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TECHNICAL ASSET MANAGEMENT FOR RAILWAY TRANSPORT BASED ON RISK ASSESSMENT

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Abstract

In the conditions of the stagnation of the global economy, the issues of finding the optimal strategy that would allow taking into account the balance of interests between costs, opportunities, performance of the company's technical assets and risks come to the forefront of the company's management. To this end, the URRAN system has been created, operated and developed in the Russian railway transport -a system for managing the reliability, safety, and resources of transport facilities based on risk assessment. Within the framework of this system, the tasks of operational collection, processing and analysis of the current state of reliability and safety of transport facilities, the activities of structural units are solved on the basis of risk assessment of maintenance management, assignments of major repairs, modernization and modification of transport facilities. The reliability and safety of transport facilities are managed within the framework of Big Data using artificial intelligence methods. Fire safety management is carried out using an automated fire risk management system, which is part of the URRAN system. It allows, based on the results of the fire risk forecast, to make a decision on the need for repair, replacement or maintenance of transport facilities and their fire safety system.

Keywords: risk, technical asset, reliability, safety, resource, railway transport facility, safety principle, risk matrix, integral risk, risk management, infrastructure, rolling stock

I. Introduction

Railway transport of the Russian Federation is mainly represented by JSC "Russian Railways", which, in turn, is the largest owner and explant of transport infrastructure facilities in the territory of the Russian Federation. Almost 335 thousand people work in the infrastructure complex of JSC "Russian Railways", they serve about 150 thousand kilometers of tracks, 30 thousand bridges and overpasses, 159 tunnels, more than 5 thousand stations and many other infrastructure facilities. At the same time, JSC "Russian Railways" is a major owner and operator of communication networks, operator of telephone and radio communications, including digital (DMR, Tetra, GSM-R). The total length of the communication lines of JSC "Russian Railways" is more than 330 thousand kilometers, the length of fiber-optic communication lines is more than 77 thousand kilometers. The railway infrastructure operates more than 500 thousand pieces of automation and telemechanics equipment, as well as more than 6 million different sensors, diagnostic equipment and telemetry.

Uninterrupted provision of the transportation process with electricity is carried out by 1,402 traction substations. 11,000 freight locomotives of direct or alternating current traction, 6,000 shunting locomotives, 1,600,000 freight cars of all types and owners, 24,000 long-distance passenger cars, more than 15,000 suburban train cars are used on the railway network of JSC "Russian Railways". Russian Railways Holding is the largest system-forming component of the

Russian economy, the most important link of its transport system, providing more than 44% of cargo turnover and more than 30% of passenger turnover of the entire transport system of the country, forming 1.7% of Russia's GDP, 1.5% of tax revenues to the country's budget system, up to 4% of total capital investments in Russia. JSC "Russian Railways" is among the TOP 5 largest companies in Russia, occupies a leading position in the world along with the highways of the USA and China, including in terms of traffic volumes. The share of the cost of fixed assets of the infrastructure of the Company "Russian Railways”. The current situation in the world, associated with the introduction of widespread restrictions due to the COVID-19 coronavirus pandemic, has led to the stagnation of the world economy, in particular, in transport. The greatest blow fell on air transport, which practically stopped its activities, stopping flights in international traffic and reducing the number of flights in domestic traffic as much as possible. Railway transport, as a system-forming link of the state economy, did not cease its activities, but also faced a sharp drop in loading, a decrease in the activity of the population and, as a result, a decrease in revenue, which led to the rejection of strategic initiatives for the development of the infrastructure complex in favor of preserving the company's teams and ensuring current operational activities. So, according to RBC (www.rbc.ru) "Russian Railways" (RZD) recorded a failure of cargo turnover in March 2020 by 7.3%, and in the whole year about 5%. Passenger turnover in 2020 decreased by 56%. Things are not going well in the European Union. According to Global Railway Review (www.globalrailwayreview.com) rail transport indicators have decreased by 30% since the introduction of quarantine measures. All participants of the transport market also have to hastily revise their investment plans in favor of solving operational tasks.

