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DEVELOPMENT OF A METHODICAL APPROACH TO THE RATIONING OF VARIOUS FACTORS IN THEIR COMBINED ACTION IN THE INDUSTRIAL ENVIRONMENT OF EMPLOYEES OF ENTERPRISES

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Abstract

To improve working conditions, it is necessary to introduce and develop risk-oriented model of labor protection management in Ukraine, based on scientifically grounded approach. This requires an objective comparison of actual working conditions with normative ones, taking into account the peculiarities of the functional state of the organism under simultaneous exposure to several factors of the working environment. Thus, there are opportunities to form the basis for further development of methodical approaches to the rationing of different factors in the working area, taking into account their combined action.

Kewwords: Occupational health and safety, occupational risk, harmful factor, hazardous factor.

Problem statement and literature analisis.

The fundamental point at the current stage of development of Ukrainian society is an objective assessment of workers' health from the position of occupational and industrial risk assessment.

On the other hand, quantitative and qualitative risk assessment is necessary in order for an enterprise to pass certification for compliance with international standards.

The introduction and development of a risk-oriented model of occupational safety and health management in Ukraine requires a scientifically sound approach at all levels.

The Code of Labor Laws of Ukraine defines the legal basis and guarantees for citizens of Ukraine to exercise their right to dispose of their abilities to productive and creative work. That is, the state regulates labor relations of all workers. Certainly, such approach will promote the growth of labor productivity, increase the quality of work, increase the efficiency of social production. Consistency of actions in this direction will promote strengthening of labor discipline and gradual transformation of labor for the benefit of society, providing, first of all, vital needs of each able-bodied person due to increase of real incomes of workers [25].

It is known that human performance is determined by his ability to perform certain work for a given time and depends on factors both subjective and objective: age, health, skill level, the conditions under which work occurs [3, 16, 18].

It should be added that the World Health Organization defines health not only as the absence of disease or infirmity, but also as complete physical, mental, and social well-being [24].

The main task in labor protection management is to create such favorable working conditions in production, which would ensure an exceptionally high work capacity and preservation of human health. In this case, an effective solution, as evidenced by the extensive practice of improving working conditions by institutions, organizations, enterprises, can be an objective comparison of actual working conditions with the normative ones adopted for the base period [4, 14–15].

Historical aspects of the development of terminological base of occupational and industrial risks, their classification according to characteristic criteria and characteristics, essence and content, as well as approaches to assessment, analysis and management of occupational risks were comprehensively considered in the works of [5–6, 10–11].

Modern approaches and international experience in health and safety management were also described, and the OHSAS approach (Occupational Health and Safety Management Systems) was highlighted in detail.

ISO 45001 standard plays an important role in the formation of a labor protection management system in an organization. In scientific paper [21] an emphasis is made on the fact that the experience of global companies shows: labor protection is one of the main directions of enterprise development. This implies the fact that in European companies it is considered that it is the culture of labor protection that is a key aspect of management of the entire enterprise.

In work [26] the analysis of the existing system of social insurance of employees in Ukraine was carried out to assess its effectiveness as a lever of economic incentives for the employer to improve working conditions, reduce occupational risk, increase labor safety. During the work a comparison of legal norms of the organization of the system of social insurance against accidents at work and occupational diseases in Ukraine and the leading countries of the world was made to determine the effective levers of management of labor safety in the country.

In the course of the analysis, scientists have identified two groups of methods for assessing occupational risks, which are used in international practice [7–9]. The work indicates that there are direct methods that use statistical information on the selected risk indicators or indicators of damage with the probability of their occurrence, and indirect methods that use indicators of deviation of the existing controlled conditions from the normative values. The results of the analysis can determine the general directions of development of the risk management infrastructure, as well as preventive measures for its prevention.

In the scientific articles [1–2, 20] the existing approaches to the formalization of risk and its integral indexes are analyzed.

It is known that the combined effect of harmful industrial factors has a negative impact on the functional state of the organism as a whole due to the tension of physiological systems. This contributes to the development of occupational diseases, even if the intensity of their parameters is relatively low [19].

