SELECTED ABSTRACTS OF D.SC. AND PH.D. THESES SUBMITTED AT RUSSIAN TRANSPORT UNIVERSITIES

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Bigirimana Juvenal. Rationale of the bus fleet performance management system in the conditions of the Republic of Burundi. Abstract of Ph.D. (Eng) thesis [*Obosnovanie sistemy upravleniya rabotosposobmostyu avtobusnogo parka v usloviyakh Respubliki Burundi. Avtoref. dis… kand. tekh. nauk*]. Moscow, MADI publ., 2023, 19 p.

In the absence of railway infrastructure and access to the sea, Burundi is dominated by road transport. Therefore, its reliability is crucial for the entire economy of the country. Maintaining vehicles in working condition through the balanced development and efficient operation of enterprises for technical maintenance and repair (TM and R) of vehicles, as well as the quality of their organisation and equipment, will contribute to development, management and uninterrupted provision of road transport services. The leading role in the technological process of ensuring operability of vehicles is played by diagnosing their technical condition, the results of which make it possible to quickly obtain information about its changes, and the use of modern scientific methods makes it possible to predict their performance.

The objective of the thesis is to substantiate the need to create an effective system for maintenance and repair of buses in the conditions of the Republic of Burundi based on the use of operational redundancy methods.

The scientific novelty of the work lies in development of a model for predicting the performance potential of the power unit and a methodology for substantiating the system for organising maintenance and repair of class M3 buses in tropical climates and mountainous areas using repair redundancy methods using repair kits.

The main reasons for reduction in the service life of buses have been identified. The service life depends on availability of asphalt concrete pavement, natural and climatic conditions, the perfection of the spare parts supply system and the lack of a functioning system for their maintenance and repair.

It has been proven that introduction of redundancy principles based on the use of complete replacement instead of «partial» one ensures the effective use of funds for organising warehouse stocks and reduces the time these parts remain in warehouses with buses awaiting repairs.

Based on the use of the developed mathematical model for predictive assessment of the operating time of the bus power unit before major repairs, it was possible to solve the problem of not only optimising the warehouse inventory of spare parts, but also effectively increasing the level of bus performance during the repair process.

Based on the collected statistical information on the state of the repair base in the country and the use of the results of this work, a methodology has been developed for organising a maintenance and repair system for buses for the conditions of the Republic of Burundi.

2.9.5. Operation of road transport.

The work was performed and defended at Moscow Automobile and Highway State Technical University (MADI).

Dulsky, E. Yu. Scientific foundations of the theory of strengthening the insulation of electrical equipment of traction rolling stock by thermal radiation. Abstract of D.Sc. (Eng) thesis [*Nauchnie osnovy teorii uprochneniya izolyatsii elektrooborudovaniya tyagovogo podvizhnogo sostava teplovym izlucheniem. Avtoref. dis… dok. tekh. nauk*]. St.Petersburg, PGUPS publ., 2023, 32 p.

The objective of the study is to create a theoretical basis for drying and strengthening insulating structures of traction rolling stock (TRS) using IR radiation by developing new methods, techniques, technical and technological solutions that increase the reliability of insulation of electrical equipment of TRS and reduce the cost of its repair.

The thesis outlines new scientifically based technical and technological solutions for increased reliability of insulating structures of electrical equipment of TRS. The developed mathematical models, methods, technical solutions and technological processes have been introduced into the practice of linear and repair shops and manufacturing plants. The conducted research allowed us to formulate the main results and conclusions.

A system approach was applied to analyse the reliability of the electrical equipment of the TRS, considering the distribution of zonal features of the Eastern train circulation area, which made it possible to identify significant differences in the failure rate of insulation of electrical equipment in different operating zones of the TRS operation. The influence of zonal features, such as climate, traffic density, and topography, is clearly visible when analysing the reliability of TRS equipment. At the same time, failures of insulating structures of electrical equipment account for about 40 % of the total number.

A study was carried out of the factors influencing the reliability of the TRS electrical equipment, based on which an appropriate classification was proposed in relation to the Eastern train circulation area.

A methodology for selecting energy-efficient IR radiation sources for their further use in industrial installations when strengthening polymer insulation is proposed based on a theoretical and experimental comparative assessment of the main energy parameters. Based on this technique, among the electrical emitters on the market today, the highest efficiency in terms of such parameters as beam efficiency (83,5 %), temperature of the emitting surface (860 °C), specific surface radiation energy (4,12 W/cm^2), electrical power consumption (600 W) was shown by high-temperature ceramic emitters of SHTS type.

A methodology has been developed for selecting effective IR radiation reflectors based on the compilation of finite-difference models that consider the distribution of values of angular radiation coefficients. Based on this technique, the best results in terms of the parameters of the directional concentration of thermal radiation (distribution density of the thermal field under the reflector), the maximum heating temperature of the irradiated surface (279^0 C), the minimum heating temperature of the reflector (542^0 C) were shown by reflectors having a trapezoidal shape with an internal angle of 150^0 C.

