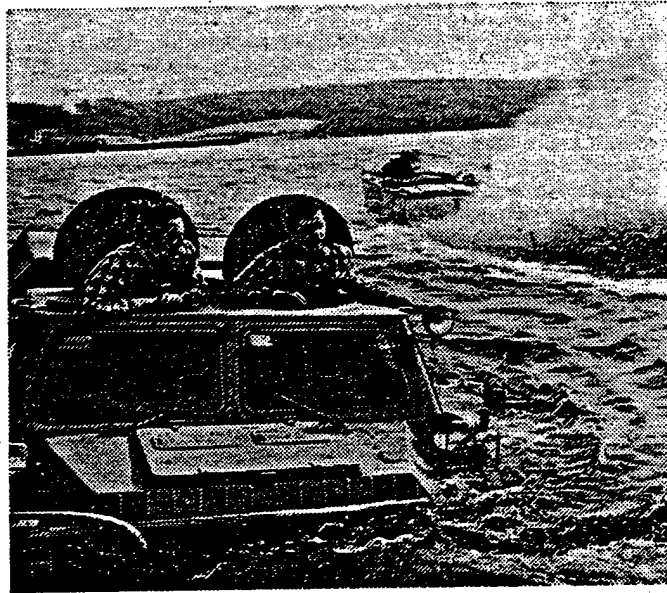
[Article by B. Khasyanov: "Landrover on Caterpillar Tracks"]

[Text] In the Gorkiy Motor Vehicle Plant, series production of floating snow-and-swamp-going vehicles for regions difficult of access has been initiated.

Leaving a deep rut in the boggy ground along the banks of the Oka, the vehicle darted into the water. And in spite of expectations, it began to float easily against the current. This is the way the "working trial" looked for one of the vehicles that Gorkiy motor vehicle builders have created for transporting people and various cargoes in areas where new territories are being opened up in the Far North, in Sibiria and in the Far East.



In the photos: the vehicle easily moves through areas with no roads; chief designer of the GAZ-3403 caterpillar conveyer, holder of the Order of Peoples' Friendship V. Rogozhin [not reproduced here]; the landrover is not afraid of watery obstacles.



The GAZ-3403 caterpillar conveyer-tractor will be used extensively in carrying out geological prospecting work and in the construction and servicing of high-voltage electric power lines and natural gas and oil pipelines. The vehicle is equipped with a powerful engine and a supply of fuel that will enable it to cover up to 600 kilometers in roadless areas without additional refueling. The capacities of the caterpillar propelling device on the new landrover have more than doubled.

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## MOTOR VEHICLES AND HIGHWAYS

### LIAZ BUS WORKS PRODUCT IMPROVEMENT EFFORTS

Moscow LENINSKOYE ZNAMYA in Russian 7 Jul 85 p 2

[Article by V. Bryukhovetskiy, director of the Likino Bus Works: "The Way of Reconstruction"]

[Text] Orekhovo-Zuyevskiy Rayon--Every day dozens of LiAZ-677M buses roll off the conveyor of the Likino plant. But the bus has been produced for about two decades already. Of course, its design is obsolete and it falls short of modern requirements for economy, comfort and a number of other factors. In addition, the production of an obsolete product hampers the institution of modern technology and worsens the economic condition of the enterprise.

In a word, the time has come for a new vehicle. The plant is busily readying itself for the production of a new large-capacity diesel city bus, the LiAZ-5256.

The vehicles have undergone comprehensive factory and field tests, according to the results of which and to the recommendations of the Ikarus plant substantial but necessary changes have been made. Last year was the beginning first of experimental, then small-series production of the vehicles at our plant. In order to develop assembly technology and to train cadres at the plant, a shop was set up for the small-series production of the new buses. We are forming the backbone of a collective here that, in the future, will transfer to the main conveyors as preparation for quantity production.

The design of the bus requires a change to new technological solutions as well as the technical retooling of the enterprise. We are speaking not only of the replacement of obsolete equipment, but of adopting technology at the level of the best world achievements.

The technical retooling that is being conducted has its own features. It is being accomplished practically without the construction of new production capabilities, on active sites, by instituting the most modern equipment on the run, as they say, without stopping production. In spite of the higher designed labor input for the manufacture of the new vehicles in comparison with quantity production, the projection is to produce them without increasing the number of workers--this owing to the adoption of technology that sharply increases labor productivity. This year, for example, a complex will begin operation in procurement production which is equipped with ChPU [programmed numerical control] and mini-computers. This will allow, without the use of almost 300 large, medium and small blanking dies, the cutting of sheets, which will reduce the number of workers occupied with press production.

Painting will be fundamentally different. Here for the first time in domestic and even in world experience with bus building, robots will find application in painting large bus bodies. Air conditioners with a 50-times air exchange are stipulated for the body preparation chambers, which means the best environment possible will be created for those working there. In mechanical processing and welding automatic lines, machine tools with ChPU and robot technology will be used.

One more important feature of the technical retooling is that we began it and are conducting it without waiting for the development, by Ikarus specialists, of a detailed plan for all technological stages, which will take about three years, but by putting technical solutions into effect in individual aspects of production. The readjustment strategy chosen by us will doubtless accelerate the organization of quantity production of the new buses and, consequently, will save a good deal of government money. This, of course, puts much responsibility on the plant's specialists and on our partners from Ikarus and other organizations that are taking part in the renovation of the enterprise. This responsibility is not only a moral factor, but an economic category as well.

Unfortunately, it is not always possible to implement plans in the necessary volumes and on time--for reasons independent of the enterprise. It happens that initiative is linked with obsolete attitudes and regulations, which only create the appearance of order, and in fact delay matters. I will cite one example. It took six months to solve the problem of financing the job of technical retooling for the plant. Our specialists haunted the thresholds of various institutions, proved themselves worthy of risk and special, out-of-the-ordinary judgements. And the answer was, "Retooling without a final plan? That is not authorized. No plan--no financing". Only after the intervention of higher organizations was financing obtained. However, time was lost, we let our partners down, the plant sustained losses and equipment delivery schedules were disrupted.

All this convinces one that working in the old way and taking refuge in obsolete regulations is like throwing a monkey wrench in the works. Time and effort are wasted, and swords are crossed not in search of the newest solutions, but in fighting inertia. Conservatism and resistance to new ways of thinking are the pitfalls that the new bus had to overcome on the way to the conveyor.

Preparations for quantity production of the new vehicle require not only the modernization of our plant. New materials and component products are being assimilated at many enterprises in USSR Minavtoprom and in allied branches of industry. KamAZ [Kama Motor Vehicle Works], for example, is carrying out design and technological measures on operational development and increasing the life of a diesel engine of a special bus modification. The tire industry is organizing production of special oval tubeless tires and chemists are developing new types of paints. The Stupino Integrated Iron and Steel Works, together with our plant, is readying the production of aluminium sections.

Far from everything is going smoothly. Problems with the manufacture of large dies for body facing parts are being solved slowly, which is already holding up a rising rate of vehicle production. These parts have to be manufactured by hand. The problem of organizing production of the new front axles at the Kanash Motor

Motor Vehicle Plant has become especially acute; the axles are necessary, by the way, not only for LiAZ [Likino Bus Works], but also for Ikarus, for the new Hungarian bus. The transfer of quantity front-axle production from our enterprise to this plant has also been delayed. As a result, we cannot free work space for the assembly of new conveyor lines.

The problems, undoubtedly, are many, and the plant collective and the party organization are persistently looking for ways to solve them. We are occupied a great deal on a daily basis with strengthening discipline and putting things in order, striving to have everyone do his job well.

It so happened, that several years ago labor and technological discipline were weakened at the plant and there was a significant departure of qualified cadres. In order to sustain the rate of production, ITR [engineering-technical workers] were enlisted on the conveyors as were temporary people from motor vehicle transport enterprises. All this was not slow to affect the quality of vehicle assembly. The number of legitimate criticisms rose and, finally, serious economic sanctions were applied to LiAZ for nonobservance of standards.

Having carefully analyzed the situation, plant management, together with the party committee, singled out the main problems for the LiAZ workers. Among them were: stabilization of the collective, increasing qualifications, acceleration of technical progress in every-way possible, merciless struggle against drunkenness and bad management, and eradication of disciplinary violations.

To a significant degree we have succeeded in coping with these tasks. Worker turnover has been significantly reduced and continues to lessen, and losses of work time and the number of disciplinary violations have become fewer. We have practically eliminated the practice of enlisting temporary workers and specialists on the conveyors. This was aided by a reorganization of labor in the main shops and by conversion primarily to the brigade form of operation. The basis of it is comprised of a new type of brigade--comprehensive and complex, with the inclusion of maintenance people, adjusters and engineering-technical personnel. The brigades are headed, as a rule, by a foreman-team leader. Their earnings, like those of all the members of the collective, are distributed by the brigade council for KTU [expansion unknown]. Within the brigade workers from preparatory, press, body and assembly production are fully unified.

It has become very uncomfortable in the brigades for shirkers, since the work left undone by them falls on the shoulders of the others, and they do not want to cover up for the idlers. There have been cases where brigade councils addressed the administration with suggestions to rid the collective of a negligent worker. Such actions are supported.

General order has been strengthened, the rate of production has improved and the fulfillment rate for contractual obligations has risen, as has the quality of the buses. People have begun to receive long-awaited bonuses.

It is true that certain managers, who either could not find the strength to reform or who simply could not cope with the business entrusted to them, have been relieved of the positions they occupied. Here the position of management is clear:

we consider the main thing to be the creation of a collective of like-minded people--knowledgeable and energetic people who are not afraid, when the need arises, to take risks, who see the long-term perspective and who are able to think in new ways.

Stabilization of the collective facilitates the accelerated solution of social problems. On the basis of a cooperative agreement with builders, we have succeeded in achieving a level of housing turnover in excess of the plan with a high quality of labor, by enlisting potential new settlers in the finishing of apartments. A housing cooperative has been set up on favorable terms for young families, and they have already begun construction of the building. A well equipped swimming pool was turned over to us in June, and construction of a plant dispensary is in the works.

Much remains to be done before the new bus appears on the country's roads. There is only one way--everyone must work harder, from the worker to the director, to find and put into action additional resources to intensify production.

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## RAIL SYSTEMS

### CHIEF ON MOSCOW METRO SYSTEM PLANS, PROBLEMS

Moscow GUDOK in Russian 3 Sep 85 p 3

[Article by Yu. Senyushkin, chief of Moscow Metro imeni V. I. Lenin, under the rubric "Our Path Is Technical Progress": "Intensification Is the Main Resource"]

[Text] In the opinion of the International Union of Public Transportation, the Moscow Metro has the highest passenger density and the highest traffic intensity in the world. This is the largest transport enterprise in the capital, responsible for almost a half of the entire city's transportation volume.

At present more than 7 million passengers are transported every day, and if we consider transfers, the figure approaches 11 million. On the most crowded lines during rush hours the intervals between trains are 80 to 85 seconds. More than 7 thousand trains a day are sent out along 9 metro lines, out of which 99.9 percent strictly follow the timetable.

In a constantly developing city, the load on the metro grows at a rapid pace. We have before us the task of carrying out a set of measures to satisfy the population's growing need for transportation. It is essential to make maximum use of our resources to increase the traffic and carrying capacities of lines, stations and transfer hubs while maintaining a strict schedule, to ensure traffic safety and raise the level of passenger service. Special attention is being devoted to utilizing the newest achievements of science and technology.

The implementation of such measures as assigning guard sections near traffic lights at station approaches to be independent isolated line sections, and developing and incorporating out-of-train speed monitoring with a transmission of control signals to the following train cars, has enabled us to cut down on the length of these sections and increase traffic capacity for the densest lines. On the Kaluzhskaya - Rizhskaya line 45 pairs of trains run every hour. This has raised the carrying capacity of the line to 5 thousand passengers an hour.

We also make maximum use of such resources as the length of the platforms. On the Zhdanovskaya - Krasnopresnenskaya line, eight-car trains have been put into circulation instead of seven-car trains, which has made it possible to supply additional transportation to 6 thousand passengers an hour. But to achieve



this the operational personnel of the metro had to carry out a lot of work on converting the automatic braking systems, track mechanisms, the energy supply, installations and station equipment and had to introduce changes in the rolling stock. Exceptional accuracy has been required of the conductors.

At present, the preparation of installations and equipment for the Gorkovskaya - Zamoskvoretskaya line to handle eight-car trains is being carried out. The conversion will be completed by the beginning of 1986. In accordance with socialist commitments accepted by the metro workers' collective for the opening of the 27th CPSU Congress, a system of automatic locomotive signals will be introduced and supplemented by an automatic speed regulation system that depends on the train's distance from the preceding train, which will enable us to free the assistant conductors. On four lines of the metro this system is already operational and the trains are run by a conductor alone, without an assistant.

The Moscow Metro is developing constantly. Before the end of this year, the Orekhovo - Krasnogvardeyskaya section of the Gorkovskaya - Zamoskvoretskaya line, the Yuzhnaya - Prazhskaya and Serpukhovskaya - Borovitskaya sections on the Serpukhovskaya line and the Marksistskaya - Tretyakovskaya section on the Kalininskaya line are to be put into service. Right now we have our attention on seeing to it that these projects are made operational by the prescribed deadlines and that they perform high-quality work. Other lines will be built as well.

And still the construction of metro lines has lagged and still lags behind Moscow's development. This lagging will also continue into the future. Besides other reasons, one must bear in mind that with each year the construction of metro lines becomes more complicated and expensive. The cost of laying one kilometer already exceeds 20 million rubles. So we will have to become even more actively engaged with the intensification of our whole operation in order to raise the return of capital investments. For us this is a permanent and vital task.

We have a long-term program for developing the metro and reconstructing existing lines and mechanisms. It is already in operation, but, considering the new requirements placed before us today, it is essential that we take a critical look at it in order that a full satisfaction of the needs of the city's population for transportation be attained first and foremost on the basis of scientific and technical progress.

The metro is our country's national pride, and we are striving to do everything to maintain stations, tunnels and all the installations and equipment in model condition. But, unfortunately, the metro trains are still not comfortable enough and in this regard we are behind the largest subways abroad. In the cars there is a constant noise and vibration and, naturally, the passenger who has to ride 30-40 minutes in one direction can have justified complaints regarding this inconvenience.

The fact is that the rolling stock delivered by the heavy and transport machine building plants and the motor vehicle and electrical engineering industry do

not fully satisfy the needs of the present day. We cannot be led around by the developers who put the question in such a way that the quotas that are handed out are oriented to today's lagging plant potential. Proceeding from the CPSU Central Committee's directive on problems of accelerating scientific and technical progress, the assignment must be made for cars to be produced that will answer the high requirements made of the metro at the present time.

There are serious complaints about the ET-type escalators. Their construction has clearly not been worked out. During the course of the year it is necessary to replace the steps three times. The metro is forced to carry out careful observation of these escalators. This requires enormous expenses. And we hear justified complaints from passengers about this. For instance, at the Marksistskaya station where we had to replace the steps once again, the escalators did not work for a long time due to an absence of parts. The Ministry of Heavy and Transport Machine Building is slow to resolve this question.

We are behind technically in the construction of lines as well. Experience has been accumulated in the world, in particular by the Prague Metro, in laying lines without ties and with open gutters, that are comfortable in service. On the concrete base of the line, plastoconcrete supports are installed to which the track lining is attached by steel pins. To lower the noise and vibration level, a rubber cushion is laid under the track lining. This improves the smoothness of the train ride and establishes better conditions for the passengers.

The All-Union Scientific Research Institute of Railroad Transport has been insistently proposing to us a track with cushioned under-frame. Its use would cause difficulties when the frame needed to be replaced in crowded metro tunnels. Experience that exists, has been approved and gives good results must be utilized.

The mechanization of labor-intensive processes connected with maintaining stations and tunnels, cleaning the enormous lobby and platform areas and washing the lamps and windows remain a large problem. The only technical maintenance equipment so far remains the floor-washing machines which we manufacture ourselves at an experimental electromechanical plant, inasmuch as industry does not produce special cleaning equipment. We are experiencing shortcomings in such machines as industrial vacuum cleaners and equipment for washing staircases and windows. It is high time to organize a centralized output of domestically produced, highly productive maintenance machinery and equipment for the metro.

