UDC 331.45(477):005.934

A. Bochkovskyi[1], Cand. Sc. (Tech.),
orcid.org/0000-0002-4166-3148,
N. Sapozhnikova[2], Cand. Sc. (Tech.),
orcid.org/0000-0001-6181-4022,
V. Gogunskii[1], Dr. Sc. (Tech.), Prof.,
orcid.org/0000-0002-9115-2346

1 – Odesa National Polytechnic University, Odesa, Ukraine, e-mail: andrew.bochkovsky@gmail.com; vgog@i.ua
2 – Odesa National Academy of Food Technologies, Odesa, Ukraine, e-mail: Natala.tala@gmail.com

LEGAL AND ORGANIZATIONAL ISSUES OF IMPROVING THE LABOR PROTECTION AND INDUSTRIAL SAFETY LEVEL AT UKRAINIAN ENTERPRISES

А. П. Бочковський[1], канд. техн. наук,
orcid.org/0000-0002-4166-3148,
Н. Ю. Сапожнікова[2], канд. техн. наук,
orcid.org/0000-0001-6181-4022,
В. Д. Гогунський[1], д-р техн. наук, проф.,
orcid.org/0000-0002-9115-2346

1 – Одеський національний політехнічний університет, м. Одеса, Україна, e-mail: andrew.bochkovsky@gmail.com; vgog@i.ua
2 – Одеська національна академія харчових технологій, м. Одеса, Україна, e-mail: Natala.tala@gmail.com

ПРАВОВІ ТА ОРГАНІЗАЦІЙНІ АСПЕКТИ ПІДВИЩЕННЯ РІВНЯ ОХОРОНИ ПРАЦІ ТА ПРОМИСЛОВОЇ БЕЗПЕКИ НА ПІДПРИЄМСТВАХ УКРАЇНИ

Purpose. To identify the promising ways of improving the labor protection and industrial safety level at enterprises of Ukraine.

Methodology. Study of problems and promising ways of improving the labor protection and industrial safety level was performed by way of examining and theoretical analysis of the following issues:

- statistical data on occupational injuries in Ukraine and 9 EU countries (Austria, the UK, Germany, Denmark, Norway, Poland, Hungary, Finland, France), countrywide for the period of 2011–2015;
- legal and regulatory framework of Ukraine and the EU on labor protection and industrial safety;
- curriculum programs of training specialists in the field of labor protection in Ukraine and the EU (by the example of the Republic of Poland).

Findings. There were analyzed structural causes of accidents and statistics under the main indicators of industrial injuries at enterprises of Ukraine and EU countries. Based on the analysis of the legal framework of Ukraine on labor protection there were identified problems, related to the introduction of complex amendments to legal and regulatory documents and their quality that directly affect human security in manufacturing environment. A comparative analysis of educational programs for the preparation of students of higher educational institutions in Ukraine and EU countries was performed (by the example of the Republic of Poland) in matters of labor protection and industrial safety. Problems were identified that may increase the occupational risk level at enterprises of Ukraine. There were also proposed priority measures of legal and organizational nature for increasing the labor protection and industrial safety level in Ukraine.

Originality. A system of automated filing and control of amendments in the legal and regulatory acts on labor protection and industrial safety was developed for the first time. Relationships between the labor protection level and reforms in the legislative and educational systems were analyzed.

Practical value. Survey results can be applied for the creation and implementation of the state automated system meant for accounting and control of amendments in the legal and regulatory acts on labor protection and industrial safety, both in Ukraine and in the EU countries.

Keywords: *labor protection, occupational injuries, industrial safety, professional risk, legal and regulatory framework, higher education*

Introduction. Sustainable path of social evolution involves the continuous development and improvement of economic, social and other systems of a particular country. The legal and regulatory framework is at the foundation of this process, in particular for the protection of labor, providing a framework for their safe operation, and also forming the educational and cultural level of society which produces and sells certain goods and services.

According to Article 1 of the Law of Ukraine "On labor protection", labor protection is a system of legal, socio-economic, organizational and technical, sanitary-hygienic and medical-preventive measures and means

aimed at preserving life, health and labor ability rights in the process of labor activities. In accordance with the above, the following principles of ensuring occupational safety (minimization of occupational risks) were allocated in rank order:

- legal;
- management;
- organizational;
- orienting;
- technical, etc.

Legislative principles (legal actions) are not accidentally highlighted foremost, since the legal and regulatory framework is the first order instrument to secure employees in a production environment.

However, the safety of employees even more so also depends on the understanding of the importance of private and public security and labor culture by every person. This understanding, primarily, is formed in the process of obtaining special education and directly depends on its quality.

So, it is clear that certain systemic changes in a state are closely associated with both changes in the legal framework and with the appropriate changes in the education system. Experience in the development of economic systems in the developed countries has proved that the increasing level of labor culture at the same time increases the level of efficiency and safety of production. However, in Ukraine the situation with the required level and quality of labor protection and industrial safety, both in terms of production and especially at the stage of young specialists training in educational institutions, is of problem.

