Assessment of the environmental risks in the development of fossil fuels deposits in the Arctic zone of the Russian Federation

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Abstract. In this paper the concept of environmental risk was investigated. The analysis of the field reconstruction stages and possible environmental risks at each of them was carried out. Risks are described according to the likelihood of their occurrence. Recommendations to reduce the likelihood of environmental risks and reduce their negative impact on the environment have been developed.

1. Introduction
Currently, one of the most important problems is climate change, the consequences of which may be: melting ice, rising sea levels, an increase in temperature [1]. One of the reasons for climate change is the active development of the Arctic zone (production of hydrocarbons, construction of oil and gas pipelines) [2].

The increased anthropogenic load on the Arctic region is associated not only with the production and transportation of hydrocarbons, but also with the construction and reconstruction of the fields themselves. Field reconstruction is a forced measure in order to improve energy efficiency and efficiency of the field as a whole. The reconstruction allows extraction of the remaining reserves using better and better equipment.

At the same time, it is very important to pay attention to the analysis and forecast of negative changes in the quality of the environment as a result of such activities. At the moment, no unified methodology has been developed for assessing environmental risks. In this regard, the study and analysis of environmental risks that can cause irreparable damage to the Arctic region is one of the urgent tasks [3].

A review of scientific works devoted to environmental risks shows that the main emphasis is a critical analysis of the existing approaches and the development of recommendations for improving the assessment of environmental risks.

In general terms, risk in the theory of risks is defined as the probability of a specific process or phenomenon occurring within a certain time or under certain circumstances. Environmental risk is the probability of receiving certain damage as a result of the manifestation of the environmental hazard factor or their combination in relation to a specific object of assessment. Any natural and/or anthropogenic object at any level of their systemic organization can act as an object of assessment.

The purpose of this work is to identify and assess environmental risks in the development and modernization of hydrocarbon fields in the Arctic zone of the Russian Federation.
It should be noted that the Arctic zone of the Russian Federation has a number of features that influence the formation of state policy in the Arctic [4]. These features must be taken into account when implementing any activity as well as when analyzing possible risks and developing recommendations for their reduction:

- Extreme natural and climatic conditions;
- Intensive industrial development of the territory;
- Low population density;
- Remoteness from the main industrial centers;
- High resource intensity;
- Strong dependence on other regions of the Russian Federation;
- Low sustainability of ecological systems [5].

2. Materials and methods

In this work, the object of the study is one of the gas fields for hydrocarbon production in the Arctic zone of the Russian Federation. The subject of the research is environmental risks that arise during the reconstruction and modernization of hydrocarbon fields in the Arctic zone of the Russian Federation.

To achieve this goal, the following research methods were used in the work: analysis of the literature, analogy and comparison, deductive method and generalization.

For the analysis and assessment of risks, the method of expert risk identification was used. This method was used since at the moment the statistical base on the frequency of negative events during the reconstruction of deposits and the possible damage from them has not yet been collected. In this case, the statistical and analytical methods is not possible to use.

The key stage in the work is risk analysis, i.e. the study of factors affecting the risk. That will allow to carry out the most effective risk management in the future. Based on the risk analysis, the risk reduction measures which consist in the targeted impact on influencing factors (risk factors) are substantiated and described.

Based on the data available to the authors, it is not possible to compile models for the probability of a negative event and the value of various damages for all affected objects [6-7]. Therefore, the work used a qualitative method based on the establishment of categories of probability (feasibility) and consequences, and then each category was assigned a certain rating. Depending on the magnitude of the risks (the degree of their negative impact and damage), their prioritization was carried out, i.e., they were arranged in order. This is necessary to prioritize the implementation of protection measures and the appropriate allocation of funds for their implementation (investment).

3. Results

In the course of the work, it was determined that the technological sequence of production of the main construction and installation works includes several processes, including preparatory work; dismantling work; welding and installation of building structures; landscaping and individual testing and commissioning. Almost all types of work damage the natural environment.

In the production of construction and installation work, the law of the Russian Federation "On Environmental Protection", decisions of administrative bodies on environmental protection and rational use of natural resources in the region, as well as other federal laws are observed. This reduces, but does not completely exclude possible environmental risks and damage to the environment.

During the work, it was revealed that during the reconstruction of the field, the following factors may act on its territory:

- Destruction of the vegetation cover by construction equipment and vehicles;
- Pollution of the territory with construction waste;
- Pollution of the atmosphere by exhaust gases;
• Pollution of the territory with fuels and lubricants;
• An increase in the threat of fires in the summer.

Since the environmental risks that may arise during reconstruction are not excluded, they were assessed in terms of the degree of damage and the likelihood of risk occurrence. Before assessing environmental risks during field reconstruction, the main sources and factors of negative environmental impact were identified, which are shown in table 1.

Table 1. Main sources and their corresponding factors of impact on the natural environment.

| No. | Sources                                      | Factors                                                   |
|-----|----------------------------------------------|-----------------------------------------------------------|
| 1   | Conducting pre-construction preparatory work | Destruction of vegetation cover by construction equipment and vehicles |
| 2   | Construction and installation works          | Contamination of the territory with construction waste     |
| 3   | Work on the sites of automotive and special construction equipment | Air pollution by exhaust gases                             |
| 4   | Organization of maintenance and provision of fuels and lubricants | Contamination of the territory with fuels and lubricants, an increase in the threat of fires in the summer |

Based on the listed factors, possible environmental risks were identified and analyzed. As a result, tables that describe environmental risk, recommendations for reducing the likelihood of its occurrence and recommendations for reducing the negative impact on the environment have been developed. The tables differ in the degree of increase in damage caused by the occurrence of environmental risk (first, second and third). Within each table, risks are also sorted according to their likelihood of occurrence (1 - most probable, 2 - medium degree of probability, 3 - least probable). Below is an example of the generated table for the second degree of possible damage caused by the occurrence of environmental risk (table 2).