The Moscow Metro has been working for 50 years and a number of installations and equipment have become antiquated. It is enough to say that we now have in operation 26 kinds of escalators. Therefore the implementation of scheduled reconstruction work on existing lines is a very current matter. A special trust, Mosmetrorekonstruktsiya, has been established for the purpose of seeing that this work is basically accomplished.

It is quite clear that intensification of production and the acceleration of scientific and technical progress are unthinkable without metro workers adopting a creative approach to the matter and without raising the responsibility of every employee to fulfil the prescribed tasks. We are striving for the subdivisions of the metro, in collaboration with scientific and planning and design organizations, to investigate more thoroughly and solve complex problems, and to aim for the highest efficiency.

12962

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## RAIL SYSTEMS

### CEMA PLANS IMPROVED, ADDITIONAL BORDER RAIL STATIONS

Moscow EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV SEV in Russian No 3, Mar 85 pp 32-37

[Article by Anatoly Lykhachov, CEMA Secretariat: "Problems in the Growth of Transportation: Improving the Work of Border Rail Stations"]

[Text] The planned development of the economies of the countries of the socialist community, deepening of the integration processes in material production and the high rate of trade, tourism and cultural exchange have caused a steady growth of transport traffic between our countries. A decisive role in this has been played by rail transport. In 1983, rail shipment in the CEMA nations exceeded 3900 billion ton-kilometers (42 percent more than in 1970) which is 55 percent of all shipment and amounts to more than 60 percent of all of the rail transport in the world (see figure).

The transportation ministries of the socialist countries and the Permanent CEMA Commission on Transport Cooperation (henceforth referred to as the Commission) have paid close attention to the tendency for growth in international shipment. The realization of many measures of the Comprehensive Program have contributed to better economic cooperation and an international socialist division of labor and an increase of mutual enrichment between the economies of the CEMA nations.

At the last (113th) session of the CEMA Executive Committee held in Moscow in January 1985, much attention was given to analysis of the state of CEMA cooperation in the area of transportation and to suggestions on how it can be further strengthened.

It was noted that the fulfillment of measures called for in the Comprehensive Program and the Long-Term Program for Cooperation in the development of transportation lines has contributed to the development of national transportation systems and improved their work and cooperation.

Considering the great importance of transportation in the realization of the basic directions of further economic growth and cooperation between fraternal nations that were established by the High-Level CEMA Economic Conference, the Executive Committee stressed that a considerable increase in the pace and

scale of technical reconstruction and modernization of transport, and especially of international transport, on the basis of scientific and technical progress is an important economic task that the CEMA nations must fulfill in 1986-1990.

In comparison to 1975, the amount of their mutual trade in 1980 increased 69 percent and amounted to 119 billion rubles. Export trade in machinery and equipment, chemical products, fuel, energy and raw materials grew. The following are the percentages by country of trade conducted with CEMA nations out of the total foreign trade conducted in 1983: Bulgaria -- 77 percent, Hungary -- 49.6 percent, GDR -- 62.5 percent, Mongolia -- 97.3 percent, Poland -- 68.5 percent, Romania -- 47.7 percent, USSR -- 51.2 percent and Czechoslovakia -- 71.9 percent. Passenger travel has steadily grown. In 1980, 3,094,000 persons used rail transport to travel between nations. This was more than in 1970 (Table 1).

With the growth in volume of passenger travel and international freight shipment, there has also been an increase in the capacity of the technical equipment at border stations and the approaches to them. For effective reception and handling of trains with passengers and import or export freight, the CEMA nations are implementing the following series of measures:

- to provide more technical resources and equipment and to enhance and improve the technology used at border stations;
- to improve and simplify the organization of border and customs control in passenger trains, inspection of baggage and freight in baggage cars, the technology of work of border stations and border formalities to increase the capacity of border crossings on both transfer and transfer-free lines;
- to improve the organization of international trains and provide uninterrupted shipment of perishable loads.

Between the railways of the socialist nations, the ties are becoming closer and stronger. Work is being done to improve scientific and technical cooperation to provide greater and quicker satisfaction of the CEMA nations' economic demands for rail shipments.

#### Increasing the Capacity of Border Stations

The constantly-growing passenger and freight traffic between the CEMA nations requires better work by border stations, better equipment and in some cases the creation of new stations. In the 1970's, construction was completed of a united container point at Batevo Station (USSR) for the transshipment of high-tonnage containers between the USSR, Hungary and Czechoslovakia as well as freight carried in transit through these countries. Work has been done to expand rail stations and networks at Brest, Kaliningrad, Chernyakhovsk, Ungeny, Reni and Batevo (USSR). The level of mechanization of freight handling has been increased at the Polish border stations of Kuznica, Semianowka, Dorohusk, Malaszywice, Medyka, Zurawica (Poland) and at the East German sorting stations of Seddin and Frankfurt-an-der-Oder. The following

border stations have been expanded: Zahony and Eperesyke (Hungary), Cierna nad Tisou (Czechoslovakia) and Ruse and Kardam in Bulgaria. The freight-handling capacities of the stations at Curtici (Romania), Raika (Hungary), Sturovo, Vojtanov, Decin (Czechoslovakia), Bad Schandau (GDR) and others have been expanded.

In accordance with measures called for by the Long-Term Program for Cooperation in the development of transportation lines of the CEMA nations and those of the current five-year plan, work has been carried out to increase the carrying capacity and freight-handling abilities of border stations and their approaches. Special attention has been given to finding reasonably inexpensive means of reducing the amounting of processing that international trains must go through and the time cars must spend standing at border stations. Thus, the Varna-Paromnaya (Bulgaria) station received modern equipment to mechanize its loading work while Zahony station in Hungary received reloading equipment for small dispatches. Eperesyke station in Hungary received a complex of D-cranes and sidetracks for loading and switching cars from 1520 mm gauge track to 1435 mm track, its locomotive depot was rebuilt and the point for chemical materials transfer was expanded. A weighing point was built at Zahony station and a second line has been built between Tuzer and Feneslitke.

To increase the number of trains processed to fit the projected increase of shipments, the East German border station of Bad Schandau is being rebuilt. In accordance with long-term plans for international shipment and the economic needs of the country, Poland is conducting a large-scale modernization of the loading points on its railway lines. To increase the processing capacity of its stations, Romania is mechanizing the gravity humps and work fronts at Curtici station and two terminals are being built at the stations of Galat and Sokala.

The USSR railway system is being equipped with electrical centralization of switches and signals at the stations of Batevo, Korolevo, Brest, Ungeny, etc. A point for transshipment of heavy loads was introduced to Batevo station and Yesen received a car rearrangement point. Work is continuing on expanding the station at Cop and increasing the number of tracks at Berestovitsa, Sarny, Zdolbunov, the car-loading preparation center at Batevo and a new border crossing is being built at Batevo-Uzhgorod-Matevce (USSR-Czechoslovakia). The carrying and processing capacities at Cierna nad Tisou, Decni, Sturovo, Bogulin, Breclav, Rusovce and Cheb (Czechoslovakia) are being enlarged.

#### Improvement of the Technology and Work Organization at Border Stations

Border stations concentrate and process a large volume of freight and railway cars, including transit loads. A high degree of efficiency and continuous work can be assured only by the introduction of standardized technology, closely coordinated cooperation with neighboring border stations and roads, more intensive use of technical resources and improved work organization.

Specialists from the railways of the CEMA nations have prepared and the Commission has approved a series of documents regulating the technical

equipment used by border stations in their operation and reconstruction as well as in the construction of new stations. These documents include the Basic Principles for Technical Equipment of Border Stations in Transfer and Transfer-Free Travel, Standard Technology for the Processing of International Freight Trains at Border Stations With Cargo Transfer, Standard Technology for Processing International Freight Trains at Border Stations Without Cargo Transfer, Standard Technology for Processing International Passenger Trains at Border Stations With Direct Communications, Basic Principles for the Operation of Border Stations, Suggestions for the Improvement of Mutual Information On the Passing of International Freight, etc.

For the development of measures associated with reducing time finding passengers and freight at border stations, an international conference was called to consider basic problems such as:

- the improvement and simplification of organization of border and customs control in passenger trains and baggage and freight examination on passenger trains;
- improvement of the organization of international trains and uninterrupted transshipment of perishable goods;
- better equipment in technical resources and development and improvement of the work technology used at border stations by 1990;
- streamlining of commercial operations, transport and moving work connected with the receiving and shipment of freight as well as the improvement of control over the sojourn and storage of freight, etc.

In improving the specific technology used by stations, progressive methods are to be used along with prior experience in expediting the handling of trains at combined transfer border stations with combined operations etc. Railroads have achieved their best results in organizing border operations at combined stations (or stations with combined operations). At such stations, operations in technical and commercial inspection as well as border customs control work is conducted simultaneously by all of the appropriate organs of the neighboring countries. Aside from this, it has now become possible to employ agreed-upon technological processes which will make it possible to use locomotives and technical resources with less labor cost.

Some of the organizational measures being introduced to many of the railroads of socialist countries include:

- the transfer of commercial, veterinary, phytosanitary and other forms of inspection to stations loading international freight;
- parallel execution of all operations with trains and cars (technical, commercial, receiving, consigning, veterinary, customs and border operations);
- the performance of operations at border stations with uncombined operations by means of distributing them among neighboring border stations;

-- creation at transshipment border stations of specialized areas for shipping certain types of freight and synchronizing the feeding of cars during the transfer of freight according to the direct variant;

-- organization of computer processing of data from preliminary information on the approach of trains and freight, etc.

One of the most important ways to improve the organization of work at border stations is to acquire accurate and reliable data on incoming trains and their freight. If this information is to be acquired by border stations before the trains come in, then part of the processing of the documents could be handled on time and this would reduce the overall amount of time spent on handling the trains at the border. Most railroads have bilateral agreements on the exchange of information between neighboring railway administrations by means of telephone, teletype and radio.

In connection with this, not all of the railroads of the CEMA nations have standardized common documentation and organizational work is directed at unifying car lists and computer processing them. The basis for creation of a single type of car list is a form suggested by the Organization for Railroad Cooperation (OSZhD). The railroad border crossings between Bulgaria and Romania and Hungary and Romania already use such documents.

At the present time, in order to more widely use computer technology, an improved car list has been created which makes it possible to completely automate data processing. At the border crossings between the GDR and Poland and between the GDR and Czechoslovakia, a single car list is used to record the cars received and released. This frees the railway using it from having to do redundant paperwork. Eventually, it will be sent in the form of telegrams accompanied by a perforated tape containing data on the car list. At the border crossing between Hungary and Czechoslovakia, the general-purpose stations of Komarom and Sturovo are already making experimental use of transmitted lists on perforated tape.

Increasing use of computer technology at border stations requires that unified organizational and technical measures be taken on the railroads of neighboring countries in order to use mechanical data carriers and a single data code. Using prior experience in identifying documents and data, some of the railroads of the CEMA nations have modernized their technology for the handling of trains. The Bulgarian, Romanian and Yugoslav railways worked together to prepare improved technologies for handling trains and freight at their common border stations of Ruse and Dimitrovgrad-Yuzhnyy.

On the railroad border crossing between Hungary and Czechoslovakia at the general-purpose station of Hidasnemeti, an experimental technology for improving the processes of receiving and passing freight trains has been developed. It has made it possible to considerably reduce the time spent copying car numbers, on technical inspection and also on the filling out of transfer documents. With the old technology, the average train wait at the



border was 5.3 hours but using the new system, trains must only wait 2.6-2.7 hours.

The new technology allows for the fact that Czechoslovakia and Hungary use the same system for listing car numbers and that the technical inspections are carried out by two inspectors (one each from Hungary and Czechoslovakia). Aside from this, the customs facilities are placed next to MAVTRANS and INTRANS [not further identified] where the customs officials start with the shipping documents. As a result of the concentration and improvement of technological processes, working conditions have also been improved. The distance walked each day by the collectives at border stations has been reduced by about 50 percent.

A single technology will be introduced by 1986 at all of the border stations of Hungary and Czechoslovakia.

The work of combined border stations and stations with combined services and operations such as Komarom, Biharkeresztes and Banreve (Hungary), Frankfurt-an-der-Oder and Kietz (GDR), Miedzylesie and Halupki (Poland), Curtici (Romania), Sturovo, Decin and Petrovice u Karvine (Czechoslovakia) and others on the Hungary-Czechoslovakia, Hungary-Romania, GDR-Poland, GDR-Czechoslovakia and Poland-Czechoslovakia lines has increased the volume of freight and passengers.

In order to increase the carrying capacity of the approaches to border crossings, the weight limits on trains have been increased on the Ruse/Varna, Ruse/Gorna-Oryakhovitsa (Bulgaria) lines. On the basis of bilateral agreements, the weight of freight trains has been increased on lines connected Hungary with Romania and Hungary with the USSR. The use of more powerful locomotives has made it possible to increase by 200 tons the weight limit for freight trains at the Bad Schandau-Decin crossing between the GDR and Czechoslovakia. Weight limits have been raised by 600-1200 tons on the border sections of the lines in the USSR connecting Brest and Orsha and Razdelnaya and Reni and this has increased their carrying capacity.

In order to concentrate the transfer of small shipments from Bulgaria to the USSR, 10 supporting stations have been designated, and from the USSR to Bulgaria, 8 stations of this sort have been established. The railroads of the European CEMA nations use an international method for marking cars and also employ the same stickers. Customs inspections of cars with small shipments travelling between Hungary and the USSR is done at the Budapest-Jozefvaros station. On the Romanian railroads, the receiving and consignment of simple cars with small shipments is handled without physical transfer at the border stations of Giurgiu, Samora, Moravita, Socola, Curtici, Episcopia Bihor and at the border stations in Czechoslovakia without customs control which is done before that at the station of departure.

In order to alleviate the work of railroads and border stations, loads of outgoing freight in containers and above all, high-tonnage containers, are continuing to be increased.

On many of the lines of Bulgaria, Hungary, Romania, the USSR and Czechoslovakia, the travel schedule determines the circulation of itinerary container trains or groups of cars with containers included in certain trains. A transcontinental Western Europe-Brest-Nakhodka-Japan container line is operating.

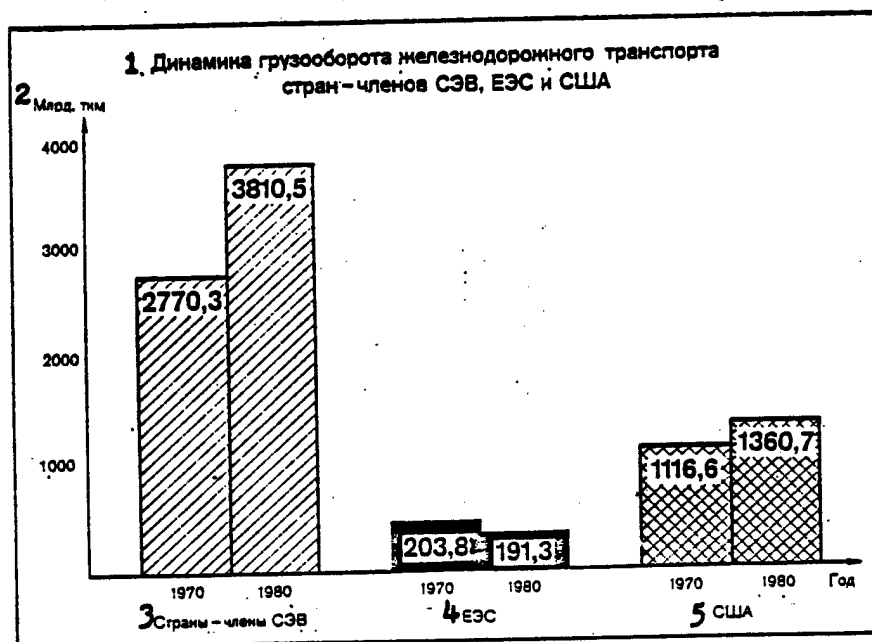
To reduce transport and shipping work, some countries send out trains and groups of cars on the same waybill. This is how some freight is sent out of Hungary, Poland and Czechoslovakia and from the GDR into Poland and Czechoslovakia.

