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ACTUALIZATION OF THE SCIENTIFIC PRINCIPLES ELABORATION ON EVALUATING THE RISKS OF OCCUPATIONAL DANGER OCCURRENCE

Purpose. Substantiation of the urgency of the scientific principles elaboration on evaluating risks of occupational danger occurrence for use in the occupational health and safety management systems (OHSMs).

Methodology. The research on risk evaluation of occupational danger occurrence problem has been conducted by means of study with subsequent theoretical analysis of:

- the normative legal documents of Ukraine concerning risk management in the occupational safety field;
- risks evaluation purposes;
- methodology of risk identification;
- procedures and steps of evaluating risks of occupational danger occurrence.

Findings. The legal documents concerning both the risk evaluation and management regarding occupational danger occurrence were analyzed. On the basis of the analysis, the problems concerning the purposes, terminology and methodology of risk evaluation processes were revealed. The analysis of the main stages of general risk evaluation was conducted and system problems were identified which significantly influence the evaluation implementation quality and objectivity and concurrently cast doubt upon feasibility of evaluation procedures within existing standards. The urgency of the scientific principles elaboration on evaluating the risks of occupational danger occurrence was substantiated, which will essentially contribute to the evaluation procedure simplification as well as to improvement of its quality and objectivity of implementation.

Originality. For the first time, the urgency of the issue was substantiated; both principles and directions for the scientific principles elaboration on evaluation of risks of occupational danger occurrence are formulated for use in the occupational safety management systems in Ukraine and internationally.

Practical value. The obtained results will be used as an analytic basis contributing to elaboration of scientific principles of risk evaluation regarding occupational danger occurrence.

Keywords: *occupational safety, occupational risk, industrial safety, risk, normative legal documents*

Introduction. The main purpose of occupational safety management system functioning at enterprises and in organizations is creating and maintaining healthy and safe working conditions, accidents and occupational diseases prevention. The accidents occurrence at the enterprise becomes possible as caused by the existence of dangerous and harmful production factors and other contributing factors (human factor, natural environment and others), which can involve, separately and in combination, a negative influence on the employee. By their nature, these factors can be stochastic and non-stochastic.

The purpose achievement and OSH management system implementation quality depend on efficiency of eliminating (minimizing) these factors within a certain enterprise. The main problem is the elimination (minimization) of factors of stochastic nature, since they have a high degree of uncertainty concerning probability of their occurrence and severity of their consequences. Such factors cause most accidents (according to various estimations, about 80–99 %) at enterprises [1, 2].

Elimination (minimization) of factors causing the accidents takes place during a risk management process.

The risk management process involves conducting the following steps:

1. Identification of all potential danger.
2. Probability determination of the certain danger occurrence and severity of their consequences.
3. Risk level evaluation on the danger occurrence (quantitative risk evaluation).
4. Critical risk evaluation (by the criterion of admissibility).
5. Risk ranking by priority.
6. Elaboration and implementation of safety ways and means.
7. Monitoring, verification and correction.

In terms of practical implementation, the most difficult stages are the first four ones which can be currently considered as a sequence of general risk evaluation process or risk evaluation [3].

Analysis of the recent research. The risks of occupational danger occurrence problems have been viewed in the following scientific works. However, these research analyses revealed a **series of unresolved problems and disadvantages.**

Thus, in study [4] the analysis was conducted, interpretation of "risk" term and its classification were offered; it was marked that the any risk evaluation procedure can be conducted within the general risk theory using its tools. However, such tools are sufficiently generalized and complex and need to be systematized within elaboration of certain methods that could be applied to solve the occupational danger occurrence tasks using the computer. Therefore, creation of the scientific principles allowing one to elaborate such methods based on the general risk theory tools still remains an unsolved problem.

In article [5] a general analysis was conducted and the disadvantages of existing risk evaluation methods were revealed. The relationship between the erroneous risk evaluation procedure and the causes of accidents that occurred at UK businesses was viewed. The general problems of risks evaluation at enterprises were identified; creation of the multidisciplinary expert groups which, in the authors' opinion, will improve the quality and objectivity of appropriate procedure was suggested. However, creation of this expert group can only improve the quality and objectivity of certain risk evaluation stages, such as danger identification; it does not solve systemic methodological problems of the evaluation. In addition, it is obvious that creation of such expert groups and implementation to permanent risk evaluation procedure for all practical purposes are affordable only for enterprises with significant financial resources.

In study [6] the risk evaluation system in Finland, one of the most prosperous countries of the world in terms of occupational safety and industrial safety level, were viewed. The urgency and importance of the evaluation procedure were accented within improving the minimization dynamics of several indicators such as the series of accidents and fatalities, GDP growth, and others. It is noted that the risk evaluation process in Finland is based on a combination of tools and expert methods whose number exceeds one hundred, but no scientific principles concerting selection objectivity and use of these methods or their combinations exist.

