

SAFETY OF TRANSPORT SYSTEMS: MONITORING OF PREDICTING, FUNCTIONAL RELIABILITY PROVISION

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Abstract: Substantive provisions of the concept of an estimation and safety of complex technical systems are envisaged. New problems are assume orientation to use of the formalized methods of an estimation of residual resources of reliability of objects, and also development of other methodological base in creation of complex technical systems that is connected with detailed elaboration of attention to a safety at all stages of creation of systems: from designing until operation. In this connection existing large objects should be provided by the developed systems of engineering monitoring and diagnostics.

Key words: problems, base development, safety, system development, diagnostics.

1. INTRODUCTION

North-Mujskij tunnel (NMT) as a whole, and its base elements on the category concern to potentially dangerous project objects (DIP) on which action of the Federal law «Industrial safety of dangerous industrial project» (1997) extends. It is tied, first, with necessity of transportation a tunnel of chemically dangerous (fire and explosion dangerous) cargoes, secondly, with transportations of people, in the third, with dangerous natural processes in a zone of a lining of a tunnel (earthquake, landslips, collapses, formation of streams of subsoil waters).

Itself North-Mujskij tunnel by virtue of the exclusive importance, for a railway transport complex of the country is included into number of censoriously important projects (CIP), defining national safety. Maintenance of security of CIP with use of the approaches is based on strategic risks, is put forward by the decision of joint session of Security Council of the

Russian Federation (SC of the Russian Federation) and Presidium of the State Council of the Russian Federation (PSC of the Russian Federation) in number of the major state, regional and branch problems of safety.

Thus, development of methods of an estimation of risks in view of a technical condition of complex nonproduction objects of NMT in conditions combined dynamic loading is should recognize that multilevel chain «NMT-DIP-CIP» which safety should correspond to requirements specified above Federal laws and decision of SC of the Russian Federation and PSC of the Russian Federation is formed.

2. SAFETY OPERATION

Considering absence by present time of official normative and technical base for the decision of this problem as in our country, and abroad, we believe, that the special attention from experts should be directed on creation of scientific bases of formation of methods and means of an estimation of risks of operation of NMT as complex technical system, in conditions of the combined multifactorial influences and continuous change of parameters of safety and risks [1].

I. For definition of risks of safe functioning of NMT construction of scripts of occurrence of the emergency and catastrophic situations changing a condition of a tunnel and its components, and also a concrete definition of methods, the criteria, the defining equations and their parameters has great value at estimations of corresponding risks of operation, that is necessary for a substantiation and realization of such planned design decisions, as increase of reliability and safety of operation, complex nonproduction objects (tunnels, in particular) and development of recommendations on construction of corresponding control systems [2]. The scientific developments which are executed to the present time create an opportunity of transition to a new stage of formation and realization of a state policy in the field of safety. Their scientific bases become risks [3].

Methods of the analysis and management of complex safety by quantitative criteria of risks are allow to translate substantially a state policy on uniform methodological base in view of noted above handling, standards-legal base and features of development of Russia. Thus it is necessary to understand complex parameters of dangers, threats and the calls, occurrence of negative, adverse, crisis and catastrophic events defined through probabilities as risks, on the one hand, and through population means of damages from these events, with another. The first component of risks concerns to the certain time intervals (most often - year or hour), the second can be measured by tens parameters (economic, human, material, ecological, time, spatial). For the first stage of formation and realization of a state policy of Russia in the field of complex safety from the big number offered two types of risks can be accepted:

- risks for a life: individual - for the person, or collective (social) - for community;
- risks for economy: absolute (in rouble calculation) or relative (in shares of gross national product).

The major works can be entered into the analysis of these risks scientific, state, administrative, supervising, financial and economic, power, educational, federal, subject and local bodies and structures in the major spheres of ability to live of the state [4].

Scientific problems of the analysis of risks consist in development of the theory of safety, theories of risks, methods, algorithms and programs of settlement and settlement-experimental definition and purpose of risks and them criterion sizes, in creation of uniform

methodological base on the predicting, monitoring and management of risks, on construction of cards of risks at various levels of ability to live of the state. A problem of the government complex safety by criteria of risks becomes fastening at a directive level of compulsion of transition of the basic state structures on the developed and scientifically proved criteria of comprehensible and inadmissible risks.

In conditions of modern Russia in view of features crisis, both catastrophic the phenomenon and processes (with expressed dynamics of a parity of the order and chaos) translation of the country into management of complex safety by criteria of risks becomes more actual, than for the majority of the developed countries with rather stable forms and parameters of functioning of the basic spheres of ability to live.

II. Natural accidents are one of the major factors creating threats of safety in natural-technogenic sphere and interfering transition to steady development. Despite of development of scientific knowledge and technologies, the size of damages from natural accidents in the world increases annually approximately on 6 %.