II. Asset management system

The work model of a modern company in a simplified form consists in a constant search for ways to increase its profitability and reduce costs while meeting all regulatory requirements, by which we can mean requirements in the field of safety and reliability of train traffic, labor protection, environmental and fire safety, etc. Of course, it is impossible to endlessly reduce costs while achieving income growth. Therefore, the issues of finding the optimal strategy that would allow to comprehensively take into account the balance of interests between costs, opportunities, risks and asset performance come to the forefront of the company's management. An asset, in accordance with the ISO 55000 series of standards, should be understood here as an identifiable object, thing or object that has potential or actual value for the organization. [1,2]. Thus, the construction of a modern effective company management system is possible only on the basis of the principles.

Asset management focuses not directly on the asset itself, but on the value that the asset can provide to the organization. Asset management involves finding a balance between costs, prospects and risks, on the one hand, and ensuring the required performance of assets, on the other, to achieve the goals of the organization.

In the asset management system , the following become mandatory: - information (asset data); - assessment of the technical condition; - risk assessment; - RCM is a process where RCM (Reliability Centered Maintenance) is reliability-oriented maintenance); - life cycle cost analysis; - analysis of performance indicators, including the overall efficiency of equipment – OEE (Overall Equipment Effectiveness), etc.

III. URRAN system: the goals of the system and composite complexes

In JSC "Russian Railways". Since 2010, the project of reliability, security, and resource management based on risk assessment (URRAN) has been implemented [3-6]. The results of this project are the basis for the management system of technical assets in railway transport. They include methodology, information support, and regulatory framework. Currently, URRAN is a set of methodology, regulatory, methodological and information support, as well as software and hardware designed for integrated management of resources and processes in order to effectively provide railway transport services.

The object of application of the URRAN system is the means and systems of railway transport and the technological processes implemented by them.

The purpose of creating the URRAN system is Adaptive management of the technical content of the facility based on compliance with the criteria of reliability, safety and economic efficiency of functioning at the stages of the life cycle, taking into account risk assessment. Here, adaptive management (adaptive management) refers to the forms and methods of managing business structures, assuming the ability and ability of the management system to change the parameters and structure of the regulator and the control subsystem as a whole, depending on changes in the internal parameters of the control object or the external environment (disturbances), as well as changes in strategic goals. The functional purpose of the URRAN system is the effective management of technical assets.

The purpose of the introduction of the URRAN system on the railway network – Improving the efficiency of railway transport on the basis of adaptive management of technical content in conditions of resource constraints. Each complex of objects of JSC "Russian Railways" has specific features that are due to the purpose of this complex in the transportation process, the conditions for the implementation of this purpose, as well as the established links with other complexes. Therefore, the goals of the URRAN system implementation for each complex are specific

Track complex: Reducing the cost of the life cycle of the track infrastructure due to the redistribution of resources, provided that the required level of operational reliability and acceptable level of train safety is ensured.

The complex of automation and telemechanics facilities: Improving the operational reliability of railway automation and telemechanics systems while ensuring an acceptable level of train delay and a predictable life cycle cost based on the redistribution of resources..

Complex of Transenergo (electrification and power supply) facilities: Increasing the life cycle of electrification and power supply systems based on risk assessment, provided that the required level of operational reliability and acceptable level of train safety is ensured.

The complex of railway telecommunication facilities: Reducing the cost of the life cycle of railway telecommunication systems by increasing the efficiency of resource management based on improving the technology of operation of telecommunication networks while ensuring the required safety and reliability indicators in the provision of telecommunication services.

Locomotive complex: Reducing the cost of the life cycle of a locomotive by increasing the efficiency of resource use, provided that the required level of operational reliability and an acceptable level of train safety are ensured.

Motor car rolling stock (MVPS): Reducing the cost of the life cycle of the MVPS due to the efficient allocation of resources while ensuring an acceptable level of traffic safety and maintaining the requirements of passenger comfort.

Asset management involves finding a balance between costs, opportunities, risks and the required performance of assets. Violation of this balance leads to unjustified costs or unacceptable risks of violating the safety of the transportation process. Achieving this balance is realistic when implementing Asset Ownership Planning **(PSV)**. This is nothing more than Results-based Management **(RBM).** This maintenance and repair strategy is based on risk, revenue, and cost management at all stages of the asset lifecycle. At the same time, effective investment decisions on the long-term horizon, investments in the development of technical personnel and information systems are envisaged.

The URRAN system is conceived and implemented as a deeply layered PSV system at the level of complexes of facilities, directorates and structural divisions. It is complemented by adaptive control technology, which expands the ability and ability of the control system to change the parameters and even the structure of the regulator depending on changes in the conditions of the transportation process.

