

**Knoware of Troubleshooting System: from Bayes Rules to Analytic Networks**

**Sarkisyan, Rafael E., Stadnichenko, Stanislav Yu., Masalida, Alexandra V.**

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Troubleshooting problems are especially valuable for automatic systems controlling the traffic of rolling stock in real-time as well as for the systems used during stationary maintenance, part replacement and repair planning.

Modern information and intelligent technology permit to combine the tasks of troubleshooting, forecasting and controlling within the integrated system of decision support (particularly DSS – Decision Sprout Systems).

The researches on troubleshooting in rail transportation are rare but important to ensure sustainable and safe high speed traffic and other railway operations. Operating conditions of locomotives change under the influence of internal and external factors. The technical troubleshooting should prevent risks and identify errors and faults.

The use of different types of models and software of mathematical support of automatic systems permits to achieve sufficient level of diagnostics.

Russian railways use automatic systems of train control, for instance a system of automatic conducting of passenger trains (SAVP). The system permanently controls the conditions of all controlling devices, pressure in the mains, electric current in the circuits etc. The subsystem of troubleshooting is an integral part of the SAVP system.

However, there are some unstructured and less formalizable tasks as a necessity to use heuristic information, ambiguity of data and of decisionmaking, limited time periods to find solutions, interactive course of decision making.

Traditional methods of extraction and processing of information are not very suitable, and Bayes technique and rules, mathematical models that allow to consider internal links between the processed data and devices, are more promising.

There is an assumption that stochastic apparatus helps to proceed with hypotheses on the impacts under indeterminacy so that the methods and computation there-of can be carried out by formalization called analytic networks [5, 6]. If there is a little number of signs under revision, then the number of experiences in order to get statistically reliable information should be rather big. So it is necessary to use for troubleshooting some generalized models which contain statistical data as well as expert's judgments.

The aim is to obtain an assessment of a posteriori probability that the observation indicates the searched condition. This objective can be achieved if there is an assumption that the object under the control is exhaustively described by a set of

parameters which represent a vector of description. The totality of all possible values of the vector is a space of description of the object. Every condition is conform to some accessible region of values with the parameter between them. If the regions and consequently the conditions are determined then the problem of troubleshooting is reduced to decision-making in favor of a certain condition every time that the description of parameters enters the accessible region of values.

To ameliorate this rule of troubleshooting it is possible to add a function describing the cost of a wrong decision

The structure of troubleshooting problem is based on the idea of a method of analytic networks.

The objective of the study of that network structure is to assess the priorities of its elements with the account for interlevel and intralevel links and influences. According to the general theory of Analytic Hierarchy Process the study is reduced to engineering and processing of super matrix  $W1$  (with the elements of ordinate matrix).

**Key words:** transport, bayes rules, analytic network, intelligent monitoring, troubleshooting, ossof-utility function, reliability, safety, electric train.

## **Time-Based Transportation Patterns and their Adjustment for Resources Processing Timetable at Points of Destination**

**Nechitaylo, Nikolay M.**

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Classical minimum-time transportation problem [ 1 , 2 , 4 ] doesn't assume any supplementary processing of resources at the points of destination. The elementary variant supposes that the processing of each consignment begins immediately after it arrives at the destination. It is a model without process queues.

The model of commensurability of transportation and processing costs considers process queues.

The problem under consideration supposes that the resources should not only be shipped from the origin to destination point but also should undergo a secondary processing at the destination. The problem is solved, once all the resources within a transfer operation have been delivered and processed. The study examines a case of such a processing and shows that the transfer length linearly depends on the volume of present consignment.

Besides, each point of destination (processing) can be regarded as a multichannel service system.

The features of such a system include aggregate capacity of processing of arriving resources as well as the time of processing by one of the channels of a resource unit ( $t_j$ ), which doesn't depend on origin point of carriage, and the quantity

of the channels ( $z_j$ ), being equal to the quantity of resources that a given  $j$ -point can process during  $t_j$  time.

The solution of a problem with multichannel processing can be reduced to solution of a problem of one processing channel at every point of destination. In an elementary case it is reason to believe that the time of processing of resource unit at multichannel processing point is  $z_j$  times less than the time of processing of similar unit by a sole channel and is equal to  $t'_j = t_j/z_j$ .

The examined problem has much in common with excess fare transportation problem [3]. The solution of excess fare transportation problem is found with the help of approximate method (linearization of efficiency function) or of labor-consuming combinatoric method. See the minimax character of the defined efficiency function, the solution of the examined problem reduces to finite sequence of problems whose computational complexity doesn't exceed a polynomial one. Meanwhile there is the assumption that a processing time at any destination point depends on the volume of processed consignment. That is why such problems are generalized minimax transportation problems.

The Hungarian method, that is a variant of sequential reduction of misalignments, permits to solve the problem. A proposed technique of adjusting of a lower bound of the efficiency function reduces the number of steps within the algorithm.

The adoption of the model permits to consider limited processing capacity of the points of destination (for instance of sea ports) during planning of train arrivals (especially those with exported freight) in order to reduce unloading time and to avoid traffic jams on house tracks.

