

RISK CRITERIA DURING TRANSPORTATION PROCESS IN EMERGENCY SITUATIONS

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ABSTRACT

The article outlines modern approaches to ensuring sustainability of transportation process in railway transport, assesses the existing system with respect to its ability to withstand external and internal destabilizing factors, and meet the risk criteria. Particular attention

is paid to stability of transportation process in emergency situations, the risks of which have increased in recent years. In this case, it is not only about preserving technical and other parameters at a given level, but also for a given period of time, and taking into account the complex human factor in governance.

Keywords: transport safety, stability, transportation process, risks, emergency situations, reliability destabilizing factors.

Background. The safety of transportation in emergency situations (ES) characterizes the state of protection of people, material values, the environment in the presence of dangerous factors. Stability of the transportation process is an integral parameter that shows the level of traffic safety. Safety and stability of transportation in ES are interrelated parameters. High safety is not possible without high stability and vice versa.

Objective. The objective of the authors is to consider risk criteria during transportation process in emergency situations.

Methods. The authors use general scientific methods, comparative analysis, evaluation approach.

Results.

1.

Stability of transportation process as a combination of organizational and technologically interrelated operations performed in preparation, implementation and completion of the transportation of passengers, cargo, luggage and cargo, means its ability to withstand external and internal destabilizing factors, while preserving the main parameters (traffic volume – for a section of the railway) at a given level.

The correlation of sustainability criteria and vulnerability of the transportation process in conditions of ES: high/weak; sufficient/average; low/high.

The main external and internal destabilizing factors of the transportation process are shown in Pic. 1.

For each factor – their risks, calculated by the formula: $R = P \cdot U$, where P – probability of occurrence of an adverse event (ES), U – mathematical expectation of damage from this event.

For each railway and for each of its individual sections, the fixed parameters will be different. They can vary significantly in their quantitative characteristics. Since the exact calculation of differential (for each risk factor) and integral values of P and U for each section of the railway with reflection of the results on the «risk maps» or in the tabular form to date is problematic (although attempts in this direction have been made), and the statistical method gives a significant variation in the values of the parameters, assessment of the transportation process by risk criteria risks is more appropriate and acceptable for the level of JSC Russian Railways. At the corporate level (scale), inaccuracies in the values of P and U are offset by the large scale of the transportation process.

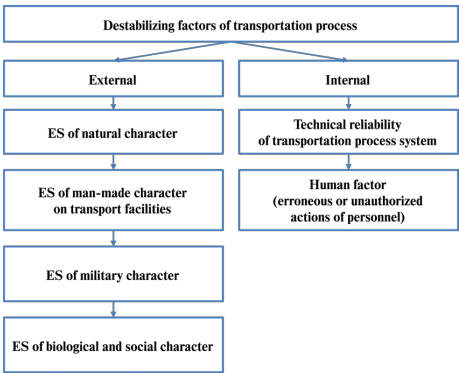
According to N. A. Makhutov, Corresponding Member of the Russian Academy of Sciences, Chairman of the Scientific Council of the Interstate Council for Emergency Situations of CIS, man-made risks are growing now more rapidly than we manage

to react and prevent them. The complexity of technical means, their intellectuality, grow much faster than the culture of their service. To prevent man-made risks, it is important that security systems at high-risk sites are not only automated, technologically reliable, but also minimally dependent on errors and unauthorized actions of personnel.

Over the past 100 years, and especially in the second half of 20th–beginning of 21st century, the risks of natural, man-made, biological, social and military emergencies have increased enormously. The territory of Europe (including part of Russia to the Urals) is oversaturated with dangerous objects: more than 700 NPP reactors, hundreds of chemically hazardous industries, in the ground and above the ground pipelines, power lines, terminals for storage of petroleum products, transport infrastructure elements and other critical facilities for life support systems. All of them can easily become objects of terrorist attacks, including via «non-contact method» – unauthorized interference in control systems. Neither now, nor in the foreseeable future, people will be able to contain the risks of emergencies at an acceptable level.

