UDC 331.461: 622.012

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STUDY OF CURRENT METHODS FOR IDENTIFYING AND EVALUATING THE OCCUPATIONAL HAZARD AT THE MINING INDUSTRY ENTERPRISES

Purpose. Analysis and systematization of the existing quantitative and qualitative methods and methodology for risk assessment in the field of occupational health and safety with a view to further justifying a choice of a method to adapt the calculations for occupational hazard in the mining enterprises.

Research methods. Currently, there is a countrywide need for developing and improving the given methods, means and principles for the protection and promotion of worker's health, whose work on existing criterion is applied to the category of high life and health risk.

Thus, to achieve this purpose there was the complex method of scientific research, comprising: generalization and analysis of the literature and static information on the working conditions in the iron-ore mines; methods of injury analysis, expert assessments, mathematical statistics and probability theory on occupational hazard assessment, which enables further development of integration of occupational health and safety management system in terms of underground iron-ore mining.

Originality. The necessity of a unified approach to risk assessment and implementation of the management of occupational hazards in the occupational health and safety management system of the mining enterprises is grounded.

Practical value. A new approach to identification and hazard assessment, which minimizes the accidents, injuries, occupational hazards and, consequently, to increase the stability of production functions, is given.

Findings. The main approaches to improve the effectiveness of health and safety management at the mining enterprises are overviewed.

Keywords: a human-machine-environment system, working-environment factor and working process, hazardous event, injury probability, harmful conditions and hazardous job, occupational hazard, criteria for risk acceptance, risk management, occupational health and safety management system.

The problem and its connection with the scientific and practical tasks. The problem for hazard systematization involved scientists for a long time, however, the criteria to uniquely classifying all health hazards at the mining enterprises have not identified yet. In practice, some enterprises and organizations use different risk assessment techniques, which, however, do not account for all the indicators of a risk assessment related to the specifics of the enterprise. To date, the regulatory system in Ukraine that would be regulate the risk assessment methodology in the field of occupational health and safety in the mining enterprises is not available. There are only scattered recommendations on this subject. It should be taken into account that the technique can encompass all existing workspace, moreover, different components of the different techniques can be applied to workplace.

Research and publication analysis. The basic scientific contribution to assess and increase social and economic effectiveness of measures for improving working conditions were made by scientists Amosha A.I., Belov P.G., Beresnyevych P.V., Bulgakov Yu. F., Vodyanik A.A., Hohitashvili G.G., Holinko V.I., Gurin A.O., Zaporozhets A.I., Klebanov F.S., Kozlov V.I., Lapshin O.E., Levchenko O.G., Levchenko O.G., Lesenko G.V., Lesenko G.G., Lysyuk M.O., Luchko I.A., Tkachuk K.N., Schwager N.Yu., Shvidkiy M.I. and others. Formation of the concept of risk are associated with domestic and foreign researchers, as Brown D.B., Kachinskiy A.B., Korniychuk M.T., Kumamoto Kh., Marshall W., Henley E.J..[2].

Formulation of the problem. On the basis of existing modern risk assessment techniques of occupational health and safety, it can be concluded that nowadays there is a significant number of techniques as a common risk assessment technique of occupational health and safety, risk assessments in certain select process of safety hazard and harmful production factors affecting the workers during the production process. Therefore, the purpose of this study is to analyse and systematize the existing quantitative and qualitative methods and risk assessment techniques of occupational health and safety with a view to further choosing the calculation method of occupational hazards at the mining enterprises.

Presentation of the material and results. Recently the formation of the regulatory framework of health and safety and general risk assessment methodology are used in practice. Their tasks are to

identify and objectively assess risks including quantitative indicators, to provide informed choice and application of practicable and economically substantiated measures aimed at minimizing the injury risk at the place production.

The DSTU OHSAS 18001: 2010, risk is defined as the combination of the probability of hazardous event or the influence(s) and materiality injury or deterioration of health that can be caused by such an event or influence(s).

All definitions are reduced to the risks generated by two quantities - the probability of negative events and the amount of damages.

Such terms as individual risk, collective risk, professional, industrial risk are used in risk management.

The state standard DSTU 2156-93 define an individual risk as the value of the risk for a particular individual, and a collective risk as the value of the risk for two or more individuals.

According to the state standard DSTU 2293: 2014 the occupational hazard is defined as the probability of damage to worker's health during the production process by the hazard and/or dangerous working conditions and scientific and technical state of production.

The work safety classification in terms of hazard and dangerous environment factors identifies a professional risk as a probability of damage to worker's health with the consequences due to factors effect of production environment and work processes [4].

According to WHO, a professional risk is a mathematical concept that includes the expected frequency and (or) severity of adverse reactions to this exposure hazards of working environment.

Professional risk is the result of complex technological, organizational, social and economic causes [5].