The collectives of railroads of the CEMA nations have done much to improve the work of border stations. However, the rate of international rail freight shipment between the CEMA nations will continue to grow. Therefore, railroad specialists will continue to work to improve the technology used by border stations and increase the quality and level of their technical resources.

In accordance with the Long-Term Cooperative Program for development of transportation lines between CEMA nations, work is being carried out according to established schedules to further improve tracks and sidetracks at border stations. They are also receiving new technology including mechanized devices and automated equipment for cargo-handling work, technical inspection of cars, document processing, etc. An important element in the development of transfer stations is large-scale mechanization of freight transfer work. In order to improve the planning of train and freight handling, great emphasis will be placed on the creation of a single system of exchanging information between CEMA nations on the approach of trains and freight to border stations.

At the 113th session, the CEMA Executive Committee recommended that, in coordinating their economic plans, the CEMA nations use technically agreed-upon parameters to develop their international trunk lines, modernize their track facilities, mechanize and automate all types of station work and increase the capacity of their border rail stations.

The railway workers of our fraternal nations will continue to devote special attention to discovering and using new reserves and transport possibilities to improve the state of international shipment and will carry out a lasting creative search for new and promising forms of cooperation that can strengthen socialist economic integration.



Key: 1. The comparative dynamics of freight transported by rail in the CEMA nations, the European Common Market and the USA; 2. billions of ton-kilometers; 3. CEMA nations; 4. European Common Market; 5. USA.

Table 1. Index and passenger and freight rail transport (1970=100).

1. Страна	10. Перевозка				
	11. грузов			12. пассажиров в международном сообщении	
	1975 г.	1980 г.	1983 г.	13. 1980 г. (отчет)	14. 1985 г. (план)
2. НРБ	116	114	121	156	244
3. ВНР	112	111	106	168	182
4. ГДР	110	119	124	137	206
5. МНР	145	207	255	516	622
6. ПНР	121	126	108	404	769
7. СРР	133	160	164	298	395
8. СССР	125	129	133	185	266
9. ЧССР	115	121	123	120	137

Key: 1. country; 2. Bulgaria; 3. Hungary; 4. German Democratic Republic; 5. Mongolian People's Republic; 6. Poland; 7. Romania; 8. USSR; 9. Czechoslovakia; 10. shipment; 11. of freight; 12. of passengers in international travel; 13. 1980 (reported); 14. 1985 (plan)

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## RAIL SYSTEMS

### CEMA RAILROAD TRANSPORT DEVELOPMENT PLANS

Moscow EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV SEV in Russian No 3, Mar 85 pp 26-29

[Article by Aleksandr Chertkov: "Problems in the Development of Transportation: Prospects for the Growth of Railway Transport"]

[Text] The dynamic growth of the economies of the CEMA member nations and the subsequent course they have taken for further cooperation and development of socialist economic integration have both contributed to an increase in freight and passenger traffic both within and between these countries. The most important precondition to the amount and quality of rail traffic is timely and optimal development of the transportation systems of these countries.

In most of the fraternal nations, the basic form of transportation is railroads. In 1983, the railroads carried about 54 percent of all freight. Out of all forms of transportation, the actual percentage of railroad transport ranged, not counting Cuba (4.6 percent) and Bulgaria (19.3 percent) from 34.5 percent in Poland to 71.6 percent in Mongolia. Railroad transportation is a very important element of international travel between the CEMA nations. In about 75 percent of the travel between CEMA nations, railroads form some part of the link (direct railroad transportation, mixed boat and railroad, water and ferry transportation) at this time and 45 percent of this is direct rail transport.

Railroad passenger transportation in the CEMA nations is also important. In 1983, the railroads carried about 38 percent of all passenger traffic and about 27 percent of all of the freight shipped by various means.

In 1983, the total amount of freight carried by railroads in the CEMA nations amounted to 3.9 billion ton-kilometers while the weight of passengers carried amounted to 0.5 billion passenger-kilometers. Respectively, these amount to an increase over 1970 of 1.4 and 1.3 times, respectively.

It has been evaluated that in the future, railways will remain important although in some countries, its actual weight may somewhat decline.

The prospective development of railway transportation in the CEMA nations has been established through national plans and concepts as well as by the Comprehensive Program for Further Intensification and Improvement of the Socialist Economic Integration of the CEMA Nations. The CEMA nations' basic directions and tasks for cooperation in the area of transportation for 1976-1980 and the following period were approved by the CEMA Session (30th) and the Long-Term Program for Cooperation in the development of lines of transportation between CEMA nations.

Made in accordance with the Program for Greater CEMA-nation Cooperation in Joint Prognosis of the Development of Transportation, the 1983 prognoses of the volume of shipment of freight and passengers, development of international lines of transportation and the technical enhancement of railway transport with the most important technical equipment and materials not provided by domestic industry are of great significance.

The indicated prognoses have determined the basic directions for development of the railways of the CEMA nations until 2000 and their technical progress until 2005.

The main directions are:

- increasing the carrying and transport capacities of the main railway lines electrifying them, constructing second lines and two-way inserts [dvukhputnye vstavki] and by increasing the capacity of stations and junctions, including those at the borders;
- improvement of the technical quality of the rolling stock and permanent installations;
- improvement of operations.

The main direction for increasing the carrying capacity of the CEMA-nation railroads will be their electrification. This makes it possible not only to attain the highest rate of growth in the amount of passenger and freight traffic but also improves the use of fuel and energy and successfully solves ecological problems.

Diesel locomotive operation has already come to take an important place in the transportation of freight and passengers in the socialist countries in which there are now about 60,000 kilometers of electrified railway lines, in other words, 26 percent of the total railway line length. According to prognoses, by the year 2000, the total length of electrified lines used in international railway traffic alone will be increased by 3500 kilometers over that of 1980 (not counting Poland, Hungary and Romania).

The four main railway lines connected the capitals and administrative and economic centers of the European CEMA nations (Berlin-Warsaw-Moscow, Rostock-Berlin-Prague-Bratislava-Budapest-Bucharest, Moscow-Kiev-Bucharest-Sofia) will be fully electrified.

Such a broad scale of electrification and the growth of the carrying capacity of these lines will require that locomotive power be increased to 5000-6000 kW. In some countries such as the USSR, it is expected that the power of locomotives used on domestic lines will be increased to 12,000 kW. Passenger locomotives will reach speeds of 160-200-250 km/h while freight locomotives will travel as fast as 100-120-140 km/h.

The diesel locomotives used to haul freight will be supplemented with new engines generating as much as 3000 kW of power (on the average) for railroads with a track gauge of 1435 mm and 3000 to 6000 kW for 1520 mm gauge track. The internal-combustion locomotives used for both passenger and freight traffic will have the same power but their speed will reach 90-120 km/h for freight transportation and 160-200 km/h for passenger travel.

The new locomotives will use fuel more economically. They will create less track wear, be more reliable and make greater use of electronics.

Still another direction for the prospective growth of the railway networks of the CEMA nations is the construction of second lines and two-way inserts. According to prognostic data, only the international railway lines in Bulgaria, East Germany, the USSR and Czechoslovakia will have built by the year 2000 about 1500 kilometers of second lines and two-way inserts. At the same time, the tracks will be substantially strengthened and this will make it possible to increase the train weight and speed. Thus, the weight of freight trains on Soviet railroads will be increased 120 percent while train weights on some lines will reach 10,000 tons and more. In the European CEMA nations, as long as the maximum allowable train weight remains stable, the minimum weight will be increased by 130 percent to 2000-4000 tons.

At the present time, the maximum permissible speed on most of the railway lines in the CEMA nations is 80-100 km/h. By 2000, the speed will be increased to 100-140 km/h for freight trains and 120-160 km/h for passenger trains. On some specialized high-speed lines, speeds will reach as much as 200-250 km/h.

An important means of increasing the carrying capacity of railroads is improvement of the freight and passenger rolling stock. This is mainly done by increasing the weight capacity of gondolas for 1520 mm gauge railway lines to 58-70 tons and for 1520 mm tracks to 69-125 tons (four-axles gondolas), raising the capacity of flatcars to 57 and 68 tons respectively, the capacity of covered cars to 52-58 and 68 tons and that of tank cars to 50-61 and 60-63 tons.

There will be a tendency in rolling stock construction to lower the technical coefficient of containers by using alloyed steels and light alloys. Brake systems will be improved and automatic couplers will be introduced. The rolling stock will be converted to roller bearings.

The Improvement of freight shipment quality will be expressed in car specialization. The car stock for shipment of automobiles, mineral fertilizers, cement, pellets, containers, closed-floor gondolas, etc. will be

increased.

Passenger cars will be made longer and hold more passengers. They will be air-conditioned and will contain darkened glass. Passengers will be able to place telephone calls to cities and the cars will also be more comfortable.

In connection with the sharp growth in the future of containerized freight, it is expected that the gross weight of all-purpose containers will be raised to 30 tons (to 50 tons in the USSR). The use not only of all-purpose but also of specialized containers for the shipment of 20-30 ton loads of granular and lumpy freight, chemicals, perishable materials and liquids has been foreseen.

Considering the considerable density in overall international freight shipment, great attention in the future will be given to the development of border stations, most of all those that transfer freight at the border between the USSR and the European CEMA nations. At these stations we should continue to strengthen the track facilities and improve the loading and unloading equipment. Continuous-action freight-handling equipment, car-rockers, devices for loosening and removing frozen loads, all-purpose electrical gantry cranes, heavy-duty electrical and automatic loaders and other technology will be put into operation. To prevent loss in bulk loads during shipment, sealing devices and protective film coverings will be used. Border stations requiring no transfer of goods will be developed by increasing their track facilities.

The growth of load intensities and greater train weight and speed cause extremely intensive use of railway lines and this requires the introduction of better designed tracks, the creation and broader use of high-speed repair machinery. Tracks can be strengthened mainly by the installation of new types of rails (included heat-treated rails), continuous tracks, ferroconcrete ties and the conversion of railway lines to crushed rock and asbestos ballast. Rails weighing up to 65 and 75 kg per meter will be laid and greater use will be made of ferroconcrete ties with more flexible plates and fastenings.

A more important direction in the technical development of the CEMA-nation railway transportation networks is the improvement of automatic blocking and dispatch devices, electrical centralization of communication and radio communication, development of new systems and apparatus that uses contact-free technology, computers, microprocessors and minicomputers.

One of the largest consumers of fuel and energy is the railways. Therefore, in the USSR, the railroads take 21.3 percent of the fuel and energy consumed by all forms of transportation.

Therefore, the reduction of railway consumption of fuel and energy has become very important. A lower rate of consumption will be provided by larger trains, reduced resistance through more use of rolling bearings, better track quality, less detention of operable stock and fewer empty trains, improved design and more economical engines and power units.

Aside from this, more economical use of fuel and power will be made possible by junction-free lines on improved beds, recuperation of electricity in sections using alternating current, reduction of energy loss in the contact circuit and at traction substations. The technical reequipment of railroad transport will have a positive effect on the environment and especially in reducing noise, harmful vibrations and harmful emissions into the atmosphere from power plants and in reducing the crushing of loads during transport.

Great possibilities for further development of railroad transport are offered by the Long-Term Program for Cooperation in the development of the transportation lines of the CEMA nations. Its basic premises have established an agreed-upon strategy for the CEMA nations to work together to solve the most important problems in the development of railway transport:

- to increase the carrying capacity of international rail lines;
- to improve container transshipments and develop the United Container Transport System;
- to transport especially heavy and large loads;
- to accelerate the development and improve the effectiveness of the work of the transportation system of the Mongolian People's Republic;
- to provide machinery and equipment necessary for the realization of measures to develop transportation lines between the CEMA nations.

In accordance with the Long-Term Program for Cooperation until 1990 on East-West international railway lines, there is being planned the construction of 1400 kilometers of second lines, automatic blocking and dispatch centralization of about 5000 kilometers, the electrification of more than 4000 kilometers of line and the reconstruction of more than 6000 kilometers of line. On the North-South lines, this work will involve 700, 2500, 2000 and 2800 kilometers respectively.

The Long-Term Program has also planned cooperation in the development of active transfer between the USSR and Hungary on the Batevo-Epereske line (1500 mm track).

Cooperation in containerized freight will be implemented through the preparation of technical and operative specifications and rational design of specialized containers, technological system of shipment of perishable freight in isothermal containers and improvement of the system of machinery used to ship and store containers, etc.

For especially large and heavy loads between CEMA nations, measures are being prepared to insure the transportation of such materials for nuclear energy, the chemical and metallurgical industries and the heavy machinery industry.

Cooperation aimed at hastening the development of railway transport and improving the economy of the Mongolian People's Republic calls primarily for



the building of more important railroad lines for the Mongolian People's Republic and special border stations at Sukhe-Bator (Mongolian People's Republic) and Nauski (Czechoslovakia).

In order to solve the problems of providing the machinery and equipment necessary for developing the transportation lines of the CEMA countries, there will be greater and more intensive specialization and cooperation in the industries producing locomotive equipment, freight and passenger cars, machines, equipment, control and measurement devices for mechanizing line work.

The Long-Term Program for Cooperation in the development of the railway transportation of the CEMA nations has specified by a series of bi- and unilateral agreements.

Therefore, at the present time, there is a concise program for the long-term development of the railway transportation of CEMA nations and this has already begun to be implemented. There is no doubt that our combined efforts will fulfill this program in its entirety and on time and this will make it possible to fully meet the needs of our fraternal nations for the transportation of freight and passengers over internal and international railway lines.

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## RAIL SYSTEMS

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### IDZHEVAN-RAZDAN LINE TUNNEL CONSTRUCTION DETAILED

Moscow TRANSPORTNOYE STROITELSTVO in Russian No 9, Sep 85 pp 17-18

[Article by A. S. Kurisko, candidate of technical sciences, Armgiprotrans/  
Armenian State Institute for Planning Transportation Enterprises/: "Tunnels  
of the New Idzhevan-Razdan Railroad Line:"]

[Text] The construction of seven tunnels is nearing completion on the new  
Idzhevan-Razdan railroad line in Armenia; one at Idzhevan, three at Dilizhan,  
and one each at Akhkikhlin, Megradzor and Kilometer 89.

In April of this year the longest of them, the Megradzor tunnel was connected.

All design work for the tunnels was done by the general design and survey  
organization, Armgiprotrans.

Construction of all the tunnels was accomplished by the contractor organiza-  
tion Armtunnelstroy/Armenian Administration of Tunnel Construction/ and its  
subcontractors, Arpasevanstroy/expansion not given/, Kievmetrostroy/Construc-  
tion Administration of the Kiev Subway/, Minskmetrostroy/Construction Admini-  
stration of the Minsk Subway/, Tbiltonnelstroy/Construction Administration of  
Tbilisi Tunnel Construction/, Tashmetrostroy/Construction Administration of  
the Tashkent Subway/, and Kharkovmetrostroy/Construction Administration of the  
Kharkov Subway/.

The work of driving the Idzhevan and Akhkikhlin tunnels has already been com-  
pleted and the remaining tunnels will be completed and put into operation in  
1985.

In conformity with the approved plan and the working documentation all tunnels  
have been provided with horseshoe-shaped monolithic concrete linings of Types  
1, 2 or 3 in the standard designs of Metrogiprotrans/State Planning and Sur-  
veying Institute for the Construction of Subways and Transportation Facili-  
ties/ (Figures 1 A, B, and C). The tunnels were driven either full size or in  
sections by the supported-roof method. Cement and sand grout was injected  
behind the linings.

During the construction process, as the result of additional design developments and creative discoveries by designers and construction workers, new design solutions for the linings were proposed, which made it possible to achieve definite savings in the amount of earth excavated and of concrete placed, and also reduced tunnel construction time and labor costs.