In article [7] the risk evaluation problems at enterprises in India were viewed. To this effect, an analysis of the normative legal documents on risk evaluation and management was conducted, as well as the assessment of risk evaluation system effectiveness for the developing countries' economies. The exceptional importance of conducting an objective risk management procedure to improve the country's economic and social indicators was marked. The main problems of risk evaluation procedure, with the major ones including the lack of unitary instruction concerning procedure methodology and the united relevant evaluation criteria, were identified. The research disadvantages can refer to the lack of suggestions concerting creation of scientific principles of the risk evaluation whose urgency and necessity of existence are accented by the authors.

In study [8], within determination of promising ways to improve the occupational health and safety management system, the necessity of scientific research systematization and risks evaluation methods standardization were identified, purposely to create unified, scientifically based risk-oriented approach for reforming principles occupational safety and health in Ukraine.

Improvement of the methodological approaches to risk evaluation in the system of occupational safety management was exposed [9]. The existing risk evaluation methods were analyzed by the authors and it was indicated that their large number, as well as the lack of a common terminology and structured tools system, could lead to errors in the results obtained. It was also marked that the risk-oriented approach in practical implementation of OHS systems is complicated by the lack of a universal approach concerning risk evaluation and related automated systems that could simplify the evaluation procedure implementation significantly and improve the preventive safety measures quality.

Objectives of the article. The purpose of this study is substantiation of the urgency of creating scientific principles of risk evaluation on occupational danger occurrence for its use in occupational health and safety management systems.

This purpose achievement can be carried out by solving the following **tasks**:

- to conduct the analysis of normative legal documents and basic terminology concerning risk evaluation in the occupational safety field;
- to analyze the main stages of risk evaluation of occupational danger occurrence;
- to identify the main practical problems of implementation of risks evaluation of occupational danger occurrence procedure in occupational health and safety management systems;
- to formulate the basic regulations and directions for development of scientific principles of risk evaluation of occupational danger occurrence**.**

Presentation of the main research. General requirements, recommendations concerning risk evaluation in the occupational safety field, as well as relevant terminology, are set out in the following normative legal documents as valid currently:

- DSTU OHSAS 18001 : 2010. Occupational hygiene and safety management systems. Requirements (harmonized with OHSAS 18001 : 2007);
- DSTU OHSAS 18002 : 2015. Occupational hygiene and safety management systems. Basic principles of OHSAS 18001:2007 compliance (harmonized with OHSAS 18002 : 2008);
- DSTU GOST 12.0.230 : 2008. Occupational safety management systems. General requirements (harmonized with ILO-OSH 2001);
- DSTU IEC/ISO 31010 : 2013. Risk management. Methods for general risk evaluation (harmonized with IEC/ISO 31010 : 2009);

- DSTU 2293 : 2014. Occupational health. Terms and definitions of key concepts;
- DSTU ISO Guide 73 : 2013. Risk management. Glossary of Terms (Harmonized with ISO Guide 73 : 2009);
- Others, including those which are referred to in the above standards.

The logical beginning of risk evaluation process consists of defining the basic terminology. It is necessary in order to:

- clearly formulate the research purpose and tasks (including those by danger identification);
- evaluate the state and availability of necessary resources for relevant process conducting;
- select the necessary evaluation method;
- obtain a reliable result that meets the standardized evaluation criteria.

The "risk" term is very multifaceted, since it is directly related to the "incident" concept [10]. An incident may have a negative or positive character and vary by manifestation (implementation) degree [10].

In the occupational safety field, an incident, denoted at the "risk" term, has a clearly negative character being associated with another term, "harm" [11]. The "harm" concept is interpreted as "damage to the health of people and/or damage to property or the environment, or a combination of these kinds of damage", and the "risk" term is interpreted accordingly as a "probability combination of causing of damage and severity of the harm" [11].

According to their application field recommendations, such terms are *intended* to be used by the executive authorities, economic entities that elaborate, consult, review normative documents in the occupational safety field and are *recommended* [11] to be used in:

- all types of normative documents concerning occupational safety;
- work on standardization;
- scientific, educational, methodical and publicistic editions;
- work of enterprises, institutions and organizations operating in Ukraine, technical committees for standardization, scientific-technical and engineering societies, ministries (departments).

However, other normative and legal documents in the occupational and industrial safety field attribute a negative incident concept ***exclusively*** to a person, more precisely to human security [12, 13]. Accordingly, the term "risk" is defined as "the correlation between the accident probability and the effect (-s) and the severity of injury or health deterioration that may be due to such an incident or effect (-s)" [12].

The standard considered for use of ***common terminology*** for those risk management responsible officers, developers of national and industry standards, guidelines, procedures, codes of established risk management practices, and so forth, generally associates the risk with such a term as a "purpose" [10]. Accordingly, the term "risk" is defined as an uncertainty concerning purpose achievement [10]. Based on the terms specified in the standard [10], a normative legal document has been elaborated exposing guidelines for selecting and applying general methods for risk evaluation. This is the standard DSTU IEC/ISO 31010 : 2013. Risks management. Methods for general risk evaluation (harmonized with IEC/ISO 31010 : 2009).