Within the European integration processes in Ukraine, the legal framework for the protection of labor and the corresponding training of specialists are undergoing significant changes. These processes, at their core, are not of a profound, scientifically-based and comprehensive nature, but occur as occasionally and isolated, which in turn may lead in the near future to a sharp increase in the number of cases of occupational traumatism, occupational diseases, industrial accidents and catastrophes. So it is to highlight the modern problems in the field of health and offer their solutions urgent right now, before these processes are irreversible. This will allow adapting the existing system of labor protection to European requirements within a short term and painlessly.

Analysis of the recent research and publications. Problems and perspective ways of labor protection and industrial safety development in Ukraine and the EU were examined in the following scientific works [1–4]. However, the analysis of these studies revealed a certain number of unresolved problems and deficiencies.

Thus, in works of A.A. Netrebskyi, there was performed a comparative analysis of occupational risk levels in Ukraine and EU countries on the major economic activities, as well as trends reducing the level of labor protection in Ukraine and priority directions of its increase. However, at the same time, virtually no attention has been paid to the analysis of legal and regulatory base of Ukraine and EU countries on labor protection, as a fundamental base for its security, and the problems of professional education are considered in a very narrow branch format, without linking them to the European education reform.

The article [1] analyzes current trends of occupational risks and hazards in Ukraine and the world, convincingly demonstrates the relevance of occupational health and safety as essential elements of sustainable development of society, highlights the modern problems of labor protection development in Ukraine as a science. However, given the systemic changes that have taken place in Ukraine in recent times, most of the proposed priority ways of improvement of labor protection and industrial safety need to be adjusted towards the European integration processes.

In the paper [2] there were quite carefully considered problems of security and quality of legal and regulatory framework of Ukraine on labor protection, but only for the food industry enterprises, which cannot be considered objective for other industries and the state system in general. In addition, problems indicated in the study are not considered in the context of the education system reform.

In articles [3], there was performed an analysis of training in the field of labor protection in the EU and noted importance and interrelationship of the education system reform in matters of improving the level of labor protection at the enterprises. However, it is not clear how to implement positive achievements and methods in other countries, in particular in Ukraine, in the context of the existing legal and regulatory framework and educational programs of specialists training.

The paper [4] shows the positive effect of improving the level of labor protection at enterprises through the introduction of appropriate European standards. However, questions of training ensuring this effect in practice were not considered.

The main drawback of a considerable part of the analyzed studies can be considered as follows:

- lack of an integrated approach to the problems of labor protection and industrial safety in Ukraine on the path to European integration;
- rapid loss of relevance, given the dynamics of changes in the legislative, educational, socio-economic and other state systems in Ukraine in recent years.

Objectives of the article. The aim of this work is identifying the promising ways of improving the labor protection and industrial safety level at enterprises of Ukraine.

It is necessary to solve the following tasks to achieve this goal:

- to perform a comparative analysis of the structure of reasons of industrial accidents in Ukraine and the EU;
- to identify problems of Ukrainian legal and regulatory framework in the field of labor protection and industrial security adaptation up to European standards;
- to analyze the system of professional training in the field of labor protection and industrial safety in Ukraine and the EU;
- to define the priority ways of development of labor protection and industrial safety in Ukraine.

Presentation of the main research. According to the Association Agreement with the EU ratified by the Verk-

hovna Rada in 2014, Ukraine has undertaken obligations to implement provisions and requirements of the European Directives on labor safety and health in the national legislation. These requirements are spelled out in Articles 419–425, Chapter 21, Section V "Economic and Sectoral Cooperation" of the Agreement, as well as specific requirements regarding the timing of implementation in Annex XL Part "Labor Health and Safety".

The Agreement is certainly a positive step towards improving working conditions at the enterprises of Ukraine, intended to affect positively the dynamics of changes in decrease of actual level of industrial traumatism and professional diseases. For good reason, the authors emphasized the word "actual level", as it is no secret today that most enterprises quite often hide the fact of occurrence of "minor" accidents resulting in death or injury of an employee.

However, the expected positive changes might be possible and give a significant effect only in combination with another, more progressive European approach to the system of occupational health and safety management, as well as corresponding changes in minds of each employee.

Progressiveness of the European labor safety management system is based on a process of prediction, evaluation and further management of occupational risks with the purpose of their elimination or minimization. The Ukrainian system, which was founded and is still being operated in most national economy enterprises virtually unchanged since the Soviet times, is based on performing analysis of accidents that have already occurred at the enterprise, with the subsequent development of measures for their future prevention. In other words, the European system of professional safety and health management is based on the methodology of risk prevention, but the Ukrainian one is based on the development of safety measures and means, to prevent the occurrence of further accidents, which have already happened *de facto*.

But, despite this fundamentally different approach to occupational risk management, statistical data regarding the distribution of occupational injuries cases by major types of accidents in Ukraine and the EU are almost identical (Table 1).

