Comparative assessment of occupational risks at enterprises of oil production and coal industries in the Irkutsk region

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Abstract. The historical development of human civilization has shaped a completely justified life axiom: if you want to achieve something, work hard. And it is true, without making efforts a person, quite logically, will not be able to satisfy his or her basic needs, to acquire the necessary material goods and services in the absence of money. Yet in fulfilling their labor functions, people find themselves in the workplace environment with harmful and hazardous factors that can lead to negative consequences for health and life, and this is especially of relevance in the light of the recent pension reform in Russia. It is perfectly reasonable to believe that each and every production activity is not able to manage without raw materials that are provided by certain industries, one of which is mining. A procedure for assessing occupational hazards exists precisely to identify negative workplace factors and then take corrective actions. In this paper, the assessment was carried out for enterprises producing natural resources of strategic importance for Russia, i.e. oil and coal. We estimated occupational hazards using the method of assessing individual occupational hazards for employees of mining enterprises in the Irkutsk region and measures to reduce them.

1. Introduction

Since ancient times, mankind has sought to know the world in which it exists, and to expand the horizons of its vision, as well as facilitate its life, labor, and in any way improve the conditions of its existence. These endeavors have led to the need of humans to extract necessary raw materials and transform the environment at their own discretion. Minerals became one of the types of such raw materials, which led to the emergence of mining.

Nonmetallic minerals, ores, precious stones and metals, combustible minerals - all this is still used by man everywhere, but the value of minerals in different periods of civilization was different. Today, combustible minerals - oil, gas, coal, and peat - are of strategic importance throughout the world, and in particular in Russia. But, in addition to the use of these minerals in the form of raw materials for the fuel and energy sector of any country in the world, combustible minerals are used in metallurgical and chemical, and even in the food industry, and medicine [1-3].

Mankind grew and expanded, so did the boundaries of mineral needs. With the development of technological progress and an increase in population, the anthropogenic impact began to cause irreversible consequences in the natural environment. Despite the catastrophic consequences of their activities, human beings still remain part of the biosphere due to their biological origin, and, equally, are exposed to harmful and dangerous factors, which they themselves create. These factors, when affecting a person as an employee, can lead to the occurrence of occupational diseases or cause industrial injuries [4].
The results of many years of work related to the study of the working conditions of employees at mining enterprises unanimously state the presence of a whole complex of multifactorial negative impacts on personnel, leading further to significant negative consequences for humans. The main factors for the mining industry are the factors of the production environment, such as aerosols of fibrogenic action, gas pollution, production noise, general and local type vibrations, radiation of various nature, unfavorable microclimate, etc. Nearly in all occupations engaged in work directly associated with the technological process, their levels and concentrations do not meet regulatory requirements [5].

Replacing the procedure of workplace certification by working conditions with a special assessment of working conditions, which occurred due to the adoption of the Federal Law “On the Special Assessment of Working Conditions” No. 426-FZ of December 28, 2013, changed some of the maximum allowable levels of physical factors, for example, MAL for industrial noise and vibration, or completely removed from the assessment other factors, such as natural lighting and microclimate in open areas. These manipulations at the legislative level did not significantly affect the similar results obtained during the certification of workplaces, and the working conditions of the mining industry workers remained at about the same quite high level of harmfulness. A comprehensive assessment of the working conditions of the main labor occupations allowed them to be classified as hazardous (class 3) of the third and, in some workplaces, fourth hazard level [6].

In the structure of occupational morbidity in the mining industry, the leading positions belong to respiratory diseases, vibration white fingers, hearing loss, diseases of the nervous system and the musculoskeletal system. In recent years, the percentage of occupational disease groups itself has changed somewhat: the number of persons with newly found pathologies of a vibrational nature decreased, but the proportion of diseases of a physical nature increased [7-9].