In territory of Russia is having greater variety of geological, climatic and landscape conditions, meets more than 30 various dangerous natural phenomena. The annual damage from these phenomena reaches 20-25 billion USD that makes about 10 % from a total national product. Especially vulnerable to the catastrophic natural phenomena there are the largest cities of the world, fast growth of the population untimely engineering which preparation of territory cause huge destructions and losses at spontaneous disasters. The problem of megacities is aggravated still with that in their territories, alongside with the dangerous natural phenomena; wide development is received with the natural-technogenic phenomena caused by influence of city on an environment. The induced seismicity, lowering of territory, its flooding, and development technogenic physical field are concerns to such phenomena (vibrating, thermal, electric, etc.) putting also heavy losses to city and its inhabitants.

There are rates of growth of economic losses from natural accidents much more above in comparison with rates of growth of a global total product now. Calculations are show, that already to the middle of the come century all efforts on growth of economic will be levelled by natural and technogenic accidents.

Comprehension of that natural disasters are seriously obstacle for steady development of economy, has induced many countries to accept essentially new concept of struggle against natural dangers. The scientific principle of prediction and the prevention of natural accidents is put in a basis of this concept instead of long time of the dominated principle given a priority to actions on liquidation of consequences of development of the natural catastrophic phenomena. The international experience shows, that size of expenses for actions on prediction and the prevention can be up to 15 times below size of the prevented damage.

Actions on decrease in risks and mitigation of consequences of accidents should become an element of state planning of social and economic development of the countries. Scientifically proved strategy of the quantitative analysis and reduction of danger should be accepted in all projects and the investment programs connected with a urbanization, construction, formation, social security, public health services, insurance. Making of the decision on investments into the areas subject to natural dangers, it is necessary to consider and define risk, and charges on its prevention or decrease to include in the economic analysis. Only such approach can provide management and regulation by natural accidents and, that, to meet the requirements of steady development.

III. There are dangerous natural processes of NMT: earthquakes, accumulation and streams of subsoil waters, icings, earth handling. The major feature of threats and heavy accidents in natural and technogenic spheres is the impossibility of their full prevention and maintenance of the guaranteed safety with zero risk. Besides there are accidents do not know national and frontiers by virtue of trans-border carries of amazing factors:

There is creation fundamental scientific, and also legal and economic bases of the decision of problems of safety of a technosphere is one of the purposes of the state scientific and technical policy and the state scientific and technical programs in industrial, power, transport, building, oil-and-gas, mining and defensive complexes.

Technogenic accidents in Russia and all over the world according to data of their analysis and generalization within the level of state technical-scientific project "Safety" [1] became constantly operating factors of economy and policy. The greatest damage to the person, a society and an inhabitancy potentially dangerous natural processes (create earthquakes, volcanic eruptions, hurricanes, floodings) and anthropogenous catastrophic situations on potentially dangerous objects. In the first case, it is possible to speak only about decrease in these damages as prevention of the dangerous natural phenomena is not possible yet. In the second case, risks of technogenic accidents cannot be excluded completely, but can be transformed to admissible and comprehensible borders. In this case the modern theory of accidents, the theory of risks, and the theory of construction of complex systems of protection enable to pass from the maintenance of absolute safety existed and postulated before a base principle in natural-technogenic sphere to a principle of management of risks of accidents. Essential increase of risk in Russia and behind its boundaries is connected by that the most dangerous technical systems have appeared placed, as a rule, in places of significant concentration of the population and course of dangerous natural processes. The NMT is not exception in this plan.

IV. The Analysis of the reasons and consequences of the largest failures and accidents in Russia also has abroad shown, that the complex technical systems representing doubtless danger to people and an environment, there are in most cases created with use of traditional rules of designing and the elementary engineering methods of calculations and tests. In a domestic and foreign practice there are no generated fundamental scientific bases of a safety of complex technical systems, people and environments by criteria of risk and survivability in strongly damaged conditions. National and international normative supervising documents are not created yet on classification of emergencies (design, overdesign, hypothetical) and their consequences (regional, national and global), there is not developed the general nomenclature of dangerous working processes, technologies, materials and technical objects, there are not developed uniform base positions on systems of rigid and functional protection, operative diagnostics and monitoring of emergencies with application of mobile ground, air and space systems, there are not created the state technical complexes of emergency diagnostics for liquidation of consequences of failures and accidents, first of all with global and national consequences. Expenses and the safety in natural-technogenic sphere and efficiency of the state actions while is inadmissible are small. The safety is indissolubly interfaced to occurrence of potential calls, dangers, threats and risks and their stage-by-stage realization. There are risks R in the theory of safety are understood as such combinations of probabilities P of occurrence of adverse events (the dangerous and crisis phenomena, catastrophic and extreme situations), on the one hand, and a population mean of damages U , with another which defines change of a level of safety

and systems of security of the person, objects of economy and an inhabitancy from threats and dangers of internal and external character. Integrated risks are defined as product, the sum or integral:

$$R = PU = \sum P_i U_i = \int C(P)U(P)dP = \int C(U)P(U)dU,$$

where P_i, U_i - there are probabilities and damages from the basic (differentiated) adverse events; C - weight functions.