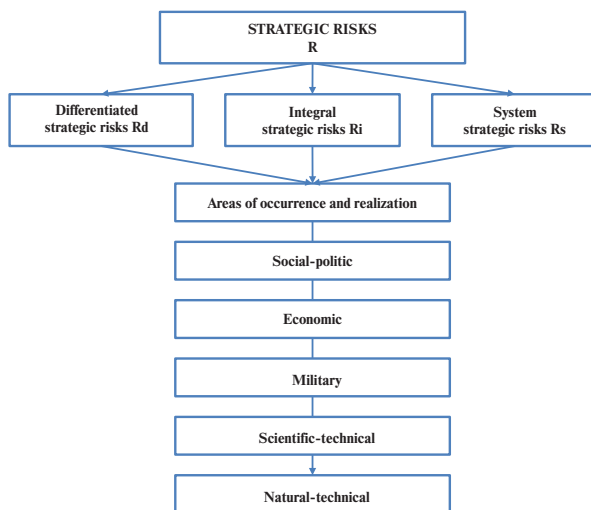
But there are also threats to biological safety. Biological safety involves prevention of damage and achievement of the protection of an individual, society and the state from potential and real biological threats. In the last decades in the world and in Russia epidemic outbreaks of various dangerous infectious diseases from influenza of various modifications to «Zik fever» have been observed, now and then there are hunters provoking attention to the topic of biological warfare.

ES related to nuclear and radiation-hazardous facilities (including components of nuclear weapons),

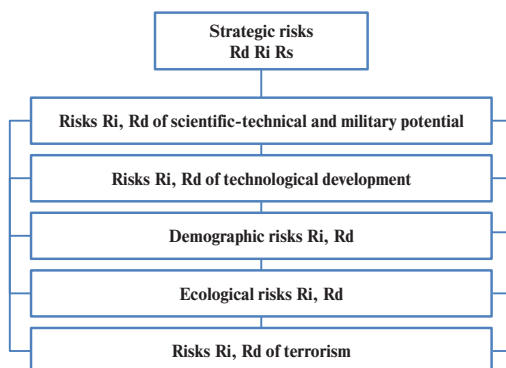


Pic. 1. Destabilizing factors of the transportation process.





Pic. 2. System of strategic risks.



Pic. 3. Structure of mutual influence of strategic risks.

nuclear materials, radioactive substances and wastes, sources of ionizing radiation, due to their particular destructive power and long-term negative consequences, constitute one of the most serious threats to national security and sustainable functioning of transport. Let's note here: railway transport can be a carrier of nuclear materials (NM) and radioactive substances (RS), therefore the issues of their transportation for obvious reasons fall into the zone of its responsibility.

2.

Analysis of threats to national security shows that they become multifactorial, mutually affect each other, acquire a comprehensive character and require a special approach for their localization and neutralization. Russia faces a need to form a long-term, comprehensive, scientifically sound and sufficiently financially secured strategy. Accordingly, the most promising is the management of national security by the criteria of strategic risks.

Under the strategic risks we understand those risks, which in their totality affect the life-support of the country, its people and each citizen separately. Strategic risks can be conditionally divided into three categories: differential risks (in certain areas of activity) R_d ; integral risks as the sum of differential risks (in related areas of activity) R_i ; system risks R_s as the sum of integral risks.

The system of strategic risks is shown in Pic. 2, and the structure of their mutual influence is shown in Pic. 3.

The system risks R_s can be expressed as the product of probability of occurrence of adverse, crisis and catastrophic phenomena P_s in all areas of the

state activity on the mathematical expectation of the associated damage U_s : $R_s = P_s U_s$.

The analysis of system risks can be carried out with division of probabilities of ES and damage from them in three areas (spheres): P_n and U_n – population; P_t and U_t – technosphere; P_o and U_o – environment.