The fact can also be stated that the main reason of accidents is the intentional and unintentional failure to comply with the requirements of legal and regulatory acts for labor protection on the part of both an employee and the employer [2, 6, 7]. According to the Ukrainian classification, such causes relate to the structural ones.

On the other hand, by the main indicators of the severity of injury, such as the coefficient of fatal cases frequency (C_{fcf}), the ratio of the number of fatal accidents to the total number of registered accidents, Ukraine is far ahead of the EU (Tables 2, 3).

So, the value of the coefficient of fatal cases frequency rate (per 1 thousand of employees) in Ukraine is almost 3 times higher in comparison with the average one for EU countries (Table 2).

The ratio of the number of fatal accidents to the total number of registered accidents (the figure recommend-

Table 1

The distribution of occupational injuries cases by major types of events that led to accidents in Ukraine and EU countries [5, 6]

Types of events	Ukraine	EU countries
Fall of a person, %	30	27
Fall, collapse, collapse of objects, materials, rocks, soil, etc., %	17	14
Action of moving, flying, revolving items and details, %	15	18
Electric shock, effect of temperatures, hazardous and toxic substances, %	5	4
Intentional homicide or injury inflicted by another person, %	4	2

Table 2

Value of the coefficient of fatal cases frequency rate (per 1 thousand of employees) in EU states and Ukraine [6, 7]

Countries	Coefficient of fatal cases frequency (C_{fcf})
Austria	0.061
Great Britain	0.01
Germany	0.018
Denmark	0.028
Norway	0.02
Poland	0.067
Hungary	0.056
Ukraine	0.117
Finland	0.07
France	0.016

Table 3

The ratio of number of fatal accidents to the total number of registered accidents in the EU and in Ukraine [6, 7]

Countries	The ratio
Austria	0.057
Great Britain	0.014
Germany	0.8
Denmark	0.024
Norway	0.8
Poland	0.7
Hungary	0.54
Ukraine	10
Finland	0.07
France	0.16

ed by the ILO) in Ukraine exceeds the average for EU countries by 100 times (Table 3).

Thus the question arises, why, despite the same causes of accidents, their severity indicators differ so much? The answer to this question is to be found in the context of two interrelated planes.

The first one relates to the quality of legal and regulatory framework of Ukraine on labor protection, which should be understandable not only for performance, but also quite comprehensive in terms of functioning of preventive mechanisms.

The quality of legal and regulatory framework is provided through the process of systematic implementation of comprehensive positive changes. This is a very difficult and responsible process, because errors made when changing the legislation will inevitably affect the overall labor safety and greatly imped it.

Legal and regulatory framework of Ukraine on labor protection consists of more than 10,000 legal acts and is one of the largest and extensive in the legal system of the state. All legal acts of Ukraine on labor protection are interrelated in one way or another, so to improve the situation in the field of labor protection and industrial safety means to promote an integrated approach. Such an approach means that altering a single document at the same time leads to changing of several others. However, in practice, these changes have occurred discretely and in isolation in the recent past. Here are just a few examples of existing changes in the Ukrainian legislation.

On the 1st of January, 2016, in the framework of the Agreement implementation, GOST 27331-87 "Firefighting equipment. Classification of fires" was replaced by DSTU EN 2:2014, "Classification of fires", which is actually a Ukrainian copy of the European standard EN 2:1992; EN 2:1992/A1:2004, IDT "Classification of fires". The replacement was carried out based on the Order of Ministry of Economic Development and Trade of Ukraine № 1494 "On adoption of European and international normative documents as national standards of Ukraine, amendments to national standards of Ukraine, the abolition of national standards of Ukraine and international standards in Ukraine" dated 30.12.2014.

The new Ukrainian standard, as the previous one, defines 5 classes of fires, depending on the material that is burning: A, B, C, D, and the new F class, which includes a fire associated with combustion substances used for (in process of) cooking (vegetable and animal oils, fats). That is, the new standard does not only provide, as earlier, the definition of separate classes of fire accompanied by the burning of energized electrical equipment (according to GOST 27331-87 class E), but also introduces a new class, which essentially duplicates classes A and B in terms of firefighting means chosen. The introduction of the new standard is facing a sharp increase in the number of injuries, including the fatal ones, that occurred due to the occurrence and liquidation of fires associated with burning of electrical installations. The importance of this issue is determined by statistic data. According to them, one of the main causes of fires in Ukraine is connected with the short circuit and, accordingly, burning of particularly electrical installations (Table 4) [8].

There is also a question of what firefighting equipment is to be necessarily used by both an employee and a team of the SES during burning of energized power installations, if such class of fires does not simply exist? The particular relevance of the issue is given to the fact that every industrial, social, or administrative space necessarily contains a certain number of potentially dangerous electrical installations.

In addition, the mentioned changes were supposed to affect the review of other legal documents. First of all it concerns the Standard norms of fire extinguishers availability (NAPB B. 03.001-2004), which do not contain instructions on accommodation of industrial, administrative and public buildings (premises, structures) with fire extinguishers, comply with class F.

