

Industrial safety principles in coal mining

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The article provides a description of injuries in coal mining enterprises in Russia. The high injury rate causes the need of developing new effective ways and means of improving safety at mining enterprises. Recently in Russia there has been a tendency for a slight decrease in fatal injuries, which indicates some progress in prevention of industrial accidents. At the same time, the problem of improving the working conditions of coal miners, reducing the level of injuries and occupational diseases in this industry remains a very urgent task.

Ensuring safe operation and industrial health and safety is not only reasonable economic policy but one of the constitutional human rights. At Russian coal mining enterprises, they take measures to reduce injuries, the supervisory authorities and employees of the enterprises carry out certain work to comply with safety requirements. However, significant success has not yet been achieved.

Despite the fatal injuries and accidents, the issue of industrial mining safety is not becoming a top priority. Occupational safety measures are often financed on a «left-over» principle, and therefore remain not implemented. Many managers do not pay enough attention to safety issues and have little control over the planned activities in this area.

The article analyzes the causes of injuries and proposes the key directions for creating normal working conditions in coal mining enterprises.

Key words: injuries rate; safety; accidents; occupational diseases; guidelines; coal mining; risks; violation

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Introduction. In the Russian Federation, every year 2-3 thousand people have work-related fatal injuries, about 40 thousand are injured, and 12-13 thousand suffer from occupational diseases. The rate of accidents in Russia is 5.5 times higher than in France, four times higher than in Germany and 4.5 times higher than the United States. Fatal injuries in Russia are 2.5 times higher than in European countries. About 35 % of employees work in harmful working conditions: 38 % are in mining, 30 % are in the energy sector, 17.5 % are in transport and communications. In this regard, the creation of good sanitary and hygienic working conditions for miners is one of the priorities of coal mining [7, 8, 11].

Underground coal mining is one of the most dangerous industries [8, 15], and the volume of this type of mining is about 100 million tons annually, with a total volume of 380 million tons.

The main types of injuries in coal mining [7, 8] are the following:

- exposure to machinery and mechanisms – 21.7 % of the total number of injuries;
- falling objects and equipment – 11.5 %;
- falling from height – 11 %;
- landslides and cavings – 11 %;
- ground transportation – 10,7 %

The annual number of fatalities in coal mining is about 50, with a total injury rate of 300-400 people. Almost all cases of fatal injuries occur at facilities of the 1st and 2nd hazard classes, where maximum safety measures must be taken.

Injuries and accidents during underground mining are several times higher than at open pits [8]; 80 % of accidents occur due to non-compliance with basic safety rules.

The main causes of accidents and fatal injuries in coal mining [5, 7-9] are the following:

- lack of special procedures for conducting hazardous operations;
- ignition of combustible materials in the places of conducting operations with an open flame;
- lack of control over the operation and condition of technological equipment;
- inconsistency of projects and face-timbering plans with actual mining and geological conditions;
- lack of necessary control over the current working conditions;
- presence of injured in a hazardous zone;

- low production discipline;
- lack of protections of moving parts and mechanisms;
- insufficient qualifications of employees;
- weaknesses in the effectiveness of the H&S management system, low level of compliance with safety rules.

Formulation of the problem. The cause of the accident is the event or process that led to the injury. The causes are divided into two groups [7-11]: objective and subjective. Objective one includes organizational reasons due to lack of training and instruction, improper organization of workplaces, control, and preventive measures; lack or non-use of personal protective equipment. Subjective is the personal (psychological and psychophysiological) causes that lead to erroneous human actions, which is a hard and intensive workload, increased fatigue, inattention, routine work, inconsistency of an employee personality, and work assignments.

Technical reasons depend on the design flaws and the technical condition of the equipment, buildings, and structures, tools, failure to comply with the repair deadlines, etc.

About a third of all fatal accidents occur as a result of cavings, which is a consequence of the mismatch of the face-timbering plans with the mining and geological conditions. A quarter of fatal injuries occurs in vehicles due to their mechanical effects on humans. The fourth most significant cause of injuries belongs to explosions of gas (methane) and dust. Extremely dangerous factors are blasting operations and electric current.

The basic principle of technological support for safety is the development of new technology, the improvement of existing procedures, and the removal of a person from the danger zone of the technosphere through the introduction of automation and remote control, robotization, and the good working practices [7-15].

In case of emergency each employee should be prepared to actively counter hazards, his actions should be documented in special operating procedures. Despite the abundance of dangers, they can be foreseen and prevented.

Methodology. The main requirement for security is a deep understanding of the health and safety conditions, which entails a large amount of work on the justification and formulation of preventive measures. The results of these works are developed into special procedures – health and safety regulatory acts – safety rules, instructions, guidelines, orders, which describe specific requirements and instructions for observing safety measures. Current regulations are being constantly updated. Rostekhnadzor recently adopted the following important documents:

- Model Provisions on a unified industrial health and safety management system for coal (oil shale) mining (processing) was approved by Decree No. 520 of November 30, 2017.

- Safety Rules for open pit mining of coal deposits were registered by the Ministry of Construction of the Russian Federation on February 12, 2018.

- On February 27, 2018, Rostekhnadzor held a meeting of the Coal Industry subsection of the Scientific and Technical Council on the topic “Improving the current methodology for assessing the risk of accidents in coal mines to develop a risk-oriented approach.” The meeting was attended by JSC NT VostNii, St. Petersburg Mining University, etc.

- On August 14, 2018, federal norms and rules in the field of industrial safety «Safety Rules for Coal Processing and Briquetting» entered into force.

The approved documents will play an important role in ensuring the safety of workers in the changing mining conditions.