Sources of risks in technogenic sphere remain and there will be occurred displacement at the state, regional, branch and individual levels of priorities from sphere of safety in economic sphere, a high deterioration and degradation of a fixed capital, underestimation of importance of prevention, forecasting and decrease in potential risks of technogenic accidents and reassessment in some cases the realized risks, insufficient legal, scientific and technical and economic support of systems of monitoring and protection against technogenic accidents.

In the theory of safety of technogenic sphere tens the potential dangers passing in threats and creating strategic risks are totaled. Safety of technogenic sphere as a whole has two complementary and cross-coupling aspects:

- Technogenic safety is defines a degree of security of the person, objects and environments from the threats proceeding from created and functioning complex technical systems at occurrence and development of emergency and catastrophic situations;
- Technological safety is defines a degree of security of the person, a society, objects and environments from the threats connected with unreasonable creation or noncreation of technical systems, technological processes and the materials providing achievement of the basic national interests of the country. Increase of separate kinds of complexes of potential and real threats in technogenic sphere demands sharp strengthening of a role of the state in the decision of problems of technogenic and technological safety.

V. There was exclusive feature of Russia at its present stage of developments a concentration of principal causes and sources of threats in the field of technological safety. Technological safety becomes a dominant of maintenance of technogenic safety. Only development of high industrial and intellectual technologies at a coming third and fourth stage of scientific and technical progress is capable to change sharply negative tendencies in loss and washing out of bases of national safety - in political, social-economic, demographic, defensive, technogenic, information spheres.

At the analysis of safety of complex technical systems [1, 5] three basic script and a kind of emergencies are formulated: design, overdesign and hypothetical (table 1.1). In its basis such parameters, as local pressure σ and deformations e , numbers of cycles N , temperature t and time τ of operation of objects. Depending on type of potentially dangerous objects extremely wide variation of these parameters takes place ($10^0 < N < 10^{12}$, $270^\circ\text{C} < t < 10000^\circ\text{C}$, $100^\circ\text{C} < \tau < 80$ $100^\circ\text{C} < \tau < 80$ years), there is leads to that scripts and design emergencies, as a rule, cover areas of research of accumulation of damages by classical

theories of resistance of materials, the theory of elasticity, plasticity and creep. Settlement and experimentally defined pressure and deformations thus remain at a level of a limit of elasticity.

Table 1.1 Types of emergencies and degree of security

	Emergencies	Security
1.	Normal service conditions	Raised
2.	Deviations from normal conditions	Sufficient
3.	Design failures	Partial
4.	Overproject failures	Insufficient
5.	Hypothetical failures	Low

At transition to overproject to failures nonlinear laws of deformation and destruction are analyzed - thus pressure become less informative parameters, than deformations. Damages from vibrations and weariness pass in damages from low-cycle fatigue.

The greatest risks in technogenic sphere are created mainly at scripts of transition of design emergencies in overproject and hypothetical.

There are at the analysis and formation of the general defining parities and functional for parameters of risks with reference to conditions of operation of The North-Mujsij tunnel consideration noted above the basic features of occurrence and realization of risks is required:

- Interaction of sources and the reasons of occurrence of failures and accidents of natural and technogenic character;
- The expressed change of base parameters of a condition and risks on time of operation of a tunnel in view of complex dynamic influences;
- Dependence of errors of an estimation of risks on a level of the control, diagnostics and monitoring;
- Change and decrease in risks due to complex actions on modernization of a tunnel.

3. CONCLUSION

1. For good safety functioning of The North-Mujskij tunnel alongside with the planned and sold nonproduction actions development of methods of an estimation of risks is necessary in view of technical condition of its complex nonproduction objects, including in conditions combined of dynamic loading.

2. The Analysis and formation of defining parities and functional for an estimation of risks at functioning of The North-Mujskij tunnel should lean on the general approaches, methods and criteria of safety of complex nonproduction objects.

3. As base parameters of risks the individual risks describing damages from loss of lives and health of the person (the operator, the personnel, passengers), from destructions and damages of an infrastructure of a tunnel and from negative influences on an environment can be chosen.

4. It is necessary to start with requirements of federal laws on a safety of dangerous industrial

projects (DIP) by development of methods and criteria of risk, project of technical regulation (PTR), and also from decisions of Security Council of the Russian Federation on increase of security of crucial objects (KBO) from extreme situations of natural, technogenic character and terrorist displays.

5. For definition of risks of safe functioning of The North-Mujskij tunnel constructions of scripts of occurrence of the emergency and catastrophic situations changing a condition of a tunnel and its components will to have great value.

6. The concrete definition of methods, the criteria defining necessary parameters at estimations of risks of operation of The North-Mujskij tunnel should be carried out at all stages of performance of works and operation.

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