UDK 331.46:614.82

METHODS OF ASSESSMENT OF OPERATING EFFECTIVENESS OF THE INTELLECTUAL INFOR MATION AND ANALYTICAL SYSTEM OF OCCUPATIONAL SAFETY MANAGEMENT AT PHARMACEUTICAL INDUSTRY ENTERPRISES

МЕТОДИКА ОЦІНКИ ЕФЕКТИВНОСТІ ФУНКЦІОНУВАННЯ ІНТЕЛЕКТУАЛЬНОЇ ІНФОРМАЦІЙНО-АНАЛІТИЧНОЇ СИСТЕМИ УПРАВЛІННЯ ОХОРОНОЮ ПРАЦІ НА ПІДПРИЄМСТВАХ ФАРМАЦЕВТИЧНОЇ ПРОМИСЛОВОСТІ

Siryk A.O. / Сірик А.О.
c.t.s. / к.т.н.
ORCID: 0000-0002-5041-7096
Evtushenko O.V. / Євтушенко О.В.
c.t.s., as.prof. / к.т.н., доц.
ORCID: 0000-0001-6773-682X
Lych I.V. / Лич І.В.
c.b.s., as.prof. / к.б.н., доц.
ORCID: 0000-0003-0444-02336
Soloshenko K.I. /Солошенко К. І.
студентка гр. БТ-4-2
National university of food technologies, Kyiv-33, Volodymyrska str. 68, 01601
Національний університет харчових технологій, Київ-33, вул. Володимирська 68, 01601

Abstract. The article overlooks methodology for evaluating the effectiveness of the intellectual information-analytical system of labor protection management at the enterprises of the pharmaceutical industry. The introduction of this technique at the enterprises of the pharmaceutical industry in the traditional procedures of internal audit will achieve a new quality of functioning of automated information-analytical systems of labor protection management and significantly increase the efficiency of information processing in decision-making processes due to the efficiency and accuracy of choosing the optimal set of measures for ensuring safety.

Key words: safety, labor, labor protection, information-analytical system, pharmaceutical enterprise.

Introduction. The development of the pharmaceutical industry in Ukraine is strategically important, as it is one of the elements of ensuring national security and the producer of products of high social significance. Pharmaceutical industry of Ukraine is one of the fastest growing and highly profitable industries. The quality of a pharmaceutical product, as a specific product, was and will be in sight of the manufacturer, intermediary, consumer, polity. Each country that produces and supplies pharmaceuticals has its own rather stringent requirements for the organization and management of production and quality control quality of medicines [1].

The operation of pharmaceutical industry equipment is a complex, multi-faceted and time-consuming process that should be considered as a combination of a number of socio-organizational and engineering measures. Now, companies independently solve many issues of their development, and from the experts who are responsible for the organization of work safety in the workplace, knowledge of the theory of organization of safe work while operating the specific technological equipment of pharmaceutical industries, methods of solving specific problems at different stages of their development is required. The main production is the central place in the

production process of the pharmaceutical industries, in which prevail technological processes that contain the series of actions that are directly related with the change in the shape, size, type, condition or properties of the objects of work, for obtaining a new product.

Since the current regulatory framework for occupational safety is oriented to "absolute" security in the overwhelming majority, and current trends in the development of occupational safety are oriented towards the prevention of injuries to the use of risk-based approaches based on prognostic models, today the problem of choosing practical and effective preventive measures has become especially relevant, aimed at neutralizing or reducing the risk [2-4]. The problem of ensuring the stability of the operation of large organizational systems, which can be referred to the pharmaceutical industry, firstly was covered in the works of O.A. Mashkov [5]. The key points of the theory of functional stability were later developed in O.V. Barabash [6] and others. Analysis of various variants of construction of diagnostic systems was carried out in works [7-10].

The purpose of the article is to study and substantiate the Methods of assessment of operating effectiveness of the intellectual information and analytical system of occupational safety management at pharmaceutical industry enterprises.

The main text. According to the results of the analysis of occupational injuries at the enterprises of the pharmaceutical industry of Ukraine, it was found that 62.4% [1] of all accidents occur as a result of wrong actions and mistakes due to the incorrect choice of a set of measures to increase the level of safety at work by the head of the structural unit. Investigations have shown that occupational injuries in pharmaceutical enterprises are a multicausal phenomena. Each accident has both a direct cause and many other indirect causes (factors, conditions, circumstances) that contribute to the occurrence of these cases.