**Key words:** transport problem, criterion of the minimum of time, resources, station of destination, processing costs.

## **Mathematical Simulation of Transshipment Process Management within a sea port**

**Prohorenkov, Alexander M., Istratov, Roman A.**

**pp. 20 – 28**

Transport nodes play central role in freight traffic. In spite of construction of new Russian port transshipment facilities the demand for them isn't satisfied (for instance in international trade only 70% of demand is met). Thereupon there is a need to increase the efficiency of transport nodes particularly by optimization of management of transshipment and port facilities on the basis of modern information and computer technology.

Transshipment processes as an object of simulation permit to solve a wide range of management tasks. Random character of processes within infrastructures of

a sea port makes management models stochastic and permits to consider them as models of queueing process [1, 3, 4].

The Murmansk transport system comprises railway, sea, road and aviation companies.

And the main problem of efficient interaction of all the actors of freight processing in Murmansk transport node is the absence of regional or seaport logistics hub. That explains the proposal to create a comprehensive information system with a subsystem of transshipment management. The subsystem should assess the costs of transshipment using economic criterion of total cost of freight traffic.

Every similar transport center has subsystems of moorages, terminals, railway and road loading facilities.

The proposed graph model describes these subsystems of loading-unloading as graph points  $K = \{K1, K2, \dots, KN\}$  ( $N = 1 \dots 17$ ) and directions of freightage as arcs  $E = \{E12, E21, \dots, E17, E71\}$ .

While the number of ships and railway cars as well as the time of their arrival are known, the presence of free reloaders and storehouses is a random number.

Therefore the description and simulation of transshipment processes in a transport node can be made through graph model and mathematical chance model.

The problem of optimization of management of transshipment can be described as follows. There is a certain number of loading/unloading points, the similar quantity of vehicles and of freight flows within the same system. It is necessary to plan a route for every freight flow and for every vehicle in order to ensure minimum transportation costs and to reduce time of processing of vehicles [1, 5].

An expression permits to define prices of all routes of vehicles within a transportation node.

Minimization of costs is achieved taking into account some restrictions: that every vehicle is within the permanent route and that it can't move more freight than its payload is. There are also time restrictions.

The following quality indices were taken into consideration:

- continuous/uninterrupted process of freightage;
- speed of freight delivery;
- level of goods' safety etc.

The above rates, once achieved, are within the range between 0 and 1 for each kind of transport. The software Simulink of Matlab simulates the whole graph model that has three sub models: way 1, way 2 и way 3 (subsystem elements). The use of the keys allows to select the routes. Adder/subtractor units sum up the costs of transshipment operations adjusted for transit.

The simulation resulted in approximation of costs of transshipment and vehicle operations, transit rates which are shown at the Web-site of Murmansk sea commercial port.

The described approaches towards mathematical model of a transport node in the form of graph model and its matrix analog help to optimize different variants of transshipment of freight within sea transport traffic center. By using a model created under Simulink it is possible to assess costs of transshipment by different vehicles

and methods and to optimize the whole process of transshipment on the basis of economic criterion of total costs of freightage.

**Key words:** sea port, transport node model, port services, transshipment, information technology, methods of control.

### **Tear and Wear of Center Plate Units of Rail Tanks**

**Voronin, Nickolay N., Voronin, Nickolay N. (Jr), Zin Aye Min (Myanmar).**

**pp. 30 – 35**

Structural elements of the rolling stock are of great importance for the safety of passengers and freightage, especially it concerns friction units, because some of them are operated under rude conditions. The presence of abrasives, absence of lubricant, specific spectrum of absorbed load provoke severe wear of contact surface.

The pivot unit ensures connection of the body with the bogie, executes the transmission of force between them and is responsible therefore for the safety of a whole wagon. The pivot unit consists of a center plate, end-trust bearing and pivot itself [1].

The comparative study of four – and eightaxle tank wagon features makes emphasis on numerical analysis of friction assemblies and on tribology particularities of different rail tanks. The equations and equation-based software have been developed in order to analyze wear in center plates units considering not only distribution of contact pressure but also load rates in connection areas.

Tear and wear rates in friction units of 8-axle rail tank are lower as compared to 4-axle tank wagon. It is explained by smaller basis (3200 mm), determined by smaller dimensions of cross beam, despite of comparatively larger load rates. The larger tear and wear zones in friction assemblies of 8-axle tank wagon are located between the copper of the tank and the cross beams, as the cistern has a significant basis and a gross weight.

The tear and wear process also intensifies when a tank wagon moves in narrow curves and thus affects the surface of center plate unit, the  $\alpha$  angle of the turn of the center plate relative to end-trust bearing being larger.

The results of the research have shown that the tear and wear rates depend on mileage, radius of track curves and on wagon structure, particularly on its basis.

Particularly, and this conclusion is confirmed by other researches, under the similar operation and freight load conditions tear and wear rates increase following linear dependency on total mileage but nonlinear dependency on the mileage run in the track curves.

**Key words:** railway, rolling stock, tank wagon, tribology, center plate unit, tear and wear, numerical analysis.

## **Assessment of Interrogation Time for Analog Signals during Troubleshooting of Railway Automatics and Telemechanics Devices**

**Bestemiyanov, Petr F. Yuldashev, Shukhrat M.**

**pp. 36 – 43**

The control of operability of railway facilities and structures presupposes exploitation of systems based on modern hardware and software tools. The fact, that those systems in different countries are based on divers concepts and operation algorithms, doesn't affect the task of upgrading of hardware and software of control subsystems used to achieve processing speed and validity in order to identify symptoms (values), preceding failures.

