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DEVELOPMENT OF CONCEPTUAL BASIS OF RISK MANAGEMENT IN THE OCCUPATIONAL HEALTH AND SAFETY

Purpose. *Improve existing theoretical understanding of the mechanisms of risks occurrence and their minimization in the occupational health and safety.*

Method. *The following research methods were used in the work: analysis of scientific and technical literature and international standards for risk management in the occupational health and safety - to improve the set of basic terms and concepts, as well as the risks classification; general logical methods - to establish and substantiate the mechanisms of risks occurrence to life and health of the employee in the "man - machine - environment" systems and the principles of their minimization.*

Results. *The basic concepts and terms for objective and comprehensive implementation of the risk management process in accordance with the purpose and tasks of the functioning of occupational health and safety management systems at enterprises were substantiated and proposed for application. The factors impacting on the level of residual risk of occupational dangers occurrence, as well as the theoretical possibilities of achieving the minimum possible level of its values within the functioning of "man - machine - environment" systems were determined and substantiated. The main factors that have a negative impact on the state of functioning of "man - machine - environment" systems and their nature were described. Mechanisms of the occurrence and minimization of risks to the life and health of the employee in these systems were established and substantiated, resulting in improving the principles of their management.*

Scientific novelty. *The principles of risk management in the occupational health and safety, which were needed to identify and eliminate vulnerabilities (within the implementation of the Schuhart-Deming cycle), which are always formed during employee interaction with elements of "man - machine - environment" system under the impact of stochastic and non-stochastic negative factors were improved.*

Practical importance. *The results of the research can be used to improve the international regulatory framework for risk management in the occupational health and safety, in particular the standards of the series ONSAS, ILO-OSH, ISO and others.*

Key words: *occupational health and safety, risk management, vaqueness factors, occupational danger, "man - machine - environment" systems.*

Introduction.

At each stage of society development, a man is constantly faced with certain risks of dangerous events occurrence. Depending on the circumstances, such an event may or may not occur, as well as be realized in a specific, varying in severity result, but the risk of its occurrence is always present. In other words, risks of a dangerous or adverse event occurrence accompany the human life. The history of the evolutionary development of society shows that man in his quest to create comfortable and safe conditions for his existence proportionally increases the number of risks, most of which are unknown, and therefore unmanageable. If in primitive society the risks could be realized mainly to harm one's own health or endanger the life of a particular person, the cost of error of modern man could be in not only millions of victims, but also in global man-made, environmental, economic and social disasters. The wide range of modern dangers, the scale of the consequences of their implementation and the unpredictability of their occurrence requires careful study of the relevant mechanisms and conditions of their occurrence and existence. The study of such mechanisms and conditions will form the directions of further research to improve the risk management process in the occupational health and safety.

Literature review.

The analysis of the basic normative-legal documents conducted within the previous researches has identified a number of difficult methodological systemic problems concerning quality and possibility of conducting process of management of risks in the occupational health and safety [1, 2]. These problems apply to all stages of the risk management process. However, from any standpoint, they are related to the absence in the standards of semantic "link" between the term "risk" and other terms that characterize specific dangerous events that are considered in the occupational health and safety. Analysis of recent research emphasizes the urgency of this problem, as their authors use different interpretations of phrases containing the term "risk". Among them, the most common are the following phrases: "occupational risk", "production risk", "risk of danger occurrence", etc. [3 - 8].

Purpose.

The purpose of the study is to improve the existing theoretical understanding of the mechanisms of risks occurrence and their minimization in the occupational health and safety.

To achieve this purpose it is necessary to solve the following research **tasks**:

- to define and substantiate the semantic interpretation of the term "risk" for use in the occupational health and safety;
- to establish the conditions of occurrence and existence of risks in the "man - machine - environment" systems;
- to determine the factors and causes of risks of occupational dangers occurrence within the functioning of "man - machine - environment" systems.

Methods.