The scientific and methodological basis for ensuring safety and stated in regulatory acts should be brought to employees through training, instruction, etc., only then we can achieve the desired result.

Discussion. Any production system is potentially dangerous and can fail as a result of an accident caused by a defect during assembly, intensive operation, wear and tear, and the fault of the operator, his erroneous actions, and wrong decisions. That is why the knowledge of possible hazards

(from machinery and behavior of operators), as well as the ways to prevent them, is the primary condition for industrial safety.

The reason for the growth of man-caused emergency is miscalculations in the technical designs, poor quality of applied research, technological backwardness of production, significant wear and tear of machinery, which in some cases reaches the pre-accident conditions. One should also note a decrease in the professional level of employees, workplace culture, the loss of responsibility of officials, as well as production and technological discipline reduction [11-14, 16].

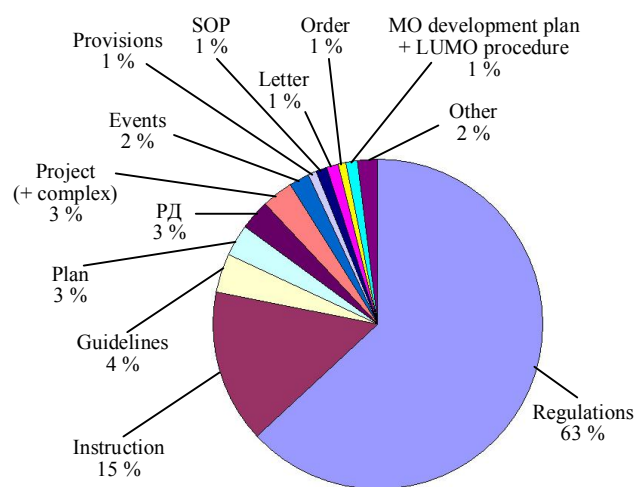
In 2015, 138 people were injured due to poor industrial safety, 12 of them died; violation of labor and production discipline led to 75 accidents, 3 of them were fatal; unsatisfactory workplace organization – 51 cases, 1 fatal; violation of safety requirements during the operation of vehicles – 49 cases, 5 fatal; standard operation procedure violations – 35 cases, 2 fatal. The number of injured due to technical reasons has decreased: during the operation of faulty machinery, mechanisms, equipment – from 14 to 9 people (1.6 times); due to the imperfection of the technological process – from 11 to 5 people (2.2 times); due to the unsatisfactory technical condition of buildings, construction, structures and facilities – from 31 to 14 people (2.2 times). The number of workers injured due to design flaws, imperfections, and insufficient reliability of machines, mechanisms, and equipment increased from 7 to 11 [5, 6].

The main problems associated with ensuring the proper level of industrial safety and reducing occupational risks are [3, 4, 7-9]:

- low quality of mining engineering support, preparation, and organization of production, together with an unsatisfactory level of labor and technological discipline;
- insufficient level of creating an integrated industrial safety management system, inefficient production control;
- insufficient implementation of current and planned R&D support of mining, field supervision of the implementation of design decisions in the process of building enterprises;
- dependence on foreign suppliers of equipment, machinery, and spare parts.

For 2017-2018 there were recorded over 1200 violations of mine safety requirements (stated in 135 regulations). The distribution of these violations by type of document is presented in Figure. Ninety-eight paragraphs of regulations were violated, which accounted for 778 safety violations [3]:

- in coal mines and open pits, there occur overlooked systemic violations that are not resolved for a long time;
- in many cases production personnel is not trained to follow emergency procedures; there are no specially developed instructions for conducting hazardous work;
- the reason for cavings is the development of workings with violation of the requirements of the technical documentation for face-timbering and the lagging of roof support and working face advancement;
- there are cases of methane accumulation in concentrations exceeding permissible levels, which creates explosion hazards;
- no special measures are developed or implemented to carry out open flame work and to handle combustible and flammable materials;
- untimely cleaning and lack of suppression of coal dust also increases the risk of explosions in the mine;
- to reduce injuries, timely maintenance of all workplaces should be organized to maintain mechanisms, electrical equipment, and other technical devices in proper condition;



Distribution of violations by types of documents

- planned health and safety measures are not always given proper financial support; therefore they are only documented and not implemented [11];
- some enterprises conceal information on accidents, which distorts the real picture, creating the illusion of improvement of safety situation.

Conclusion. In many mines and pits, industrial safety management systems do not comply with current state standards.

The main causes of accidents and incidents are indifference, irresponsibility of managers and accident prevention specialists, which leads to loss of employees' health and lives.

Based on the analysis, we propose the key directions for improving health and safety conditions of coal mining:

- providing professional retraining and advanced training of specialists, increasing quality of safe working practices training for miners;
 - management of mining enterprises should implement a program ensuring the industrial safety of miners, distribute responsibility and authority of managers and employees of various levels of supervision, managing and performing work in this area and communicate necessary information to all employees;
 - ensuring the priority of safety in all production processes and timely management decisions in the field of industrial mining safety;
 - identification of professional risks at coal mining facilities, determination of their nature and extent, manage, decrease, and exclude them;
 - ensuring the inevitability of punishment for violation of safety rules, improving work discipline and production culture;
 - improving supervision of potentially hazardous facilities and prevention of accidents and emergencies;
 - improving the quality of design and technological documentation, preventing any deviations from of face-timbering plans and development of workings;
 - often, we only respond to accidents and injuries that have already occurred and limit ourselves to the payment of compensation instead of taking appropriate preventive measures and effectively managing professional risks;
 - the continuous care for the health and well-being of the employees is a key factor.
- Any injury and occupational disease can be prevented, eliminated, or minimized.

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