To date, most attention has been paid to the study of the effects of individual factors of the working environment on the human body [17]. The study of features of the functional state of the body under the simultaneous action of several factors of the working environment seems relevant, as it is the basis for further development of methodical approaches to the rationing of the various factors in their joint action.

The purpose of the article. Objective comparison of actual working conditions with normative ones on the basis of determining the potential occupational risk at workplaces with harmful working conditions at enterprises.

Main body.

At present, to determine the risk of air pollution by chemical substances in Ukraine, the international method [23].

But the existing methods for determining the level of hazard from the combined action of harmful factors in industrial conditions are based on taking into account only those factors that have the maximum impact.

Since Ukraine has declared its accession to the European space, it is necessary to eliminate the non-compliance of the requirements of the Hygienic Classification of Labor on the Indicators of Harm and Hazard of the Industrial Environment Factors, Severity and Tension of the Labor Process [22] with the requirements of ISO 45001 [3].

The fundamental difference between the Hygienic classification of labor according to the indicators of harm and hazard of the factors of the working environment, the severity and intensity of the work process is that the certification of workplaces does not take into account the response of the human body.

In order to increase the reliability of the obtained results of the evaluation of working conditions, all factors that surround a person in the system "man - machine - environment" should be taken into account. The only objective law that allows this is the Weber-Fechner law.

According to the Weber-Fechner law, in the case of air pollution, there is generally some functional relationship between the level of pollution, perception and risk [12]:

$$r = \frac{1}{k} \cdot \lg \frac{C}{C_0}, \qquad (1)$$

where r – the level of risk;

C – the concentration of airborne pollution, mg/m^3;

k – the factor of proportionality;

C_0– the lowest concentration, where the effect is felt.

Using the methodology [12], we can calculate the potential risk under the action of heterogeneous factors using the following dependence:

ГДК (permissible exposure limit)

ЛК (lethal concentration)

$$r = \frac{0{,}5 - 1 \cdot 10^{-6}}{\lg \frac{ЛК_{50}}{ГДК_{СД}}} \lg \frac{\mathrm{C}}{\mathrm{ГДК_{СД}}} + 1 \cdot 10^{-6}. \qquad (2)$$

Having applied expression (2) we define dependences of risk for factors of the industrial environment for calculation of potential risk at action of heterogeneous factors. It will allow subsequently to consider the combined influence of harmful industrial factors.

To implement the risk-based approach, we use expression (2) to calculate the potential risk based on the data obtained by studying the factors of the working environment and the work process during the certification of workplaces [13].

In the course of the study a quantitative assessment of the potential harmfulness of production processes was carried out on the basis of assessment data on the factors of the working environment and subsequent analysis of maps of working conditions based on the results of the certification of workplaces of employees in the repair shops and crane facilities of the enterprise. The table shows the results of the calculation of the assessment of the parameters of the working area of the enterprise (Table 1).

Table 1

The results of calculating the parameters of the working area of the enterprise

№ Work-place	Workplace, profession, workshop (section, department)	Class of working condi-tions	Factors of production environment and working process	Stan-dard value	Actual value	Potential risk, r_i,
1	Accumulator man	3.1	Hazardous chemicals (sulfuric acid)	1	1,2	0,010704
2	Fuel equipment lock-smith (repair and testing of injectors)	3.1	Hazardous chemicals (mineral petroleum oils)	5	5,4	0,004179
3	Fuel equipment lock-smith (repair and testing of high-pressure fuel pumps)	3.1	Working posture (be-ing in a forced pos-ture)	10	12,5	0,121765
4	Rolling stock locksmith	3.1	Noise, dBA	80	84	0,000806
			Working posture (be-ing in a forced pos-ture)	10	14	0,183606
5	Blacksmith on hammers and presses	3.2	Hazardous chemicals (mineral petroleum oils)	5	5,7	0,007114
			Noise, dBA	80	96	0,00301
			Vibration, dB	76	85	0,001848
			Infrared radiation, W/m^2	140	365	0,159937
			Working posture (be-ing in a crouching position 30^0), % of shift time	25	40	0,339036
			Percentage of shift time (torso tilts)	50	112	0,225052
6	Electric welder (engaged in cutting and manual welding)	3.2	Hazardous chemi-cals, (manganese)	0,2	0,26	0,012955
			Dust of fibrogenic action (iron oxide)	6	7	0,011461
			Infrared radiation, W/m^2	140	358	0,156705
			Working posture (be-ing in a forced pos-ture)	10	35	0,683605
7	Electric welder (engaged in cutting and manual welding)	3.2	Hazardous chemi-cals, (manganese)	0,2	0,26	0,012955
			Dust of fibrogenic action (iron oxide)	6	7,1	0,012516
			Infrared radiation, W/m^2	140	365	0,159937
			Working posture (be-ing in a forced pos-ture)	10	45	0,820742
8	Electric welder (engaged in cutting and manual welding)	3.2	Hazardous chemi-cals, (manganese)	0,2	0,7	0,014819
			Dust of fibrogenic action (iron oxide)	6	7.2	0,013556
			Infrared radiation, W/m^2	140	372	0,163108
			Working posture (be-ing in a forced pos-ture)	10	34	0,667787

