Prediction Basics of Oil Products Transport and Storage Facilities Exploitation Risk

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Abstract. It is shown that Technological safety ensuring is in demand in the modern world, protecting the interests of man and society is impossible without preserving the environment. The security problem of social, natural and technological systems is relevant in the Republic of Sakha (Yakutia). Technological hazard specificity of the region is determined by the characteristics of the extreme climate. Common technogenic hazardous facilities were established on the territory of the republic: industries associated with the production, transportation and storage of oil and oil products. Main oil and gas pipelines and oil products storage tanks represent a real danger for the environment as an economic and energy determining objects are shown. Examples of oil facilities damages are given where the scale of destructions and oil spills are shown. Analysis of accidents shows that they are accompanied with significant material, environmental and social damage. It is shown that the main property of the system is security, and the determining parameter is risk. The basis of forecasting is risk as the likely damage, which is a technical and economic indicator and allows you to calculate the integral risk from the effects of several dangerous factors, various objects of the technosphere and territories. The safety problem can be solved by minimizing accident damage, which should be based on forecasting and timely warning of upcoming risks.

1. Introduction
The present stage of human development is characterized by high rates of technological development, the involvement of an increasing amount of natural resources in the economy, which is accompanied by the depletion of the Earth’s available natural resource potential and environmental pollution. The unlimited consumer orientation of the market, the enlargement and concentration of various industries that do not take into account the economic capacity of the respective ecosystems, the unstoppable race of creating and owning high energy-intensive technologies, and the increase in the scale of various means of destruction that can get out of the control of the mind, are potentially possible catastrophes of a global scale. New dangers arising in the course of further development of human capabilities and technological development require the knowledge of negative properties, the degree of their impact on the environment and control over them. Under these conditions, the most important task of environmental protection is a more reliable identification of hazards.
The basis of the Sakha Republic economy becomes the oil and gas industry. The main pipelines transporting oil and gas to the Far East have been built. The operation of these largest facilities is carried out in extremely difficult climatic, geocryological, seismic, tectonic and hydrological conditions of Yakutia. The route of the Eastern Siberia–Pacific Ocean oil pipeline crosses many water barriers, including the Lena - the largest river in Yakutia. The fuel and energy sector also plays an important role in ensuring the livelihoods of the population in the Far North. For energy supply of settlements, various energy-intensive industries, a large number of oil products are needed, the annual reserves of which are delivered and stored in oil storage facilities [1].

Despite the continuous improvement of engineering and technology, emergency situations at the facilities of the oil industry occur with a certain statistical regularity [2]. It is known that absolutely safe technical systems do not exist. The causes of accidents can be associated not only with the technical condition of the facility but also with the human factor, climatic effects or terrorist threat. The risk of failures increases with the long-term operation of facilities, the absence of a clear management strategy, unforeseen natural and social impacts, and design errors. For the oil and gas industry, accidents are a serious problem, primarily due to the enormous potential of hazards at oil enterprises of any type and the scale of possible losses [3]. Therefore the operation of such structures poses a real catastrophic danger to the environment and public health.

2. Key points

Examples of major accidents with significant material, environmental and social damages that occurred in the Sakha Republic indicate that this problem remains of particular relevance [4]. Consider typical examples of accident descriptions. On January 8, 1986, a tank accident with a capacity of 3,000 m³ occurred with a complete destruction and spill of about 2,000 tons of summer diesel fuel at the Nizhneyansk oil depot. As a result of the accident, the body wall was divided into two parts and torn from the bottom by the metal of the sheet of the welded belt. Technological pipelines were broken and neighboring tanks were damaged from which gasoline leaked. The example shows that accidents are accompanied by a large-scale spill of oil products.

November 20, 1987 during operation under a pressure of 35.5 atm. at an outdoor temperature of −500 °C, the temperature compensators of the first string of the Mastakh – Berge – Yakutsk gas pipeline were destroyed with gas ignition [5], which spread over a 3.3 km stretch. Numerous pieces of the gas pipeline were thrown to a distance of 80 meters. As can be seen from descriptions, the destruction of structures is catastrophic in nature with its fantastic linear size, and this example shows what potential destructive power gas and oil pipelines have.