In 2017, the Federal State Statistics Service in the Russian Federation registered 25,445 cases of industrial injuries (of which 1,545 in the mining industry) and 3,614 cases of diagnosed occupational diseases (of which 1,437 in the mining industry). Accordingly, the probability of the employee’s exposure to risk while performing his duties in the extraction of minerals is quite high. The procedure for assessing risks, namely, occupational risks, allows for analyzing the degree of impact of these factors directly on the employee. But it is not enough just to assess the occupational risks by establishing the degree of impact. It is necessary to carry out comprehensive work on the management of occupational risks, namely, by determining the probability of risks to manifest over time and the severity of their consequences for employees, to implement measures to eliminate and reduce risks, to identify possible financial costs for compensation [10].

The Siberian Federal District has significant mineral reserves. The extraction of a significant proportion of some of them is carried out only in this district, such minerals as molybdenum, manganese, platinum and coal. But the most valuable for this district is Lake Baikal, belonging to the national heritage of our country. The territory adjacent to Lake Baikal and uniting three regions - the Irkutsk Region, the Republic of Buryatia and the Zabaikalye Territory, is distinguished into the common name of Baikal Siberia. Of these regions, only the Irkutsk Region has the largest reserves and variety of fuel and energy raw materials [11].

Our Irkutsk Region belongs to the regions that have extensive own reserves and extracting combustible minerals, which, as we pointed out earlier, are currently of strategic importance for our country.

According to the existing estimates, the total recoverable hydrocarbon resources in the Irkutsk Region are estimated at 2.5 billion tons for oil, 460.0 million tons for condensate, and 8.4 trillion m³ for gas. Large fields have been discovered in the region - the Kovykta (gas), Verkhnechonsk, Yarakta, and Dulisima (oil, gas) fields. The discovered oil and gas fields will soon be actively developed. Hydrocarbon raw materials have the potential to become one of the main branches in the mining industry of the Irkutsk Region.
11 enterprises carried out mining operations for oil, gas and condensate at 17 facilities. The volume of production at oil and gas condensate enterprises in the Irkutsk Region for 2017 amounted to: oil - 18,193 thousand tons, gas - 6,308 million m³, condensate - 3,325 thousand tons.

The coal fields in the region are located in the Irkutsk coal basin, the southern part of the Tunguska basin, as well as in Poymenno-Cheremshansky and Pribaikalsky coal regions. Coal deposits in the region amount to 43.6 billion tons. 96% of the coal reserves of the region are concentrated in the Irkutsk basin. Most of the coal produced is used in the power industry. Most of the production is carried out at three fields in the Irkutsk basin: Cheremkhovo, Azeyykoye and Magunskoye fields.

5 enterprises carry out coal mining operations at 12 facilities. The main scope of work was carried out by the companies Vostsibugol Company LLC, Umix LLC, Promregion LLC, and Glinki LLC. The volume of production at coal mining enterprises in the Irkutsk Region for 2017 amounted to 12,184 thousand tons.

According to the statistics of the Irkutsk Region, in 2017, 350 cases of industrial injuries (of which 52 in the mining industry) and 100 cases of newly discovered cases of occupational morbidity (of which 32 in the mining industry) were registered [12]. The data are presented graphically in Figure 1.

![Figure 1. Comparative chart of industrial injuries and occupational diseases in the Irkutsk Region in general and for the mining industry in particular](image)

According to the Ministry of Labor and Employment of the Irkutsk Region, working conditions at many enterprises in our region still do not meet regulatory requirements. The main reasons for unsatisfactory working conditions remain:

\[ \text{– obsolescence of production processes and equipment;} \]
\[ \text{– low rates of work on the mechanization of the most time-consuming technological processes;} \]
\[ \text{– low levels of modernization;} \]
\[ \text{– a significant reduction in the work on the reconstruction and technological re-equipment, the creation and procurement of new, modern and safe production technologies and equipment;} \]
\[ \text{– insufficient volumes of capital and preventive repair of technological equipment, buildings, etc.} \]

2. Research methods and techniques

There are many various methods of occupational risk assessment unique in their essence, which have both advantages and disadvantages, and also differ in complexity of application. One of them was applied in our work, namely, a method for estimating the individual occupational risk (IOR) level.