The process of general risk evaluation is defined as a consecutive process including stages of identification, analysis and risks evaluation [3, 10], where the identification process involves identifying, understanding and describing risks. The analysis process is conducted in order to understand the risk nature and determine the risk level. So, the risk analysis determines the consequences and their probability for the identified risk incidents, taking into account the availability and effectiveness of safety ways and means, as well as the risk level [3]. In this case, the risk level is determined by a combination of results as to the identified incidents probability and consequences [3]. Risk evaluation is interpreted as: comparing the risk analysis results with risk criteria to determine the risk probability and its admissibility degree [10].

At the same time, other existing standards suggest for the appropriate application of another term "risk evaluation". Risk evaluation is a process of risk evaluation which is caused by danger, taking into account the adequacy of available management tools and the decision on risk admissibility or inadmissibility [12, 14]. The above definition is more general and does not provide accurate understanding of the evaluation steps conducted, although it is obvious that these steps will be similar to those described above.

Thus, the first problem faced by an economic entity when it comes to the risk management process is to determine the purposes of achieving the result, which are not completely obvious (Figure).

The second problem is the lack of a common methodology in the relevant standards for the implementation of overall risk evaluation process and its stages.

Therefore, a qualitative risk management process and the desired result are impossible without defining a clear purpose and understanding of the evaluation implementation methodology.

Due to the uncertainty concerning the purposes and methodology of implementing the risk evaluation process, one more problem arises for enterprises which relates to ***resources.*** That is, if the purpose is to ensure human safety while performing a labor activity, appropriate resources must be available to manage such risks. If the purpose is expanded and, therefore, additional risks are considered, the number of resources to manage those risks should be increased. It is also obvious that increasing the purposes as to the number of risks that shall be managed by a particular person (or unit) at the enterprise, the task is complicated and the preconditions for reducing the expected result quality are laid.

Thus, the lack of a common terminology on the "risk" concept and a unified methodology for its evaluation in the occupational safety field can result in a number of problems related to the purpose definition, allocation and availability of resources for their implementation, as well as the risk management quality.

The term "occupational safety" understood as a "system of legal, socio-economic, organizational and technical, sanitary-hygienic, therapeutic and prophy-

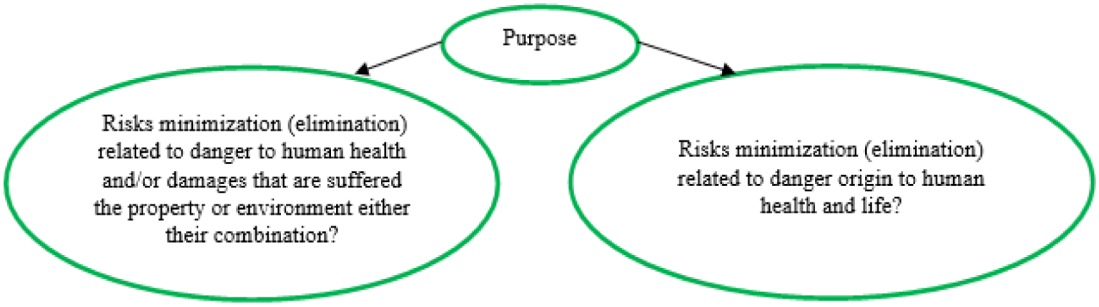

Fig. Problem of determining purposes during risk evaluation on occupational danger occurrence by the economic entities

lactic ways and means aimed at maintaining the health and working capacity of a person in the workflow" gives an unequivocal answer to the question of purpose setting concerning occupational safety risks [15].

According to the definition, the purposes should be related exclusively to ensuring the human safety and maintaining the human life and health during workflow. That is, they are related to minimizing (eliminating) ***occupational danger***, i.e. danger which can lead to injuries, sickness or death of the employee during professional activities [11].

Separation of material and environmental harm from human life and health harm has an effect on the standard [14]. However, such risks should also be evaluated if they can affect the health and safety of a person during in the workflow.

Defining the purpose allows proceeding directly with the overall risk evaluation process.

Taking into account the fact that standard [3] is one of the main governing documents describing the process and methods of general risk evaluation the most comprehensively each economic entity should depend on its provisions in the first place.

As stated above, this standard defines general risk evaluation as a common process for identifying, analyzing and evaluating risks [3]. Accordingly, the ***first stage (risk identification***) is defined as a process of revealing, perceiving and recording risks [3].

In order to conduct the risk identifying process, expert methods in the form of individual methods and their combinations according to the applicability criteria are mainly proposed to apply [3]. There are three such criteria:

- always applicable;
- applicable;
- not applicable.

According to the standard, one (or combination of several ones) of 25 applicable and always applicable methods should be selected by the entity (enterprise, organization, institution, and others) [3]. In addition to these criteria, the method should be selected in accordance with certain characteristics that are the most appropriate for an individual economic entity, namely:

- available resources and opportunity;
- the nature and degree of uncertainty;
- complexity;
- the possibility of obtaining quantitative results.