Source information on conditions of different elements and units is received from diagnostic sensors or detectors. Every separate standard operation of data processing can be realized by different methods and, consequently, with different algorithms.

The unit of analog control, transforming analog value into digital data, is one of the core elements of control system. The most accurate algorithms of such units occupy large memory volume and have a prolonged execution time.

High sample rate causes control system sophistication and the excessive load on computing part of microcontroller. Low sample rate risks to make interrogation pointless.

The study of methods and techniques of determination of the interrogation time of analog signals is followed by extension of some new techniques intended to ensure the required accuracy of measurement, quality of received data, and validity of checking of effective values.

The process of uploading of information on permanently changing rates into the microcontroller is discrete in terms of time, so there is a task to restore the values of measured rates at instants of time, which do not coincide with the instants of measuring.

The data reconstruction process is usually based on different interpolation techniques while the accuracy is limited by quantization error. In conformity to Kotelnikov-Shannon theorem the exact reconstruction is possible only if analog signal  $x(t)$  has a limited spectrum.

The required accuracy of definition of interrogation value on analog-digital transformations is deemed to be achieved without having recourse to special extrapolation algorithms but by step extrapolation. Besides, thanks to that approach computing unit loading by data processing is considerably reduced.

Assessment of unknown period of interrogation of analog systems supposes computing of interrogation period by step extrapolation for every meaningful measured value.

Let standard error of  $x(t)$  value definition equal to  $sDx_{max}$ , i. e. random component of sensor and step extrapolation errors. The problem is to find under those

conditions a time slot between adjacent measurements, so that measurement, error should not exceed its prescribed value.

In order to proceed with initial computation of unknown time slot, an experimental measuring was held during which series of measurements were taken. Each value was measured 30–50 times with arbitrary time slots between adjacent measurements. The expanded process of further handling of results is shown in table 1 and in the text.

Practical implementation of the research can result in prolongation of time between measurements (i. e. for a signal of 220V and 50Hz to 1 ms, and for a signal of 110V and 25Hz to 1,5 ms), and consequently in making requirements for automatics and telemechanics troubleshooting hardware more ease.

**Key words:** railways, troubleshooting and control system, interpolated values, sampling rate of analog signals, algorithms of recovery of shape and value of the measured signals, determination of the effective value of the analog signal.

## **Energy Analysis of Oxyhydrogen Production**

**Pavlov, Georgy Mitkov, Cherneva, Galina Petkova, Vaseva, Radka  
Cyrillova, Sekulov, Lubomir Simeonov**

**pp. 44 – 51**

In order to optimize the use of oxyhydrogen mixtures in internal combustion engines, various indices of the electrolytic cell conditions have been tested with regard to its physical parameters. Density of the current passing through the electrolyte is perceived as key indicator of effectiveness and output capacity. Experiments were staged in a variety of physical settings: under different pressure, temperature, distance between the electrodes, varying electrode square area and strength of the electrolyte solution.

The researches resulted in following main findings:

1. The maximum effectiveness of an electrolyte cell is achieved at 3,5-7 A/m<sup>2</sup> current density.

2. Volume and energy distribution of hydrogen (liquid hydrogen) in combustion chamber attains about 3,7% of chamber volume, the same rate for petroleum fuel is about 1%, while for oxyhydrogen it equals 22,5% and oxyhydrogen compression nears critical value. The fact shows that this fuel can't directly replace petroleum fuel, but is suitable as an oxidizing agent only under certain conditions in reciprocating internal combustion engines with crank gear.

3. Actually oxyhydrogen can't be considered as a full substitution for conventional fuel because of high energyoutput ratio of electrolyte cell manufacturing.

4. Rise in output capacity of electrolyte cell consequently diminishes its effectiveness. Therefore, engineering of electrolyte cells requires optimization of

their dimensions which should conform to the criterion of maximal space of electrodes in order to achieve the required current density.

5. The engineered electrolyte cell allows for operation under 70 bar pressure. The testing proved that the output capacity increases following increase in pressure. This finding is a certain guideline towards optimization of energy-output ratio of oxyhydrogen production.

The testing and the study on oxyhydrogen production by electrolysis have revealed that under certain conditions transformation of electric energy as regards energy density of the gaz could attain 90%. This assumption creates outlook for researches on conservation and further use of the released energy in innovative engines.

**Key words:** oxyhydrogen, internal combustion engine, electrolyte cell, non-carbon fuel, energy efficiency, energy conversion unit, energy conservation.

## **Development of Hybrid Cars Fleet**

**Rakov, Viacheslav A.**

**pp. 52 – 59**

The comprehensive review of the development of hybrid cars production from the origins through the year 2012 shows significant differences between various countries and regions over the world as for the levels of manufacturing and sales. The study notes primary advantages and disadvantages of hybrid vehicles from the customer point of view. See the different competitive and ecological factors, it is evident that hybrid vehicles production and sales require a certain public support from behalf of the countries and within the regional organizations, and the relevant measures are also briefly reviewed.

On the basis of prevailing trends a short conclusion on possible outlook for the hybrid vehicle production is presented

A short but targeted chapter is devoted to the sales and especially to engineering of hybrid cars in Russian Federation, to the assessment of existing and required measures of public support there-of. Important investments are made in order to develop hybrid engines, there are some test models, and some of them have been already tested. But to the author's opinion, the serial production of hybrid vehicles still doesn't exist in Russia and the existing measures of public support are insufficient.