IV. Tasks of the URRAN system

To achieve the intended goals, the URRAN system is designed to solve the following tasks: - to assess and predict the reliability and safety indicators of infrastructure facilities and rolling stock in real time; - manage technical and technogenic risks;

- to assess the wear, residual resource and marginal condition of railway transpredict the state of infrastructure facilities. Predict dangerous failures of infrastructure and rolling stock; The task of predicting the condition of infrastructure facilities is one of the most costly and responsible tasks of managing their technical content. In the URRAN system, this task is solved both with the help of diagnostic complexes, and especially on the basis of Data Scensis technology with the help of artificial intelligence algorithms [7-12].
- to estimate the cost of the life cycle of railway transport facilities;
- evaluate the activities of the divisions of JSC "Russian Railways" taking into account their results of work to ensure the reliability and safety of operated facilities;
- manage resources aimed at technical maintenance; port facilities;
- on the basis of a single corporate platform **(*ECP) URRAN*** to provide support for management decisions. The task of providing support for management decisions based on the unified corporate platform of the *URRAN ECP* is a large-scale work on the informatization of the processes of collecting, analyzing, processing and investigating events and decision support **(***DSS***)** for the heads of enterprises, railways, Directorates, Management of JSC "Russian Railways". The *URRAN ECP* system is formed in the form of a four-layer architecture. The lower layer is data sources (automated systems of JSC "Russian Railways".). The second layer is the integration layer, which contains data integration modules. The third layer is data warehouses. It includes databases, aggregating functions and a computational pipeline for data aggregation. The fourth is the central layer. this is the analytics layer that implements the methodology of the URRAN system.

The task of risk management within the URRAN system is aimed at solving problems:

- ensuring the safety and reliability of the transportation process;
- ensuring the safety of professional activities related to the technical maintenance of railway transport facilities;
- ensuring fire safety;
- rational allocation of resources to ensure acceptable levels of safety of the transportation process and reliability of transport facilities

V. Principles of risk management and features of risk assessment in the management system of technical assets in railway transport

Principles of risk management. The task of risk management within the URRAN system also includes minimizing the risks of pedestrian injuries at pedestrian crossings. This report focuses on the conceptual provisions of risk management in the URRAN system. There are many accents in the definitions of risk [13]. Most of them concentrate either on taking into account the impact of uncertainty on goals (ISO 31000), or on a combination of probability and severity of consequences (harm) (IEC 62278). The definition of the IEC 62278 standard has been adopted in railway transport [14]. This circumstance predetermined the application of the principles of MEM, GAMAB, ALARP for risk management.

The principle of MEM (Minimum endogenous mortality) is as follows: *"the threat associated with the new system should not increase the minimum endogenous mortality rate for an individual*."

The principle of GAMAB (Globalement Au Moins Aussi Bon (France) is generally at least the same): "*All new managed transport systems should generally have a degree of risk at least the same as an equivalent existing system."* This formulation takes into account what has been achieved and implies the need to improve the designed system through the requirement "at least". It does not consider a certain type of risk, as indicated by the words "in general". Suppliers of infrastructure and rolling stock are free to choose between different types of risk inherent in the infrastructure and rolling stock, and apply the appropriate approach, i.e. qualitative or quantitative.

The principle of ALARP (As Low As Reasonably Practical: *"The risk is as low as it is practically reasonable"*) . An acceptable level of risk , according to the ALARP principle, is a level of risk for which the costs of achieving it are cost–effective. This principle is the basis for risk management in the URRAN system. The essence of the ALARP principle is as follows. In relation to individual risk, three zones are distinguished: 1. The zone of unacceptable risk, when the risk must be reduced for any cost - some risks are so great, and the consequences are so unacceptable that they are unacceptable and cannot be justified in any case. The upper bound defines the risk levels that are unacceptable. If the risk level cannot be lowered below this limit, then the risk should be excluded; 2. The zone of negligible risk - no risk reduction measures are required; 3. The ALARP zone - this zone between the upper and lower boundaries is called the ALARP area.