Further, the standard provides an analytical guide for each of the methods, which includes:

- a general overview;
- recommendations on the application, the need for input data and the process sequence;
- information on the expected results;
- method advantages and application limits.

The identification process conduction allows the ***next step: risk analysis*** consisting of two interconnected stages. The first one is the identified dangers probability evaluation, and the second one serves to determine the level of identified dangers implementation severity.

Risk analysis is the most difficult stage, since it is necessary to evaluate all possible results of implementations (by probability) of each identified danger, and then to determine all possible consequences for each result according to the severity level. In order to obtain the most objective result (by the danger incident probability and severity), influence of other factors ("human", external, and so forth) on the identified factor (as well as their possible combinations) should be taken into account along with the evaluation of availability and effectiveness of safety measures and means. The obligatory stages of the consequence probability and severity evaluation involve verifying the final results.

To accomplish the risk analysis stage, the application of qualitative, semi-quantitative and quantitative methods is proposed which are selected by the economic entity in the same way as the identification process by the criterion of applicability and criterion characteristic [3]. The most susceptible in terms of the result convenience are quantitative methods.

To evaluate the danger occurrence probability there are about 20 methods available to be used, and about 23 are suggested to determine the number of consequences [3].

According to the concept, the "risk" is a combination of the danger occurrence probability and its implementation severity. Combining these two components, it is possible to obtain the following intermediate evaluation result: the danger occurrence risk level or a quantitative risk evaluation. To determine the risk level, about 20 methods are suggested to select.

The next stage – risk evaluation [3] is a process of comparing the obtained risk analysis results with risk criteria. There are different admissibility criteria in different fields of activity when it is required to implement a risk evaluation process. They differ by their essence (financial, environmental, socio-political, security and other criteria), by the admissibility scale (acceptable with verification, acceptable, admissible, unacceptable, and so on) and other parameters.

There are no uniform, standardized criteria for risk evaluation in the occupational and industrial safety field. During evaluation process, it is proposed to be supported by approach which divides the risks into three ranges [3]:

1. The upper range is an unacceptable risk level. This range risks must be minimized regardless of the necessary resources or benefits that potentially can be derived from activities in this risk conditions.

2. The average range corresponds to the levels where benefits and advantage from activities in risk conditions are balanced with potential negative consequences.

3. The lower range is an insignificant risk level when the economic entity business activities can be carried out without additional measures to minimize risks.

For the risk evaluation process conducting, 21 always applicable and applicable methods are proposed to select from.

Finally, the last stage is the risk ranking by significance. This stage purpose is to reject insignificant risks and to focus on processing the most significant ones, thus allowing [3]:

- to process the risk without further general evaluation;
- to reject insignificant risks, whose processing is inappropriate;
- to conduct a more detailed evaluation process.

It should be noted that the risk ranking stage is proposed to be implemented before the evaluation process beginning; in this case the above stage is named the preliminary analysis stage. However, possible disadvantages will be presented further.

What main problems of general risk evaluation process can be identified in terms of its practical implementation by the economic entity? For a more accurate understanding, problems of ***possibility*** of implementing each stage are analyzed**,** and using the obtained result the general problems of risk evaluation of occupational danger occurrence are determined to be used in the occupational health and safety management systems.

The possibility problems of practical implementation respectively to the first stage – ***risks identification*** are considered.

Analyzing the phrase itself, one can ask a question: How can the risk be identified [3]? It is not comprehended how uncertainty in terms of achieving purposes can be identified, understood, and recorded.

The main purpose of risk management process is to ensure the safety and preservation of human health during workflow. That is, the purpose consists in protection against the action of every potentially danger, harmful and other negative factors, including the prevention of the employee's own erroneous actions. Thus, it is obvious that not the risks, but the above factors that could have negative influence on the human within the "human – engineering system – environment" system individually or in certain combinations should be identified. Therefore, such factors could be considered as dangers or occupational dangers [11, 13].

From the existing standards, the process identification procedure is not comprehended. It is noted that this process "covers the identification of risk causes and sources (dangers in terms of physical harm), incidents, situations or conditions that could material influence on the achievement of purposes, as well as identification of the nature of this influence" [3]. Talking into account the large nomenclature of these factors and the resulting action's varied nature, it is obvious that the identification processes should differ methodologically. Therefore, these factors should be considered as an additional criterion during selecting appropriate identification method that is proposed by the standard [3].

By the identification methodology particularity, all factors (dangers) could be divided into two main groups:

1. Factors subjected to instrumental measurement (objective identification).

2. Factors not subjected to instrumental measurement.

The factors of first group include levels of in-plant noise, vibrations and microclimatic parameters of the working environment, occupied zone air cleanness indicators, and others. The second group factors include psycho-physiological factors, the "human factor", stochastic factors of the environment and some danger and harmful production factors, whose influence can never be quantified (for example, "direct and reflected gleam", and others) [16].