The Type 1 lining (Figure 1 A) is intended where the rock hardness ratio ( $f$ ) is equal to or greater than 6. Examination of the moment curve from rock pressure and the intrinsic weight of the structures shows that the maximum moments in a lining occur at the crown, are somewhat less in the vault quadrant, and are gradually reduced in the direction of the spring line. Within the walls they are inconsequential. The curves of material distribution show the reverse -- minimum thickness of the lining at the crown, and maximum in the walls. This runs counter to the prevailing moments, which means that it is unjustifiable and irrational. Broadening the walls at the bench in the presence of soil is also illfounded, since the lining is intended for hard rock. Reducing the thickness of the walls made it possible to produce a design (Figure 1 B) for which the volume excavated per meter of tunnel was reduced by  $1.3 \text{ m}^3$ , and the volume of concrete placed was reduced by the same amount. The overall savings per meter of tunnel amounted to 100 rubles.

Further modifications of types of linings for rock defined by a hardness ratio greater than or equal to 6 demonstrated the feasibility of using linings of shotcrete with anchor bolts. Armgiprotrans, in cooperation with LIIZHT/Leningrad Research Institute of Railroad Transportation/ and TSNIIS/expansion not given/, produced a lining of shotcrete and anchor bolts that was used in one of the sections of the Megradzor tunnel (Figure 1 L). This type of lining, compared to the standard one shown in Figure 1 A, makes it possible to reduce the volume excavated, and therefore the volume of concrete placed, by  $3.5 \text{ m}^3$ , and also eliminates the processes of installing and removing forms and of injection. The overall savings per meter of tunnel amount to about 400 rubles.

In rock where  $f=3-5$  the lining normally used (Figure 1 D), is constructed by the supported-roof method, with excavation of the lower portion of the core and side drifts. To replace this type a new design has been developed that has extended footings and reduced wall thickness. This made it possible to excavate the lower portion full face without any breakdown into core and side drifts. Moreover, since the footings are supported on rock, and there is no lateral ground pressure, the thickness of the lining walls has been reduced, which cut down the volume of excavation and the lining concrete by  $3 \text{ m}^3/\text{m}$ . As a result of this the speed of driving the lower portion of the tunnel was nearly doubled.

It should be noted that wall thickness can be increased by reinforced concrete anchors, and in many cases concrete can be replaced by shotcrete, metal mesh and anchors.

Lining with extended footings and reduced wall thickness was constructed in the major part of the Idzhevan tunnel. Use of it made possible overall savings on the order of 850,000 rubles.

Initially a Type 3 lining (Figure 1 F) was used for rock where  $f=1-2.5$ . In connection with the decision to accelerate construction of the Dilizhan tunnels, two types of design were used: prefabricated reinforced concrete tubing, and solid blocks with cylindrical joints (Figures 1 E and G). These types of linings have been used in other tunnels, but a new solution for linings of smooth prefabricated blocks with cylindrical joints (Figure 1 G) was to use Yerevan-type antiseismic ties. Figure 1 H1 shows the normal design of Tashkent-type seismic ties between blocks. These ties are installed on the interior of the lining, and consist of crisscrossed reinforcing rods at rigid joints, which eliminate the articulation at the joints of the lining blocks and alter the static operating arrangement of the lining by reducing its bearing capacity. There are considerable difficulties with rigid joints.

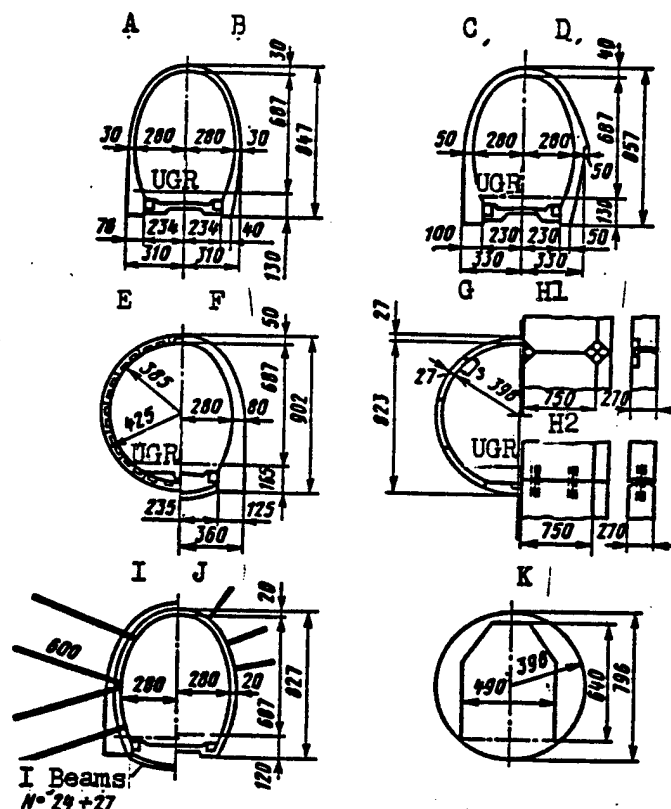


Figure 1

In the light of these shortcomings Armgiprotrans designers, in cooperation with the construction workers of Armtunnelstroy, proposed a new type of seismic ties based on installed studs, anchored in holes with a grout of expanding cement (Figure 1 H2). This type of ties preserves the articulated operating arrangement of the lining at the joints, increases its bearing capacity in the ties by transferring part of the stress from the zone of

contact between the ends of the blocks via the rods into the depth of the blocks, reduces the expenditure of metal by 50 tons per kilometer of tunnel, and increases the rate of installing the ties.

It is clear from Figure 1 K that linings of circular shape are not advisable, since the area of obstruction clearance for monolithic horseshoe-shaped concrete linings is 1.3, and for precast circular ones it is 1.7.

However, circular linings with a diameter of 8.5 m considerably exceed horseshoe-shaped concrete linings in bearing capacity. A circular lining of this diameter can support a vertical load of about 1 MPa, while a Type 3 horseshoe-shaped concrete lining can only support 0.24 MPa. Since in one section of the Dilizhan tunnels, the clayey-sandy shales exert horizontal and vertical pressure of about 0.5 MPa on the lining, the normal Type 3 lining was deformed and had to be reinforced. Six arches of No. 27 I-beams per meter /sic/ of tunnel were installed on the inside surface of the lining, reinforced in certain sections by eight reinforced concrete anchors 70 mm in diameter and 6 m long, which were installed four on each side. This lining design (Figure 1 I) had no less bearing capacity than a circular one, and at the same time made it possible, in certain sections of the tunnel where the rock pressure was higher, to maintain the method adopted for organizing the construction and design of the lining. This method is especially promising for rebuilding and reinforcing old tunnels.

In the process of building the Megradzor tunnel, in the middle portion of it, 700 m from link-up, signs of spalling and the fall of some chunks of rock began to show up on both forward faces within the excavation.

Stresses inside a rock mass are mainly produced by gravitational and tectonic forces, but we must keep in mind that the latter may exceed the effects of gravitational forces by two to five orders of magnitude. To obtain the actual stresses in a rock mass, we must consider both gravitational and tectonic forces.

To determine the fall-proneness of a rock mass in excavations one must investigate first the friability of the mass, and second the stresses in it.

Hard rock is considered fall-prone in which the compressive stress reaches 80 percent of the rock's compressive strength, and elastic deformation is 70-80 percent of total destructive deformation. Quartzites, granites, granitoids and quartz sands are considered the most fall-prone rock.

To ensure work safety in both sections of the forward faces, fall-safety procedures were adopted, and excavating was done by fracturing the section of the rock wall located in front of the face. To achieve fracturing, relief holes were drilled in the middle of the face in the horizontal plane, 100-200 mm in diameter, 4.5-6 m deep, and spaced an average of 75 cm apart. Between these holes and in the same plane blast holes 43-45 mm in diameter and 4.5-6 m deep were drilled. The hole was charged to a depth of 2.5-4 m, the remainder was packed with close-grained stemming, and the round was fired. The advance of the face per cycle was less than 2 m, and the minimum depth of the safety

zone was no less than 2 m. Thanks to the method adopted, no rockfalls occurred.

Certain problems arose during tunnelling in connection with higher temperatures at the faces at considerable depths, which we were able to eliminate by increasing the amount of ventilation.

Prior to link-up another interesting experiment took place in the Megradzor tunnel. On the north side the tunnelling proceeded by excavating calottes, and then the core and side drifts. On the south side the tunnelling proceeded by the lower-bench method, followed by the excavation of the heading. It was shown that under these conditions the rate of tunnelling by the lower bench (15 m per day) was more than double that of the calotte method.

The experience of scientifically planning, designing and building the tunnels of the Idzhevan-Razdan line can be extensively utilized at other construction projects in our country.

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## RAIL SYSTEMS

### VELIKIYE LUKI LOCOMOTIVE REPAIR PLANT MODERNIZATION

Moscow GUDOK in Russian 11 Sep 85 pp 1-2

[Interview with P. G. Ropay, deputy chief engineer of Velikiye Luki Locomotive Repair Plant, by GUDOK special correspondent V. Chibisov, in Velikiye Luki: "And a Robot Will Take its Place at the Machine"]

[Text] On many of the country's mainlines, the work of the Velikiye Luki Locomotive Repair Plant imeni 50-letiya SSSR is known. Each year here sees a growth in the productive capacity and output of repaired diesel engines with hydraulic transmissions and diesel trains, and the manufacture of specialized automatic-discharge hopper cars.

The plant's collective has repeatedly won the socialist competition in the sector. For work results in the second quarter of the present year it was awarded the challenge Red Banner of the Ministry of Railways and the Central Committee of the Trade Union of Railroad Transport and Transport Construction. One of the main accelerators of production is an improved repair technology and the practical implementation of technical progress.

This is the topic of the talk between our correspondent and deputy chief engineer of the enterprise, P. Ropay.

[Question] "Petr Grigoryevich, the collective of your plant has always reacted quickly to everything new appearing in the sector, in mechanical engineering, in order to incorporate in practise a higher output quality, and on this basis they have achieved growth in labor productivity. In solving today's most important task, the acceleration of intensifying production on the basis of scientific and technical progress, it seems that it would be easier for you, than for anyone else..."

[Answer] "Easier to reorganize ourselves, do you mean? It's true. I think that the workers and leaders of our enterprise are psychologically prepared to review certain work methods that have become habitual. To reorganize ourselves technically, economically and psychologically. There is a basis for this. The

collective has seen with their own eyes the practical advantages incorporated in innovations. I'll cite an example: we reconstructed a diesel engine repair shop. Its area was only slightly enlarged, but the stock of machine tools and nonstandard equipment was renovated and special testing stands were distributed in it. The locomotive repair was organized on a continuing assembly line method... And this was the result: the design capacities were calculated for an output of 300 diesel engines, but today they are almost doubling the output. And it's the same for other production sections.

"The product output increases, and that means the profits grow. And from that we have more deductions for acquiring new equipment and for the social development of the plant. We have good sports and recreation facilities here. During recent years the housing problem has been improved. In this five-year plan we have built more than 20 thousand square meters of living space.

"During the four-and-a-half years, in the enterprise as a whole, with literally no change in personnel, the production volume grew by 7.3 percent. Overplan production has amounted to more than 2 million rubles."

[Question] "The first stage of the plant's reconstruction finished in 1975 and in a year the second stage will be over. Will that be the end of the reorganization or will it continue?"

[Answer] "I would put it a little differently. In the broadest sense, the reconstruction and the fundamental technical re-equipping connected with it should not stop. What seems the height of progress today may be out of date tomorrow, and certainly will be by the day after tomorrow. So dividing it into stages is a conventional process. First-rate production, technically speaking, urges and impels each person constantly to seek out the new, the advanced. Reconstruction, as a rule, cannot manage without demolishing antiquated ideas and habits... And an intensification of production with all the means at our disposal, toward which our party and government are directing us, proposes a reorganization of everything. Here there can be no trivialities. Everything that is directed at increasing productivity is timely and will not tolerate procrastination. We have erected a facility for painting the outsides of diesel trains in an electrostatic field. Goodness knows what kind of an innovation it is, but the mechanized process freed several people. And the quality of the paint job was greatly improved. Right now the painting division is in line for conversion for painting and drying automatic-discharge hopper cars. In the repair shop for series D, D-1 and Dr-1 diesel trains, following the example of the diesel engine repair shop, we are setting up a process for improving the line flow method and many operations here are also being mechanized. In the final analysis this will enable us to increase the output of diesel trains to 1.5 its previous volume.

"The plant's locomotive repair process is complicated. We depend on other enterprises for the delivery of a large nomenclature of parts. This means that when one of the parties violates the terms of a contract there can be interruptions and an unevenness in our production schedule. We are faced with the task of reducing this dependance to a minimum and of adjusting the production of necessary spare parts directly in our own plant. In this area we



have already had many successes.

"In recent years we have experienced a real 'hunger' for spare parts for D and D-1 diesel trains. We have been successful in solving this problem in regard to many items with the organization of a shop for producing spare parts. Its first phase has already been put into operation. We have set up an output of sleeves and piston rings for cylinders and diesel engines and are making gears and shafts for hydraulic transmissions... Besides supplying the plant's needs for spare parts, we manufacture and deliver to other transportation enterprises more than 40 items. It is profitable for us and, by minimizing purchases abroad, we save currency resources for the state.

"The majority of operations in the shop are automatic. Machine tools with numerical control and semiautomatic machine tools are widely used. Recently the shop's second phase began work, where the production of cylinder bushings for the 121D diesel engine is being set up.

"But it is not always profitable and it is not always necessary to manufacture new parts. A careful approach directs us to travel the path of utmost economy, to assimilate extensively technology that preserves our resources and, in particular, the repeated utilization of used parts. We have organized in our plant a multi-purpose section for restoring rolling-stock parts with the aid of mechanisms for gas-flame and plasma jet spraying, and electric arc metal plating. The process is being fully used of restoring pins for ventilator drives, axle box liners and sleeves for axle reduction gears on wheelsets, i.e. those parts whose rubbing surfaces quickly wear out. The advantage here is obvious. The restoration of a ventilator pin alone yields an economic effect of around 6 thousand rubles a year. And in the restoration we apply advanced technology. Thus, if the chrome-plating method for these purposes took up to 48 hours, now it takes literally only a few minutes.

"Plans are for the shop to give a 'second birth' to wheelpair axles for locomotives, cylinder sleeves, crankshafts and connecting rods for diesel engines..."

[Question] "At many enterprises today you can hear complaints about a lack of personnel. A 'help wanted' announcement is posted at the entrance to your plant as well. How is this problem being solved in connection with the technical re-equipping of production?"

[Answer] "As in other related enterprises, we are experiencing personnel problems. And the solution of them is directly connected with introducing scientific and technical developments into practise. All the mechanization and automation of production not only lightens the work for people but supposedly frees a working force. If formerly we kept several metal cutters for the preparation of automatic-discharge hopper cars, now with the use of plasma cutting not only has productivity doubled, but we have been able to free these people and transfer them to other sections where we are experiencing a temporary lack of personnel. I already spoke about the spare parts shop. Now an automatic 'warehouse' line is being installed there. Parts will travel on a conveyer from warehouse to warehouse, into and out of the shop.

"But now let's take another example: to turn out a part for a diesel train of second or third class precision we need at least a fourth-class lathe turner. A personal earns this qualification in approximately 4-5 years. But for work at a lathe with numerical control, the training for the operator takes a total of two months, and he fulfils operations of the same complexity as the qualified lathe turner.

"The robotization of production processes is opening up great possibilities. A massive introduction of this is scheduled for our plant in the next five-year plan. Already by next year a robotized complex for working hydraulic transmission gear-box shafts for diesel trains will begin to operate, and in the forge shop there will be an automatic complex for drop forging hardware. By the way, the warehouse line, and in part the work of the spare parts shop, will be controlled by computer. With its help we will keep track of the movement of parts through the warehouse, the availability of stocks and instruments, and the distribution in the warehouse of finished parts, and we will even be able to record the arrival of operators at the machine. The computer will give them a work schedule for every shift and likewise make up monthly quotas for the output of spare parts. At present the Kiev affiliated branch of the Planning, Design and Technical Bureau of Locomotive Construction is already working out a computer program."

[Question] "Petr Grigoryevich, in the plant administration office I was shown a telegram addressed to the Ministry of Railways..."