The following set of scientific methods were used in the study: analysis of normative-legal documents and scientific and technical literature on risk management of occupational dangers occurrence – to define the problem statement and to improve the set of basic terms and concepts in the occupational health and safety; general logical methods - to establish and determine the factors and causes of risks of occupational dangers occurrence, as well as the conditions of their occurrence and existence in the "man - machine - environment" systems, to establish and substantiate the principles of their minimization.

Presentation of main material.

Based on the definition of "term" which is interpreted as a word or phrase that is the name of a particular concept, the term "risk" should clearly characterize the specific features of a particular phenomenon (event). Therefore, the first word in these phrases (terms) obviously provides a specific semantic interpretation of the term "risk", linking it to various phenomena or events. In this case, these terms cannot be considered identical. The term "risk" is used in almost all branches of science and economics. In each of these branches it has a different semantic meaning. This aspect determines the absence and impossibility of a single common definition [1, 3]. In general, the term "risk" means the expectation of a dangerous (adverse) event occurrence *(author's definition)*. This is due to the fact that the implementation of the risk management process takes into account only events that may have negative consequences. According to the branch direction, the term "dangerous (adverse) event" may also have a different meaning. Thus, in economics it is mainly the expected economic damage, in the socio-political sphere - instability of the political system, unemployment, riots, and so on.

The term "risk" in the occupational health and safety has different definitions, despite the expected "link" to specific dangerous events and phenomena. Thus, the OHSAS standards interpret risk as a combination of the probability of a dangerous event occurrence or impact and the severity of an injury or deterioration in health that may be caused by such an event or exposure. A direct definition of the term "dangerous event" as well as the concept of "dangerous impact" is not given in the standard. Only the term "danger" is defined as a source, situation or action with potential harm in the form of injury or deteriorating health or a combination thereof. Deteriorating health, in turn, is defined as an identified (confirmed) unfavorable physical or mental state caused by performed work or associated with it. ILO-OSH 2001 contains a rather vague, but close in meaning to ONSAS definition of risk. Accordingly, "risk" is interpreted as a combination of the probability of occurrence of a dangerous event, the severity of injury or other harm to human health caused by this event during work. As in the standards of the ONSAS series, in ILO-OSH 2001 the definition of the term "dangerous event" is not given. Instead, the term "danger" is also used - a factor of the environment and the work process which can cause injury, acute disease or a sudden sharp deteriorating health. As well as the combined concept "injury, deteriorating health and diseases associated with it" - results of the negative impact of chemical, biological, physical factors, organizational and technical, socio-psychological and other production factors on the employee's health during work. ISO Guide 73: 2009 defines "risk" as vaqueness about achieving purposes. It is clear that in our case such purposes are in the occupational health and safety and are also connected with dangerous events (phenomena), which at the same time are not defined by the standard.

As can be seen, some standards link the term "risk" with events (hereinafter - risk events) that can cause harm only to a person (group of people), and others, in addition to

these events, require to consider events related to the causing harm to: material values; the environment. Thus, due to the vaqueness of the nomenclature of risk events, for the business entity there is a problem, which does not allow to clearly determine the purposes of risk management and allocate the necessary resources [4 - 8]. At the same time, this nomenclature is refined in the term "occupational health and safety management system", in which risk management process is actually carried out. According to the definition of the term, the "occupational health and safety management system" is "a component of the overall management system of the industry, association of enterprises, enterprise, institution, organization that helps prevent accidents (at work) and occupational diseases, sets policies and purposes of occupational health and safety and ways to achieve, covers a set of measures aimed at meeting the requirements of occupational health and safety legislation" [9]. So, it is a question of the prevention of accidents (at work) and occupational diseases exclusively. That is, industrial accidents as well as occupational diseases should be comprehensively considered as risk events. Accordingly, an accident is a time-limited event or sudden impact on an employee of a dangerous productive factor that occurs during professional activity, resulting in injury to health or death. Occupational disease is a pathological state of the employee caused by the professional activity of one and associated with the impact of harmful production factors exclusively or mainly.