The factors identification process should be conducted by the economic entity itself, or by an expert or expert group involved in that process implementation. They can conduct identification relying on:

1. Current normative and legal documentation.

2. Their own knowledge and experience.

3. Results of instrumental measurements of certain factors characteristics.

The first group factors identification due to the possibility of instrumental measurement could be considered an objective process and, thus, be conducted using known methods, which are clearly described in the normative legal documents.

The second group factors identification is more complicated, because it is impossible to measure their characteristics in an instrumental way. The methods specified in the normative legal documents for identifying such factors relate to expert methods in their essence. Therefore, the economic entity can conduct the identification process only based on their own knowledge and experience.

The conducted preliminary analysis shows that the general identification procedure is carried out on the relevant term basis, regardless of the selected methodology [17]. Identification (lat. Identifico – to equate) is the procedure of recognizing an unknown object by its equating to some known one based on the coinciding particularities [18]. In this case, the second group factors should be considered as the recognition object.

It is obvious that the identification procedure for the second group factors always has an approximate character, since it is impossible to conduct an objective identification of the reason for such factors not to have any quantitative (objective) particularities physically. Therefore, the second group factors can be identified only by coincidence of their qualitative (nominal) particularities. Such factors' nominal particularities are formed by the economic entity or expert (contractor) at the stages of their educational process at educational organization,

while passing production and other practices [19]. Therefore, in this case the identification process objectivity depends directly on the depth of knowledge (learning and education quality) and the expert's experience.

Thus, the main problems of the practical and objective identification process implementation are the following:

- uncertainty regarding the standards requirements concerning the identification purpose and methodology;
- necessity of having in-depth relevant knowledge and experience for the responsible executive (an economic entity, an expert);
- possibility of erroneous selection of an identification method (due to their large amount and subjectivity of the select by the proposed criteria), as well as its practical implementation;
- necessity of spending considerable time and effort on the required method (techniques combination) selection.

The second stage is ***the identified dangers (factors) probability evaluation, identification of the danger severity and the risk level*** (the first, second and third stages of the risk analysis process) [3].

It is obvious that to obtain objective results of probability evaluation of occupational danger origin and to determine its consequences severity, the expert must have in-depth knowledge in the higher mathematics field (especially the relevant special areas), as well as occupational safety, industrial safety and special (technological) disciplines. In-depth knowledge in higher mathematics is needed to understand the selection alternatives and possibility of using existing methods to obtain quantitative probability and to estimate results (necessary to determine the risk level), as well as for probability of the mathematical analysis of the obtained results veracity. And the knowledge in the occupational safety, industrial safety and special disciplines field is needed for:

- objective evaluation of effectiveness of the existing safety measures and means;
- identification of all potential factors within the "human – technical system – environment" system which could influence the danger occurrence probability and such probability consequences separately or in combination;
- an analysis on primary and secondary consequences of the danger implementation;
- evaluation of "human factor" possible demonstrations, which are analyzed with difficultly by the mathematical analysis;
- possibility of expert analysis of veracity of the obtained results.

In addition, to determine the risk level it is necessary to process a significant amount of data and their combinations; it is impossible without the availability of special technical equipment and software at the enterprise.

Consequently, the main problems of practical and objective implementation of risk analysis process are the following:

- necessity of having in-depth knowledge and competence in the field of higher mathematics, as well as occupational safety, industrial safety and special (technological) disciplines for the expert;
- possibility of erroneous selection of the appropriate methodology and its practical application;
- necessity of spending considerable time and effort on the required method (techniques combination) selection;
- necessity of availability of special technical equipment and software for calculations at the enterprises.

The next step is ***the process of risk evaluation (criterial risk evaluation).*** The risk analysis process results are recommended to evaluate by three ranges [3]. These ranges are based on the balance between the benefit from the economic entity's activity and the potential negative consequences of such activity. The responsibility for determining the ranges and the respective balance rests with the economic entity. Moreover, the ranges limits which the economic entity should never go beyond are not clearly defined within the normative legal documents. Risk evaluation criteria should be elaborated by each economic entity independently, according to the recommendations [3]. As the criteria elaboration basis the following characteristics can be considered [3]:

- agreed purposes;
- criteria identified in the specifications;
- general data sources;
- current industry criteria;
- readiness to risk;
- legal and other requirements for certain equipment or certain cases of its application.

The independent elaboration of risk evaluation of occupational danger occurrence criteria by the economic entity has the following ***main problems***:

1. Establishing of criteria of economic expedience motives. As historical experience proves, for economic entity "temptation" always exists to obtain surplus profits even at the expense of human security and working conditions worsening. This problem is especially topical for only developing economy countries where the human consciousness (both the employer and the employee) concerning the safety aspects priority over the economic benefits is not completely formed yet.

2. Fallibility of criteria elaboration procedure for risk evaluation of occupational danger occurrence. It is obvious that economic entity should have in-depth special knowledge to determine the risk elaboration criterion as an important indicator. The problem is deepened due to the generalized principles recommended in the standard for criteria elaboration and due to lack of their relating to a certain branch of industry. It is obvious that the risk evaluation of occupational danger occurrence criteria should be elaborated only considering a specific industry orientation and just such principle should be the basis. Bringing the criteria ranges into step of, for example, a current risk level of $1 \cdot 10^{-6}$ incidents per year (which, for example, can be taken as a basis in accordance with recommendations [3]), is not correct. It is impossible to compare the occupational danger risk levels in, for example, the mining industry field and in banking field. In certain fields, reaching the current risk levels is practically impossible, especially in terms of their existence economic expediency [20].