There are various ways to apply the ALARP principle. In some cases, it is sufficient to indicate that the best of the available modern standards and practical developments have been used. In the case of new types of activities or when the adequacy of modern standards and practical developments is in doubt, the concept of cost-benefit analysis is used. The content of this concept is as follows. If the risk of an object is located in the ALARP zone and its reduction is impossible, or the costs of reducing it are clearly not commensurate with the expected benefits, then such a risk is undesirable, but nevertheless allowed. Here the final word remains with the operating organization. The lower part of the ALARP area corresponds to a situation when the disparity between costs and benefits does not exceed the specified value for the risk reduction measure under consideration. In these cases, funds should be spent on risk reduction. This risk is commonly called acceptable. The results of cost-benefit analysis often depend on how the consequences of a dangerous event are assessed (for example, the value of human life or prevented mortality). A demonstration of the use of the ALARP principle is given by us in GOST 33433-2015 [15].

Risk management in the URRAN system is carried out according to the standard scheme of the following steps: 1.Stage of risk assessment: definition of the scope of risk analysis; identification of risk; assessment of the magnitude of risk; analysis of consequences; determination of the permissible level of risk. 2. Stage of risk assessment and processing (risk assessment (or comparison); risk processing :risk prevention, risk transfer, risk reduction, risk acceptance. 3. Stage of risk monitoring and revision: risk monitoring, risk revision.

The risk matrix. The presentation of the results of risk assessment is most often carried out using a risk matrix. The risk matrix is a modified form of the risk graph and allows you to display risk levels in the frequency-consequences coordinates, set both qualitatively and quantitatively. Since the risk level R is expressed by the product of the frequency f of the occurrence of an undesirable event and its specific damage C, the scales of the frequency scale and the scale of consequences on the risk graph should be logarithmic. This ensures that the hyperbolic dependencies f = R/C (R = const) are displayed in the "frequency-consequences" coordinates in the form of straight lines and allows you to move from the risk graph to the risk matrix with the least significant loss of accuracy. If a straight line $f = R_{acceptable}/C$ is given, where $R_{acceptable}$ is the established acceptable risk level, then all points lying below this straight line will correspond to a risk level less than acceptable, and those above this straight line will correspond to a risk level more acceptable.

For practical use, as a rule, several interval ranges are set for risk assessment in several categories. The first task in constructing the risk matrix is to select the parameters of the risk scale. This problem was solved in [15-19 et al.]. Since quantitative risk assessment is of the greatest interest, such parameters will be: - the number of estimated intervals of the risk scale; - sensitivity of the risk scale, expressed by the relative step K of the risk scale; - binding value – the absolute value of the risk corresponding to a given point on the risk scale; usually the value of $R_{accrptable}$ is set at the point of the scale corresponding to the permissible level of risk. As a rule, the number of risk intervals (categories) is set for a wide range of risks and is not subject to change in the process of constructing risk matrices. For all the risks under consideration, a risk scale is adopted, which has 4 estimated intervals of risk values, colored in appropriate colors: *unacceptable* - ***red*** , *undesirable* - ***orange*** ; *acceptable* - ***yellow*** ; *not taken into account* - ***green***

The binding value is uniquely determined by the acceptable risk level, which is set for each type of risk, or by two ALARP levels (acceptable and negligible risk levels), which are also set for each type of risk. The choice of risk scale parameters, frequency scales and consequences is described in detail in [19].

Integral risk. A measure of the security of a system object can be the magnitude of its risk, which is based on the risks of the composite factors (elements) of the object. The need to determine the integral risk of the object and the system is as follows. Summing up the risks of all elements is not acceptable, because, for example, they may have different dimensions (the number of deaths over a certain time is a social risk or the cost of losses is an economic risk). We need another methodological tool that is able to transform various security measures of objects (elements) to some single integral measure of the system. Similar tasks arise in medicine, the food industry, transport, etc.[20] .