The topic of fire safety within this article is not in vain given the first place. The dynamics of the number of fires, and direct property losses caused by them, increases in Ukraine from year to year (Table 5) [8].

However, despite this, requirements of fire and explosion risks to such potentially dangerous objects as grain storage and dryers, which by their characteristics belong to category B – fire and explosion risky (NAPB B. 03.002-2007), were cut out of the existing Fire Safety Regulations of Ukraine (NAPB A. 01.001-2014). NAPB A. 01.001-2014 does not contain fire safety requirements for engineering equipment of thermal networks, elevators, lifts, garbage chutes as well, although these technical systems still continue to be designed, installed and operated on the territory of Ukraine.

Table 4

Causes of fires in Ukraine

Causes of fires	Percentage in the total
Careless handling of fire	63
Violation of fire safety rules at power device operation and installation	20
Violation of fire safety rules during operation and installation of heating stoves, thermal generating units and devices	7
Others	10

Table 5

Dynamics of the number of fire break-outs in Ukraine and resulting damages

Year	Direct material losses, thousands hryvnias	Quantity of fires
2011	828958	60290
2012	860070	71443
2013	710863	61114
2014	1489741	68879
2015	1458296	79581

It should be noted, that Fire Safety Rules in Ukraine is one of the basic legal and regulatory documents on fire safety, and the above shortcomings of the qualitative composition of documents significantly increase the risk of hazards.

Since August 1, 2012, according to the Order of the Ministry of Economic Development and Trade of Ukraine No. 640 "On adoption of international and European regulatory documents as national regulatory documents by way of confirmation" dated May 28, 2012, there was introduced a European standard IEC 62305-2010 IDT "Protection against lightning" in Ukraine, which received the name of DSTU EN 62305:2012 "Protection against lightning". The Ukrainian version of the legal document, as well as the European one, was made and enacted in 4 parts, each having a separate number and title:

- DSTU EN 62305—1:2012, "Protection against lightning. Part 1. General principles" (EN 62305—1:2011, IDT "Protection against lightning – Part 1: General principles");
- DSTU IEC 62305—2:2012 "Protection against lightning. Part 2. Risk management" (IEC 62305—2:2010, IDT "Protection against lightning – Part 2: Risk management");
- DSTU EN 62305-3:2012, "Protection against lightning. Part 3. Physical damage to structures and life hazard" (EN 62305-3:2011, IDT "Protection against lightning – Part 3: Physical damage to structures and life hazard");
- DSTU EN 62305-4:2012, "Protection against lightning. Part 4. Electrical and electronic systems within buildings and structures" (EN 62305—4:2010, IDT "Protection against lightning – Part 4: Electrical and electronic systems within structures").

The standard DSTU EN 62305:2012 is made in English and still has no official translation. Hence, designers, when designing a lightning protection system, must rely on the accuracy of their own translation (or a third-party translator), thereby to interpret the requirements and to make constructive decisions subjectively.

Simultaneously with the specified standard, DSTU. BV. 2.5-38:2008 "Engineering equipment of buildings and structures. Arrangement of lightning protection for buildings and structures" is still in force in Ukraine, while actually being the equivalent of IEC 62305-2006 "Protection against lightning" and duplicating it. This greatly increases the risk of wrong decisions at the stage of design and installation of lightning protection systems that in their further operations can negatively affect the level of fire safety and the number of industrial accidents.

Sections that consider the issues of industrial hygiene and occupational health are those of the most important ones together with fire, explosion and electrical safety issues in design of technical systems. Actions and tools that eliminate or minimize the impact of dangerous and harmful production factors on employees are within the framework of the above issues. The key ones are sections related to provision of safety and maintenance of the optimal microclimate parameters for industrial premises, air purity, and lighting of working areas. SNiP 2.04.05-91 "Heating, ventilation and air conditioning" was one of the main documents regulating the creation of comfortable microclimate conditions in the workplace. The mentioned document of January 1, 2014 was replaced by DBN (Ukraine's National Building Code) V.2.5-56:2014 "Fire protection system" and DBN V.2.5-67:2013 "Heating, air conditioning and ventilation". However, appropriate references to the SNiP (Construction rules and regulations) 2.04.05-91, that is no more in force, are still applied in vast majority of sectorial and intersectorial legal acts on labor protection. This discrepancy makes it impossible to design secure technical systems in compliance with current legal and regulatory acts.

Design of industrial lighting is not the best way viewed in the foreseeable future as well.

The fact is that the application with the methodology of natural lighting calculation was excluded from the draft amendments project to the existing DBN.2.5-28:2006 "Engineering equipment of buildings and structures. Natural and artificial lighting". The project proposes not to calculate the natural lighting, but only to measure its coefficient (NLC), that is, to act *ex post*. But, it is not clear how the design contractor should calculate the size of skylight openings for industrial, public and administrative buildings and spaces of different type and purpose with job places that require maintaining appropriate level of natural illumination of the working area (NLC indicators by nature of visual work).