As for health and safety risks in the production, it is estimated as a probability of manifestation the dangerous factor system "human-machine-environment" (equipment, technology and type of production environment factors, severity and intensity of work, work organization, workers training) that affect the security [4].

However, in theory the risk is distinguished "a priori" (prognostic) and "a posteriori" (real) risks. Assessment of working conditions for hygiene criterion is a priori and preliminary should reinforce posteriori, i.e., a real risk assessment. The main criterion in the posteriori risk assessment is an occupational illness, so the frequency diseases from influence of specific occupational factors.

The evaluation diagram of risk (fig. 1) involves the actions resulting in an informed decision as a manner of risk influence [1-5].

Methods of research are integrated into a scheme shown in fig. 1and should: provide information on the injury causes (explicit and implicit), obtain quantitative estimates of the injury risk for these reasons, transform research results into preventive measures.

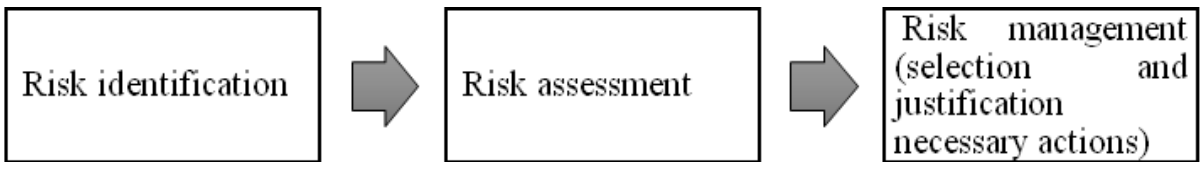

Fig. 1. Scheme of justification of preventive measures to minimize the risk of [1- 3]

According to the international standard OHSAS 18001: 2010 hazard identification is to recognize that danger exists, and to determine its characteristics.

Identifying hazards (DSTU 2156-93) establishes each of the potential dangers initiated now:

events that initiate the dangers and conditions of their implementation;

probability of occurrence;

source;

recipients and exposure to nature;

the character and means of measurement (quantitative expression), the impact (critical danger);

a combination of factors that increases or decreases the probability of potential danger and factors that reinforce its negative effects [1-5].

The choice of indicators and methods for risk assessment of occupational health and safety at the mining enterprises depends on various factors. The risk management is to identify the dangers, to define possible damage to employee's health and life and the probability of their occurrence, as well as the adequate availability of statistical data about the calculation of the required risk indicator.[1].

The main direct risk assessment techniques include:

the British Standard BS-8800 (UK);

the risk assessment techniques based on the matrix ", the probability of injury" (the UK, France, Latvia, the US, Australia);

the method of building the risk assessment graph (Germany, Finland);

the Research and Development Establishment methodology for occupational health and safety (Nats NIIOT in Ukraine);

the risk assessment code methodology (United Kingdom);

the method of verbal functions (European Union).

The indirect risk assessment techniques of worker’s health and life use indicators characterizing the deviation of current (controlled) conditions (parameters) of the rules and have a risk effect. They do not involve the direct detection and identification of hazards in the workplace and in the performance of production activity.

The main indirect risk assessment techniques of occupational health and safety are:

an occupational risk assessment technique for Elmer method;

risk assessment technique of ranking on the basis of risk requirements (code IAD).

Index iAd, as well as the index of Elmer, is not directly associated with the presence and assessment of specific risks in the workplace and is based on the assumption of the consequences related to possible dangers, already accounted for occupational health and safety requirements by assigning the specific levels of the system of occupational health and safety (government requirements, industry, local).

Nevertheless, there is an opportunity to further improve of the ISI index due to the competent professionals or specialized organizations. [1-15].

It should be considered that risk analysis methods are determined by the selected criteria for acceptable risk. This criterion can be specified in regulatory documentation and determined at risk analysis planning. In order to emphasize that we are talking about the measured, the concept of "risk score" and "the level of risk" are used.

According to the level of risk, the production is usually divided into four (or more) groups with high, intermediate, low or negligible risk. In this case, a high level of risk is considered, as a rule, inadmissible, interim requires a program of work to reduce the risk, a low level is considered acceptable, and insignificant is not considered.

The main requirement for the selection of criteria for risk acceptance in conducting risk analysis is not its austerity and relevance, certainty. The correct measures and choice of acceptable risk allow for processing the risk analysis results clearly, which significantly improve the effectiveness of risk management.

Based on the foregoing, we compare different approaches of the methodology presented in this paper. This allows us to establish the correspondence between the parameters of the risk assessment techniques of occupational health and safety. Table 1 shows the results of this comparison [1].