A set of mathematical models has been proposed for calculating effective modes of IR energy supply in the processes of strengthening elements of insulating structures of electrical equipment of TRS. Mathematical models make it possible to describe the processes occurring during heating of multilayer insulating structures using IR radiation, considering the optical properties of impregnating materials and the spectral characteristics of modern emitters. The proposed complex of mathematical models allows us to quickly determine the types of structural elements of the system, to select the optimal parameters of their operation, considering the geometric features of the windings, the type of insulating and impregnating materials, operating time and other external factors.

A quantitative and qualitative analysis of the influence of technological modes of the process of heating insulating structures of electrical equipment of TRS with IR radiation on their performance in operation was carried out, which resulted in revealing new dependencies of the parameters of the structural elements of the system from each other and on the hardening process as a whole. During the experimental evaluation, the optimal modes of IR energy supply in the oscillating mode were established, which make it possible to increase the electrical strength of insulation by an average of 45 %, in comparison with the standard method (IR drying

on average – 4,3 kV, convective drying on average – 2,4 kV). It was revealed that the hardness and elasticity of polymer insulation changes slightly with changes in heating conditions.

Analysis of the research carried out from the standpoint of the chemical composition, structure of impregnating materials and heat treatment modes indicates the decisive importance of the chemical properties of the polymer in optimising strength and ductility when forming a capsule on the surface of a possible zone of insulation damage. Thus, the content of the soluble part of the binder after treating polymer insulation with thermal radiation is 8 times lower (2,4 to 22,0), and the degree of curing is 30 % higher (97,6 to 78,0), compared to the convective method.

A technique has been proposed for experimental evaluation and coordination of the spectral characteristics of IR emitters with the optical properties of insulating materials, which makes it possible to select IR emitters for any insulating materials to increase the energy efficiency of the hardening process in terms of such parameters as absorption, transmission and reflection coefficients. The «gray gas» environment, when strengthening insulating structures impregnated in varnish, reduces the intensity of the IR radiation flux at the initial time (10 %), which is due to the intensive removal of solvent vapours, which absorb radiation.

Methods and technical means have been developed for strengthening the insulating structures of electrical equipment of TRS based on the use of infrared radiation, increasing the reliability of insulation by 40 %, reducing energy costs by 6 times, increasing repair productivity by 4 times (14 patents for inventions and utility models, 3 certificates for computer registration).

Technical solutions for the use of thermal radiation in the repair of insulating structures of electrical equipment of TRS were introduced into production at the Ulan-Ude Locomotive Car Repair Shop (UULVRZ) – a branch of JSC Zheldorremmash (Ulan-Ude), LLC Angarsk Montazhenergoremont (Angarsk), motor-car depot Irkutsk-Sortirovochny – a branch of the East Siberian Directorate of Motor-Wagon Rolling Stock – a structural subdivision of the Central Directorate of Motor-Wagon Rolling Stock – a branch of JSC Russian Railways. Feasibility studies have been carried out to improve the reliability of insulation of electrical equipment of TRS and the efficiency of the proposed technical solutions for strengthening the insulation, allowing to obtain a total estimated annual economic effect from implementation of the proposed developments in production of about 3 million rubles by replacing one furnace only.

As promising field for further development of the subject of the thesis, research related to optimisation of drying modes and strengthening the insulation of electrical equipment of TRS using IR radiation is proposed in terms of determining the completion time of the polymerization process with IR heating and drying time, respectively.

2.9.3. Railway rolling stock, train traction and electrification.

The work was performed and defended at Emperor Alexander I St. Petersburg State Transport University.

Poleshkina, I. O. Methodology for ensuring aviation accessibility of the regions of the Eastern Arctic of the Russian Federation. Abstract of D.Sc. (Eng) thesis [*Metodologiya obespecheniya aviatsionnoi dostupnosti regionov Vostochnoi Arktiki Rossiiskoi Federatsii. Avtoref. dis…dokt.tekh.nauk*]. Moscow, MSTU CA publ., 2023, 43 c.

The objective of the thesis is to solve the scientific problem of ensuring aviation accessibility of sparsely populated Arctic territories that have the potential for economic development of the regions of the Eastern Arctic of the Russian Federation.

The patterns of development of the transport system of the regions of the Eastern Arctic of Russia have been identified, the main ones being the following: the absence of railway transport and roads of year-round use; the predominance of water transport (up to 78 % of the total volume of transported goods) in complex multimodal schemes for delivery of goods, carried out in several stages on average for 350 days a year due to natural and climatic constraints; there is no alternative to the use of air transport for year-round passenger transportation (98 %).