"About the new car? Yes, a self-discharging gondola car for transporting bulk freight, we think, has a significant advantage over the existing ones. It has been designed on the model of the well known automatic-discharge hopper cars. Its upper part is all-metal with a special construction to keep the load from blowing out along the way. The loose materials are unloaded through side hatches. And the interior construction of it is such that the load runs out with practically nothing left in the car. And the most important thing is that one person can control the unloading with the help of pneumatic control directly from the car or even from the operator's booth.

"The plant's collective is prepared to start production of such gondola cars. This year we have already come out with the proposal to manufacture an experimental batch of them. But until now the Ministry of Railways has not granted the confirmed technical requisitions for their construction.

"The plant's collective is striving in all ways to utilize technical progress, the true path of accomplishing the tasks of accelerated intensification of production."

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RAIL SYSTEMS

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LOCOMOTIVE ID SYSTEM HISTORY, NEW SYSTEM DETAILED

Moscow ELEKTRICHESKAYA I TEPLOVOZNAYA TYAGA in Russian No 3, Mar 85; No 4, Apr 85

[Article by V. A. Rakov, engineer: "Traction Rolling Stock Series Symbols; 1. How the Existing System Was Established"]

[No 3, Mar 85 pp 20-23]

[Text] By Order No. 22Ts (15 May 1984) of the Minister of Railways "On the Introduction of a New Numbering System for Ministry of Railways Rolling Stock," the existing symbols for locomotives and multiple-unit trains have been changed to a numerical system. The new system ensures that the various information on rolling stock can be more simply used in computer processing.

We present two articles on rolling-stock symbols for our readers. The article below gives a historical review of the present numbering system for locomotives and multiple-unit rolling stock from the building of the first steam engines to the present. The second article discusses the new rolling-stock numbering system, the advantages and disadvantages of the numerical system relative to the existing system; it also discusses the implementation of the new system and its links with the previous system.

In accordance with the Technical Operating Rules for USSR Railroads, each locomotive and multiple-unit train is given a series and number. The series describes a group of similar traction units; in recent years it has also been used to designate groups with minor design differences which, as a rule, do not affect the basic traction parameters.

In the 150 years of domestic locomotive construction, the locomotive symbol system has changed many times and has developed into a system which is more or less different from foreign systems.

The first steam engine of M. Ye. and Ye. A. Cherepanov had no designation of any kind. The practice of naming steam engines, as well as steamships, began with the former Tsarskoye Selo Railroad, using such names as

Provornyy, Strela, Bogatyr', Orel, Lev etc. Then, the steam engines built in the early 1860's for the Dinaburg-Vitebsk and Riga-Dinaburg Railroads were given the names of cities (Riga, Moscow, Paris, Vienna), rivers (Volga), famous people (Suvorov, Del'vig) and even the names of planets (Mercury).

Other pre-revolutionary Russian railroads used a letter system to designate the series. There was no standard system; each railroad used whatever letters it desired. As a result, identical steam engines on different railroads sometimes had different series symbols. When steam engines crossed from one railroad into another, a depot might contain identical locomotives with different letter symbols.

The size and location of the letters were also not standard. On many railroads (Kursk-Kharkov-Azov, Azov-Sevastopol, Transcaucasus, St. Petersburg-Warsaw, Southwest, Vladikavkaz etc.), the steam-engine series and number were displayed on small plaques fastened to the lower part of the smokestack and to the middle of the tenders.

On the St. Petersburg-Moscow Railroad, the steam-engine series and number were displayed on the side walls of the engineer's cab below the windows; sometimes, the letters were above the number. Minor design changes were noted by the addition of a small letter placed near the top of the main letter (for example, the K<sup>8</sup> series of steam engines of the Southwest Railroads) or near the bottom (the G<sub>a</sub> series of the St. Petersburg-Moscow Railroad).

In order to regularize the steam-engine symbols, a standard "Nomenclature for Steam-Engine Series" for all Russian railroads was developed in 1912, based on a proposal by Professor Yu. V. Lomonosov. A system using only letters was used to designate the series. Thirty Russian letters were used, including Ө (fita), V (izhitsa), I, "hard sign" and "soft sign." Somewhat later (in 1912 and 1913), the letters Y (yery) and Ye were also used. Only letters M and Yu were not used.

The letters chosen for some locomotive series had a certain significance. For example, type 2-3-0 passenger steam-engines had the letter B attached, to indicate that the locomotive was designed and built at the Bryansk Plant; V stood for the system of Engineer Volken; D, for two paired axles (old types 1-2-0, 2-2-0, 0-2-1 and 2-2-1); K, for the Kolomna Plant; L, for the preliminary design of Engineer V. I. Lopushinskiy; O, for the main type of commercial steam engine; S, for the design of the Sormovo Plant; T, for the commercial steam engines with three paired axles, types 0-3-0, 1-3-0 and 0-3-1; U, for the Ryazan-Urals Railroad type; F, for the 1-5-0 Flamm type and the Fairlie system and Ya, for the Moscow-Yaroslavl-Arkhangel Railroad type.

The letter "soft sign" designated tenderless steam engines (tank steam engines) for freight and switching work, while the "hard sign" designated passenger-service tank steam engines. Individual design changes to locomotives were shown by a small letter (upper- or lower-case letter), near the top of the main letter and usually called the superscript. The

manufacturer (plant) was designated by a small letter near the bottom of the main letter if the steam engine had no design changes from the others in its series manufactured at other plants. Lower letters were rarely used.

The most common superscripts were: P for steam engines with superheated steam; D and V for the Joy and Val'skhart link gears, respectively; K and L for the Kolomna and Lugansk plants, respectively; M for modernized; R for rebuilt; U for strengthened; Sh and G for steam engines built in Sweden and Germany, respectively, and Ch for locomotives featuring the proposal of Professor Chechotta of using superheated steam with a compound machine. Thus steam engine symbols in 1912 were  $A^v$ ,  $A^d$ , B, V, G,  $G^P$ ,  $Ye^s$ , Zh, Z, I, K,  $K^u$ , L,  $N^d$ ,  $N^v$ ,  $N^o$ ,  $N^k$ ,  $N^{ch}$ ,  $O^d$ ,  $O^v$ ,  $O^k$ , P, R, S, U, F, Kh, Ts, Ch, Sh, Shch,  $Shch^{ch}$ ,  $Shch^P$ , Y (yery),  $Y^P$  (yery), E,  $E^s$ ,  $E^{shch}$ , Ya, Ө (fita) and V (izhitsa).

The system of symbols can be represented by the following formula:

$S_z^i$  No, where S is the main series number, i is the superscript, z is the manufacturer and No is the locomotive number. The part " $S^i$ " is called the series (i.e., the group part), while the part "z No" is the individual part; it designates only a single locomotive. Thus, the series symbol and the locomotive numbering system are completely different, independent systems.

The 1912 system of symbols also provided for the use of two main letters, which, along with the superscript, made possible over 30,000 letter combinations. This was more than sufficient to reflect even minor design changes in locomotive series. The system also regulated the location and size of the letters and numbers on the trains. They were to be displayed on the side of the engineer's cab below the window, on the buffer beams and on the back walls of the tender.

When the 1912 system was adopted, almost all series had symbols that prevented the occurrence of identical numbers. This was not the case with one widely used series of passenger steam engines, series S. These retained the numbers used by the individual railroads. Thus, when steam engines of this series were subsequently transferred from one railroad to another, some depots had two or even three steam engines with the same number.

To distinguish steam engines in these cases, the numbers 1, 2 or 3 or letters standing for the name of the railroad to which it had previously been assigned were added on after the number in the form of a fraction. Thus, the Moscow-Passenger Depot of the former Moscow-Kursk Railroad had three S6 steam engines whose full symbols were  $S6^k$ ,  $S6^P$  and  $S6^{yu}$ , where the letters K, P and Yu stood for Kursk, Perm and Southern.

The 1912 locomotive symbol system was used in its pure form for locomotives built after the October Socialist Revolution. For instance, the letters E,

L and Shch were used for the first Soviet steam engines built in the early 1920's (steam engines of these series were also built before the revolution). The old system of locomotive symbols was also used in a somewhat distorted form. For instance, the group of steam engines which were designed under the leadership of L. S. Lebedyanskiy and which were built after World War II were designated L, but with a hyphen and zeros in place of the numbers for future locomotives (for instance, L-0005).

Alternating-current (a.c.) electric freight locomotives ordered in France also received the series designation  $F^i F^r$  (r for regenerative braking), while the passenger locomotives were series  $F^p$  (p for passenger). Series F electric locomotives with numbers 1 through 9 had a zero before the number (for example, F05). The a.c.-electric freight locomotives with silicon-controlled rectifiers purchased in FRG were designated K (for silicon), but a dash followed the series letter and, for numbers 1 through 9, a zero was placed before the number.

Experimental diesel locomotives built in 1924 and thereafter were designated  $Shch^{el}$ ,  $E^{el}$ ,  $E^{mkh}$ ,  $O^{el}$  and "soft sign" $^{mkh}$ . The main letters indicated that these locomotives were the equivalents of Shch, E, O and "soft sign" series steam engines, while the superscripts el and mkh showed that the locomotives were diesel-electric or diesel-mechanical. The symbols for experimental diesel locomotives were  $Shch^{el}$ ,  $E^{el}$ ,  $E^{mkh}$  and  $O^{el}$ , and the later the general symbol for series produced diesel locomotives was  $E^{el}$ .

The six-axle diesel electric locomotives built at the American plants Alco and Baldwin at the end of World War II were designated  $D^a$  and  $D^b$ , respectively. In this case, D stood for diesel locomotive, while the superscripts stood for the initials of the plant names (the  $D^a$  and  $D^b$  diesel locomotives were quite different in design and, strictly speaking, shouldn't have been given the same main letter D).

A system of letter-only symbols was used for motor- and trailer cars on the electrified, suburban Moscow-Zagorsk section. Originally, motorcars were designated EM, for electric motorcar, while trailers were designated E for electric car. In 1936, electric trailer cars were designated series  $S_v$  and  $S_d$ , which indicated that they were the Northern Railroads type with electrical equipment from the Vickers or Dinamo Plants. The superscripts were mistakenly shown as subscripts; i.e., the considerable difference in designs was not taken into account.

The three-car units built after World War II with an  $S_d$  type mechanism were designated with the superscript "r," for the Riga Railcar Building Plant; i.e., series  $S^r$ . However, some changes were later made and the electrical equipment was converted to operate only at 3000 V; the series was then

designated  $S_3^r$ , where the number subscript (the number 3) stood for "only 3000 V." The structure of the symbol system was thus disrupted.

The letters-only system for series designation was also used for the first diesel motorcars Av-El and Av-Mkh, where Av stands for diesel motorcar and El or Mkh stand for the type of drive, the same as for locomotives. It should be noted that experimental diesel locomotives Shch<sup>el</sup>, E<sup>el</sup> and E<sup>mkh</sup> were earlier designated as Shch-El, E-El and E-Mkh.

In 1925, engineers R. P. Grinenko and V. F. Yegorchenko, of the Scientific-Technical Committee of NKPS [People's Commissariat of Railways] proposed a new letter-number system of symbols for locomotive series and numbers. Engineer P. O. Krasovskiy, chief of the traction department of the Central Railroad Administration, NKPS, did not approve the letter-number system, but did not alter it. The Scientific-Technical Committee's idea actually was to completely eliminate the letter designations for series and adopt a completely numerical system, similar to that of several foreign railroads.

Each existing series of steam engines was given a number, the idea being that each series would not contain more than 99 locomotives, numbers 01-99. For the transition period, it was proposed that the letters would remain on alongside the numbers. Thus, the series  $S^u$  and  $E^u$  steam engines being built at that time and the later  $E^m$ ,  $E^r$  and M steam engine had long symbols. The full series and numbers according to the 1925 system would look like this:  $S^u96-01$ ,  $E^u682-01$  and M160-01.

Since most series contained more than 99 identical locomotives, new numerical series symbols had to be introduced in order to avoid violating the two-digit system. This resulted in series designations  $S^u9$ ,  $S^u101$ , and then  $S^u200$ ,  $S^u201$  etc. The same thing occurred with series  $E^u$ ,  $E^m$  and  $E^r$  steam engines. This situation forced them to retain the letter symbols, especially since, for example, some steam engines in the  $S^u97$  series were identical to engines in the  $S^u98$  series, and only the letters  $S^u$  tied these locomotives together.

The use of the 1925 system of symbols was limited to steam engines of the series  $S^u$ ,  $E^u$ ,  $E^m$ ,  $E^r$  and M and electric locomotives for the Suram Pass: S,  $S_s$ ,  $S^i$  ( $S10-01$  etc.,  $S^s 11-01$  etc. and  $S^i10-09$  etc.); the superscripts "s" and "i" in this case stood for "Soviet manufacture" and "Italian manufacture," while the main letter S stood for "Suram type."

In 1931, yet another system of symbols for new locomotives was introduced: the first two letters in the series stood for the initials of the first and last name of important politicians and organizations, while the two numbers stood for the driving-axle load, followed by a dash and the locomotive

number. This system was used for VL19 (Vladimir Lenin) electric locomotives (VL19-01 etc.), FD20 (Feliks Dzerzhinskiy) steam engines (FD-20-1 etc.), IS20 (Iosif Stalin) steam engines (IS20-1 etc.) and S017 (Sergo Ordzhonikidze) steam engines (S017-1 etc.), as well as PB21-01 (imeni Politburo VKP(b)) experimental electric locomotives, the 2-7-2 type AA20-1 (Andrey Andreyev) steam engine and the VM20 (Vyacheslav Molotov) diesel locomotive.

In order to indicate design changes, beginning in 1941, the FD and IS steam engines were given the series designations FD21 and IS21, while S0 series steam engines had three basic types: S017, S018 (with fan-equipped traction) and S019 (with tender-condensers). The 1931 system had three other series of direct-current (d.c.) electric locomotives: VL22, VL22<sup>m</sup> and VL23; the last two series designations were given to electric locomotives built after World War II.

The 1931 system was used, in a somewhat altered form, to designate the experimental lot of SK (Sergey Kirov) d.c. electric locomotives (SK-01 to SK-04), without indicating the driving-axle load. It was also used for the country's first experimental a.c. electric locomotive, the OR22-01, where the letters OR stood for single-phase, mercury-rectifier type.

After World War II, locomotive building quickly recovered in our country. In those difficult years, it was most important to design new locomotives and get production going, while the matter of assigning symbols was secondary. There were other reasons why a unified system of locomotive and motorcar symbols was not used: this equipment was ordered by various structural subdivisions of NKPS (and later MPS [Ministry of Railways]): the Central Steam-Engine Administration, the Central Diesel-Locomotive Division, the Central Electrification Administration and the Moscow Subway Administration.

Steam engines were designated by not only the altered 1912 system (series L steam engine), but by the following series: LV18, OR21 and OR23. The letters LV signified that the steam engine was based on the L steam engines (designed by Lebedyanskiy) at the Voroshilovgrad Plant, while OR signified that the steam engine was built by the Voroshilovgrad Plant imeni Oktyabr'skaya Revolyutsiya. A hyphen followed the series symbol, followed by the steam-engine number.

The last type 2-4-2 passenger steam engines were not given a series symbol at all, but were given a factory-type sequential symbol P36 (type 36 steam engine, Kolomna Plant). The P34 experimental freight steam engine also had such a factory symbol. The 1-5-2 experimental steam engine of the Ulan Ude Plant was designated simply 23-001. Series S<sup>u</sup> steam engines built after the war by the Sormovo Plant were designated S<sup>u</sup>250-01 and up, while the industrial tank steam engines were designated, for example, 9P, for ninth type of industrial steam engine.



Eight-axle, d.c. electric road locomotives (the above-mentioned VL22<sup>m</sup> and VL23) were designated as series N8 and T8, which stood for "Novocherkassk eight-axle" and "Tbilisi eight-axle." Alternating-current electric locomotives were designated NO (Novocherkassk single-phase), N60 (Novocherkassk six-axle single-phase) and N80 (Novocherkassk eight-axle single-phase).