Based on the above definitions, within the occupational health and safety management system, as events it is necessary to comprehensively consider injuries, deaths and diseases of the employee. The comprehensive characteristic of such events is defined by the relevant term - "occupational danger" [9]. Occupational danger is a danger that can result in injury, disease or death of an employee during professional activity. The need to eliminate (minimize) occupational dangers as the purpose of the functioning of occupational safety management systems is clearly defined by the relevant legal term. Occupational safety is a "system of legal, socio-economic, organizational and technical, sanitary and hygienic and prevention and treatment measures and means aimed to protect the health and working capacity in the working process" [1, 10]. That is, it should be recognized that the terms "occupational risk" and "production risk " used by both researchers, and specialists are related to events that are only partially consistent with the purposes of the occupational health and safety management system or do not comply to them at all. The latter concerns events related to material and environmental harm. Such terms can be used only for individual cases of risk management process in the occupational health and safety. The separation of material and environmental harm from harm to human life and health is emphasized in the standard [11]. However, such risks should also be evaluated if they may impact on the safety and health of employees during working process. Thus, in the occupational health and safety the using the term "risk of occupational dangers occurrence", as one that is comprehensively consistent with the purposes and tasks of the occupational safety management systems at enterprises, institutions and organizations, is correct and reasonable.

Effective risk management within the occupational safety and health management systems involves the simultaneous implementation of the process in two directions:

- minimizing the probability of occupational dangers occurrence;
- minimization of the severity of the consequences of the realization of occupational dangers.

The desirable purpose is to minimize even one of these components to zero. In this case, according to the definition of risk as a combination of probability and severity of harm, perfectly safe system "man - machine - environment" is obtained. However, in practice, achieving a state of perfect safety is impossible therefore always the ultimate purpose of the risk management process is to achieve and maintain a certain acceptable level that should be as close as possible to zero.

The term "acceptable risk" in the existing standards has several interpretations. Thus, in OHSAS, "acceptable risk" is referred to as "risk reduced to a level that the organization can sustain, given its legal obligations and its own health and safety policy". It is clear that the level of acceptable risk is a balance between the economic feasibility of the entity and the safety of the employee under the production conditions. Other occupational safety and

health risk management standards do not contain a relevant definition, but always recognize the existence of so-called "residual risk". Based on the semantic aspect of the term, the amount of residual risk should be equal to the difference between the level of acceptable and zero risk. Thus, with regard to risk-based approach, the tasks of the occupational health and safety management system are risk management of occupational dangers occurrence, and the purpose of one is to achieve and maintain acceptable values of such risks.

The level of residual risk depends on many factors, which, however, can be divided into two main groups:

- factors of epistemological impact. They are determined by the quality of methodological tools for risk management in the occupational health and safety, as well as the level of work culture of each participant in the working process;
- factors of financial impact. These include occupational health and safety costs mainly.

These two groups of factors represent inherently a set of previously identified methodological, human and financial resources that are necessary for the implementation of the risk management process in the occupational health and safety. To understand the theoretical possibilities of achieving the minimum possible level of residual risk in the presence of these resources, it is necessary to research the conditions of its occurrence and existence.

The first axiom of life safety emphasizes that any activity (inaction) is potentially dangerous to humans. In other words, any actions (inaction) can be realized in occupational danger (injury, occupational disease, death, etc.). But such a danger does not always occur. As noted, in the general sense, risk is perceived as an expectation of a dangerous (adverse) event occurrence. This is due to the specifics of the risk management process, but in fact the expected event may have three different results depending on the circumstances [3]:

1. Positive.
2. Neutral.
3. Negative.

This difference in expected results is explained by the presence of a state of vaqueness within the system "man - machine - environment". That is, the difference between vaqueness and risk in semantic perception is the difference of the possible expected results of their implementation in a certain event. Depending on the conditions, vaqueness can be realized in a positive, neutral or negative result. Expecting a negative result equals risk. The question arose, however, what conditions are necessary for negative (risk) result? To do this, it is necessary to interpret the terminology and determine the factors of vaqueness, as well as the causes of its occurrence within the "man - machine - environment" systems. This will further determine the conditions of occurrence and existence of risks of occupational dangers.