It has been determined that the effective use of air transport is complicated by low population density and its dispersed settlement over a large territory, which does not allow flights to be carried out with sufficient frequency and load on the required number of routes. It was revealed that 99 % of air transportation at the local level is carried out by MI-8 helicopters with a capacity of 22–24 seats, which are extremely expensive to operate in Arctic conditions, which leads to a reduction in the number of flights.

The theoretical provisions of the concept of ensuring aviation accessibility of the regions of the Eastern Arctic have been developed and scientifically substantiated, within the framework of which the concept of «aviation accessibility of the region» is specified, the functions and types of services performed without alternative by air transport are structured, making it possible to predict the need for development of elements of the air transport system based on assessment of aggregate demand and hidden socio-economic effects obtained from them.

A dependence was obtained between the intraregional aviation mobility of the population of the Arctic regions, the cost of the flight and its waiting time due to the inconsistency of the schedule of connecting flights and their delay due to weather conditions. A new comprehensive methodology has been developed for assessing the transport accessibility of the Arctic region at the regional and local levels, including assessments of accessibility of passenger transportation, accessibility of transportation of socially significant perishable goods, availability of air ambulance services and of the services of the Ministry of Emergency Situations, taking into account seasonal restrictions. Using the example of the Republic of Sakha (Yakutia), it was revealed that the level of accessibility of passenger transportation is 12 times lower than the standard in terms of time and 35 times lower in cost, the level of accessibility of transportation of socially significant perishable goods varies greatly throughout the year, the level of accessibility of air ambulance and emergency services in the most remote settlements is below the maximum permissible by 1,7 times.

A method for assessing the seasonal distribution of passenger flows of local air transportation in less populated areas has been improved and experimentally confirmed, making it possible to divide them into clusters for which an individual strategy for ensuring aviation accessibility is applied. The difference between this method and existing ones lies in formation of clusters, considering simultaneously a large number of criteria that determine the size of demand for air travel and its seasonal distribution. Five clusters were obtained for the Republic of Sakha (Yakutia). In the first, air transportation must be carried out 8 months a year by helicopters and light multipurpose aircraft (LMA), in the second – year-round by helicopters and LMS, in the third – 3 months a year by helicopters, in the fourth – year-round by LMS, in the fifth, air transportation is not required due to availability of alternative types of transportation. This method allows us to justify the need to develop a network of airfields and heliports in Arctic settlements.

A method has been developed for two-level forecasting of demand for intraregional passenger air transportation on existing routes, which differs from the known ones by sequentially solving two problems: forecasting the demand for transportation between populated areas and the centre of the Arctic district and, on its basis, forecasting the demand for interregional transportation from the district centre to the capital of the region. This method allows you to plan the volume of passenger flows of existing intraregional airlines when changing various parameters.

A methodology for calculating passenger flows on newly opened direct air routes between the centres of neighbouring Arctic districts has been developed and scientifically substantiated, taking into account the infrastructure of district centres, the size of the living population and their needs for flights. It has been established that opening of direct routes will triple the inter-district aviation mobility of the population from 0,98 to 2,98 trips

per year. This technique makes it possible to predict passenger flows on newly opened routes and change the configuration of the airlines' route network.

The methodology for assessing the required fleet of aircraft for organising local air transportation has been improved, allowing one to find rational combinations of the types of aircraft used, considering the given frequency of flights and the conditions for minimising their costs. The results of applying this methodology showed that when replacing MI-8 helicopters with AN-2 / AN-3 / Baikal aircraft on several routes, it is possible to achieve a 28 % reduction in the cost of transporting one passenger by reducing fuel consumption and increasing the aircraft load factor while simultaneously increasing the number of flights operated. It has been established that an increase in the number of flights will lead to an increase in the aviation mobility of the population at the local level to 0,65. This methodology allows airlines and regional authorities to plan the composition of their aircraft fleet to organise a given frequency of flights. The feasibility of constructing airfields in populated areas where the demand for passenger air transportation is present for more than 5 months a year is economically rational.

The concept and set of methods and techniques developed in the thesis to ensure aviation accessibility of the Eastern Arctic regions corresponds to the National Development Goals of the Russian Federation; the Fundamentals of the state policy of the Russian Federation in the Arctic, the Strategy for development of the Arctic zone of the Russian Federation and ensuring national security; Transport Strategy of the Russian Federation; Comprehensive plan for modernisation and expansion of trunk infrastructure and the Doctrine of Food Security of the Russian Federation.

According to the results of the study, to ensure aviation accessibility of the Arctic regions, are recommended: amendments to the legal regulation in terms of simplifying the requirements for airports, landing sites and heliports with low flight intensity; introduction of the concept of small aviation into the Air Code, simplifying the requirements for commercial airlines operating LMS; development of a network of landing sites; organisation of domestic production of multi-purpose aircraft with a capacity of 9–12 and 2–4 seats with an increased flight range for air transportation to small populated areas.