Since 1963, all Soviet-built electric locomotives have been designated VL. Therefore, the full designation of series N8, T8, NO, N60 and N80 became VL8, VL10, VL61, VL60 and VL80. Later electric locomotives were designated VL110<sup>u</sup>, VL11, VL12, VL15, VL26, VL40, VL41, VL62, VL81, VL82, VL83, VL84 and VL85. The series numbers up to 39 indicate are d.c. locomotives, while 40 and up are a.c. locomotives. For a.c. locomotives, the first numbers 4, 6 and 8 indicate the number of driving axles. The superscript "u" by the number 10 indicates that it has an increased adhesion weight. When the numbers 61, 62, 81, 82 etc. appeared, the letter "O" in the VL60 and VL80 electric locomotives became "zero."

In order to distinguish between individual design distinctions within the VL80 electric-locomotive series, the superscripts "k" (VL80<sup>k</sup>), "t" (VL80<sup>t</sup>), "r" (VL80<sup>r</sup>), "s," "a" and "v" are used to indicate, respectively: equipped with silicon-controlled rectifiers, with electric rheostatic braking, with regenerative braking, designed to operate in multiple units, equipped with asynchronous electric traction motors and equipped with rectifier traction electric motors. Strictly speaking, such major design changes as the use of asynchronous and rectifier (synchronous) electric traction motors should not have been designated by the superscripts "a" and "v," but by different series numbers.

For the VL60 series of electric locomotives, the superscripts "k" and "r" (VL60<sup>k</sup> and VL60<sup>r</sup>) have the same meanings as for the VL80 series, while the superscript "p" (VL60<sup>p</sup>) indicates that the locomotive is for passenger trains. Electric locomotives VL82, designed to operate on a.c. and d.c. became designated VL82<sup>m</sup> (for "modernized") to reflect changes in the electric equipment.

All passenger electric locomotives built since 1958 by the Czechoslovakian Shkoda Plant for USSR railroads also have a letter-number series symbol, where the first two letters ChS indicate that the locomotives were built in Czechoslovakia and the following numbers indicate the locomotive design. Four-axle, d.c. electric locomotives are designated ChS1 and ChS3, while six-axle d.c. electric locomotives are series ChS2 and a.c. locomotives are ChS4.

Two-unit, 8-axle d.c. electric locomotives are designated series ChS200, ChS6 and ChS7, while a.c. models are ChS8. The superscripts "t" for electric locomotives ChS2<sup>t</sup> and ChS4<sup>t</sup> indicate that the locomotives have rheostatic braking (electric locomotives without this type of braking are

designated simply ChS2 and ChS4). The number 200 for the ChS200 electric locomotive shows that it is designed for a maximum speed of 200 km/hour.

For diesel locomotives built after World War II, the letter-number series symbols are much different from those for electric and steam locomotives. For Soviet-built diesel locomotives, the letter part of the series symbol consists of two or three letters. The first letter T designates that the locomotive is a diesel. The second letter (either E or G) indicates either a diesel-electric or diesel-hydraulic drive. Finally, the third letter P or M indicates either passenger or switching service.

Thus, the letter part of the series symbol for Soviet-built diesel locomotives is: TE and TG (diesel freight locomotives), TEP and TGP (diesel passenger locomotives) and TEM and TGM (diesel switching locomotives). For diesel freight and passenger locomotives, the number part of the series symbol indicated the plant which designed the diesel locomotive, as well as the identification number. Numbers from 1 to 49 indicate that the design was made at the Kharkov Transport Machine Building Plant, numbers 50 to 99 indicate the Kolomna Diesel Locomotive Plant and 100 and above indicate the Voroshilovgrad (Lugansk) Diesel Locomotive Plant. Thus, the Kharkov Plant has series TE1, TE2, TE3, TE4, TE5, TE7, TE10, TE30 and TE40; the Kolomna Plant has TE50, TEP60, TEP70 and TEP75; and the Voroshilovgrad Plant has TG100, TG102, TG105, TG106, TE109, TE114, TE116, TE130 and others.

Individual design changes in diesel locomotives were shown by adding additional letters after the numbers. Thus, the TE10 diesel locomotives have the following versions: TE10L (Lugansk Plant version), TE10V (with changes made by the Voroshilovgrad Plant) and TE10M (modernized).

Originally, the series symbol did not indicate how many units the diesel locomotive had. Thus, TE2, TE3 and TE7 diesel locomotives were not identified as having two units. Later, diesel locomotives began being designated 2TE10, 2TE10L, 2TE10M, 3TE10M, 4TE10S, 2TE116, 2TE10V etc. The numbers 2, 3 and 4 before the letters indicate the number of units. The individual units of diesel locomotives are given identical numbers, and are distinguished by, for instance, the letters A and B (the same is true for two-unit electric locomotives).

Exceptions to the above system of designating diesel road locomotives are the M62 and 2M62 locomotives.

Diesel electric switching locomotives are designated by the series letters TEM, followed by numbers designating the specific type of locomotive. The numbers begin with 1; i.e., they use the numbers set aside for diesel road locomotives designed by the Kharkov Plant. Diesel switching locomotives are designated: TEM1, TEM2, TEM5, TEM6 and TEM7.

Diesel switching locomotives obtained abroad have series designations VME1, VME2, ChME2 and ChME3, where the letter V designates Hungarian locomotives and Ch, Czechoslovakian. The location of the letters ME on these diesel

locomotives is different than for Soviet-built locomotives (no reason could be found for this change).

Electric multiple-unit trains built since 1957 for electrified sections are designated by the letters ER (electric multiple-unit train built by the Riga Car-Building Plant) and by a number indicating the design features of the train cars. Suburban d.c. electric multiple-unit trains were designated as series ER1, ER2, ER5, ER10, ER12, ER2<sup>P</sup> and ER22, while suburban a.c. electric multiple-unit trains were designated ER7, ER9, ER9P, ER9<sup>m</sup> and ER9<sup>ye</sup>.

The ER200 is a high-speed electric multiple-unit train, designed for a speed of 200 km/hour.

The number part of the series symbol for electric multiple-unit trains is displayed in various ways: sometimes the numbers are the same size as the letters, while in other cases they are smaller and placed near the bottom of the letters, such as ER<sub>2</sub>, ER<sub>9p</sub> etc.

Subway motorcars have only numbers on their body side walls, while the series (Ye, Yezh, Yem etc.) is at best indicated on small plates mounted inside the cars. The word "series" was rarely used for subway motorcars; the word "type" was used instead. In recent times, the words "model" and even "brand" are often used.

The diesel multiple-unit trains built by the Riga Car-Building Plant are designated series DR1 (diesel train of the Riga Plant, first type). . . Different versions are indicated by additional letters after the 1, such as "P" and "A." Diesel multiple-unit trains built by Hungarian plants are designated series D and D<sub>1</sub>.

Industrial electric locomotives have the same variety of series symbols. For instance, a.c. electric locomotives built by the Dnepropetrovsk

Electric Locomotive Plant are designated D100, D100<sup>m</sup> and D94, where the numbers after the letter indicate the locomotive's adhesion weight in tons. Four-axle d.c. electric locomotives are designated as IV KP-1: IV is the quantity, K stands for contact, P for industrial and 1 for the first version.

Industrial electric locomotives built by Czechoslovakian plants are designated, for example, 21Ye and 26Ye, while those built by East German plants are designated YeL1 and YeL2. Special two-axle, Soviet-built electric locomotives for cokemaking shops have series symbols EK1, EK2, EK13, EK14 etc.

The so-called traction sets, consisting of a locomotive and motor-equipped cars (dump cars), have been designated series OPE12, OPE2, PE1 and etc. Here, the letter E stands for electric locomotive, P for industrial, and O for single-phase current, while the number stands for the particular type of rolling-stock unit.

[Article by G. P. Alad'in, chief technical expert of the Main Locomotive Administration, Ministry of Railways, and N. N. Kamenev, sector manager, All-Union Scientific-Research Institute of Rail Transport: "Traction Rolling Stock Series Symbols; 2. New Numbering System"]

[No 4, Apr 85, pp 2-4]

[Text] The Ministry of Railways has developed a unified system of numerical symbols for traction rolling stock (TRS). This system takes into account the computer equipment used by the railroads and has sufficient capacity to handle future locomotive development.

The structure of the unified numerical system is such that the class of rolling stock can be determined by the first digit (0 designates passenger car; 1, traction and special rolling stock and 2-9, freight cars). A total of seven digits are used to designate the rolling-stock unit, while the eighth digit (the check digit) is used to check that the calculation is correct and that the rolling-stock number is correctly recorded in the primary documents.

The seven-digit part of the new number codifies the basic operating-technical characteristics of the TRS (form and type of traction rolling stock, type of service, series etc.) The system takes into account that multi-unit locomotives and motorcar rolling stock can be subsequently rearranged; therefore each unit or car has its own number.

The structural principle of the new traction rolling stock numerical system is shown in Table 1 (excerpts). A first digit of 1 (unity), as was mentioned above, indicates that the coded equipment is either traction or special rolling stock.

The second digit of the new number indicates the type of rolling stock: 0, steam engines; 1, single-unit electric locomotives; 2, multiple-unit electric locomotives; 3, electric multiple-unit trains; 4, cars of electric units (series  $S_3^m$ ,  $S^r$  and  $S_3^r$ ) and subway cars; 5, single-unit diesel locomotives; 6, multiple-unit diesel locomotives; 7, diesel motorcar rolling stock (diesel multiple-unit trains, diesel motorcars); 8, shunting locomotives and motor trolleys; and 9, track machines and mechanisms.

The third digit indicates the rolling stock's type of service (passenger, freight, switching or special). In addition, for diesel locomotives, it indicates the type of traction transmission (electric or hydraulic), while for electric rolling stock, it indicates the type of current (d.c., a.c. or dual supply).

Table 1. Structural Principle of the Numerical System

<u>1st digit</u>	<u>2nd digit</u>	<u>3rd digit</u>	<u>4th digit</u>
<u>Class of Rolling Stock</u>	<u>Type of Rolling Stock</u>	<u>Application and technical description of rolling stock</u>	
1 (traction rolling stock)	1 (single-unit electric locomotives)	0 (d.c. passenger type)	0 (ChS2) 1, 2 (ChS2T) .....
		1 (d.c. freight)	0, 1 (VL22M) 2 (VL23M) .....
		.....	.....
		.....	.....
	2 (multiple-unit electric locomotives)	0 (d.c. passenger)	0 (ChS200) 1 (ChS6) .....
		.....	.....
		2 (d.c. freight)	0-3 (VL10) 4-7 (VL8) .....
	3 (electric multiple-unit train)	3 (d.c.)	4 (ER22V motor car) 5 (trailer car) 6, 8 (ER1 motor car) 7 (trailer car) 9 (driving car) .....
		.....	.....
		.....	.....
	(6) multi-unit diesel locomotives	0 (passenger)	0 (TE7)
		1 (freight)	0-9 (TE3)
		2 (freight)	0, 1 (TE3) 2-4 (2TE10V) 5 (3TE10V, "A" unit) 6 (3TE10V, "B" unit) .....
		.....	.....
	.....	.....	.....
		9 (freight)	0, 1 (4TE10S, "A" unit) 2, 4 (4TE10S, "B" unit)

Note: The fifth, sixth, seventh and eighth digits can range from 0 to 9 and do not contain technical information.

Locomotives are given the following numbers:

steam engines: passenger, 0; freight, 1 to 4, and switching, 6;

single-unit electric locomotives: d.c. passenger, 0; a.c. passenger, 9;  
d.c. freight, 1; a.c. freight, 3, and switching, 6 and 7;

multiple-unit electric locomotives: d.c. passenger, 0; a.c. passenger, 9;  
d.c. freight, 1 through 3, and a.c. freight, 4 to 8;

single-unit diesel locomotives: passenger, 0; freight, 1; diesel-electric  
switching, 2 through 6; diesel-hydraulic, 7 to 9;

multiple-unit diesel locomotives: passenger, 0; freight, 1 through 9;

electric multiple-unit trains: d.c., 0 to 5; a.c., 6 through 8; express, 9.

The fourth digit (either separately or in a number of cases where there are a large number of items, in combination with the third digit) indicates the series. The fifth, sixth and seventh digits, as well as the eighth (check digit) do not contain any information, except for two-unit locomotives, where an odd seventh digit indicates the A unit and an even digit indicates the B unit.

Intermediate units of multiple-unit diesel locomotives have the same serial numbers as the driving units (for a three-unit diesel locomotive, an odd number for the driving, A, unit) except for the fourth digit, which gives information about the unit's distinguishing design features. This feature of the coding system for multiple-unit locomotives can be used, in particular, to keep track of these units when they come in for service or planned maintenance, as well as to resolve other operating tasks.

The inventory number of traction or special rolling stock is formed by the combination of the fifth, sixth and seventh digits of the number. It should be noted that because of the limited length of the code in many cases, when the number of coded items with identical technical characteristics exceeds 1000, the series of traction rolling stock must also be designated by the fourth digit. Therefore, a number of series have been assigned 2 or more different numerals for the fourth digit, except for future series (VL80S, VL85 etc.), for which 10,000 new numbers have been specially set aside. This will permit them to be uniquely identified by the first three-digit part of the code (Table 2).

Table 2. Numerical Codes of the Main Series of Traction and Special Rolling Stock (2nd, 3rd and 4th Digits of the Code)

Electric Passenger Locomotives

ChS2: 100	ChS200: 200
ChS2T: 101-102	ChS6: 201
ChS4T: 190-191	ChS7: 202-204
ChS4: 192	ChS8: 290-291
VL60PK: 193-194	

**Electric Freight Locomotives**

VL22M: 110-111  
VL23: 112  
VL60K: 132-134  
VL110U: 210-214  
VL11: 215-219  
VL10: 220-223  
VL8: 224-227  
VL15: 230-231

VL80S: 250-259  
VL80R: 260-264  
VL80A, V, K, T: 265-269  
VL85: 240-249  
VL86: 270-279  
VL84: 280-281

**Diesel Passenger Locomotives**

TEP10L: 501  
TEP60: 502-503

TEP70: 504-505  
2TEP60: 601-602

**Diesel Freight Locomotives**

TE3: 610-619, 620-621  
2TE10L: 631-638  
2TE121: 640-647  
2TE116: 684-687  
TE10M: 660-667 (A unit)  
650-657 (B unit)  
3TE3U: 672-674 (A unit)  
675-677 (B unit)  
2M62: 680-683  
4TE10S: 690-691 (A unit)  
692-693 (B unit)

**Diesel Switching Locomotives**

TEM1: 521-522  
TEM7: 526  
TEM2: 530-538  
TEM2U: 543  
ChME3: 551-556

TGM1: 570  
TGM3: 580  
TGM23: 590

**Electric Multiple-Unit Trains**

ER1: 336, 338 (motor cars)  
337 (trailer cars)  
339 (driving cars)  
ER2: 310-319, 320-325 (even numbers, motor cars; ending in 1 and 9,  
driving cars, and other odd numbers, trailer cars)  
ER2R: 302, 304 (motor cars)  
305 (trailer cars)  
309 (driving cars)  
ER9P: 366, 368 (motor cars)  
365, 367 (trailer cars)  
369 (driving cars)  
ER9M: 370, 372 (motor cars)  
373 (trailer cars)  
371 (driving cars)

ER9Ye: 374, 376, 378 (motor cars)  
375, 377 (trailer cars)  
379 (driving cars)

Diesel Multiple-Unit Trains

D1: 702, 704 (trailer car)  
703, 705 (motor car)  
DR1: 710, 712 (trailer car)  
711 (motor car)  
DR1A: 714, 716 (trailer car)  
713 (motor car)

Subway Cars

Ye: 431-432  
Yem: 433  
Yema: 434

Yemkh: 435  
Yezh: 436

Motorized Rolling Stock

AGVM: 742-743  
ACh2: 751 (motor car)  
752 (trailer car)  
MG2: 800  
MK2-15: 801  
DGKU: 824-827  
AS1A: 830-831

Thus, after the renumeration of single-unit locomotives, the serial number, reflected in the 5th, 6th and 7th digits of the new code number, remains unchanged, while the fourth digit will be different for each new 1000 coded units of a given series of traction rolling stock. For instance, electric locomotive ChS2T-270 will receive the new designation 1101270 (here and below, the new designations are shown without the eighth, check, digit), while electric locomotive ChS2T-1270 will be 1102270 (see Table 1).