3. Possibility of conflict situations which arise from during the risk level evaluation of economic entity's activity by the state supervisory authorities. Such an evaluation is regulated by the Law of Ukraine "On the Basic Princi-

ples of State Supervision (Control) in the Economic Activity Field" and should be conducted by the criteria elaborated in accordance with an appropriate method [21]. However, the fact that the critical limits of risk evaluation ranges are not established by the law could result in non-acceptance of evaluation results objectivity by the economic entity, since the evaluation criteria elaborated by them can differ significantly from the evaluation criteria elaborated by the supervisory authority. That is, the lack of unification and limits established by the law concerning the risk evaluation ranges (by the industrial branch) forecloses a possibility of conducting objective controls of the occupational safety level at enterprises by risk level.

The final stage of general evaluation process is the ***risk ranking*** by significance which is proposed to be implemented before the process of criterial evaluation of risks. However, the decision-making procedure of risk processing (processing discard) without the criterial evaluation can allow:

- neglecting by certain (low probable) risks that can cause severe consequences;
- availability of frequently occurring (highly probable) insignificant risks, with severe cumulative effects consequences.

It is possible to agree with the fact that conducting risks ranking at the last stage complicates the evaluation process to a certain extent. However, taking into account the exceptional importance of the evaluation purposes, namely human life and health, the thorough danger analysis should be priority.

Thus, the analysis of general evaluation of occupational danger occurrence process stages ***revealed series of systemic problems*** that not only can influence significantly the quality and objectivity of the evaluation conduction, but also cast doubt upon practical possibility of implementing this process within the existing standards.

Despite the rather complete methodological support of the general risk evaluation process, this process cannot be considered as sufficient one, and, most crucial, as comprehensible and easy to use for economic entities.

In the first place it concerns the economic entities with insignificant financial and human resources. For Ukraine, where 99.8 % of economic entities are small and medium-sized businesses, the risks evaluation process complexity is ***relevant particularly*** [20]. All evaluation stages should be conducted by such economic entity itself; it is possibility due to having a series of different knowledge and competencies. Namely, ***in-depth complex knowledge and competencies*** are necessary in the following fields:

- occupational safety and industrial safety (on a risk-oriented approach basis);
- higher mathematics and its special areas (theory of probability, decision making, and others);
- human psychology;
- special subjects relating to the peculiarities of technological processes organization and functioning.

The necessity of having such knowledge and competencies is explained due to the large number of proposed risk methods for identification, probability, consequences, level and evaluation (at the very least 25, 20, 23, 20, 21 and their combinations, respectively), which in practice have a very small number of professional experts, as well as due to their complexity. In addition to knowledge, the expert's desirable competence level includes at least 5 years' experience of practical professional work.

This fact is fair, since none of training programs among all levels at educational organization in Ukraine ***has foreseen or foresees*** such complex knowledge and competencies for training specialists. In addition, the latest trends concerning decrease in scheduled hours for studying occupational and industrial safety subjects, removing these subjects from the "normative" category, the nonobligatoriness to elaborate relevant sections of graduation theses and other negative aspects significantly reduce the required knowledge level of future professionals. Still on the contrary, increasing "computer literacy" subjects are gaining popularity.

Thus, it is obvious that improving the existing complicated risk evaluation procedure for its simplification is necessary. However, it is not a simplification of the methodology itself which is meant, but the simplification of its use.

Consequently, the process complexity, responsibility for achieving the purposes (human life and health), as well as a series of identified methodological problems having a systemic nature, require not only the corrective measures implementation, but the scientific principles elaboration of risk evaluation regarding occupational danger occurrence.

The basic regulations for such principles elaboration are the following:

- objectivity (especially at identification and risks analysis stages);
- taking into account demonstrations of stochastic factors ("human", external, and others);
- simplicity for use;
- obtaining quantitative results;
- accurate evaluation criteria;
- possibility of implementation of the evaluation procedure using available hard- (personal computers) and software.

The achievement of these regulations should be conducted in two main directions:

1. Elaboration of a scientifically substantiated mathematical model for the risk evaluation process of occupational danger occurrence.
2. Creating available software based on this model for users (for example, using the Windows-based system).

This model should be elaborated based on well-known risk evaluation methods. It should be presented as a new, generalized methodology, which includes all the advantages of the above ones and takes into account their disadvantages [17]. Considering the fact that the perspective methodology is constructed on the basis of international standards for risk management, it could be recommended for use by economic entities in Ukraine and in other countries of the world.

Conclusions and recommendations for further research. The analysis of normative and legal documents concerning the risk evaluation of occupational danger occurrence revealed problems related to the lack of a common terminology for risk concept and the methodology of its evaluation.