Let system A consist in the general case of a finite set of elements of different types $A=\{a_1,a_2,...,a_i,...a_j,...,a_k\}$. At the same time , the possibility of equivalence between the individual constituent elements is not excluded $a_i \Leftrightarrow a_j$. The safe operation of each element of the system is assessed by a certain amount of risk $a_i \rightarrow R_i$. Risks are formalized using the risk matrix tool. In general, the risk matrix contains m rows and n columns. Each line corresponds to a certain frequency of occurrence of a dangerous event $f_1, f_2,..., f_m$. The columns correspond to possible damages $c_1, c_2,..., c_n$. The extent of the damage depends on the object of the study. This may be the price (relative to economic, technical or man-made risks), the lethal outcome in relation to social risks, the number of negative events due to a dangerous event (relative to moral risks), etc. It is assumed that the frequency of occurrence of dangerous events and damages from them are estimated according to a posteriori data. This makes it possible to determine the security risks of all system elements at the intersection of the corresponding rows and columns.The risks of elements of different types are not equal to each other, for example $R_1 \neq R_i$ (equivalent elements have equal risks $R_i = R_j$). The task is to assess the risk level of the system based on the results of risk assessment of composite elements of different types. It is assumed that the risks of the system elements are mutually independent.

In many cases, the system under study consists of different types of objects that differ in damage scales and types of risks (for example, technological or social). Now it is impossible to summarize the risks of composite objects, as well as it is impossible to form a general scale of damage. To assess the risk of a system based on the totality of risks of composite elements of different types, it is necessary to have at least one common measure for all risks. If we consider the risks with respect to the measurement scales f and c, then this general measure is missing. The measure of damage may be different. This also applies to the frequency of occurrence of dangerous events, which elements and can vary many times. However, upon careful consideration of the constructed risk matrices of the system elements, we find a general measure of risk assessment, which, If we consider the risks relative to the measurement scales *f* and *c*, then this general measure is missing. The measure of damage may be different. This also applies to the frequency of occurrence of dangerous events, which elements a_i and a_j can vary many times. However, with careful consideration of the constructed risk matrices of the system elements. we find a general measure of risk assessment, which is contained in the decision-making levels. In accordance with the ALARP principle, there are four levels of risk hazards in total. The common field for combining the results is the decision colors (risk levels) for each of the objects. In order of increasing their importance, these levels are displayed in green, yellow, orange and, finally, red. The green color of the decision means that the risk is so insignificant that it may not be taken into account. The significance function in the green cells of the matrix should have small values (from zero to some insignificant value). At the same time, orange, especially red, means the highest degree of danger and the significance function in these matrix cells should have the highest possible values. There are three possible strategies for constructing the significance functions of the risk level decision in accordance with the accepted colors: 1. Linear 2. Power 3. Logarithmic. Strategy 2 corresponds to a responsible attitude to changing the significance of the color of the decision. Strategy 3 of constructing the significance function should be considered as an irresponsible attitude to the decision made about the level of risk of the object, since in this case the significance function levels the degree of danger of the red color, which reflects an unacceptable level of risk. Thus, it is advisable to use a power function to digitize the results of the risk assessment of objects expressed in one of the four specified colors. Step functions with a base $1 \leq a < 2$ do not provide high sensitivity to changes in the significance of the color of the solution, especially in the area of high risk levels. At the same time, based on $a > 2$, there is an unjustifiably high sensitivity to an undesirable and especially unacceptable level of risk and practically neglect of the significance of the permissible level of risk.

A compromise solution consists in choosing the basis of a 2-step function of the significance of the colors of decisions about the level of risk. The procedure for calculating the color weight and, on this basis, the integral risk assessment are given in [20]. Within the framework of the URRAN system, technical asset management tasks have been implemented based on risk assessment of infrastructure facilities and rolling stock complexes [21,22, etc.], a digital risk management platform has been created [23].

An example of calculating the integral risk and making decisions based on it can be the process of managing the technical content of a section of the track. The cost of maintenance costs for the facilities of the track complex reaches 80% of the cost of maintenance costs for all infrastructure facilities. For this reason, the implementation of rational management of the technical content of the facilities of the track complex is of great practical importance .based on a risk assessment.