**Key words:** transport, hybrid car, statistics, world car fleet, outlook.



## **Crack Growth Resistance of Bituminous Concrete Pavement**

**Duhovny, Georgy S., Sachkova, Alisa V.**

**pp. 60 – 63**

The methods used to increase temperature resistance of bituminous concrete pavement are in the focus of researches in the sphere of road engineering which study first of all the bituminous concrete mixtures with polymer modified cementing bitumen. But the most common polymers of styrene-butadiene-styrene type, like DST-30–01, Kraton, Lupren LG, considerably increase costs of highways construction. That's why the researchers have restarted study on possible use of the waist of tyre manufacturing as modifier.

The study refers to the powder of discretely devulcanized rubber which serves as modifier under the name of Unirem.

The authors' technology permits to manufacture polymer astringent bitumen.

Evaluation of low temperature properties of such material were conducted during typical testing according to AASHTO TP1 standard that figures on the list of specifications «Superpave».

The tests revealed the data on crack resistance of rubber-bitumen cementing component of highways. A new method of analysis of deformation of cementing properties under low temperature and varied speed of reconstruction of lost properties is proposed. The results of “dry” and “wet” modes for the initial and modified bitumen components are compared.

Bringing in of rubber granules by “dry” mode doesn't ensure stability of the properties of bituminous concrete pavement. While the introduction of the rubber granules into bitumen and concrete mixture together with rubber-bitumen cementing component positively affects crack growth resistance and reduces the total costs of highway construction.

**Key words:** highway, bitumen concrete pavement, rubber cementing bitumen, crack growth resistance, hardness, deformation, comparative tests.

## **Reserves of the Cruising Speed in the case of Speed Restrictions**

**Feoktistov, Valery P., Borisenkov, Sergey S.**

**pp. 64 – 68**

Power consumption rate setting influences energy saving in the process of train traction. Possible growth of cruise, line and route speed is limited by track infrastructure, safety requirements and by additional power consumption.

Therefore there is a problem of assessment of possible cruise speed growth under the conditions when there are speed restrictions due to the infrastructural issues

(there are 4900 speed limits imposed a long of about 6000 km within the rail network of JSC Russian Railways), as well as of estimation of supplementary power inputs.

Such a system should be completed by the methods of statistical assessment of power and time losses caused by imposed speed restrictions. The dependencies between specific power consumption rates for the traction are found, given the example of cruise speed at Moscow-Vyazma track section. The number of coaches in a passenger train is also considered as specific indicator.

The analysis of received data permitted to decompose singular restrictions into point and prolonged limits. The survey of railway staff opinions helped to determine certain dependencies between speed, train length, and some safety precaution values to be further used to compute time and electric power losses.

**Key words:** railway, high speed traffic, speed restrictions, time losses, energy saving, traffic safety.

## **Russia and WTO: Transport Standards, Drivers, Innovations**

**Tereshina, Natalia P., Zhakov, Vladimir V.**

**pp. 70 – 76**

An active position of Russia in relations with trade partners as well as targeted interaction of the government and foreign trade actors are necessary in order to use benefits and advantages following Russian adherence to WTO processes.

In transport sphere it is necessary to shapely link safety, quality and competitiveness factors of traffic. New traffic technologies, including multi-mode traffic with packaging and container freightage, are at the same time consequences and prerequisites of efficient use of innovations.

Today while the drivers of traffic growth are concentrated around the goods which are traditionally delivered mostly in large containers, other goods which might be forwarded in containers are less considered. The part of transit container traffic in Russia is comparatively low and doesn't respond to its geographical situation as of a main land component of many transport corridors. The main limiting factor is lesser price/quality competitiveness of railways as compared to sea services. The main guidelines for container business in Russia are defined, notably for interior container traffic, international transit, foreign trade.

The main requests of customers as for the quality of container services are reviewed. The satisfaction with price is higher than with quality. The brief analysis of promoting measures outlines the necessity for new types of rail vehicles, information support, logistics and intermodal technology, new technology for perishing goods deliveries.

The development of transport industry can be described in terms of cycles, when periods of evolution (modernization) are replaced by qualitative bounces. So there are three forms of innovative development: replacement of vehicle models

within one and the same generation of technics and mode of traffic; change of generation of vehicles and technology within one mode of traffic (e. g. steam engines are replaced by diesel locomotives); emergence of new modes or vehicles based on scientific discoveries (e. g. maglev). The quality model of a generation of transport vehicles includes traditional criteria of assessment but also the notion of scientific and technical level of transport technics. Some comments refer to the life cycle of transport vehicles, particularly on the possibility to simulate the stages of the life cycle and distribution of the costs, so that to concentrate research capacity in the areas where Russia needs modernization and adaptation to WTO conditions. The main terms of Russian participation in WTO concerning transport and relevant spheres have been also reviewed.

**Key words:** competitiveness, intermodal freightage, multi-mode container traffic, World Trade Organization, WTO , transport innovations, international trade, railways, development, planning.