9	Manual electric welder	3.2	Hazardous chemicals, (manganese)	0,2	0,27	0,014819
			Dust of fibrogenic action (iron oxide)	6	7,3	0,014581
			Infrared radiation, W/m^2	140	368	0,161304
			Working posture (being in a forced posture)	10	32	0,63471
10	Manual electric welder	3.2	Hazardous chemicals, (manganese)	0,2	0,28	0,016614
			Dust of fibrogenic action (iron oxide)	6	7,2	0,013556
			Infrared radiation, W/m^2	140	435	0,18922
			Working posture (being in a forced posture)	10	46	0,826771

Studies have found that no single r_i index is consistent with the concept of acceptable risk [4].

The analysis of data from the certification of workplaces of the company's employees by environmental factors shows that only one detected harmful factor among the given cards of working conditions has the value of potential risk, which corresponds to 10^{-4} (maximum permissible).

The value of potential risk equal to 10^{-2} (large), have 11 harmful factors (37 % of the total number of identified factors in the working areas of employees).

It was found that the value of 14 individual indexes of potential risk r_i out of 30 detected harmful factors of the working environment is excessive ($r_i = 10^{-1}$). This is 47 % of the total number of detected harmful factors.

Among these factors with the value of excessive potential risk 2 detected harmful factors in those maps of working conditions, which in accordance with the Hygienic Classification of Labor are classified as 3.1 class. That is, to the class, which is defined as the class with the lowest harmfulness for working conditions.

Conclusions.

Analysis of the data of the certification on the factors of the working environment indicates that the existing method of establishing the degree of harmfulness and hazard of work and its nature according to the Hygienic Classification does not take into account their joint harmful effects.

According to the Hygienic Classification of Labor by Indicators of Harmfulness and Hazards of the Industrial Environment, Severity and Tension of the Work Process, when the simultaneous presence of several harmful substances of unidirectional action in the air of the working area is based on the calculation of the ratio of actual concentrations of each of them to their permissible exposure limit. If their sum does not exceed one, then working conditions correspond to permissible. This means that the harmful effects of such detected substances on the worker of the repair shop or crane facilities are not taken into account. Although it is known that the systemic response of the body to the combined effects of physical factors of the working environment is determined by the nature of the influencing factors, their intensity and the response features of physiological systems.

The carried out calculations testify to the imperfection of Ukrainian normative base on justification of assignment of workplaces to categories with harmful (especially harmful), heavy (especially heavy) working conditions.

At the moment in Ukraine, the probability of occurrence of potential occupational risk, taking into account all identified harmful factors, is not taken into account when assigning a workplace to the class of harmfulness according to working conditions. The given research data make it possible to conclude that the obtained values of potential risk will significantly correct the probability of occurrence of occupational risk at the workplace of an employee of the enterprise, where harmful factors of production are identified.

In order to objectively attribute a workplace to a certain class of hazardous working conditions, it is necessary to take into account all harmful industrial factors that are present at the workplace of an employee, as well as taking into account their mutual influence.

The relevance of taking into account features of the functional state of the organism under simultaneous exposure to several factors of the working environment as a basis for further development of methodical approaches to the rationing of different factors when taking into account their combined action is substantiated.

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