There are the following interpretations of the term "vaqueness" in the literature [3]:

- Absence or lack of clarity and (or) certainty about the condition of the considered object state;
- Awareness of lack of knowledge about current events or future capabilities of the object;
- Absence or lack of information about the object.

The term "vaqueness" is used for different objects and different branches of science: metrology, physics, mathematics, economics and others. In this study for further research the interpretation of this term, which would be correct for use in the occupational health and safety, namely for "man - machine - environment" systems need to be clarified. Thus, the vaqueness of the state of the "man - machine - environment" system is determined by the lack of information and confidence in the guaranteed stable state of its components in a certain time and space (*author's definition*). In the functioning the components of the "man - machine - environment" system (hereinafter, the research system) are influenced by many factors that cause certain vaqueness in the modes and results of its work [12 - 17]. Such factors can be conditionally considered as factors of vaqueness of "man - machine - environment" systems. In the context of the components of the "man - machine - environment" system, the factors of vaqueness can be divided into four groups [3]:

1. "The human factor".
2. Factors of the external (natural) environment in which the research system functions.
3. Dangerous and harmful factors of the technical system.
4. Dangerous and harmful factors of the production environment.

Therefore, the main task that needs to be addressed in the process of creating a stable and safety "man - machine - environment" system is to eliminate (minimize) the factors of vaqueness that can have negative effects on its functioning in a given mode. Such factors can be inherently random (stochastic factors) or non- random (non-stochastic factors).

Stochastic factors are factors, for which time of their occurrence and their impact on the future state of the "man - machine - environment" system cannot be anticipated and accurately predicted for various reasons. Such reasons may be the following:

- lack of knowledge at this stage of human development (for example, at the present stage of development of science it is impossible to predict the place and time of earthquakes);
- the presence of certain phenomena, whose essence, nature and characteristics cannot be fully determined;
- behavioral actions of a person, formed under the combination of features that cannot be changed based on moral and ethical considerations (human genotype).

Non-stochastic factors are factors, for which time of occurrence and their impact on the future state of the research system can be predicted under certain conditions. Non-stochastic vaqueness of the system state can be characterized by the following main reasons:

- lack and improper compliance with the requirements for the safety of the "man - machine - environment" system;
- behavioral (phenotypic) characteristics of a person or group of people (level of culture, consciousness, etc.) that are part of this system;
- subjective evaluation in predicting the future state of the research system;
- impossibility or lack of instrumental control and correcting of parameters of functioning of the "man - machine - environment" system.

As the above reasons shows, the modes and results of the research system can be impacted by two main groups of stochastic factors: "human factor"; certain environmental factors (natural phenomena in the atmosphere, hydrosphere, lithosphere, etc.). These factors have different proportions of impact on the system and usually different degrees of vaqueness. It can be assumed that the "human factor" has the greatest impact on the system and the highest degree of vaqueness, because a person is not only an integral and unchanging element of the research system, but also its creator. In other words, a person makes mistakes starting with the idea of creating a system and ending with its functioning, which under unfortunate circumstances are realized in various dangers that can harm the person himself. External factors impacting the vaqueness state of the research system include certain natural phenomena. By vaqueness reason, natural factors can be both stochastic and non-stochastic. Stochastic vaqueness of certain factors of the natural environment (natural phenomena) is due to weak prediction of their characteristics (time, place of origin, power of impact, etc.). However, modern scientific methods allow relatively accurate predicting the characteristics of some of them (e.g. meteorological conditions). Therefore, such factors by their nature can be conditionally attributed to non-stochastic. This allows predicting concerning minimizing the impact of such factors on the vaqueness state of the system "man - machine - environment" and providing specific measures to protect against their harmful effects.