It should be emphasized that the examples presented are not isolated cases of the existing problems in the legislative framework of Ukraine on labor protection. They indicate the continuation of negative trends in unstructured approach to its reform [2].

The practice of adoption and enactment of the relevant documents by noncore ministries exacerbates the existing problems in the reform and in functioning of the legislative framework of Ukraine on labor protection. In particular, the introduction of standards IEC 62305-2010 IDT "Protection against lightning", DSTU EN 2:2014, "Classification of fires" by the Ministry of Economic Development and Trade in Ukraine, challenge their quality and legitimacy.

However, it is clear that changes and quality of the legislative framework is only the foundation, but a prevalent factor in the implementation of these reforms in the field of occupational safety is the formation of the alternate approach in the mind of employees to individual and collective security, as well as to labor culture. That is, the second most important issue within the frame of which it is necessary to consider the issues of improving the state of occupational safety for Ukraine on the way to the European integration, is the formation of safety and occupational health priorities in relation to any performance results. The formation of these priorities primarily happens when a person – future specialist obtains professional higher education.

However, despite the European way of reforming the educational system in Ukraine, the level of training of Ukrainian specialists in the field of labor protection and industrial safety differs from the European not only

qualitatively (for the better), but in recent years significantly deteriorates compared to the previous academic training programs for students.

As an example, we can consider the system of training specialists in the field of labor protection and industrial safety of Ukraine and neighboring Poland. The choice of the Republic of Poland, as a referenced one, is due to the almost related to Ukraine number of economically active population (Ukraine – 20.1 million persons, Poland – 17.01 million persons) and kinds of economic activity (agriculture, engineering, metallurgy, coal, chemical industry, etc.) [10]. However, despite these correlative indicators, the ratio of the number of higher education institutions (HEIS) that train specialists on labor protection and industrial safety to the total number of HEIS in Poland is almost 1.9 times higher than in Ukraine (Figure), with the number of economically active population which is lower by 1.18 times.

In addition, the planned number of academic hours for studying subjects related to labor protection and industrial safety issues in higher educational institutions of the Republic of Poland is 1.5–1.7 times higher than in Ukraine. Study programs in HEIS of Ukraine include the study of three disciplines for students, with the total number of 180 hours: "Life Safety", "Fundamentals of Labor Protection", "Industrial Labor Protection". At Polish HEIS, students in the framework of educational programs implementation, study significantly more subjects related to labor protection and industrial safety. Among them there are the following: "Safety and Ergonomics", "Labor Physiology", "Human Factor in relation to Systems of Enterprises", "Labor Protection Management", "Organization of Occupational Safety", "Risk Assessment and Analysis", "Analysis and Control of Contamination in a Production Environment" and others. By the way, the situation similar to the Polish HEIS is evidenced in other EU countries, where the issues of labor safety are considered not only within the given disciplines, but are necessarily integrated in a wide range of related disciplines and curricula at all levels of training, starting from primary school.

But even in this, compared to European universities, pared format of disciplines associated with occupational health, industrial safety and safety during emergencies, in recent years there have been observed some negative trends of failures for the relevant departments to provide advice to students on "Labor protection and safety in emergencies", the withdrawal of such sections out of the graduation projects, merge of the appropriate disciplines for some criteria, the significant reduction in the number of classroom hours for their studying, replacement of exams by tests, dismissive (minor) attitude to issues of labor protection, industrial safety and civil protection, as well as moral and physical obsolescence of the relevant departments infrastructure. These trends contradict both the current legislation of Ukraine in the field of occupational safety and common sense, and do not contribute to the maintenance of high professional level of Ukrainian graduates in the labor protection and industrial safety issues.

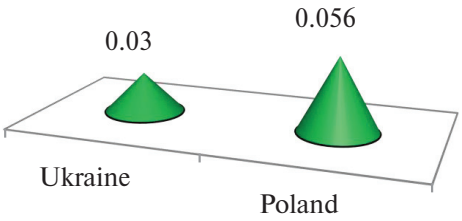

Fig. The ratio of the number of higher educational institutions (HEIS) of Ukraine and Poland which train specialists in labor protection and industrial safety, to the total number of HEIS in these countries

According to Article 21 of the law of Ukraine "On Labor Protection", the design of production facilities, development or modification of processes (both of technical and intellectual nature), means of production and others (that is, all the actions that a student performs within the process of writing the degree project) must be conducted in full compliance with the requirements of legal and regulatory acts on labor protection.

The above Article of the law of Ukraine also provides for the compulsory examination of project documentation for compliance with the requirements of this Article. Only highly qualified experts (in high educational institutions they are academic teaching staff of Health and Safety or Labor Protection departments) carry out verification of such conformity and the relevant examination.