The work [4] presents the results of a study of pollution during an emergency discharge of oil products (March 1994, the Zhhatay-Yakutsk pipeline) to the surface of the Markhinka river, where the area, concentration and depth of pollution are determined. According to the results of the analysis, it is shown that even in winter there is a large penetration of petroleum products into the soil (0.74 meters).

One of the large facilities on the Lena River with high risk is the Eastern Siberia–Pacific Ocean oil pipeline, which crosses the Lena River, where the river is 1,440 meters wide. The consequences of accidents can be catastrophic. The behavior of oil under ice is almost unpredictable, and difficult to monitor. According to experts [6], in the event of an oil pipeline accident (pipe diameter of 1400 mm under a pressure of 10 MPa), the following dangers and consequences are possible at the crossing section of the Lena River:

- up to 3500 m³ of oil may get into the environment;
- at the crossing, the front of oil pollution will exceed 800 km, the area of pollution will be more than 600 square meters. km;
- In winter, up to 140 settlements, with a population of over 500 thousand people, can remain without drinking water.
As can be seen from the descriptions of accidents of oil facilities in the North, that accidents are accompanied by significant material, environmental and social damage, a decrease in the quality of life in extreme living conditions of the population.

Large financial, material and production resources are spent on restoring the operability of such systems and eliminating the consequences of accidents. Since failures of technical systems will occur, an important task is to minimize damage from them, which should be based on forecasting and timely warning of upcoming risks. To solve the problem of preventing emergencies, significant material costs are required, which increase with increasing security. In this regard, in conditions of limited resources, the task of assessing the effectiveness and optimality of their distribution to reduce the risk of a particular hazard is of great importance. The practical need for risk analysis as the basis for decision-making to ensure the environmental and social safety of the population during the operation of technical systems increases significantly [7,8]. The strategy to ensure an adequate level of safety of oil and gas industry facilities in the North is based on maintaining an optimal quality of life. This position is achieved by maintaining a balance between the leading principles of efficiency and safety. In forecasting tasks, the value of acceptable risk is determined from the balance of two types of costs: for measures to reduce risk and for possible damage at a given risk level, i.e. minimizing the amount of these costs [9, 10]. On the basis of minimizing these costs, managing a risk sets various measures to increase the reliability of component systems, the introduction of various protection.

In management practice, an economic approach to determining risk is more suitable. The economic concept of risk provides a consistent and coherent logic diagram for analyzing situations. In this case, the risk is taken as a quantitative measure of danger, taking into account its consequences. Risk is accepted as possible, probable damage. Hence risk assessment (economic, social, environmental, etc.) is associated with damage assessment. Therefore, risk (R) is defined as the product of the probability of danger of the event or process in question (P) and the amount of expected damage (U):

$$R = P \cdot U$$

In this setting, risk is measured by an assessment of damage. This is the advantage and the wide possibilities of applying this approach to the tasks of management and ensuring the security of territories. Possible events with severe consequences and low probability and events with small consequences and high probability will have different possible outcomes. The low probability of an accident does not yet determine the high risk of the event. Dependence (1) allows us to calculate the integral risk from the effects of several hazardous factors, various objects of the technosphere and territories. Theoretically, any loss, even loss of life, can be determined in monetary terms. Thus, risk is a technical and economic indicator and the basis for the safety management of technical systems.

3. Conclusion
Cost indicators, in principle, allow the most reasonable use of the optimization approach to decision making while taking into account heterogeneous factors. This is possible if the safety of oil and oil products transportation and storage facilities in the North, its operational state is assessed by a generalized indicator in the form of risk. To reduce the consequences of emergency situations of oil transportation and storage facilities in the North, it is necessary to forecast possible damages. Risk assessment depends on the likelihood of adverse events and the level of possible damage in this case. For each object, its own models for determining these indicators are created.

4. References
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