Factors of the production environment, as well as factors of the technical system are non-stochastic factors, because they are characterized not only by the predictability of the impact (under certain conditions), but also can be managed. Thus, the microclimatic indicators of the production environment can be controlled using automated microclimate control systems, dust and gas in the air of the working area - using sensors, gas analyzers, as well as aspiration and ventilation systems and so on [18]. And the safety state of the technical system can be provided and maintained by a set of organizational and technical activities and means (with appropriate implementation of the relevant rules and regulations) [18], that is without a negative impact of the "human factor", which could take the form of violation of safety rules, operating modes, deadlines for scheduled preventive inspections, work and other violations [18].

The division between the stochastic and non-stochastic factors is always conditional, because the evolutionary development of mankind involves the gradual accumulation of new knowledge and skills that eliminate stochastic factors that may affect the stability and predictability of a system. For example, the creation of automated control systems for lathes allows eliminating discrepancies (vaqueness) in

the results of accuracy (stability) of the dimensions of parts that were previously made by hand. The accuracy of manual labor depended on the experience of the specialist, the state of his psychophysiological health, and so on.

Thus, as noted, the achievement of safe and stable functioning of the "man - machine - environment" system is possible under the conditions of elimination (minimization) of vaqueness factors. Based on the characteristic of the causes of vaqueness occurrence in the state of the "man - machine - environment" system, it can be concluded that at any stage of development of science only non-stochastic factors can be objectively eliminated (minimized). However, objective minimization of such factors is possible only within the creation and implementation of appropriate automated systems in the existing occupational safety and health management systems. Such systems should control non-stochastic factors and manage them within the criteria set by occupational safety and health regulations. The need to create and implement such systems is due to the large range of non-stochastic factors, as well as the dynamics of changes in their characteristics over time.

Thus, the existence and occurrence of risk is possible if there are following three necessary conditions:

1. Vaqueness factors (stochastic and non-stochastic) which can negatively impact on the process of its functioning in a given mode;

2. The object which may be harmed (to simplify the term " risk object " may be proposed);

3. The object which harms (respectively - "danger object ").

In this study the risk object will be only a person (group of people), and the danger object will be any component of the system "man - machine - environment", including a person or group of people (who are not "risk object") and external factors.

An objective research of the nature of the risks of occupational dangers occurrence is impossible without their classification, as well as the identification of factors and causes. As mentioned, risk as a term has a different meaning regarding the scope. Therefore, its classification requires linking to a specific branch of science or national economy. There is no unified classification of risks, there is only a certain systematization in the literature [18 - 20] according to the following criteria by:

- the area of occurrence (natural, related to the "human factor", technical, socio-economic);
- the spatial orientation (external, internal);
- the temporal characteristics (permanent, temporary, monotonically increasing or decreasing, periodic, non-periodic);
- the type of values that are at risk (life, human health, spiritual, material values, etc.).

This classification is not limited by this list, since there are, for example, large classes which include economic and business risks, which in turn are divided into certain subclasses and types. In the occupational health and safety and industrial safety an interpretive classification of risks, which will be based on the necessary conditions of their occurrence and existence (namely, the vaqueness factors, the object, which may be harmed (risk object) and the object, which harms (danger object)) will be appropriate.

Therefore, the risks of dangers occurrence can be classified by following:

- the area of occurrence;
- the probability of occurrence;
- the severity of the consequences;
- the scale;
- the temporal characteristics.

In this interpretation the classification by the type of values that are at risk was not taken into account by the author, because the main principle of occupational health and safety is preservation of life and health of the employee (as the main value) as a result of his professional activities. We will determine that the risk of harm of the technical system (material values), which is not associated with the risk of harm to employee, will be attributed to economic and business risks, which are not considered in this study. The environmental risks will also not be considered, since their management is not the purpose and area of interest of occupational health and safety management.

