Modern approaches to conduct the in-process control at high-risk mining enterprises

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Abstract. The low level of the in-process control at mining enterprises is one of the main reasons for the high accident rate, injuries and occupational illness. The article discusses modern approaches to conduct the in-process control at high-risk mining enterprises, which allow reflecting an objective assessment and analysis of the factory world; offer optimal solutions to emerging problems; determine the current level of factory management and reduce the level of accidents and injuries.

1 Introduction

At the date of January the 1st, 2019, in the state register of hazardous production facilities, 2402 objects of mining and non-ore industry were registered. Among them there were:

those of the 1st hazard class — 62 hazardous production facilities (3 %);
those of the 2nd hazard class — 549 hazardous production facilities (23 %);
those of the 3rd hazard class — 1539 hazardous production facilities (64 %);
those of the 4th hazard class — 252 hazardous production facilities (10 %).

The largest number of the registered hazardous production facilities is exploited in the field of extraction of building materials - 1390 hazardous production facilities (58%) as well as precious metals and stones - 518 (22%).

As enterprises of the 1st hazard class, 22 hazardous production facilities for the extraction of ores for non-ferrous metallurgy and 13 hazardous production facilities in the chemical industry were registered [1].

The total number of employees at hazardous production facilities of the industry amounted to 226 thousand people (in 2017 - 246 thousand people) [1].

2 Materials and methods

An analytical review of accidents, injuries and occupational illness at the mining enterprises for the period from 2009 to 2018 was carried out on the basis of information provided in the reporting documents of the Federal Environmental, Industrial and Nuclear Supervision

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Service (Rostekhnadzor) as well as the Federal Consumer Protection Supervision Service and human well-being (Rospotrebnadzor) [1, 2].

The results were processed using the Excel software with plotting the trend line and finding the R-squared value (R^2). The risk of the fatal injuries of people in the workplace is calculated.

3 Results and discussion

According to the data of Rospotrebnadzor for 2018 [2], among the employees of mining enterprises, the largest share (47.59%) of newly registered occupational illness is observed.

Modern labour conditions of mining workers are characterized by a high dust content, intense noise and vibration, unfavorable microclimate, which levels often exceed hygienic standards and pose a high risk of loss of a professional working ability [3].

The labour conditions of people working in an underground mining are particularly severe and tense, because the effect of increased concentrations of dust, vibration and noise levels, as well as an unfavorable microclimate on the human body is aggravated by the psychoemotional stresses. The constant shortage of sunlight, the limited space during performing the work operations (forced uncomfortable postures), the presence of explosive and soufflare (natural) gases objectively form the conditions for injuries [4].

The distribution of cases of the occupational pathology depending on the work-related factors showed that the physical factors have the most damaging effect (49.85%), then follow physical overload and overstrain of individual organs and systems (24.73%) and industrial aerosols (15.89%) respectively.

The results of investigations of cases of acute occupational illness in 2018 revealed that the main reasons were the non-use of personal protective equipment (25% of cases, professional contact with an infectious agent (18%), deviation in technological regulations (14%) and violations in safety regulations (11%) [2].

Figure 1 shows the number of accidents and fatal injuries that occurred from 2009 to 2018 at Russian mining enterprises.

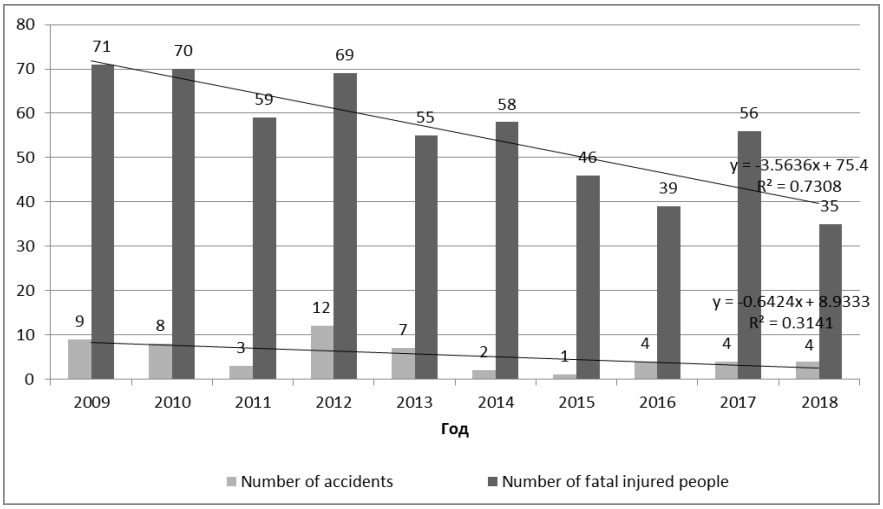

Fig. 1. Dynamics of changes in the accidents and fatal injuries for the period 2009 – 2018.

There is a general decrease in accidents. Fatal injuries remain at a relatively constant level.

The total risk of accidents (R) was equal to $1.17 \cdot 10^{-5}$, that is, 10 times higher than the acceptable risk (10^{-6}), and the risk of the fatal injuries is $1.5 \cdot 10^{-4}$.