Given that a thesis project is essentially the qualification characteristics of the graduate as a future leader of an enterprise, who, according to Article 13 of the law of Ukraine "On labor protection", bears direct responsibility (from administrative to criminal, Article 44 of the Law) for the safety, life and health of every member of the team, so their expertise in the industrial safety is of top priority. Qualification of teachers of the respective departments in the field of labor protection and industrial safety is to be confirmed and to be constantly improved by availability and development of scientific and scientific-methodical papers, practical experience and training certificates proving the right for teaching of the relevant disciplines and providing advice on section "Labor Protection and Safety in Emergencies" for the diploma projects. Such training, according to the "Model provisions on training and testing of knowledge on labor safety" (NPAOP 0.00-4.12-05) can and must be taken by lecturers of Health and Safety (Labor Protection) departments. In other words, consultations and advice given within the section "Labor protection and safety in emergencies" by graduate education departments contradict with the requirements of the current Standard regulations. The deletion of sections "Health and safety in emergencies" out of the graduation projects of students and lack of its qualified expert check for compliance with the applicable legislation requirements, contest the legitimacy of the graduation project itself and, as a result, the received diplomas on higher education.

The initiative to merge such diverse in their intent and essence subjects as, for example, "Industrial Labor Protection" and "Civil Protection", which demand different levels of knowledge and competence from students, in the curricula and work programs, is also of

concern. Such a merger is not only in conflict with section 2.1. of the Model regulations (NPAOP 0.00-4.12-05), but also makes it impossible to master the material qualitatively for the lack of elementary logical link between these disciplines.

In addition, the practice that includes various forms of knowledge control per semester on the specified disciplines for students of different groups, but those listening to lectures in a single class is astonishing.

Directions for reforming the higher and professional education in Ukraine should be determined by the priority and exclusivity of issues related to labor protection and industrial safety in the curriculum of training specialists in accordance with the all-European concept, which can be conventionally represented as a continual process of learning and improving knowledge in matters of occupational health and safety through the whole time of employment for each person [3, 7].

The defined negative trends in terms of unsystematic approach to reforming the legislative framework for the labor protection and professional training system are already expressed in the negative dynamics of the increase in the number of accidents in Ukraine.

Thus, only for the first half of 2016, the number of accidents compared to the same period in 2015, increased by 3.4 %, while the number of fatally injured in some regions of Ukraine has increased significantly (in Volynsk – by 3.7 times, in Cherkasy – by 7 times, in Kiev – by 1.7 times). Institutional causes has traditionally been the main ones for accidents occurring because of non-compliance with instructions on labor protection (36.4 % of the total) and through the personal negligence (14.8 %, respectively) [8].

Considering certain delayed in time negative effect associated with the introduction in recent years of the measures in law reform and education in terms of health protection, affecting the industrial security, we can make a prediction on the increase in the number of indicators in the near future.

So, what directions should be chosen to make priority strategic steps able to give positive results radically and in due time?

First, it is necessary to develop and implement special software with the concept of a unified electronic register of legal and regulatory documents on labor protection. In addition, a single statewide automated system of filing and control of amendments to the regulatory framework on labor protection must be developed and implemented. Such software should allow developers and law-makers to amend the existing legal and regulatory acts in a timely manner, efficiently and in full when replacing the aged ones or developing the new documents.

To proceed in this direction, there was developed an automated system on filing and control of amendments in the legal and regulatory acts of Ukraine on labor protection (AFCS) and the relative certificate of copyright (No. 70334) was received by A. P. Bochkovskyi and N. Yu. Sapozhnikova.

Implementation of the above system will stop an unstructured approach to reforming the legal framework for labor protection and will significantly enhance the safety of technical systems at every stage of life cycle. The introduction of AFCS will significantly reduce the number of occupational traumatism cases, occupational diseases and industrial accidents and disasters occurring for organizational and technical reasons (by increasing the composition of legal acts quality).

This system can also be proposed for the introduction in the EU states to improve the accounting and control of amendments to the regulatory framework on labor protection and industrial safety.

Secondly, it is necessary to prohibit the adoption and enactment of legal and regulatory acts on labor protection by noncore ministries and agencies.

The third direction, which is also the way that can significantly affect the reduction of accidents due to organizational reasons, is improving the quality of education in the field of labor protection and industrial safety with the simultaneous promotion of these issues at national, household levels, in schools and in terms of production. Such an approach should be implemented through:

- increase in the number of disciplines related to occupational health, industrial safety, methods of assessment and occupational risks management, etc. at higher educational institutions of Ukraine;
- introduction of new educational standards regarding the mandatory inclusion of sections on “Occupational health and safety in emergencies” in the diploma projects (works) of students;
- implementation of principles of priority and exclusivity of labor protection and industrial safety issues at all stages of specialists training according to the all-European concept.

However, the effectiveness of the proposed measures will only be highest possible when they are pressed primarily at the state level.

Conclusions and recommendations for further research. By the main indicators of industrial injuries severity, Ukraine is far ahead of the EU states. The main cause of accidents, both in Ukraine and in the EU, is a failure to comply with instructions on labor protection.