The area of risks occurrence that prevent safe functioning of the system "man - machine - environment" can be natural (natural phenomena and behavioral characteristics of certain objects of the biosphere) and production environment, technical system (majority of potentially dangerous and harmful production factors), as well as human actions ("human factor") that creates and manages this system.

The probability of occupational dangers occurrence depends on existence of the vaqueness of the system, the vulnerability of its elements, as well as their propensity to risk. The vulnerability of an element is its ability to move from a safety state to a danger state under the impact of certain negative factors. Propensity to risk is the ability of a system element to be negatively affected by certain dangerous and harmful factors. In this case, a direct correlation should be determined: the greater the vaqueness of the system is and the more vulnerable and prone to risk elements in its composition are, the greater the probability of occupational dangers occurrence is.

There is no unified methodology to determine the probability of occupational dangers and risk quantitative evaluation, as well as the criteria by which it can be evaluated in the world today. There are only separate relevant methods, techniques and recommendations, which differ significantly. This could be again explained by the "semantic link" of risk to a dangerous or undesirable event (injury, occupational disease or economic damage) that may occur under certain conditions. There are no unified criteria for evaluation the severity of the consequences of the implementation of risk in a dangerous event. The recommendations of the BS 8800 standard which includes three degrees of severity: high, medium and low are the most common in modern enterprises.

By scale of the action the risk can be individual (the risk of danger occurrence threatens one person) or group (respectively - a certain group of people). The group risk is the most dangerous regarding consequences and the most common. This fact can be explained by the complexity, branching and existence of close relationships between the elements (risk objects) of modern ergatic systems in which a dangerous event on one of the elements is transmitted to all others by domino effect (each of which is by definition potentially dangerous).

Depending on the specifics of the functioning and operation of dangerous objects, its could become a temporary or permanent threat to the risk object. The lifetime of a permanent risk is equal to the lifetime of the risk object, and the lifetime of the temporary risk is less than the lifetime of the risk object. For example, during life, a person is constantly at risk of injury from any danger object (car, work equipment, etc.), at the same time towards a particular danger object (suppose a car) the risk of danger occurrence is only when a person is a road user.

Discussion of results.

Based on the conditions of the risk existence, its implementation in danger depends on the unfavorable coincidence of circumstances for the risk object in contact with the danger object. This coincidence of circumstances becomes possible in case of certain weak (vulnerable) element in the system, which were formed or may be formed in the future under the impact of stochastic and non-stochastic factors of vaqueness.

Such elements are inherently risk factors. For example, an error in the design of the steering mechanism of the car in an emergency (forced rapid maneuver in the event of an unexpected obstacle on the road) can lead to its jamming and accident, although during normal driving such a defect will not appear. That is, the risk factors in this case were particular design errors, as well as the unexpected obstacle on the road (stochastic vaqueness factors). And what was the cause of the risk in this case? The cause of the risk was the existence of three necessary conditions for its occurrence in the system: vaqueness of the state of the system at a particular time, the risk object (the driver who had an accident) and the danger object (obstacles on the road). The existence of risk factors allowed implementing the vaqueness of the state of the danger object in a real dangerous event for the risk object.

The cause of a particular risk of danger occurrence is always related to the necessary conditions of its existence and the appropriate danger, and risk factors are certain circumstances that contribute to the implementation of the risk in a particular danger without being its direct cause. That is, the cause of the risk of fire occurrence is always related exclusively to a particular danger - fire, as well as with the existence of vaqueness factors in the system (fire is possible under certain conditions or impossible), the risk object (an object where a fire may occur) and danger object (an object that can cause fire).

Risk factors may include sufficient concentration of oxidant, ignition source, combustible medium (fire centre), wind, due to which the flame can spread from the centre to a particular object, fire resistance of the materials, which this object consists of, etc.