### **Typologization of Crises in Socio-Economic Systems**

**Makarov, Oleg N.**

**pp. 78 – 85**

The causes and problems of crisis in socioeconomic systems are considered as the main reason that influences the situation of railways

The indicator of the level of crisis situation in a system is proposed. The crises are classified by institutional sign, which helps to better understand their phenomenon. The study pays special attention to Kondratiev waves (also called supercycles, great surges, long waves, K-waves, the long economic cycle) and the cause-and-effect relations within them. The Kondratiev supercycles are taken as a reference point for the brief relevant study of developments of Russian railways in 19–20th centuries, including the impact of military risks of the reviewed period. The study substantiates the consistency of assessment of a crisis as of the event that is characteristic of a system, organization or economic sector at any stage of their developments. The conclusion accentuates the necessity to promptly assess the risks and to develop crisis management measures for railways, which run primary risks following general economic crises.

**Key words:** socio-economic system, economic crisis, railways, Kondratiev waves, adaptivity, stability, risk, economic equilibrium, crisis level indicator, classification.

## **Profitability of Passenger Traffic**

**Zhardemov, Bolat B., Bogdanovich, Svetlana V.**

**pp. 86 – 90**

The growth of profitability of passenger traffic is among the main tasks of railways. The best solution is to find an optimum balance between customer demand (possible train occupancy) and transportation offer (existing coaches rolling stock), taking into consideration the cycles of passenger flow variations (fluctuations considered weekly, by ten-day periods, monthly, seasonally, annually). The problem of optimization of traffic scheduling should not be limited to evaluation of profits from ticket sales and coach operational costs but should account for a number of qualitative and quantitative indices of the given route of a passenger train.

The profitability of passenger traffic depends mostly on two parameters: rate of passengers alteration (shift) and rate of operation use of train capacity. The critical values there-of are determined for seasonal cycles like «winter», «summer», «spring-fall». The created patterns help to forecast the number of passengers for forthcoming periods and to optimize thus the number of coaches operated for the given itinerary.

The researches have resulted in adoption of operation manual which governs train route scheduling and algorithms of specially engineered software packages. The results, if further implemented, may maximize profits of the railways.

**Key words:** railway, economics, passenger flow, profitability, train, seasonal traffic fluctuations, passenger shift, rate of capacity use, optimization.

## **On Civil Aviation in the Northeastern European Part of Russian Federation**

**Kiselenko, Anatoly N., Malaschuk, Petr A., Sundukov, Evgeny Yu.**

**pp. 92 – 98**

The detailed study enriched with actual data is devoted to the developments of civil aviation in the Northeastern European part of Russia. The analysis covers the historical roots and actual specific problems concerning replacement and enlargement of the number of aircrafts, development of airport network (especially airfields and landing grounds for local aviation), regional air business, training of the staff. The analysis of financial resources shows that allocations from federal budget, regional and local budgets, grants of EU are used in order to reconstruct and maintain local airports, especially in Arkhangelsk. The accent is made on the situation in the Republic of Komi to illustrate the problem, complicating profitability of air business in the region. Particularly the article contains a proposal to consider a possibility to found an enterprise «Airports of the Republic of Komi» under the legal form of state

enterprise. See the specific geographical characteristics of the region, the problem of criteria of the efficiency assessment of air transport activities is deemed to be considered through breakeven and social expedience rather than through profitability criterion.

**Key words:** civil aviation, local airlines, air company, training, air fields, airports, air traffic, aircrafts, investment, European northeastern part.

## **Results of Implementation of the Project of Integrated Management of Resources, Risks, Reliability Analysis at all the Stages of Life-Cycle (URRAN)**

**Zamyshliaev, Alexey M.**

**pp. 100 – 109**

The system of Integrated Management of Resources, Risks, Reliability Analysis at all the Stages of Life-Cycle (the short name URRAN is due to abbreviation of Russian spelled project title) has been developed by Research & Design Institute for Information Technology, Signalling and Telecommunications on Railway

Transport (JSC NIIAS) in cooperation with its parent company JSC Russian Railways and other partners in order to create a modern technology of support of decision-making in the sphere of reliability and operation safety of railways. The project implementation started in 2010 at the Severnaya (Northern) railway, a regional subsidiary to JSC Russian Railways, under the coordination of Russian Railways senior vicepresident Valentine Gapanovich. The previous researches were held by JSC NIIAS together with the officials of different functional divisions of Russian Railways particularly representing track, signalling and interlocker, automatic devices and teleautomatics, electrification and power supply divisions.

Testings of intermediary and final results of researches were organized at 261 stations, 288 stages, 29 permanent way divisions, as well as at different teleautomatics, electrification and power supply divisions. More than 3200 km of tracks were used for testing during 22 months.

The track divisions were tested in order to assess the quality of operations in conformity with URRAN indices, which go beyond the statistics of failures. The results and conclusions of assessments with URRAN methods are shown on the charts.

The teleautomatics divisions tested URRAN system by assessing reliability of automatic devices. The system allows identifying the devices with reliability indices below primarily designed and even allowed levels. The same tests were held in electrification and power supply division to verify aerial contact network.

The risk management segment was aimed at creating national standard «Functional safety. Risk management at railways», at staff and workforce training, at exact assessment of actual risks like violation by pedestrians of the rules of track

crossing, at engineering of the processes of interaction of different corporate divisions.

Traditionally the repairs of track infrastructure are scheduled in conformity with initially determined terms and periods of operation regardless of the actual conditions. The resources segment of the URRAN system is engineered from behalf another approach that permits to save important resources. Major repairs are held when the track achieves a «limit» condition. To assess the rate of «limit» condition the system evaluates the risks of traffic safety violations (depending on the aspects, specific for every railway technical division).