VI. Example of managing the technical content of a section of track based on risk assessment

An example of calculating the integral risk and making decisions based on it can be the process of managing the technical content of a section of the track. The cost of maintenance costs for the facilities of the track complex reaches 80% of the cost of maintenance costs for all infrastructure facilities. For this reasons , the implementation of rational management of the technical content of the facilities of the track complex is of great practical importance .based on a risk assessment. The management process consists of the following procedures: 1. Choosing the distance of the path (IF) and the stage and dividing the stage into sections of the path. 2. Determination of the actual tonnage missed. 3. Comparison of the value of the actual missed tonnage with the standard value, then calculation of operational reliability indicators [24-27, etc.] and . calculation of technical indicators characterizing the residual resource based on the Sedyakin principle [28]. 4. Comparison of calculated values of indicators characterizing the residual resource, as well as calculation of indicators of operational reliability of the track object under the condition. when the operating time of the object before the required repair is less than or equal to the predicted time (all calculations are automatically done in the Unified Corporate Platform of the URRAN Track Complex (ECP URRAN P). 5. Comparison of indicators of operational reliability of the object under the condition of its overhaul (CR) or reconstruction. Calculation of economic indicators of the assessed object.6. Assessment of current repairs according to the criteria for making decisions on the appointment of repairs (.medium, lifting, planned preventive (alignment of the path)). 7 Integral assessment of the sections of the path according to the selected type of current repair. In accordance with the integral assessment, the preliminary ranking of the evaluated sections of the stage path within each of the types of repairs is carried out by priority. 8. Comparison of the values of economic indicators with normative ones. 9. Comparison of operational reliability indicators with normative ones. 10. Integral assessment (ranking) of sections of the road for capital repairs and reconstruction.

An example of ranking a section of the path based on an integral risk assessment is given in Table.1. On the basis of the constructed risk matrices, an integral risk matrix is formed for the list of plots and on the basis of an integral assessment, each plot is assigned priority for its inclusion in the title of the major repair of the track. In the example shown in the integral matrix of security risks in the plots of the put1.2,3....,M, the most priority is plot 2 (its integral risk is assessed as "unacceptable"). This section is ranked at number 1. The next in the ranking is determined by plot 1. Then plot 3, etc Similar management of the technical content of railway transport facilities .it is carried out in the locomotive complex, MVPS, in the complex of automation and telemechanics facilities, communications, electrification and power supply, etc.

Table 1: *Integral risk assessment of the section of the track.*

Risk factors	Plot 1	Plot 2	Plot 3 …	Plot M
Defectiveness of the roadbed	**0,13**	**0,53**	**0,13**	**0,07**
Single output of acutely defective rails	**0,53**	**0,13**	**0,13**	**0,07**
Output of defective rails	**0,07**	**0,27**	**0,07**	**0,13**
Number of defective fasteners , %	**0,13**	**0,27**	**0,27**	**0,07**
Number of sleepers with splashes , %	**0,27**	**0,53**	**0,13**	**0,07**
Number of unusable wooden sleepers , %	**0,27**	**0,13**	**0,07**	**0,07**
The given number of temporary recovery locations	**0,07**	**0,53**	**0,13**	**0,07**
total	**0,45**	**0,64**	**0,25**	**0,14**
Priority of the plot	**2**	**1**	**3**	**3**

VII. Fire risk management

Fire safety management of both stationary and mobile railway transport facilities covers all stages of the life cycle from design to decommissioning. At the same time, JSC "Russian Railways" must simultaneously provide fire safety for more than 14,000 locomotives, as well as hundreds of stationary facilities that employ more than 300 thousand people. This problem is solved with the help of an automated fire risk management system, which is part of the URRAN system. It allows, based on the results of the fire risk forecast, to make a decision on the need for repair, replacement or maintenance of transport facilities and their fire safety system.

Two blocks of methodological risk assessment tools have been identified. The first block operates with fire statistics. Its purpose is to assess the a posteriori probabilities of a fire on stationary and mobile transport facilities. The peculiarity of estimating the probability of fires (based on fire statistics) is that objects of each type are divided into groups on a regional basis. The operating conditions of the objects in the groups differ in such parameters as maximum and minimum ambient temperature, repair quality, traffic intensity, etc. All these factors can influence the sets of elementary outcomes that favor the "fire" event. There are questions about the belonging of samples (groups) to one general population and the need to assess the probability of a fire at transport facilities, taking into account the belonging of a particular group of objects. To answer these questions, hypotheses about the equality of sample characteristics are tested using well-known criteria, for example, Pearson or Kolmogorov-Smirnov. It is established that locomotives with similar design characteristics, but differing in performance, may belong to different general aggregates (for example, diesel locomotives 2TE10 and 3TE10).Based on the calculated values of fire probabilities and known levels of fire consequences, a risk matrix of transport facilities is built; groups of objects forming undesirable or unacceptable risk levels are identified.