That is, a negative (risk) version of events in the "man - machine - environment" system is possible by the existence of three necessary conditions:

1. The risk object.
2. The danger object.
3. Risk factors.

The absence of just one of these conditions makes it impossible occupational dangers to occur. A danger object exists always with the existence of a risk object. Since the risk object in the occupational health and safety is a person, these conditions are constants.

So, to impact on the course of events is possible only by changing (minimizing) risk factors. However, to completely eliminate occupational dangers in "man - machine - environment" system is never possible due to the stochastic nature of risk factors. It is a certain acceptable or residual level of risks of occupational dangers occurrence, which can be achieved and maintained in the process of managing them.

Conclusions.

1. In the occupational health and safety using the term "risk of occupational dangers occurrence" as one that is comprehensively in conformity with the purposes and tasks of the functioning of occupational health and safety management system of enterprises, institutions and organizations is correct and reasonable.

2. The existence and occurrence of risk is possible by the existence of three necessary conditions: vaqueness factors (stochastic, non-stochastic), the object which may be harmed (risk object) and the object which harms (danger object).

3. Risks of occupational dangers occurrence can be classified by the following characteristics: the area of occurrence, the probability of occurrence, the severity of the consequences, the scale, the temporal characteristics. The cause of a particular risk of danger occurrence is always related to the necessary conditions of its existence and the appropriate danger, and risk factors are certain circumstances that contribute to the implementation of the risk in a particular danger without being its direct cause.

The probability of occupational dangers occurrence depends on the number of risk factors, as well as their nature (stochastic or non-stochastic). The process of risk management in the occupational health and safety can be conducted only by eliminating (minimizing) risk factors.

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РОЗВИТОК КОНЦЕПТУАЛЬНИХ ЗАСАД РИЗИК-МЕНЕДЖМЕНТУ В ГАЛУЗІ ОХОРОНИ ПРАЦІ

Мета. *Удосконалити існуючи теоретичні уявлення щодо механізмів виникнення ризиків та їх мінімізації в галузі охорони праці.*

Методика. *В роботі застосовувались наступні методи наукових досліджень: аналіз науково-технічної літератури та міжнародних стандартів з менеджменту ризиків в галузі охорони праці – для удосконалення комплексу основних термінів і понять, а також класифікації ризиків; загальнологічні методи – для встановлення і обґрунтування механізмів виникнення ризиків для життя та здоров'я працівника в системах «людина – машина – середовище» та принципів їх мінімізації.*

Результати. *Обґрунтовано та запропоновано до застосування основні поняття та терміни для об'єктивної і комплексної реалізації процесу ризик-менеджменту, відповідно до мети та завдань функціонування систем управління охороною праці на підприємствах. Визначено та обґрунтовано фактори, що впливають на рівень залишкового ризику виникнення професійних небезпек, а також теоретичні можливості досягнення мінімально можливого рівня його значень в рамках функціонування систем «людина – машина – середовище». Охарактеризовано основні фактори, що чинять негативний вплив на стан функціонування людино-машинних систем та їх природу. Встановлено та обґрунтовано механізми виникнення та мінімізації ризиків для життя та здоров'я працівника в зазначених системах, що дозволило удосконалити принципи управління ними.*

Наукова новизна. *Удосконалено принципи управління ризиками в галузі охорони праці, що полягають у необхідності визначення і усунення вразливих ланок (в рамках реалізації циклу Шухарта-Демінга), які завжди утворюються під час взаємодії працівника з елементами системи «людина – машина – середовище» під впливом негативних чинників стохастичної та нестохастичної природи.*

Практична значимість. *Результати проведених досліджень можуть бути використані для удосконалення міжнародної нормативно-правової бази з управління ризиками в галузі охорони праці, зокрема стандартів серії OHSAS, ILO-OSH, ISO та інших.*

Ключові слова: *охорона праці, менеджмент ризиків, чинники невизначеності, професійна небезпека, система «людина – машина – середовище».*

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