The URRAN testing implementation has resulted in considerable reduction of track maintenance costs. For instance the major repairs are held at the track divisions where rails can still be used, if one sees standard period of exploitation, but where current operational costs are higher than the critical rates of economic criterion.

The URRAN system gives the possibility to determine the track divisions which need repairs the most and to rationally distribute financial resources, to assess the risks of accidents at given divisions, ensure safety control even if the information is incomplete.

**Key words:** railway, resources management, risk management, reliability management, safety, project, research, results

### **What is Necessary to Respect the Schedule?**

**Levin, Dmitry Yu., Aung Hein Zaw, Myanmar, Shmal, Vadim N.**

**pp. 110 – 119**

The problem of respect of the train schedules is important for railways of different countries. It is insufficient to compose the schedule, it is necessary to create and to maintain the optimum conditions for it should be respected. Analysis of fulfillment of schedules and of some mathematical applications used for traffic control and planning shows that there are some less known regular occurrences, useful to plan and assess the density of train flows. For instance there is a widely spread opinion, based on standard equation, that if more trains pass by a given leg then the volume of traffic is bigger. Or less is the interval between the trains, more is traffic capacity use ratio. Practices and researches show meanwhile that the interval between the trains can't be reduced to arbitrarily small value. Besides, while the inter-train interval reduces, the gap between the actual and idealized traffic capacity grows. The study defines factors to be considered while creating conditions for schedule respect at the branched track divisions. Some tools to control super-density of trains at the track divisions and to optimize the regulations in effect on the freight and passenger traffic are proposed. The whole system of proposed equations and algorithms is aimed at respecting of schedules rather than on scheduling itself.

The tools are proposed to adjust and to make conform to each other the planned volumes of traffic and the traffic capacity of the legs.

**Key words:** railway, traffic schedule, optimization, distribution of train flows, acceptable number of trains, control of train density, time zone, planning by 24 hours and by teams.

## **Building Railway Self-Regulated Organizations**

**Kolesnikov, Maxim V.**

**pp.120 – 123**

A comparatively new issue for Russian transport system is introduced and proposed for discussion. The brief analysis shows that there are two different approaches depending on the given fields of activities.

There are fields where voluntary self-regulated organizations may be useful. Capacity of self-regulated organizations can be realized in some spheres of railway business, for instance in machinery construction, in the sphere of private operation of rolling stock, as the state legal regulations have not yet been adopted these in fields.

Secondly, there are fields where the access is legally restricted to members of self-regulated organizations only (or by certification received from them). Such practices became legally binding in 2010 in construction sphere, so it is the same for the construction of railway infrastructure.

The list of promising spheres of self-regulated activities composed by the author includes namely services to passenger (as a functional sphere common for all kinds of transportation including air, railway, river and road transport), researches, professional training and some others. There are no rigid conclusions as for the usefulness of voluntary self-regulated institutions in the railway sector of economics but there is a wide space for discussions.

**Key words:** self-regulated organizations, transport, freight and passenger market, alternative to competition, interaction principle, conciliation of interests.

## **Technological Necessity for Train Making-Up and Scheduling Updating**

**Erofeev, Alexander A., Korenev, Pavel G.**

**pp. 124 – 129**

The number of freight cars in Russia has considerably increased lately (more than 1 mln units in 2011), but the rate of satisfied demands of customers for freightage has on the contrary reduced. The time of delivery is increasing. As there is

no shortage in cars the problem resides in non-efficient operation of private car rolling stock. The capacity of reduction of delivery time should be considered through reducing staying idle time and delays under technical and loading operations rather than by increasing technical speed. So the problem of enhancement of freightage should be seen and approached firstly as an economic and technological process.

According to technology in force the car traffic is organized in conformity with the plan of train makingup. But the plan, which is adopted for a full year period, is optimum for a certain assessed volume of car traffic. As a rule, it's the most probable value of traffic density. And there are considerable fluctuations from and towards the average value during the year.

In order to put the plan of train making-up in conformity with real traffic density it is proposed to implement the technology of prompt updating of train making-up plan and of selection of car traffic operation. The updating supposes the choice of a variant that permits to deliver all goods in time, depending on their logistics characteristics, and with minimum possible costs. It should be taken into account that the updating of train making-up plan at one station has a direct, and sometimes, negative impact on the plans of other stations of a rail network. In order to avoid negative effects it is necessary to compute critical max and min values of car traffic that allow maintaining the actual plan.

The proposed planning and scheduling are based on a simulation model, that, processing data on the approaching trains, number of the cars within the local network and their logistics characteristics, results in scheduling the trains traffic towards destination point.

The patterns of integrated computation are shown for departing routing and for through trains planning.

**Key words:** computation, railway, train making-up, freightage, private cars, operation planning, economic benefits.

## **Classification of the Methods of DDoS-Attacks**

**Kovaliev, Dmitry A.**

**pp. 130 – 134**

The article describes Internet distributed denial of service- attacks (DDoS-attacks) and proposes classification of such offences by the objectives and tools of realization, making distinction between typical methods and those based on the hierarchy of generalized structure.

The hierarchical classification proposed in the article can be considered to be universal from the point of view of DDoS-attacks mechanisms and sufficient for understanding of the processes of their organization. The hierarchy-based approach can significantly reduce the time of analysis during solving typical problems,



necessary for the protection of a system and for neutralization of malicious attempts. Such classification can serve as a basis for engineering of the tools of detection and identification of DDoS-attacks in certain protocols at application level which makes it not only analytic but practically oriented as well. See the modern electronic service systems for customers in the transport sphere it can be useful for the protection of this sector too.