The second data processing unit on fire safety conditions uses as initial information the results of diagnosing malfunctions of objects that lead to an increase in fire danger. For such objects, sequences of events leading to the appearance of a fire are simulated. The decision on the priority of measures to ensure the fire safety of facilities should be made on the basis of an assessment of the danger of the totality of the identified conditions. Indicators of fire danger are: the probability of a fire, the time before the appearance of a dangerous condition. To assess these indicators, a model is being built, with the help of which it is possible to imagine the process of getting into a state of fire danger of a transport object. The key characteristic of fire danger is the probability of a fire, i.e. the probability of falling from the actual non-dangerous state to the specified dangerous state of the model. The theoretical solution of this problem is given in [29]. For a priori assessment of this probability, it is provided to diagnose the actual state of serviceability of the object and assess the possibility of such a malfunction, as a result of which the object falls into a fire-hazardous state. This procedure is called a fire safety audit. In accordance with [30], fire safety audit is divided into the following types: declarative audit, repeated audit, supervisory audit. The declaration audit is the primary fire audit. In case of successful completion of the declarative audit, the declaration of fire safety of the object is carried out. A re-audit of the fire safety of the facility is carried out in case of failure or unsatisfactory results of passing the declarative audit of fire safety.

Based on statistical information about fires, fires, violations of fire safety requirements, scenarios of typical fire-hazardous events and the conditions of objects preceding them have been developed. According to these scenarios, classifiers of fire-hazardous conditions have been developed. The classification of fire-hazardous conditions also makes it possible to identify significant violations of fire safety requirements (SR) characteristic of objects. Using classifiers of SR violations and fire-hazardous conditions, experts diagnose fire-hazardous conditions (fire safety audit) of objects. The fire safety audit is based on the analysis of initial information about the fire hazard conditions of objects and the processing of expert opinions on the severity of possible consequences. The need for the work of experts is caused, among other things, by the fact that a significant part of the data on fire danger states is non-numeric. As a result of the audit, either a set of fire-hazardous conditions of the object is formed or a set of violations of fire safety requirements (the choice of approach depends on the complexity of the formation of one or another set). A set of states or events are sufficient information to estimate the a priori probability of a fire at an object.

When assessing fire risks at stationary facilities, in particular at railway stations, the consequences expressed in the minimum wage (minimum wage) are considered. In the table.2. an example of test calculations of individual and collective fire risks at railway stations in Russian cities of federal significance is given.

From the table.2 it follows that the most prosperous situation with fire safety is observed at the stations of Samara, Chelyabinsk, Saratov, etc. However, as the test calculations show, the levels of fire and collective risks at the Yaroslavl, Novosibirsk and Kiev railway stations in Moscow are two orders of magnitude higher than the risks at safe stations. This circumstance requires special attention to ensuring the fire safety of these stations.

Table 2: *Fire risks at railway stations in Russian cities*

Railway station	Fire risk	Collective (social) risk
Samara	10 -6	4*10 -6
Belarusian	10 -6	5.3*10 -6
Saratov	10 -6	4*10 -6
Kaliningrad - Yuzhny	10 -6	5.3*10 -6
Rostov – the main	4*10 -6	1.6*10 -5
Chelyabinsk	10 -6	4*10 -6
Yaroslav	10^{-4}	5.4*10 -4
Krasnoyarsk	5.5*10 -7	2.2*10 -6
Novosibirsk	1.1*10 -4	5.5*10 -4
Kiev	1.1*10 -4	4.4*10 -4
Moscow	5*10 -6	2.5*10 -5
Leningrad	5*10 -6	2.5*10 -5
Kazan	10 -6	5.2*10 -6

VIII. Conclusion

Risk assessment is a key element of managing technical assets at all stages of their life cycle. At the same time, efforts in railway transport are mainly focused on technical, technological, professional, fire and environmental risks. Since asset management includes their acquisition, maintenance, modification, modernization and disposal, insurance risks should also be taken into account. In general, the management of technical assets based on risk assessment makes it possible to find the most balanced solutions and significantly reduce the costs of maintenance of transport facilities while ensuring acceptable levels of their reliability and safety. It has been established that the quality of decision-making, and consequently the economic efficiency of its results, can be significantly improved by using artificial intelligence methods to predict, in particular, dangerous failures of infrastructure facilities and rolling stock.

The problem of asset management based on risk assessment is under development, it requires a lot of attention from scientists and practitioners.

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