If such a division is carried out, further structuring and risk analysis can be conducted using the expressions that characterize them for probabilities and damages:

$$P_s = P_{ps} (P_n, P_t, P_o); U_s = U_{us} (U_n, U_t, U_o).$$

A distinctive feature of the current differentiated and integral strategic risks is a stable trend to increase the risk of emergencies of global and national scale (level). This is due to the fact that in the modern world there is a lot of weapons and ammunition, including weapons of mass destruction. In addition, the territories of industrialized countries are oversaturated with dangerous production facilities, whose security systems are becoming more complex and expensive, not meeting the strict requirements to the full.

3.

In Germany and France, an approach is being used to manage sustainability of the transportation process in rail transport, taking into account the so-called «stability pyramid».

Stability of technical means or technological processes, here the logic of Europeans coincides with ours, is the ability to withstand external and internal destabilizing factors, maintaining and restoring the parameters of its functioning at a given level.

Reliability of technical means or technological processes is their ability to withstand external and

internal destabilizing factors, while maintaining and restoring the parameters of its functioning at a given level and – it should be added – within a given period of time.

Sustainability, so to be understood, reflects the integral (final) criterion (indicator) of reliability of technical means or technological processes. It relies on reliability of three elements: people (personnel with a high level of competence, representing a system of theoretical knowledge, a set of practical skills and the ability to act in emergency situations); equipment (long-term high-quality reliability); technical regulations governing the use of equipment and actions of personnel to ensure their safe operation and risk levels of violations are not higher than the specified (acceptable, guaranteed).

On the Russian railway transport, the increase in the competence level of the personnel of JSC Russian Railways holding is carried out using the constantly developing and improving system KASKOR (complex automated system for monitoring and evaluation of resources). The continuous increase in the level of reliability of technical means is realized within the framework of the investment program for improving traffic safety. Improvement of rules and technical regulations is carried out in the general system of traffic safety management (STSM). The ultimate goal of development of competencies and implementation of the principles of STSM is to improve safety culture of production, based on an understanding of the full severity of possible consequences of breaches of security requirements.

Stability is the most important parameter of the dynamic processes of complex systems consisting of many elements. To manage stability of complex and large-scale systems, including those related to sustainability of the transport process in rail transport, the most appropriate risk management system, as mentioned above. In order to control individual technical elements of the system, other methods of corrective control over sustainable reliability are possible – in the form of monitoring the technical condition of parts, assemblies, and engineering structures.

Under the influence of external forces, the elements of machines and structures change their original geometry and dimensions. Typically, such changes are small, but in some cases may interfere with normal operation. The ability to determine deformations, their permissible values is of no small importance in design and calculation of loads. Consideration of deformations is necessary, in particular, for elucidating the law of distribution of stresses in structural elements, for solving statically indeterminate problems, for evaluating performance according to strength conditions.

For constant and continuous monitoring of technical parameters of the elements of the transportation process, identification of their pre-emergency and emergency states, a reliable monitoring system should be established at the first

stage. And this task at JSC Russian Railways is being solved within the framework of a long-term investment program to improve traffic safety.

Conclusions.

1. Application of the proposed methodology for assessing and forecasting the state of the transportation process will allow us to shift to regulating the level of traffic safety through a single system of differentiated and integral risks.

2. Taking into account the increase in the risk and correspondingly the share in the total material damage from ES of individual technical means, to an evaluation and forecast of their reliability should be given no less attention than system failures and violations. You can have a whole cargo or passenger train serviceable, but because of the breakdown of just one part of one car, you end up with a massive wreck with a million losses.

3. The development of management solutions in such a complex area as sustainability of the transportation process in railway transport should be comprehensive, harmonized not only with the requirements of traffic safety, transport regulations, but also with environmental requirements.

4. In order to reduce the risks of emergency situations, it is advisable to apply risk management methods, train personnel in time for work with new equipment, network technologies, and raise the level of competence of specialists.

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