A promising area of research on the topic of the thesis is the study of the use of artificial intelligence and digital twins of complex objects and subsystems for managing air transport in the Eastern Arctic. Organisation and management of a system for delivery of goods by unmanned aerial vehicles and creation of a reliable infrastructure for servicing them in the Arctic regions require a detailed scientific and methodological study.

2.9.1. Transport and transport-technological systems of the country, its regions and cities, organisation of production in transport (technical sciences).

The work was performed at Moscow State Technical University of Civil Aviation (MSTU CA), defended in the joint dissertation council of Moscow Automobile and Road State Technical University (MADI) and MSTU CA.

Saburov, M. B. Method and models for organising cargo flows in the conditions of reforming railway transport of the Republic of Uzbekistan. Abstract of Ph.D. (Eng) thesis [*Metod i modeli organizatsii gruzopotokov v usloviyakh reformirovaniya zheleznodorozhnogo transporta Respubliki Uzbekistan. Avtoref.dis..kand.tekh.nauk*]. St.Petersburg, PGUPS publ., 2023, 16 p.

Currently, extensive economic reforms are being carried out in the Republic of Uzbekistan. In this process, the «New Uzbekistan» strives to form close and mutually beneficial economic relations with neighbouring Central Asian countries, including the countries leading in foreign trade which are China and Russia. The desire of the Republic of Uzbekistan to enter the Eurasian Economic Union and the World Trade Organization will lead to an increase in foreign trade turnover. However, recently in foreign trade turnover there has been a significant superiority of imports over exports of goods. For example, for the top three leaders in foreign economic relations of the Republic of Uzbekistan, imports of goods are 2,5–3 times more than exports. In the Republic of Uzbekistan, more than 20 million tons of fruits and vegetables are produced annually, of which 1 million is exported to different countries. The Republic of Uzbekistan is the fourth largest cotton exporter in the world. With large and stable volumes of cargo transportation, the role of railway transport can hardly be overestimated. In particular, we are talking about packaged cargo. Unlike the Russian and Chinese railways, where private operators occupy more than 95 % of the market, on the Uzbekistan railways the main fleet consists of inventory cars with an expiring service life, and refrigerated rolling stock, due to the expiration of their service life, is operated only within the Republic of Uzbekistan. This leads to the search for new approaches to organising transportation, in particular the transition to container transportation of the above goods, which simplifies the supply chain for export transportation and reduces transport costs.

The objective of the study is to increase the efficiency of providing containerised cargo flows to Agroexpress trains in the conditions of a new model of the cargo transportation market in the Republic of Uzbekistan by developing a method and mathematical models for their organisation.

The main conclusions, theoretical and practically significant results of the work are as follows.

The analysis of the volume of transportation of packaged cargo was carried out and the main reasons were identified that negatively affect the transportation by rail, such as the lack of a fleet of cargo cars, the high cost of delivering goods relative to road transport. The relevance of developing a comprehensive methodology for organising cargo flows of the agro-industrial and textile complexes in the conditions of updating the rolling stock fleet with innovative cars and containers in the Republic of Uzbekistan has been proven.

An assessment was made of the volume of cargo loading in the agro-industrial and textile complexes and, on its basis, the need for railway rolling stock and the shortage in cargo cars were determined. The total shortage of cargo cars will be 4590 units, of which 1458 units are in export traffic on the Uzbekistan Railway.

A mathematical model has been developed for optimal supply of cargo to the Agroexpress train, which ensures development of effective logistics solutions for formation and distribution of cargo flows of agricultural and textile products, allowing for development of an increased cargo base for Asian countries.

A method for providing cargo to the Agroexpress train has been proposed, considering the variability of structures and stages of cargo delivery with minimal costs in the Republic of Uzbekistan.

An algorithmic support has been developed for solving the problem of optimal supply of goods to the Agroexpress train, which allows for end-to-end monitoring and management of logistics supply chains for agricultural and textile products, considering the following criteria: delivery costs, time differences when delivering goods, environmental damage and safety of goods in the process of delivery.

A simulation model for delivery of cargo to Agroexpress trains has been developed, taking into account the integration of cargo flows, coordination of the elements of the transport and logistics complex and coordination of the interests of participants in the transportation process, for design of logistics schemes for delivery of agricultural and textile products and their replication for different conditions.

The research results were approved, implemented and used in the work of Karshi regional railway junction of JSC «Uzbekistan Temir Yollari» to increase the efficiency of formation of Agroexpress trains for transportation of packaged cargo in the conditions of reforming cargo transportation in the Republic of Uzbekistan. The results were also used in the educational process at the Tashkent State Transport University.

2.9.4. Transportation process management.

The work was performed and defended at Emperor Alexander I St. Petersburg State Transport University. ●