The risk evaluation procedure involves the following sequence of basic steps: risk identification, analysis and evaluation, each of these steps has some problems concerning the possibility of their practical implementation within the occupational safety management system.

The analysis of the existing procedure revealed series of main systemic problems at all stages of the general risk evaluation. The above problems could influence significantly the evaluation process quality and objectivity and cast doubt upon the practical possibility of its implementation within existing standards.

The procedure complexity, responsibility for achieving the purposes, as well as series of identified systemic problems require creating of scientific principles elaboration of risk evaluation regarding occupational danger occurrence, which is a perspective way of this research development.

The basic regulations for such principles elaboration are the following:

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- taking into account demonstrations of stochastic factors;
- simplicity for use;
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References.

1. State Inspection of Labour Issues of Ukraine. *Statistical data on occupational injuries in Ukraine* [online]. Available at: <http://dsp.gov.ua/category/diyalnist/travmatyzm-na-vyrobnytstvi/> [Accessed 1 November, 2017].

2. Information and analytical agency UNIAN. *Achieving zero traumatism at Ukrainian enterprises is hampered by the "human factor"* [online]. Available at: <https://economics.unian.net/industry/560248-dostich-nulevogo-travmatizma-na-ukrainskih-predpriyatiyah-meshaet-chelovecheskiy-faktor-ekspertyi.html> [Accessed 31 October 2017].

3. GP "NII Sistema", 2013. *DSTU IEC/ISO 31010:2013 Risk management. Methods for general risk assessment (IEC/ISO 31010: 2009, IDT)* [online]. Available at: <http://online.budstandart.com/en/catalog/doc-page?id_doc=66723> [Accessed 1 November 2017].

4. Orlov, A. I. and Pugach, O. V., 2012. Approaches to the general risk theory. *Large systems management: collection of works*, 40, pp. 49–82.

5. Karen Russ, 2010. Risk Assessment in the UK Health and Safety System: Theory and Practice. *Safety and Health at Work* [online], 1(1), pp. 11–18. Available at:<http://dx.doi.org/10.5491/SHAW.2010.1.1.11> [Accessed 19 January 2018].

6. Hannu Anttonen and Rauno Pääkkönen, 2010. Risk Assessment in Finland: Theory and Practice. *Safety and Health at Work* [online], 1(1), pp. 1–10. Available at: http://dx.doi.org/10.5491/SHAW.2010.1.1.1 [Accessed 12 November 2017].

7. Sengupta, A., Bandyopadhyay, D. and Van Westen, C. J., 2016. An Assessment of the Risk Assessment Framework for Industrial Accidents in India. *Journal of Loss Prevention in the Process Industries* [online], 41, pp. 295–302. Available at: https://doi.org/10.1016/ j.jlp.2015.12.012 [Accessed 1 November 2017].

8. Zdanovsky, V. G. and Tsybulskaya, O. V., 2017. Some aspects of improving the occupational safety system in Ukraine. *Problems of labor safety in Ukraine: collection of scientific works*, 33, pp. 1–14.

9. Kruzhilko, O. E., Watchman, Ya. B., Lutak, Z. I. and Prachnikov, N. A., 2017. Methodical principles of industrial risk estimation in preventive measures planning. *Problems of labor safety in Ukraine: collection of scientific works*, 33, pp. 15–21.

10. *DSTU ISO Guide 73:2013 (ISO Guide 73:2009, IDT) National Standard of Ukraine. Risk management. Glossary of terms* [online]. Available at: <http://metrology.com.ua/download/iso-iec-ohsas-i-dr/61-iso/325-dstu-iso-guide-73-2013> [Accessed 31 October 2017].

11. National Research Institute of Occupational Health and Safety. *DSTU 2293:2014. Terms and definitions of fundamental conceptions* [online]. Available at: <http://online.budstandart.com/ua/catalog/doc-page?id_doc=61781> [Accessed 23 October 2017].

12. Derzhspozhyvstandart of Ukraine.*DSTU OHSAS 18001:2010. Hygiene and safety management systems* [online]. Available at: <https: //dnaop.com/html/34112/doc-%D0%94%D0%A1%D0%A2%D0%A3_OHSAS_18001_2010> [Accessed 23 October 2017].

13. *DSTU GOST 12.0.230:2008 System of safety standards. Systems of occupational safety management. General requirements. (GOST 12.0.230-2007, IDT)* [online]. Available at: <http://online.budstandart.com/en/catalog/doc-page?id_doc=64462> [Accessed 08 November 2017].

14. *DSTU OHSAS 18002:2015 Hygiene and safety management systems. Basic Principles for OHSAS 18001:2007 (OHSAS 18002:2008, IDT) Labor Requirements* [online]. Available at: <http://online.budstandart.com/en/catalog/klassifikator-ics/13-dovkiillya-zakhy-413/13.100_profesiiina_b_4190/18002-2015 + 64325-detail.html> [Accessed 05 January 2018].