When renumbering two-unit locomotives, one must take into account that each unit has its own serial number, while the seventh digit of the new code must be odd ( $2N - 1$ ) for an A unit and even ( $2N$ ) for a B unit, where  $N$  is the old TRS unit number. Thus, the new code for the A unit of electric locomotive VL3-0721 (the range of numbers set aside for this series is 1224001-1227999) will be 1225441 ( $n_A = 2N - 1 = 1442 - 1 = 1441$ ), while that of B unit will be 1225442 ( $n_B = 2N = 1442$ ). For diesel locomotive 4TE10S-052, the driving units will be given numbers 1690103 ( $2N - 1$ ) and 1690104 ( $2N$ ), while the trailer units will be 1692103 and 1692104, respectively. Finally, after the conversion, the driving units of diesel locomotive 3TE10V-001 will be numbered 1625001 ( $2N - 1$ ) and 1625002 ( $2N$ ), while the middle unit will be 1626001 ( $2N - 1$ ).

As was noted above, a few series of diesel locomotives are exceptions to this and the new numbers do not correspond to the old ones. The exceptions were made for: series in which only a small quantity were transferred to the Ministry of Railways; outmoded series which are rapidly decreasing in



number and several series which presently have the same numbering system as unmodernized rolling stock and which are only differentiated by the additional superscript in the letter part of the existing (old) symbol.

The renumbering of such traction rolling stock units begins with No 001, without any necessary analytical interrelationship between the new and old numbers, but taking into account the sequence in which the renumbered units were put into operation. For instance, 2TE10V diesel locomotives, manufactured earlier with the same numbering system as 2TE10L diesel locomotives, which had numbers 2956, 2987 and 2988 will have new numbers (beginning with the first and in increasing order) of 1622001, 1622002, 1622003 etc. These numbers have a different third digit from the new numbers for the 2TE10L.

The eight-digit length of the new code does not permit the previous coding principle for motor-car rolling stock to be used. Therefore, as in the case of multiple-unit locomotives, the new system for diesel and electric multiple-unit trains provides that individual numbers will be assigned to each type of car (motor, trailer or driving), while mainly retaining a correspondence between the old and new numbers.

Thus, with new numbers 1336001-1339990 (see Table 1) set aside, and using the system of designating motor cars by an even digit (6 and 8 as the fourth digit of the number); trailer cars by an odd number (7) and driving cars by an odd number (9), the cars of electric multiple-unit train ER 1-0137 we will be designated:

**Driving:**

ER1-137 01: 1339273 ( $2N - 1 = 2 \cdot 137 - 1 = 273$ )  
 09: 1339274 ( $2N = 2 \cdot 137 = 274$ )

**Trailer:**

ER-137 03: 1337409 ( $3N - 2$ )  
 05: 1337410 ( $3N - 1$ )  
 07: 1337411 ( $3N$ )

**Motor:**

ER1-137 02: 1336681 ( $5N - 4$ )  
 04: 1336682 ( $5N - 3$ )  
 06: 1336683 ( $5N - 2$ )  
 08: 1336684 ( $5N - 1$ )  
 10: 1336685 ( $5N$ )

The check digit of the number of any type of rolling stock is calculated by a standard method: each digit of the number occupying an odd-numbered place (counting from left to right) is multiplied by 2, and each digit occupying an even-numbered place is multiplied by 1. Then all the digits of the resulting sequence are added together. The check number will be that number which, when added to this sum, produces the nearest multiple of 10. For instance, for the number 1690103, the calculation will be:

Locomotive number	1	6	9	0	1	0	3
Multiplier	2	1	2	1	2	1	2
Product	2	6	18	0	2	0	6

Total of the digits:  $2 + 6 + 1 + 8 + 0 + 2 + 0 + 6 = 25$

Consequently, the check digit--that number which makes 30--is 5, and the number with its check digit, is 16901035. If the sum of the digits is equal to a multiple of 10, then the check digit will be zero.

The new numbers are to be displayed on the body side walls of traction rolling stock in accordance with the special drawings developed by the Project Design Bureau of the Main Locomotive Administration, Ministry of Railways, for each type of traction rolling stock. The old letter-number symbols will for the time being be retained on the front walls or the buffer rail of locomotives and other units of traction rolling stock, including trailer cars of electric and diesel multiple-unit trains.

The new number will not contain information about the railroad and depot to which the traction rolling stock units are assigned. Considering that this information, however, is necessary for the operation of locomotive depots, the existing letter designations for assigned railroad and depot will be retained for visual determination, while the address value of the stored code number can be used in machine data processing.

This capability of computers can also be used to simplify the task of making out operating technical documentation. Actually, when filling out, for example, the engineer's route or the depot daily log or when making out the train diagram, one need only put the new number of the A (odd-numbered) unit of a multiple-unit locomotive, when the unit code, recorded in parenthesis after the number of the A unit, is used. The new locomotive number can be recorded in the operating documentation even more simply, since in a number of cases, only the last 4-5 digits of the new number need be recorded if there are no other locomotives with these same last digits used within the same section.

Traction rolling stock belonging to other ministries and departments which has been permitted to enter the Ministry of Railways network can display only the series of the traction unit on the side walls of the body (cab), without showing the factory serial number. For instance, if diesel locomotive TGM23-0273, belonging to the Ministry of Railways, has a designation of 15902737, then a diesel locomotive of the same series but belonging to other organizations, will be designated 15900004.

However, practical use of this numbering system for these locomotives does not exclude mistakes in filling out the train commodity sheet (form DU-1), since if these locomotives are being transferred in tandem, several identical numbers, corresponding to the total quantity of locomotives, must be put in this document in this case. Apparently, when traction rolling stock belonging to other ministries and departments goes onto MPS tracks, it is more feasible to use their temporary transit number codes with the eighth check digit. Similar codes are presently being used when transferring locomotives built abroad into the USSR.

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## MARITIME AND RIVER FLEETS

### RIVER FLEET MINISTRY'S TECHNICAL DESIGN BUREAU WORK

Moscow RECHNOY TRANSPORT in Russian No 7, Jul 85 pp 9-13

[Interview with Yuriy Nikolayevich Gorbachev, director of the USSR Ministry of the River Fleet's Central Technical Design Bureau, conducted by RECHNOY TRANSPORT's editors: "On the Path of Technical Progress"; date and place not specified]

[Text] It has been 50 years since the founding of the Ministry of the River Fleet's Central Technical Design Bureau (CTDB) in Leningrad. In connection with the birthday of this organization, whose staff members have done a great deal for the river fleet's development and the acceleration of scientific and technical progress in water transport, the editors asked its director Yuriy Nikolayevich Gorbachev to answer questions related to CTDB's history and future and the life and work of its staff, and to tell what the designers are doing in order to greet the 27th CPSU Congress in a worthy fashion.

Editors: Yuriy Nikolayevich, first of all we would like to know about the basic stages of the bureau's development.

Yu.G.: Our organization's history began 4 August 1935, when an order of the People's Commissariat for Water Transport established the Technical Design Bureau of the People's Commissariat of Water Transport.

The bureau was given the tasks of drawing up and providing the technical and economic feasibility studies for designs of inland-water and maritime vessels and of designing mechanisms for them.

In 1939, when the People's Commissariat of Water Transport was reorganized, the Technical Design Bureau was separated into Morsudoproyekt [Institute for the Design of Maritime Vessels] (now the Ministry of the Maritime Fleet's Central Technical Design Bureau) and the USSR Ministry of the River Fleet's Central Technical Design Bureau.

In the prewar years several designs of steel barges, ladder dredges with a productivity of 120 cubic meters per hour, gas-propelled paddle-wheel and propeller tugboats of 60 and 120 horsepower, and a number of other vessels were built on the basis of documentation supplied by the latter design bureau.

During the years of the Great Patriotic War the CTDB, which had been evacuated to Belyy Yar, engaged primarily in preparing documentation for defense purposes. However, even during this period it drew up several designs for tugboats and dry-cargo and oil barges.

Starting in 1945 the bureau continued its work in Leningrad.

As a result of a sharp increase in the volume of ship designing, branches of the CTDB were established in Moscow, Kiev and Gorkiy, and subsequently (in 1953) they grew into independent design organizations.

Ship designing was carried out on a new technical basis and was oriented toward the growing capabilities of industry. The widespread introduction of diesels in the river fleet was a significant stage. A group of employees of the Ministry of the River Fleet, including the bureau's chief engineer S. D. Vozdvizhenskiy, was awarded the USSR State Prize in 1950 for the development and construction of motor ships with ZD6 engines. Specialists headed by M. M. Dubrov made a great contribution to the development and introduction on river-fleet ships of the remote automated control of mechanisms and of devices for the comprehensive automation of ship power units; this made it possible to reduce the number of shipboard personnel in the transport fleet by one-third. The development of a new architecturally designed type of pentagonally shaped ships with open holds and of motor-powered cargo platform vessels contributed to a substantial increase in the pace of cargo haulage and reduction in the percentage of manual labor in ports. Bureau specialists took the most active part in extensive and multi-leveled work on the introduction of the push-towing method in inland shipping. In a short period they drew up a number of designs for push tugs and barges specially designed for work by this method.

The successful introduction of push towing and the mechanization of above-deck work was closely bound up with the development of automatic coupling devices. V. P. Zhukov, chief designer at the CTDB's Novosibirsk Branch, along with a number of river-fleet specialists, was awarded a USSR State Prize for work in this area.

During the postwar years, CTDB designs were the basis for the construction of large series of vessels of various types and purposes that presently constitute the foundation of our country's river fleet: motor-powered dry-cargo ships (designs 573, 765, 821 and others), tankers (866, 868 and R77 of the "Lenaneft" [expansion unknown] type), tugboats and push tugs (522, 574, 795, 911, R14, R33, R45 and others), the most powerful Soviet push tugs of the "Marshall Blyukher" type, suction dredges (592, 805) and other dredges (721, 892 and R36, single-walled floating docks, and many other vessels.

Motor-powered passenger ships of the "Rodina," "Moskvich," "OM," "Moskva" and "Zarya" types, which were designed by our designers, are well known.

I would also like to note the development in 1962, in conjunction with TsAGI [expansion unknown] imini N. Ye. Zhukovskiy and LIVT [Leningrad Water Transport Institute], of our country's first air-cushion vessel, the "Neva."

The CTDB has done a great deal of design work on motor vessels designed for combined inland and maritime navigation, and on technical devices for extending navigation.

Bureau specialists take an active creative part in the development of vessels supplied by foreign shipyards for our inland fleet; they perform design work on them, examine and pass on technical designs, and take part in acceptance tests and the monitoring of performance.

A substantial national economic effect has been realized as the result of the execution of designs drawn up by the CTDB for the transportation by waterways of large-sized and heavy equipment: the impellers of hydraulic turbines for the Nurek Hydroelectric Power Station and the Konshyadorskaya Pumped-Storage Electric Power Station, technological equipment for the Fosforit [Phosphorite] Production Association, and walls for installations to protect Leningrad against floods.

Most of the ship auxiliary mechanisms, equipment, monitoring and signaling devices and remote automatic control systems produced by enterprises of the Ministry of the River Fleet are manufactured on the basis of our organization's designs.

It would be difficult to tell about all of the bureau's work. In 50 years more than 1,600 passenger ships with a capacity of more than 250,000 persons, about 700 self-propelled cargo vessels with a total tonnage of 420,000 tons, more than 3,200 tugboats, push tugs and icebreakers with a total power of about 1 million horsepower, and more than 2,200 barges, vessels belonging to the technical fleet, motorized auxiliary harbor boats, landing stages, etc. have been built on the basis of more than 130 of the CTDB's designs.

Editors: What new areas of technical progress is the bureau's staff developing and utilizing in the 11th Five-Year Plan?

Yu. G.: In carrying out the decisions of the 26th CPSU Congress and subsequent plenums of the CPSU Central Committee, the collective has directed its main efforts toward improving the economic effectiveness, quality and dependability of vessels on the basis of the introduction of scientific and technical advances.

It must be said that the creation of new ships that are more effective than prototypes designed 10 to 15 years ago is a technically complex task. This is attributable to the fact that regulations of the RSFSR River Register and the sanitary-inspection agencies and the requirements of safety techniques have changed substantially during the intervening period. A large number of these changes are due to the consistent policy of the party and government of continuously improving the working and recreation conditions of Soviet people, reducing the percentage of manual labor and protecting the environment.

In addition, the normatives of the shipbuilding yards have changed (deductions for social insurance and accumulations have risen, workers' salary and wage rates have increased), and the prices of materials and component equipment

have also changed. Increased outlays for creation of the new fleet should be compensated for by an increase in its economic effectiveness. Therefore, today the designers' main task is to search for new technical solutions that will ensure a reduction of the construction cost of ships, a reduction of operating expenses, an increase in the volume of transport work, and an increase in the labor productivity of crews.

The staff is accomplishing this task together with scientists in the branch, applying progressive methods of ship designing and construction--a system of automated designing and the modular-aggregate method--and by working to reduce the use of fuel and lubricants and to increase ships' operating period.

Paramount importance is being accorded to introduction of the modular-aggregate method of shipbuilding. "Assemble ships, don't build them" is the demand of the times.

In the early 1980s under the direction of chief project designer A. B. Belkin, standardized modular sections of the parallel middle body for ships of the "R" and "O" class were developed which were subsequently utilized in the designing of platform barges with tonnages of 200 to 2,500 tons. To make it possible to carry out cooperative deliveries of the modular sections, the CTDB drew up an arrangement for them to be carried by rail that prevents the structurals from becoming deformed.

Modular sections are also being employed in the designing of motor ships with tonnages of 100-200 tons and 200-500 tons, and they have been incorporated in technical proposals for an 1,800-ton motor-powered platform vessel.

We see the further development of the modular-aggregate method as lying in the creation of more complex modules--for example, a unified stern end with a completely equipped wheel house and machinery-and-tiller compartment, as well as a bow end. Such modules will be utilized in the development of ships of diverse architectural-design types and dimensions.

Modular designing principles are being widely employed in the development of ship power units and systems. This primarily means the aggregating of mechanisms and the mounting of piping on panels. More than 60 different aggregates, including five standardized ones, have been developed and are being used in 20 ship designs. The practice of making up three-dimensional MO [expansion unknown] mockups in the bureau and turning them over to the shipbuilding yards has become usual.

I would like to stress that the maximum effect from the use of aggregating and of modular sections can be obtained when their production is centralized at mechanized enterprises.

In shipbuilding about 12 to 20 percent of the total labor intensiveness is accounted for by the outfitting of shipboard space. A radical reduction of labor outlays can also be achieved here as the result of the introduction of modular methods. The CTDB together with the LIWT has drawn up design workups for a standard-sized series of cabins and other shipboard space.

On their basis, modular structurals for elements involved in the outfitting of shipboard space have been worked out that have already found use in seven designs.

Even more promising work on the manufacture of outfitting modules made of polymer-coated steel bands is being done in conjunction with the Neva Shipbuilding and Ship Repair Yard. In the near future we shall begin the development of superstructures that will be entirely assembled from standardized modules.

Great importance is being attached to standardization. A long-range program for the development of manuals encompassing about 2,000 standard-sized articles and ship structurals has been drawn up and is being implemented. In the future, working drawings of them will be published and technological processes for their manufacture will be developed.

We are accomplishing the task of reducing outlays for fuel and lubricants by improving the ship's propulsion complex and developing and introducing new methods of reducing hydrodynamic resistance, means of optimizing operation of SEU [expansion unknown], raising the extent to which thermal energy is recovered, and utilizing heavy grades of fuel.

Under the direction of Candidate of Technical Sciences B. M. Sakhnovskiy, a method of designing propellers that takes depth changes in the wake into account has been developed and put to use in practice. The use of this method makes it possible to reduce fuel consumption by 5 to 10 percent in the operation of ships in shallow water.

In conjunction with the LIWT and SRIWT [Scientific Research Institute of Water Transport], effective new solutions for the shape of hull lines and for the engine and steering complex have been worked out and introduced into a number of designs.