The ranking of the fatal accidents by the injury-risk factors, presented in fig. 2, shows that the main causes were the rock fall and damage by the combustion products. The analysis shows that the "human factor" continues to be the main cause of accidents and industrial fatal injuries. Most of the causes of accidents and industrial injuries are the organizational ones.

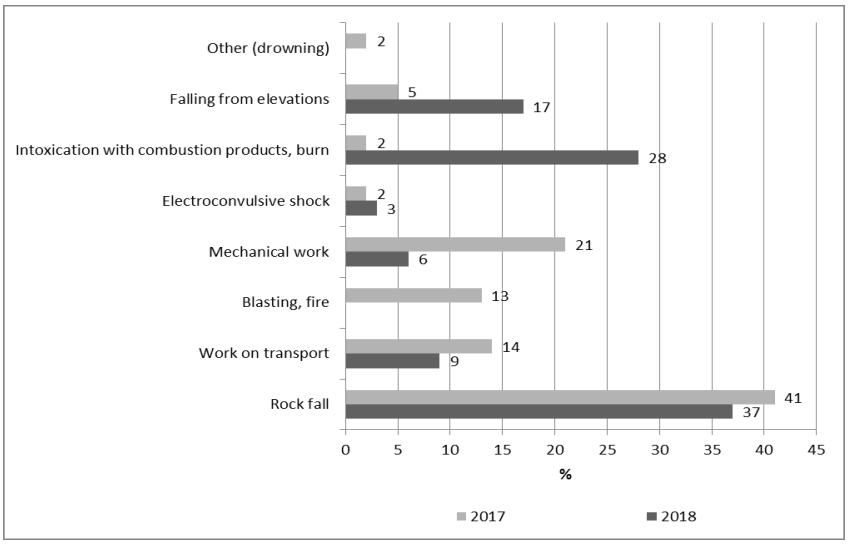

Fig. 2. Distribution of fatal accidents by injury-risk factors.

An analysis of the acts of investigation of the fatal accidents for 2017-2018 that occurred during the mining operations showed that the cause of 20% of the accidents was a gross violation of the work discipline by the injured people.

In the operating organizations, there is no system for conducting the medical control (examination) of the workers before the start of a shift, which makes it possible to be in a state of the intoxication in the workplace when performing the production tasks.

The low level of the in-process control (lack of the technical inspection of the mining equipment, the absence of fences near the vertical workings and a poor cutter break) caused the largest number of the accidents and injuries (53% of the total amount of investigations).

Gross violations of the work schedule and work discipline by employees, including being intoxicated in the workplace, caused 21% of the fatal injuries [5].

Poor organization of the mining operations (work in the absence of the design and production documents, the insufficient knowledge of the mining and geological features of the field and lack of the design solutions) caused 11% of the accidents and fatal injuries.

Procedural violations in the work conducting (performinf the sinking operations deviating from the design solutions, violation in the geometry of the mine workings and failing the gas depletionn process) caused loss of life and accounted for 11% of the accidents and injuries.

A low level of knowledge of the in-process safety standards and rules caused 4% of accidents [6].

State mining supervision in accordance with the requirements of the federal legislation on subsoil was also carried out at sites excluded from the category of the hazardous production facilities. These include facilities where mining is carried out, related to the extraction of common minerals and the development of placer accumulations, carried out in an open way without blasting operations [7].

The functions of the person responsible for the implementation of the in-process control at such facilities are usually assigned to the technical process manager, who also solves all production issues, at the first instance those of the plan execution.

In such a situation, an "internal conflict" between the need to increase the production performance and following the industrial safety requirements is inevitable for a technical manager. Production indicators become a priority, which leads to a decrease in the quality of the in-process control and is the cause of accidents.

Therefore, to improve the situation, an increased attention should be paid to the ensuring the independence of the industrial safety service, removing it from the subordination of the heads of the operating structures and providing it with the controlling functions [8]. This approach to solving the security issues allows us to:

- reflect an objective assessment and an analysis of the factory world;
- offer optimal solutions for the emerging problems;
- determine the current level of the management of the operating processes and reduce the level of the accidents and injuries

4 Conclusion

Thus, the priority tasks of control and supervision activities in the field of the industrial safety and emergency tolerance at the facilities of the mining industry are:

1. Decrease in the accident rate and industrial injuries:
- continuation of work on improving the control in the mode of continuous state supervision;
- monitoring the equipment of mines with positioning systems that allow to search the workers through the rubble and in the absence of electricity.

2. Creation of a legislative and regulatory framework:
- preparation of the administrative regulations for the provision of the public services for the coordination of plans and schemes for the mining development;
- preparation of the administrative regulations for the execution of documents certifying the boundaries of property.

3. Improvement of control and supervision activities for exchange the relevant information is necessary to:
- provide the methodological guidance and control over the compilation the concluding documents of inspections conducted by the local agencies;
- participation by representatives of the central office in the inspections conducted by the local agencies, as well as in the technical investigations of the resonant accidents in order to implement the uniform methodological methods for conducting the inspections and improving their quality.

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