In 2009, the Research Institute of Occupational Medicine of the Russian Academy of Medical Sciences, together with the Klin Institute of Occupational Safety and Working Conditions “OLS-complect”, developed a methodology for assessing individual occupational risk (IOR) depending on the working conditions and health status of an employee. The methodology is based on determining
the level of individual occupational risk, which is a combination of a set of indicators, such as age, individual characteristics of the health status of workers, and parameters of the production environment [13].

But this methodology was based on the parameters taking into account the results of the procedure of workplace certification by working conditions, which, with the adoption of the Federal Law “On the Special Assessment of Working Conditions” No. 426-FZ of December 28, 2013, was replaced by a special assessment of working conditions. In this paper, we have adapted the method for estimating IOR to the requirements and conditions that were established by implementing the Federal Law No. 426-FZ.

The definition of the individual occupational risk of an employee is calculated by multiplying the weighted values of the parameters (working conditions, working experience of the employee in harmful and (or) hazardous working conditions, his age and health status) by the indicators of injury rate and morbidity in the workplace, and is presented in the formula:

$$IOR = SUM \cdot I_i \cdot I_m$$

The totals of the weighted values of the parameters is determined by the following formula:

$$SUM = V_1 \cdot IAWC + V_2 \cdot H + V_3 \cdot A + V_4 \cdot E$$

where IAWC is an integral assessment of working conditions in the workplace;

H is an indicator of the health status of the employee;

A is an indicator of the age of the employee;

E is an indicator of the working experience of the employee in harmful and (or) hazardous conditions;

$I_i$ is an indicator of the injury rate in the workplace;

$I_m$ is an indicator of the occupational morbidity in the workplace;

$V_i$ are coefficients that take into account the significance of factors and ensure the conversion of parameters into relative values.

We chose to use this method based on the uniqueness inherent in it, in the form of taking into account the working conditions of workers, together with their individual characteristics [14-16].

3. Results and discussion

As the objects of research, we chose enterprises producing combustible minerals - oil and coal. One of the enterprises engaged in the extraction of these minerals are Trailing LLC and RN-Burenie LLC.

Trailing LLC is a subsidiary of Vostsibugol Company LLC. The main activity of Trailing LLC consists in the development of the Zheronskoye black coal field, namely, the Vereinsky open-pit mine, which is territorially part of the Ust-Ilimsk Municipality of the Irkutsk Region. The capacity of the mine is 1,500 thousand tons of the extracted coal mass per year.

The Irkutsk branch of RN-Burenie LLC is a subsidiary of Rosneft Oil Company. The main activities of the company are the provision of services for the construction and operation of oil wells and the implementation of work at these drilling sites [17]. For the study, we chose well No. 2 of the Verkhneichersky license area, which is located in the territory of the Katangsky Municipality of the Irkutsk Region, 20 km south-east of the settlement of Nepa.

Occupational risk assessment was conducted for workers directly involved in mining (oil and coal) [18]. The calculation results are presented in the form of diagrams in Fig. 2 and 3.
4. Conclusion

Based on the diagrams presented, it follows that despite the importance and necessity of mining, the level of occupational risks and, as a result, working conditions in the workplace leave much to be desired. The overwhelming majority of positions at the enterprises under consideration, according to the results of the occupational risk assessment, are classified as occupations of “medium” risk, as well as high-risk occupations, such as miner in Trailing LLC and assistant driller in RN-Burenie LLC. The high value of risk at mining enterprises is due, in this case, to the nature of the work performed, technical condition and characteristics of the equipment used for the occupation. In total, according to Rosstat, in our country, 988,681 people are employed in the extraction of minerals, who to some extent subject to the impact of hazardous production factors [19,20]. Effective solution of labor protection issues, compliance with labor protection and industrial safety requirements, introduction of new, more advanced methods for organizing safe work will significantly reduce occupational risks, improve working conditions at mining enterprises and prevent significant financial costs that mining companies bear for compensation payments and employee benefits, as well as the consequences of accidents and occupational diseases of employees.
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