In 1984 the CTDB, CSRI [Central Scientific Research Institute] imini Academician A. N. Krylov and SRIWT began research on the utilization, for the purpose of reducing the hydrodynamic resistance of river vessels, of a unit that makes it possible to lay down a layer of air on the bottom. The results of tests of a barge model equipped with such a unit confirm the possibility of reducing resistance in deep water of a loaded vessel by approximately 35 percent, and of an empty vessel by 40 to 45 percent. It is necessary to move more rapidly to test the proposed unit under actual operating conditions.

Considerable untapped potential exists for cutting fuel consumption by improving the efficiency coefficient of propellers. At present the blades produced in the Ministry of the River Fleet are mainly made out of carbon steel, and the propeller blades are machined according to the ordinary class of surface smoothness. The relatively low hardness characteristics make it necessary to thicken the blade edges and cross sections, and this reduces the propeller's efficiency coefficient.

As actual tests performed by the CTDB together with the motor-ship unit of the Volga River Shipping Association on the "Volgo-Don-5083" motor ship have shown, the use of propellers made of light-weight steel and having blade surfaces machined according to the middle or high class makes it possible to reduce fuel consumption by 9 to 10 percent. These figures indicate the need to organize the production of such propellers at enterprises of the Ministry of the River Fleet as soon as possible.

Work on the development of units that limit fuel consumption and protect diesel engines from overloads when ships are sailing in shallow water is drawing to a finish. Tests of an experimental model on a motor ship in the "Nevskiy" series have confirmed the unit's fitness. Fuel savings on lines with segments of shallow water may be from two to five percent.

Major untapped potential for raising the fleet's hauling capacity lies in lengthening the navigation season. In recent years most new ships have been designed so as to be adapted for work in broken ice in conditions of extended navigation. A search for new icebreaking and ice-clearing devices is under way. In the 11th Five-Year Plan the CTDB has continued work on improving standard-duty river icebreakers. Multipurpose, special-duty icebreakers with a power of 440 kilowatts are presently under construction on the basis of the bureau's designs. An ice-clearing attachment is being built at the Shipbuilding and Ship-Repair Yard imini III Internatsional according to the CTDB's design 2158.

On the basis of preliminary work done by the GIWTE [Gorkiy Institute of Water Transport Engineers], a design was drawn up for the LLP9 icebreaking-ice-clearing attachment; it was built and, according to available information, gave a good accounting of itself during the 1984/1985 winter season.

The search for new technical solutions is also being carried out in other areas. For example, one can cite shallow-draft push tugs of designs 81340 and 81350, for which specialists from the CTDB and the LIWT's production acoustics laboratory developed a new arrangement for insulating living and working space from sources of noise. This arrangement provides for dividing the hull and superstructure into two independent units--the stern and the bow, which are joined together by means of rubber and metal shock absorbers. This arrangement makes it possible to ensure noise levels that meet the requirements of sanitation regulations in the living and work areas, which are located in the bow section, of small ships. In order to achieve this goal using a traditional noise-insulation complex, it would be necessary to increase the vessel's main dimensions, which, as is known, results in increasing its construction cost.

Editors: Speaking of ways to increase the effectiveness of ships that are developed, you mentioned the introduction of automated designing systems. Would you tell about this work in more detail?

Yu. G. Since 1984 the first stage of a system for the automated designing of river vessels (SAD RV) has been under development by the CTDB, together with the branch's teaching institutes, on the basis of the "Design-1" and



"Foran" [expansion unknown] systems. Experience shows that the use of such a system makes it possible, together with improving the quality of design documents and reducing the designers' labor outlays, to save substantial amounts of money on the construction and operation of vessels by means of optimizing their elements.

Development of the first stage of SAD RV, which is intended for the automated designing of cargo transport ships, will be completed in 1986. It includes 10 subsystems whose overall operation, on a uniform technical, program and data basis, will make it possible, in the early stages of designing, to optimize the basic elements and characteristics of a vessel and, in subsequent stages, to produce a lines drawing, evaluate the stability and floodability of a vessel and its navigational characteristics, and to design optimal engines and test the vessel's steering qualities. At the same time, the load of the vessel's masses, its overall and localized strength, the parameters of its shafting, and the makeup and effectiveness of its storm-resistance complex are determined and calculations are made regarding the economics of its operation.

Work is being done in the bureau to create subsystems and programs for producing textual design documents on the computer--lists for the ordering of equipment, inventory supply and standard-component drawings, specific norms for the use of materials, estimate and financial calculations of the cost of building a vessel, etc. At present, three subsystems have been put into use.

In order to improve the planning of internal work during the current year, the program "work-assignment and short-term calendar planning" [ob'yemno-kalendarnoye planirovaniye] will be run on an experimental basis. Subsequently, in addition to extending the area of use of the SAD RV to other types of vessels, we envisage the development of a system of automated technological support for shipbuilding. It will make it possible to supply plants with mold lofts, diagrams for metal cutting, control programs for thermal cutting machines with numerically programmed control, technological documents for hull-assembly shops, etc.

Editors: What is the bureau's staff doing in order to develop transportation on small rivers?

Yu. G.: In recent years a good start has been made on the development of design documents for the construction of shallow-draft vessels. In 1981 the Sokolskoye Shipyard built a 600-ton sectional dry-cargo motor ship with a flexible unit on the basis of design R143 (chief designer M. G. Avrukh).

Tests and experimental operation have shown that the vessel possesses high maneuverability and sailing characteristics and can be successfully operated in conditions of small rivers. Despite this, for reasons that are incomprehensible to bureau staffers, the series construction of the motor vessels has not yet begun.

In 1983 technical proposals were developed for cargo motor ships for small rivers that were intended to replace obsolete and physically worn-out vessels

with tonnages of 50 to 600 tons (designs M-105, 776A, 821, 890, etc.). Two ship versions are proposed: a platform motor ship and a motor ship with a hold, which are being developed on the basis of identical stern and bow ends, and the parallel parts of their hulls are being assembled out of standard sections. According to the first technical proposal, the ship's tonnage, with a draft of 0.8 to 1.1 meters, is 100 to 200 tons, and according to the second technical proposal, with a draft of 1.0 to 1.6 meters, the tonnage is 200 to 500 tons. At present the bureau is completing the development of a detail design for a motor ship with hold with a tonnage of 200 to 500 tons (chief designer A. B. Belkin). Construction of the prototype ship is slated for the Velikiy Ustyug Shipbuilding and Ship-Repair Yard. Work on the second design, unfortunately, cannot be continued, since a shipyard has not yet been designated to build it.

The tugboat fleet for small rivers is being almost completely replaced. The series construction of shallow-draft push tugs with a power of 330 kilowatts intended for operation on rivers with depths of up to 0.9 meters has begun. The development of detail designs for tugboats with powers of 110 and 220 kilowatts has begun, and their production will begin during the 12th Five-Year Plan with the aim of replacing obsolete vessels of designs R96A, R96B, 861 and 911V. All the enumerated designs were developed under the direction of chief designer A. I. Palatov.

The non-self-propelled fleet for small rivers is being augmented with platform barges built in series at the Petrozavodsk Repair and Maintenance Base that have a tonnage of 80 to 130 tons (with a draft, correspondingly, of 0.6 to 1 meters). The use of folding ramps makes it possible to load and unload machinery "by its own motion." Large-series construction has also begun of 200-900-ton barges made of modular sections.

Editors: What contribution is the CTDB staff making to the implementation of the country's Food Program?

Yu. G.: Since the CPSU Central Committee's May (1982) Plenum, designs have been drawn up of ships specially intended for hauling agricultural products. In 1984 a prototype motor ship for hauling vegetables was built on the basis of our documentation (chief project designer M. G. Avrukh) at the Shipbuilding and Ship-Repair Yard imini 40-aya godovshchina Otkyabrya; it can also haul separately crated goods.

The first navigation season demonstrated that the ship has high performance characteristics: the produce transported in its holds keeps well. The motor ship is distinguished by its simplicity and dependability, all-purpose nature and the convenience with which it can be handled in ports. Our design served as the basis for the development of vegetable carrying ships produced by the enterprises of the Ministry of the Shipbuilding Industry. Since 1984 construction of ships of this type has also been begun at shipyards in Yugoslavia.

During the 11th Five-Year Plan the river fleet acquired 500-ton refrigerator ships built in the GDR, in the development of which our designers took

part. Design workups were begun on a motor ship of the same type with a shallower draft and lower tonnage.

In 1983 in connection with an assignment from the Leningrad Gorispolkom, the bureau's staff, in close cooperation with the Neva Shipbuilding and Ship-Repair Yard and the Northwest River Shipping Line, developed on a rush basis a motor ship for hauling grain that can navigate the Neva without the bridges' being raised (chief project designer V. N. Veretennikov).

Series construction is under way of specialized barges for hauling grain from which the grain will be unloaded with the use of pneumatic machines.

Editors: What work is being done to develop passenger transportation?

Yu. G.: In recent years the passenger fleet has been replaced at an intensive rate. Our specialists took part in the development of a new series of tourist motor ships that have been delivered from the GDR since 1984 and of shallow-draft ships of the "Sergey Yesenin" type that are built at the Korneuburg Shipyard in Austria. With our participation, a design for an analogous ship is also being drawn up at the Boizenburg/Rosslau shipyard in the GDR.

A great deal of attention is being given to perfecting pleasure and excursion vessels and motor ships for intercity and suburban lines. Our staff has been engaged in designing them since the first postwar years.

In 1983 construction of 179-passenger motor ships in the "Moskovskiy" series was begun at the Moscow Shipbuilding and Ship-Repair Yard on the basis of a CTDB design; the ships are intended to replace type MO and OM ships. This motor ship has been designed for class "O" (ice) and has an engine-tiller complex that is protected against ice.

Work is being completed on documentation for the construction of a 100-passenger class-"R" (ice) passenger motor ship to replace type PS and "Moskvich" ships. The design work and the materials and component equipment used in all these ships are standardized to the utmost (chief project designer Yu. S. Lappo).

On the basis of CTDB documentation, construction is continuing of "Moskva" pleasure and excursion motor ships and "Volga" passenger catamarans. A cargo and passenger launch is being designed for local lines and ferry crossings.

Editors: What fundamentally new and promising types of ships are the bureau's specialists working on?

Yu. G.: As already noted, one of the main sources of untapped potential for enhancing the river fleet's economic effectiveness lies in increasing the operating period--among other means, by expanding the region of navigation. This concept was made the basis for a number of design workups on promising types of vessels.

The magazine's issue No. 6 for 1984 told in detail about a sketch design for a 280-passenger motor tour ship with mixed inland-water and maritime

capability. Ships of this new type will be operated for a longer period since they can be used in the spring and autumn in southern regions, which will make it possible to attract additional flows of tourists and to completely utilize the ships' passenger capacity throughout the entire navigation season.

The possibility of such use provides them with a higher economic effectiveness than existing passenger motor ships.

At the present time design workups are being carried out on a passenger motor ship with a smaller capacity for the tourist line that links inland regions of Finland with Leningrad and Lakes Ladoga and Onega via the Saimaa Canal. Modifications of it will be effectively operated on lines passing through the White Sea-Baltic Canal via the Solovetskiye Islands, Arkhangelsk and inland ports. In a take-down version, the ship can be transported overland to Baikal.

We recently completed the design workup of an all-purpose motor ship for combination inland-water and maritime navigation for transporting vegetables; it can also be used for hauling individually crated and bulk cargoes. Such ships will make it possible to substantially increase the shipment of vegetables and fruits to the country's central regions from the Caspian and Black Sea basins.

In our view other promising types of ships are specialized motor ships for transporting motor vehicles. Their effectiveness has been confirmed by many years of experience in operating a vehicle-hauling barge built according to a CTDB design; unfortunately it is presently the only one of its kind.

Attention also ought to be given to the design workup of a motor ship with a reduced above-water clearance for transporting general cargoes, containers and equipment without transshipment between ports located on the inland waterways of the USSR and Western Europe (the Seine, Rhine, Rhone, Main and Danube rivers, and others).

Construction of a 440-kilowatt push tug of a new and, we believe, promising type has been begun at the Shipbuilding and Ship-Repair Yard imini Butyakova. The distinguishing feature of the push tug (chief project designer S. B. Shur) is a rotory support device that allows the tug to turn at an angle of up to 20° relative to the axis of the towed vessels. This device, in combination with a rotary steering nozzle, provides a degree of guidance in the motion of a push tug with an 8,000-ton tow equivalent to that of a traditional type of tug with 700 kilowatts of power.

Interesting proposals for paddle-wheel push tugs with a draft of 0.4 to 0.5 meters and barges for them have been prepared by specialists at the CTDB's Novosibirsk branch. In our opinion, the use of the new design of paddle-wheel push tugs may solve the problem of developing vessels for rivers with minimal depths.

Editors: One final question: With what sort of results will the CTDB staff conclude the 11th Five-Year Plan and greet the 27th CPSU Congress?

Yu.G.: Over the years of the present five-year plan, 28 prototype vessels of various types and purposes have been built on the basis of designs of the CTDB and its Novosibirsk branch and turned over for operation, and the river fleet has also acquired new vessels built abroad in the development of which the bureau's designers took the most active part. Every year on the basis of documentation supplied by the bureau, more than 200 vessels are built, and more than 35,000 mechanisms, pieces of equipment and instruments are produced. About 70 percent of the output of the Ministry of the River Fleet's industrial enterprises that has been awarded the State Seal of Quality is manufactured on the basis of our documentation, and vessels of two designs are delivered abroad.

In the first four years of the five-year plan, CTDB specialists have received certificates of invention for inventions and industrial prototypes, and CTDB designs have received three gold, 11 silver and 33 bronze medals at the Exhibition of Achievements of the USSR National Economy. Today almost every design for a vessel employs inventions that originated in the course of its development, which provides grounds for recognizing the vessels made according to such designs as new industrial prototypes.

The economic effectiveness obtained from the use of the bureau's designs, as confirmed by clients, came to about 35 million rubles over the past four years.

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## MARITIME AND RIVER FLEETS

### NEW RIVER FLEETSUCTION DREDGER PROFILED

Moscow RECHNOY TRANSPORT in Russian No 7, Jul 85 p 41

[Article by N. Shapovalov; deputy director of the Ministry of the River Fleet's Central State Design Bureau; "Self-Propelled Trench Suction Dredge"]

[Text] In 1984 a prototype self-propelled suction dredge built at the Shipyard imini Ul'yanov (Lenin) on the basis of design R-161, which was developed by the Ministry of the River Fleet's Central State Design Bureau in close contact with the Volga Basin Waterways Administration, was turned over for use. Suction Dredges of this type are intended to carry out bottom-deepening work by the trench method on loose ground in water basins of the "R" category.

#### Ship's Basic Characteristics

##### Main dimensions, meters:

overall length, with sectional nose	78.4
overall length, with elliptical nose	82.4
maximum length	65.45
overall width	12.23
maximum width	12.0
height of side	3.1
Above-water clearance, meters	10.25
Draft in working condition with sectional nose,	
with 50 percent reserve, meters	1.29
Dredges productivity, cubic meters/hour	1000
Depth of ground extraction, meters:	
with sectional nose	8
with elliptical nose	11
Depth of floating pulp line, meters	400
Extent of independent navigation with fuel	
and oil reserves, days	20
Number of berths for crew	29
Speed in still water without pulp line, km/hour	14.6
Vessel class according to RSFSR River Register: "R"	

Construction of the suction dredge was preceded by extensive design and research work, in the course of which the ship's design was worked out.

Extremely important conditions of designing were the observance of a specified draft, improvement of the crew's working and living conditions, and the dependability of the technological equipment.

On this suction dredge the berthing space has been included in the superstructure, i.e., moved out of the hold, for the first time. It fully meets present-day requirements for river and lake vessels as to sanitation norms. All the technological equipment is manufactured at enterprises of the Ministry of the River Fleet, and the ship equipment is manufactured at Soviet plants. At the same time, it should be noted that at the Shipyard imeni Ul'yanov (Lenin) in the course of construction the production of 700-mm-diameter ball-and-socket joints was set up. The suction dredge's mechanisms are remote-controlled, from the wheel house.

The experimental operation of the suction dredge will begin in the 1985 navigation season; this will make it possible to determine the dependability of the ship's design and its elements.

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