15. Law of Ukraine "On Occupational Safety" [online]. Available at: <http://zakon3.rada.gov.ua/laws/show/2694-12> [Accessed 10 October 2017].

16. *GOST 12.0.003-74 SSBT Hazardous and harmful production factors. Classification* [online]. Available at: <https://znaytovar.ru/gost/2/GOST_12000374_SSBT_Opasnye_i_v.html> [Accessed 05 January 2018].

17. Bochkovskyi, A. P., 2016. Theoretical aspects of the universalization of professional risk assessment in occupational safety management systems. *Bulletin of Lviv State University of Life Safety*, 14, pp. 134–151. DOI: 10.13140 / RG.2.2.22043.87848.

18. Bochkovskyi, A. P., Sapozhnikova, N. Yu. and Gogunskii, V. D., 2017. Legal and organizational issues of

improving the level of labor protection and industrial safety at Ukrainian. *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu,* 5(161), pp. 100–108.
19. Bochkovskyi, A. P., 2015. Theoretical aspects of the hazardous and harmful production factors analysis methodology. *ONAFT Scientific papers*, 46(1), pp. 285–291. DOI: 10.13140 / RG.2.1.5073.8969.
20. Stoetsky, V. F., Golinko, V. I. and Dranishnikov, L. V., 2014. Risk assessment for accidents of technogenic character. *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*, 3, pp. 117–124.
21. *A methodology for developing criteria to assessing the risk degree from conducting business activities and determining the planned state supervision (control) inspections frequency* [online]. Available at: <http://zakon5.rada.gov.ua/laws/show/752-2013-%D0%BF/paran13#n13> [Accessed 1 November 2017].

Актуалізація розробки наукових основ оцінки ризиків виникнення професійних небезпек

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Мета. Обгрунтування актуальності створення наукових основ оцінки ризиків виникнення професійних небезпек для застосування в системах управління охороною праці (СУОП).

Методика. Дослідження проблем оцінки ризиків виникнення професійних небезпек проводилися шляхом вивчення й теоретичного аналізу:

- нормативно-правової бази України щодо керування ризиками в галузі охорони праці;
- цілей оцінки ризиків;
- методології ідентифікації ризиків;
- процедури та етапів оцінки ризиків виникнення професійних небезпек.

Результати. Проаналізовані нормативно-правові документи щодо оцінки та керування ризиками виникнення професійних небезпек. На основі аналізу виявлені проблеми щодо цілей, термінології та методології процедури оцінки ризиків. Проведено аналіз основних етапів загального оцінювання ризиків і виявлені системні проблеми, що суттєво впливають на якість і об'єктивність їх виконання, а також ставлять під сумнів практичну можливість здійснення процедури оцінки в рамках існуючих стандартів. Обгрунтована актуальність створення наукових основ оцінки ризиків виникнення професійних небезпек, що дозволить значно спростити процедуру оцінки й підвищити якість і об'єктивність її проведення.

Наукова новизна. Уперше обгрунтована актуальність і сформульовані принципи й напрями створення наукових основ оцінки ризиків виникнення професійних небезпек для застосування в системах управління охороною праці як в Україні, так і у світовій практиці.

Практична значимість. Отримані результати будуть використані як аналітична база для створення наукових основ оцінки ризиків виникнення професійних небезпек.

Ключові слова: *охорона праці, професійна небезпека, промислова безпека, ризик, нормативно-правова база*

Актуализация разработки научных основ оценки рисков возникновения профессиональных опасностей

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Цель. Обоснование актуальности создания научных основ оценки рисков возникновения профессиональных опасностей для применения в системах управления охраной труда (СУОТ).

Методика. Исследования проблем оценки рисков возникновения профессиональных опасностей проводились путем изучения и теоретического анализа:

- нормативно-правовой базы Украины по управлению рисками в области охраны труда;
- целей оценки рисков;
- методологии идентификации рисков;
- процедуры и этапов оценки рисков возникновения профессиональных опасностей.

Результаты. Проанализированы нормативно-правовые документы по оценке и управлению рисками возникновения профессиональных опасностей. На основе анализа выявлены проблемы, касающиеся целей, терминологии и методологии процедуры оценки рисков. Проведен анализ основных этапов общего оценивания рисков и выявлены системные проблемы, существенно влияющие на качество и объективность их выполнения, ставящие под сомнение возможность практической реализации процедуры оценки в рамках существующих стандартов. Обоснована актуальность создания научных основ оценки рисков возникновения профессиональных опасностей, что позволит значительно упростить процедуру оценки и повысить качество и объективность ее проведения.

Научная новизна. Впервые обоснована актуальность, сформулированы принципы и направления создания научных основ оценки рисков возникновения профессиональных опасностей для применения в системах управления охраной труда как в Украине, так и в мировой практике.

Практическая значимость. Полученные результаты будут использованы в качестве аналитической базы для создания научных основ оценки рисков возникновения профессиональных опасностей.

Ключевые слова: *охрана труда, профессиональная опасность, промышленная безопасность, риск, нормативно-правовая база*

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