Table 1

Comparison of risk assessment technique parameters of occupational health and safety accepted in modern techniques

Techniques	Risk assessment according to standard "risk assessment of occupational health and safety" [8]		
	low (accepted)	average (accepted)	high (accepted)
The British Standard BS-8800	1 - Very low (accepted); 2 - Low (accepted)	3 - Medium (accepted)	4 - High (unaccepted); 5 - Very high (unaccepted)
Risk score methodology	R<20 A moderate (measures are not required)	20÷70 Medium (measures arerequired)	200≤R<400 High (requires immediate action); R≥400 Very high (the operation should be stopped)
NatsNIIOT methodology	$R<1,0\div10^{-6}$ Minor (accepted)	$2,17\cdot10^{-5}\div1,0\cdot10^{-6}$ Medium (accepted)	$R>2,17\div10^{-5}$ High (unaccepted)
Risk assessment code methodology	1 - The low risk , any measures are not required, danger control is recommended	2 – Risk accepted, control risk is required; 3 - The undesirable risk , it is necessary to monitor and control risk probability.	4 - The unacceptable risk must be eliminated or controlled guarantee
Techniques of Work Safety Institute (Moscow) ISI index,%	90≤DOH≤100	60<DOH≤90	DOH≥60

The above techniques allow for concluding that the effectiveness of a risk assessment depends substantially of the level:

development and precision of calculation methods;

auxiliary agents for practicing (databases, information systems, etc.);

qualifications and competence of experts carrying out risk analysis;

risk analysis organization, including the choice of objects for analysis.

Based on the previously mentioned risk reduction recommendations in manufacturing, one can recognize the existing risk acceptable or specify measures to reduce the risk.

Risk reduction measures could be technical, operational or organizational. A general assessment of the effectiveness in choosing the type of critical measures affect risk is of vital importance [8].

The risk reduction measures must take into account:

primarily there were developed and implemented simple and cost-related recommendations aimed at improving security;

the risk reduction achieved through the introduction of a recommendation is not known in advance;

the resources directed to risk reduction are limited;

for the development of each recommendation, it is not feasible to spend a lot of time and money;

the significant investment in further reduction of the more or less "tolerant" risk is not included.

In the operation of the dangerous object, the operational and organizational measures can be offset with the limited possibilities for making major technical measures for risk reduction. The risk analysis of the operating objects is of great importance [8].

Report on the risk analysis should document risk analysis process. The dimensions of report depend on the risk-analysis purposes and should reflect: objectives and targets; baselines and constraints that limit risk analysis; description of the system analysed; analysis methodology; identification of hazards; description of the used models, their original settings and use; input data sources; the results of a risk assessment; the uncertainty analysis; recommendations.

Conclusions. The implementation of the methodology of risk - management in developing the occupational health and safety management system (HSE-MS) allows enterprises to improve occupational health and safety, to prevent financial, material and human losses from injuries, occupational diseases, accidents.

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Рукопис подано до редакції 15.04.17

УДК 504.056:502.5/8 (477.63)

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ВПЛИВ ВІДВАЛІВ ТА ХВОСТОСХОВИЩ ЗБАГАЧУВАЛЬНИХ КОМБІНАТІВ КРИВОРІЖЖЯ НА СТАН ЕКОЛОГІЇ ПРИЛЕГЛИХ ТЕРИТОРІЙ

Актуальність проблеми. Відвали та хвостосховища гірничо – збагачувальних комбінатів (ГЗК) є місцями складування і накопичення відходів відкритого видобутку та збагачення залізорудної сировини. Відвали сучасних ГЗК конструктивно представляють собою величезні за площею та висотою насипи (терикони) із пустих скальних розкривних порід або із гематитових кварцитів (окислених руд) поверхневих шарів залізистих горизонтів кар'єрів. Хвостосховища є місцями накопичення відходів збагачення у формі твердих залишків, що у вигляді водної суспензії (пульпи) транспортуються пульпопроводами від збагачувальних комплексів та намиваються на спеціальні карти намиву (пляжі). Конструктивно хвостосховища можуть бути площинного типу або багатоярусними спорудами, подібні відвалам.

Розміщуючись на поверхні землі, відвали та хвостосховища не тільки докорінно спотворюють ландшафт місцевості, а і стають новими техногенними елементами в структурі екології оточуючого навколишнього середовища [1]. В результаті цього, похідні природні структурні елементи території, а саме: геологічні масиви, ґрунти та гідросфера отримують джерела локального інтенсивного впливу, а не знищені техногенезом живі організми зазвичай вступають у взаємодію з новими абіотичними чинниками техногенного походження. Завдяки цього на ділянках раніше існуючої природної екосистеми виникає нова система змішаного походження **техногенна геоекосистема (**ТГЕС) або сучасний ландшафт. Як відомо, геоекосистема – це керована або підконтрольна людині територіальна система, що являє собою частину ландшафтної сфери із характерними для неї процесами обміну речовин, біогеохімічними кругообігами, певними видами господарської діяльності та соціокультурних стосунків [2]. Техногенна геоекосистема складається із геосистеми (відносно цілісного географічного утворення із елементів