**Key words:** transport, control system, processing, Internet, denial of service, classification, DDoSattacks, hierarchical structure, security.

## **Ultraviolet Radiation for Decontamination of Wastewaters**

**Pashinin, Valery A., Pavlov, Alexander V., Kovalenko, Maria A.**

**pp. 136 -143**

Rail transport has always pretended to be most resource conserving in terms of natural resources consumption per unit of transported goods and ecologically less harmful as for emission and discharge of contaminants. Nevertheless the issue of the quality of purified effluent at the installations of JSC Russian Railways is still urgent and the environmental activities are among the most demanded engineering tasks.

Regardless of almost ultimate renunciation of steam traction, the railways increase water consumption because of the growth of their length and traffic capacity. An important part of the water is consumed irrevocably (in passenger coaches, for reception of steam, fabrication of ice) as the rate of water recycling and reuse is about 30%. The remainder goes to surface water bodies. The most harmful are: cleaning and steaming posts for rolling stock, disinfection posts for cars, locomotive and wagon depots etc. The most common pollutants are oil, petrol, diesel fuels, phenols, dissolved acids. Carbon monoxide, nitrogen oxide, hydrocarbon, phenols are emitted at different stages of operations and so form the priority indices of the level of pollution.

Different tools of purification have their own advantages and disadvantages. The main industrial method of chlorination can't ensure the totality of hygienic and ecological requirements. The up-andcoming industrial method is decontamination of waters by ultraviolet radiation. The basic principles of decontamination by ultraviolet instruments, together with mode of processing of waters, results' monitoring tools and indices are described.

Ultraviolet radiation finds also some other applications. The proposed method of control of waters is based on the capacity of most organic matters of different classes to absorb light in the range of 200–280 nanometer. The proposal of the authors consists in measuring ultraviolet rate (A 254) with the wavelength of 254 nanometer in quartz dish with measured solution layer's thickness of 10 mm, distilled water serving a solution of comparison. A spectrophotometer of any model capable to take measures in ultraviolet spectral region can be used. Ultraviolet rate is a new

optical index, which can define demand of chemical oxygen, biochemical consumption of oxygen, contents of residual organic impurities in purified wastewaters. The correlation dependencies «A254 – demand of chemical oxygen» and «A254 – biochemical consumption of oxygen» permit to assess the level of quality of purified wastewater. The proposed method can ensure continued real-time monitoring of the quality of water purification.

**Key words:** ecology, railway, biosphere, hydrosphere, methods of water decontamination, quality control, ultraviolet radiation, UV-decontamination.

### **The Use of Devices of Preflight Screening**

**Bochkarev, Alexander N., Bochkarev, Ilya A.**

**pp. 144 – 147**

The risk of illegal interference acts in the airports and on board of aircrafts with the use of dangerous objects and self-made explosive devices, hidden in the clothes and in the shoes of passengers, is still high.

The measures on neutralization of such risks depend on the level of terrorist threats in a given country. In order to respond to terrorist alert it is necessary to use the integrated approach so that any separate kind of preflight screening has its own function within the framework of security measures. To simplify the process of shoes control there are some special radio-metal devices (Magshoe of Israel, Shoe Analyzer Metal Detector of Italy, some Russian devices).

The deployment of the radio-metal locators needs financial resources. But the costs should be reasonable and substantiated economically. But at the same time the process of screening should respond, as far as it's possible, to customers' interests. The example of relevant economic substantiation is described for a device installed at the airport of 20 mln passengers / year and a breakeven point in two years from installation is proved.

**Key words:** aviation, cost effectiveness, capital expenditure, flight security devices, cost justification.

### **Enhancement of Efficiency of Heating System with the Help of Infrared Heater**

**Sidorov, Yuri P., Tolschina, Ekaterina Yu.**

**pp. 148 – 151**

See the Russian climate there is always a task to find most efficient systems of heating of industrial sites in transport sector. The article considers possibility to use infrared gas heaters in car repair shed.

Radiation heating is more efficient if compared to convection system as it results in more even distribution of temperature in the premises, fast changing of temperature to the required level, reduces effects of airflows, and consequently the dust level. It also saves at about 15-30%% of heating power. These conclusions are substantiated by mathematical methods. The algorithms of correct installation are also shown.

It is proved that thanks to well-engineered heating process, infrared heaters are ecologically less harmful than heating systems with gas burning in boilerhouses. They are safe and conform to the job safety standards in effect.

**Key words:** railway, car repair shed, heating system, energy effectiveness, ecological conformity, infrared gas heaters, radiator suspension, radiation flow, operation conditions.

## **Optimum Time Spans of Preventive Replacements for Railway Engineering Structures**

**Smirnov, Vladimir Yu., Kos, Oxana I.**

**pp. 152 – 155**

As total length of engineering structures within the railway network of Russian Federation exceeds some thousand km, their reliability has a direct impact on the traffic safety.

The reliability and safety of their operation depends on correct maintenance. Two approaches prevail in calculating of time spans of maintenance of a bridge: the permanent one that uses mean values for bridge maintenance works, and the flexible one that uses the results of the assessment of actual state of a bridge. The trend to use the least approach now dominates.