4. Discussion

Based on the list of environmental risks compiled in the course of the work, it should be noted that the smallest in terms of the number of points are environmental risks with an average degree of probability (number 2 in the column of the probability of risk occurrence). Unfortunately, this does not mean that we are well protected from these risks. However, in this assembly, it is precisely the risks that the relevant authorities most often pay attention to when checking the work (when the object is being delivered or already in the process of its work) [8]. It should be noted that the most serious problem from this list is the gradual disappearance of some species listed in the Red List (Siberian Crane, bowhead whale, taimen, Kamchatka long-legged crane, etc.) [9].

The second in terms of the number of items are environmental risks with a lower degree of probability of occurrence (number 3 in the column of probability of risk occurrence). These are the risks from which the best, up-to-date system for detecting and eliminating risks should be provided, which should be foreseen at the stage of designing a reconstruction plan, changing landscapes during operation and when organizing further hydrocarbon production. A man-made mining accident, the collapse of the upper layers of the rock, the propagation of a shock wave are the most terrible, but, fortunately, the most unlikely environmental risks.

The most likely environmental risks (the number in the probability column is 1) make up the largest list. This is due to the fact that when carrying out construction and installation work, they are almost impossible to avoid, since absolutely all work will require special equipment.
Table 2. The second degree of possible damage caused by the occurrence of environmental risk.

| Risk probability | Environmental risk | Recommendations to reduce the risk likelihood | Recommendations for reducing negative impact on the environment |
|------------------|--------------------|-----------------------------------------------|--------------------------------------------------------------|
| 1                | violations of the existing forms of natural relief during earthworks | perform construction and installation work only within the territory allocated for construction | reclamation of disturbed lands |
| 1                | violation of the upper layers of the earth's crust | no release of water from the construction site is allowed without protection against surface erosion | territory planning, backfilling of erosional forms and thermokarst subsidence with soil with similar physical, chemical and mechanical properties |
| 1                | violation of the conditions for the existence of vegetation, animals, birds, fish (change in abiotic factors) | restoration of a natural or organized drainage system; biological reclamation; comply with fire safety rules during work | carry out construction work strictly within the boundaries of the land allotment; move equipment only within existing and temporary roads; removal of soil and vegetation before the start of development and its return to the site during the period of technical reclamation |
| 2                | flaring of associated gas and excess hydrocarbons during testing and operation of wells | prohibition of operation of equipment in forced mode | reducing the duration of idling of machine engines |
| 2                | abandonment of quarries after construction and installation work increase in the content of dispersed gases in nearby drinking water wells | prohibit leaving careers | limit excavation and dumping operations |
| 2                | increase in the content of dispersed gases in drinking water wells illegal logging | organization of special fences to reduce the concentration and the likelihood of gases entering the drinking water | unauthorized cutting of trees and shrubs is not allowed |

Since reconstructions, as a rule, take place in several stages, they, in turn, can be divided into 3 parts:

- Preparatory work (basic solutions for the organization of construction);
- Basic construction and installation work;
- Tests, quality control and subsequent first stages of operation (the first stages of operation in order to detect defects in construction and installation work).

Certain environmental risks are possible in each part of the reconstruction. So, for example, the following risks will be included in the preparatory work: seizure and violation of significant areas of land (for the construction of roads, site structures); illegal logging; to a small extent, soil erosion will
manifest itself with the further movement of vehicles and equipment, emissions into the atmosphere from them will be minimal at this stage, therefore the latter factors will be taken into account in the second part [10].

Distribution of environmental risks by parts of a reconstruction stages set makes it possible to present all the information in the form of a diagram (figure 1).

The diagram shows that 56% of all possible environmental risks are in the second part - the main construction and installation work. The second place are tests and the first stages of operation of a new technically re-equipped point, accounting for 33% of all possible risks. And the riskiest stage is the first part - preparatory work (11%). Potential risks can be significantly reduced if indicators are prescribed in the reconstruction project to control the quality of some work, but a strong bias is also required for the environmental friendliness of the work carried out. When carrying out the first tests and launching new equipment, it is necessary to pay special attention to the quality of the work performed, compliance with the requirements and attitude of companies to the environment, and their non-violation of their prescribed duties.

5. Conclusion
Based on the results of this investigation, it can be concluded that the complex natural and climatic conditions of the Arctic zone of the Russian Federation require significant efforts to maintain an easily destructible ecological system.

Reconstruction of deposits can negatively affect the environmental situation due to improper actions to reduce the likelihood of risks and reduce the impact on the environment. At the same time, the most probable environmental risks arise at the second stage of reconstruction - during construction and installation work, they account for 56% of all possible risks, and it is this stage that requires increased attention of specialists in the field of ecology, engineering and law, because the combination of these three skills will ensure minimizing the occurrence of environmental risks and protecting the ecological system as a whole.

In the recommendations that should be in project documents, specialists are required to prescribe clear criteria for quality control of reconstruction objects in order to exclude negative aspects associated with the third degree of possible damage to the ecological environment. The recommendations developed in this study will minimize the likelihood of environmental risks during reconstruction, or, if they arise, reduce their possible negative effect.
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