The main problem of adaptation of Ukrainian legislation to the European one in the sphere of labor protection and industrial safety is the lack of an integrated approach and low level of legal and regulatory documents quality.

The level of educational training of Ukrainian specialists in the field of labor protection and industrial safety does not only differ in quality (not for the better) from the European one, but in recent times has been much worsening compared to the previous training programs of students.

Principal and priority ways of improving the labor protection and industrial safety level in Ukraine include the development and introduction of a single electronic registry and the nationwide automated system of filing and control of amendments to the legal and regulatory framework of Ukraine on labor protection, as well as the implementation of positive systemic changes in educational level and consciousness of future specialists comply with the European concept.

References.
1. Bochkovskyi, A. P., 2015. Actualization of the occupational health and industrial safety in the sustainable development of mankind. *Environmental Safety Balanced Use of Resources*, 1(11), pp. 117–126. http://dx.doi.org/10.13140/RG.2.1.2110.9527.
2. Bochkovskyi, A. P. and Sapozhnikova, N. Yu., 2015. Promising Direction for Improving Regulatory Legal Framework on Labour Protection for Enterprises Producing Food and Beverages. *Environmental Safety Balanced Use of Resources*, 2(12), pp. 85–93. http://dx.doi.org/10.13140/RG.2.1.4156.3927.
3. Frank J. van Dijk, Marija Bubas and Paul B. Smits, 2015. Evaluation Studies on Education in Occupational Safety and Health: Inspiration for Developing Economies. *Annals of Global Health,* 81(4), pp. 548–560. http://dx.doi.org/10.1016/j.aogh.2015.08.023.
4. Świątkowska, B., 2013. Legal aspects of workers' health protection against asbestos in Poland in the light of the EU legal framework. *Medycyna Pracy,* 64(5), pp. 689–697. http://dx.doi.org/10.13075/mp.5893.2013.0057.
5. Eurostat, 2016. *The Analysis of Causes of Accidents and Professional Diseases Occurrence in EU Countries* [online]. Available at: <http://ec.europa.eu/eurostat/web/main/home> [Accessed 20 December 2016].
6. Federation of Trade Unions of Ukraine, 2015. *Current State of Labour Protection in Ukraine. Trade-Union Information and Analytical Report* [online]. Available at: <http://www.fpsu.org.ua> [Accessed 11 December 2016].
7. European Agency for Safety and Health at Work [online]. Available at: <https://osha.europa.eu/> [Accessed 15 February 2017].
8. Information and Analytical Note of Emergency Situation in Ukraine 2011–2015 [online]. Available at: <http://www.dsns.gov.ua/> [Accessed 27 January 2017].
9. Economic Forecasts from the World's Leading Economists [online]. Available at: <http://www.focus-economics.com/> [Accessed 27 January 2017].

Мета. Визначення перспективних шляхів підвищення рівня охорони праці й промислової безпеки на підприємствах України.

Методика. Дослідження проблем і перспективних шляхів підвищення рівня охорони праці та промислової безпеки проводились шляхом вивчення й теоретичного аналізу:

- статистичних даних виробничого травматизму в Україні та 9 країнах ЄС (Австрія, Велика Британія, Германія, Данія, Норвегія, Польща, Угорщина, Фінляндія, Франція), у цілому по країнах, за період 2011–2015 рр.;

- нормативно-правової бази України та ЄС з охорони праці й промислової безпеки;

- навчальних програм підготовки спеціалістів у галузі охорони праці в Україні та ЄС (на прикладі Республіки Польща).

Результати. Проаналізовані структурні причини виникнення нещасних випадків і статистичні дані за основними показниками виробничого травматизму на підприємствах України й країн ЄС. На основі аналізу законодавчої бази України з охорони праці виявлені проблеми, що стосуються внесення комплексних змін до нормативно-правових документів та їх якості, що напряму впливають на безпеку людини в умовах виробництва. Проведено порівняльний аналіз навчальних програм підготовки студентів вищих навчальних закладів України й країн ЄС (на прикладі Республіки Польща) у питаннях охорони праці й промислової безпеки та виявлено проблеми, що можуть сприяти підвищенню рівня професійного ризику на підприємствах України. Запропоновані пріоритетні шляхи правового та організаційного характеру з підвищення рівня охорони праці й промислової безпеки в Україні.

Наукова новизна. Уперше розроблена система автоматизованого обліку й контролю змін нормативно-правових актів з охорони праці та промислової безпеки. Проаналізовані взаємозв'язки між рівнем охорони праці й реформами в законодавчій і освітній системах.

Практична значимість. Результати дослідження можуть бути використані для створення й впровадження на державному рівні системи автоматизованого обліку й контролю змін нормативно-правових актів з охорони праці та промислової безпеки як в Україні, так і в країнах ЄС.

Ключові слова: *охорона праці, виробничий травматизм, промислова безпека, професійний ризик, нормативно-правова база, вища освіта*

Цель. Определение перспективных путей повышения уровня охраны труда и промышленной безопасности на предприятиях Украины.