The authors use the method of probabilistic model of a structure as of a complex technical system to forecast the limits of faultless operation. So the control of technical state of engineering structure is considered under the conditions of damage accumulation till the determined level [1–5].

Automation of the control with the help of a specially designed software package permits flexible interventions when the real state of a structure demands replacement or reinforcement works. The model under the study demonstrates the advanced accumulation of damages in one of the bridge span elements and the control of the safety of the whole construction uses two levels of limit states [6].

The programming language for software package is C#. Installation package facilitates the operations assisting to design a new construction or to generate a construction based on standard prototypes.

The software package of computation of optimum time spans for preventive replacements of the elements of engineering structures has some special features: high generality as it fits any kind of engineering structures, interactivity while

computing. It conforms to any moment of operation of structures (from the beginning of operation or at any other moment), suits rowing function of failures, considers all possible variants of replacements. It also takes into account different optimization scenarios (minimum visits to the structure, resources saving, climate specific conditions). Invariance as for train types is also of importance.

All the organizations that design or operate railway structures can efficiently use the software.

**Key words:** transport structure, technical state, reliability, safety, control, automation, software, replacement time spans.

## **Cleaning of Streams and Storm Runoffs**

**Riazantsev, Vladimir R.**

**pp. 156 – 158**

Industrial zones adjoining transport locations and railways need efficient treatment hydro-facilities. The continued study of MIIT researchers concerns hydrobiological methods of fighting pollution of rivers and lakes by discharged waters. The technique replaces chemical agents via hydrobiological and hydro technical processes.

The installation proposed is a tankage that resembles a sewer with an isolated inlet. The sewer is well adjusted and the water comes from the stream by gravity with the help of an original hydro device. The aeration of waters takes place by overflow and level difference.

The process of purification of waters passes within artificial specific ecosystem (water fleas, mollusk, protozoa, and some Pisces etc). The above mentioned species purify the waters themselves (as water flea, mollusk) or assist the plants by creating specific ecosystem in the limits of hydro- and bio tableland of artificially built brook

This project seems more ecological and can be widely implemented under certain conditions.

**Key words:** streams, wastewaters, treatment facilities, hydrobionics, ecosystem, natural shield.

## **Call-up of «Working Days»**

**Belogurova, Tatiana A.**

**pp. 160 – 167**

Historical review covers the period of the 1930s and reveals labor conditions, food and other goods provision of the workforce, social conditions of the railways of

Smolensk region. Some of the facts show that the Smolensk subsidiary of Moscow Institute of Railway Engineering, then training the workers in the evenings, gained wide popularity. The lack of engineers was to be compensated by accelerated training of young people. There are also some statistical data on the rail transport developments.

**Key words:** railway, history, Smolensk region, labor, workforce recruitment, social supplies, training, spread of polytechnic education

### **«New Comintern» of Bonch-Bruevich**

**Grigoriev, Nickolay D.**

**pp. 168 – 175**

Commemorative historical article is devoted to the 125th anniversary of Mikhail Bonch-Bruevich (1888–1940), founder of Russian electronic industries and broadcasting, corresponding member of the Academy of sciences of ex-USSR. One of his merits was to organize broadcasting of musical concerts for the first time in Europe...

In 1909 he graduated from the military higher college of electric engineering as a second lieutenant. In 1913 he published his first research paper on the theory of spark discharge and was awarded some prizes. At the beginning of the world war I he became a chief of one of two Russian spark radio stations responsible for communications with Russian allies – Great Britain and France... It was a start of his career of a brilliant radio engineer...

**Key words:** radio engineering, electron tube, radio station, directional aerial, radiophonics, short waves, ultrashort waves.

### **Interlink Integration**

**Lahmetkina, Natalia Yu.**

**pp. 180 – 184**

The review of the book: Balalaev, A.S., Leontiev, R. G. Transport and Logistics Interaction in Multimode Freightage. Monograph. Moscow, Training and methodological center of rail transport. 268 pp. (2012).

The book contains system analysis of problems and tasks, referred to logistic follow-up of freight traffic in multimode transportation. The authors have revealed the particularities of origins and of actual conditions of transport and logistics structures, the study is based on strict criteria of assessment, quality standards. The

conclusions and recommendations can be useful for the experts in logistics and transport services.

**Key words:** multimode traffic, logistics, transport market, actors of traffic, transport and logistics centers, integration, interaction.

## **THE ORDER IN THE TRAFFIC**

**Lerman, Vladimir D.**

**pp. 185 – 187**

The review on the book: Zabiroy, H. Sh., Shapkin, I. N. Logistics of Railway Freightage (Actual State, Theory, Practices, Outlook). Moscow, VINITI of Russian academy of sciences editions. 343 pp. (2012).

The contents of the book widely cover the issues of engineering of logistics methods of management of freight and passenger traffic. The ideas of the authors are illustrated and proved with the help of many concrete cases concerning practices of stations and local railway networks, of e-documents circulation, freightage with firm schedule fragments, promising techniques of logistic centers. There is an important focus on the intelligent transport systems concept and its implementation in logistics.

The monograph will be useful to a wide spectrum of railway experts, will help to solve the tasks of optimization and management of rail traffic. And it will certainly be a good piece of knowledge for the students of transport universities, colleges and high schools.

**Key words:** railway transport, logistics, traffic, freightage, theory, practices, technology, logistics centers, information resources, outlook for development, management, goods traffic.