Методика. Исследование проблем перспективных путей повышения уровня охраны труда и промышленной безопасности проводились путем изучения и теоретического анализа:

- статистических данных производственного травматизма в Украине и 9 странах ЕС (Австрия, Великобритания, Германия, Дания, Норвегия, Польша, Венгрия, Финляндия, Франция), в целом по странам, за период 2011–2015 гг.;

- нормативно-правовой базы Украины, ЕС по охране труда и промышленной безопасности;

- учебных программ подготовки специалистов в области охраны труда в Украине и ЕС (на примере Республики Польши).

Результаты. Проанализированы структурные причины возникновения несчастных случаев и статистические данные по основным показателям производственного травматизма на предприятиях Украины и стран ЕС. На основе анализа законодательной базы Украины по охране труда выявлены проблемы, касающиеся внесения комплексных изменений в нормативно-правовые документы и их качества, прямо влияющие на безопасность человека в условиях производства. Проведен сравнительный анализ учебных программ подготовки студентов высших учебных заведений Украины, стран ЕС (на примере Республики Польши) по вопросам

охраны труда и промышленной безопасности и выявлены проблемы, которые могут способствовать повышению уровня профессионального риска на предприятиях Украины. Предложены приоритетные пути правового и организационного характера по повышению уровня охраны труда и промышленной безопасности в Украине.

Научная новизна. Впервые разработана система автоматизированного учета и контроля изменений нормативно-правовых актов по охране труда и промышленной безопасности. Проанализированы взаимосвязи между уровнем охраны труда и реформами в законодательной и образовательной системах.

Практическая значимость. Результаты исследований могут быть использованы для создания и внедрения на государственном уровне системы автоматизированного учета и контроля изменений нормативно-правовых актов по охране труда и промышленной безопасности как в Украине, так и в странах ЕС.

Ключевые слова: *охрана труда, производственный травматизм, промышленная безопасность, профессиональный риск, нормативно-правовая база, высшее образование*

Рекомендовано до публікації докт. техн. наук В. Е. Волковим. Дата надходження рукопису 30.10.16.

UDK 519.6:622.812

M. M. Nalisko, Cand. Sc. (Tech.), Assoc. Prof.

Prydniprovs'ka State Academy of Civil Engineering and Architecture, Dnipro, Ukraine, e-mail: 59568@i.ua

MODIFICATION OF THE METHOD OF LARGE PARTICLES IN THE PROBLEM OF CALCULATION OF AN ACCIDENTAL EXPLOSION IN MINE ATMOSPHERE

М. М. Налисько, канд. техн. наук, доц.

Державний вищий навчальний заклад „Придніпровська державна академія будівництва та архітектури“, м. Дніпро, Україна, e-mail: 59568@i.ua

МОДИФІКАЦІЯ МЕТОДУ ВЕЛИКИХ ЧАСТОК У ЗАДАЧІ РОЗРАХУНКУ АВАРІЙНИХ ВИБУХІВ РУДНИЧНОЇ АТМОСФЕРИ

Purpose. Development of an effective scheme for numerical calculation of the joint solution of the problem of gas dynamics and the chemical kinetics of combustion of a gas-air medium on the basis of the large-particle method.

Methodology. Mathematical modeling, numerical experiment, analysis and generalization and results.

Findings. For joint solution of problems of gas dynamics and chemical kinetics of combustion gas environments it is proposed to introduce concentration function into the numerical scheme of the method of large particles, which allows taking into account the multicomponent composition of the gas medium. This function is defined at the stage of formation of the estimated area and it defines the mole fraction of each substance in each cell of the design scheme. The function is involved in the calculation of the mass flows across the boundaries of computational cells, determining the mass flow for each substance. The concentration function allows introducing equation of chemical kinetics into the numerical scheme in the form of the Arrhenius equation and differentiating chemical reaction components and combustion products. In the problem of calculation of detonation explosions there are strong gradients of pressures, which, at the exit of the shock front on the border of the "free exit" generate non-physical fluctuations of the parameter. To exclude their influence on the process analysis of different types of approximation of the parameters in the fictitious layer design scheme is conducted. From the analysis of physical processes effective form of the boundary conditions of "free exit" for the problem of shock wave propagation in the channel is found.

Originality. Due to the introduction of a concentration function, modification of the numerical method of large particles allows for the joint solution of problems of gas dynamics and chemical kinetics of combustion of an explosive gas-air environment. For correct operation of the boundary conditions of "free access" in terms of discontinuous currents approximation scheme of the parameter in a dummy layer based on shock adiabats of a specific gas has been developed.

Practical value. The conducted modification of the method of large particles allows carrying out numerical experiment on the calculation of safe distances in case of emergency of gas explosions in coal mines as well as determining the dynamic blast load on structures based on the calculation of distribution of air shock wave on the channel.

Keywords: *the gas-air mixture, accidental explosion, numerical calculation, method of large particles, concentration function, non-reflective border*