The main cause of the wrong actions is the formal attitude of employees to the safety rules, or the imperfect knowledge of the normative and technical documentation by the heads of the structural subdivisions of pharmaceutical enterprises, the volume of which is significant; or their neglect, as well as the inability to successfully apply the necessary knowledge in a particular, especially extraordinary situation.

At the modern enterprises of the pharmaceutical industry, information-analytical systems are widely used. With the help of such systems, the head of the department (services) of labor protection communicates with the heads of structural divisions. Besides, these systems can be used to find a solution to choose a set of measures to increase the safety level of the pharmaceutical industry.

Essence of effectiveness assessment of the intellectual information and analytical management system (IIA SOSM) consists in comparison of quality of the decisions made by the head of occupational safety department (service) without IIA SOSM or using it [11]. Before proceeding to direct estimation of IIA SOSM effectiveness, let's consider in details the process of interaction of the head of occupational safety department (service) at pharmaceutical industry enterprises and the information system when producing managing influences without application of intellectual components and by their application. Typical interaction pattern of the

head of occupational safety department (service) and the information and analytical system is given in **fig.1**.
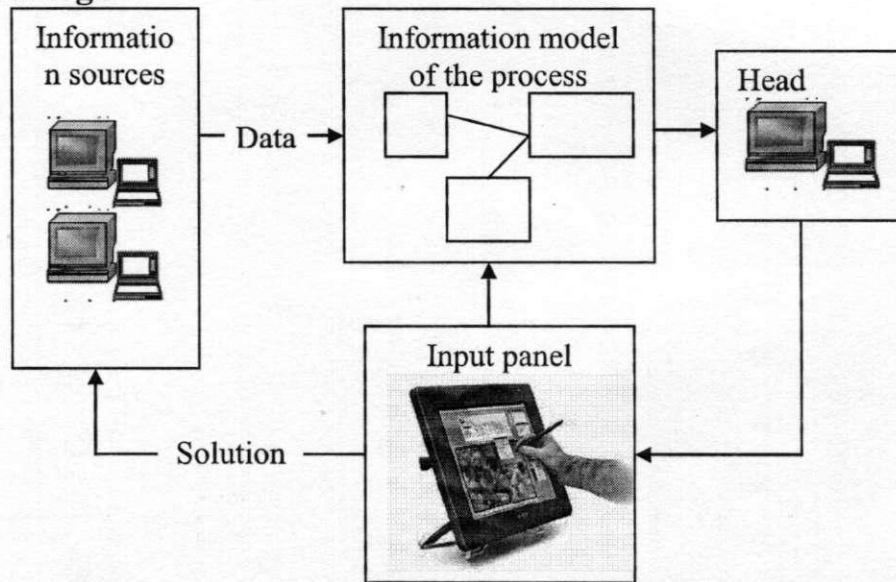

Fig. 1. Scheme of work of the head of food industry of information and analytical management system

Peculiar feature of similar interaction pattern of the head and IAS (information and analytical system) is significant time losses for forming an information model (IM) of conflict situation, that is, for information preparation of solution. Experimental researches show that these time losses may reach a half and more of the general available time for making decision that is unacceptable under the conditions of acute shortage of time for resolving a conflict situation.

It allows drawing a conclusion on the need to automate the process of information preparation of the decision making, transfer to essentially new interaction pattern of the head and IIA SOSM in the conflict situation that is based on dialogue between them in using artificial intelligence techniques on the basis of the decision-making support system. This scheme provides automatic processing of the information on conflict situation and preparation of variants of probable solutions using IIA SOSM (**fig. 2**).

Such an interaction pattern differs from the scheme given in **fig. 1** by presence of contour of automated forming of virtual models for decision making. These models should contain the data necessary for conflict situation analysis and solution development, possible variants of solution as well as a set of recommendations and instructions, which help the head of occupational safety department (service) to implement decisions quickly.

Variants of decisions are formed in the following way. Based on data about the current condition of manageable process of occupational safety condition at pharmaceutical industry enterprises coming from the system, automatically using intellectual components (or automatically using intellectual components and the head), variant of totality of occupational safety measures is developed. Then on the basis of using the experience accumulated by the system operation, hypotheses on
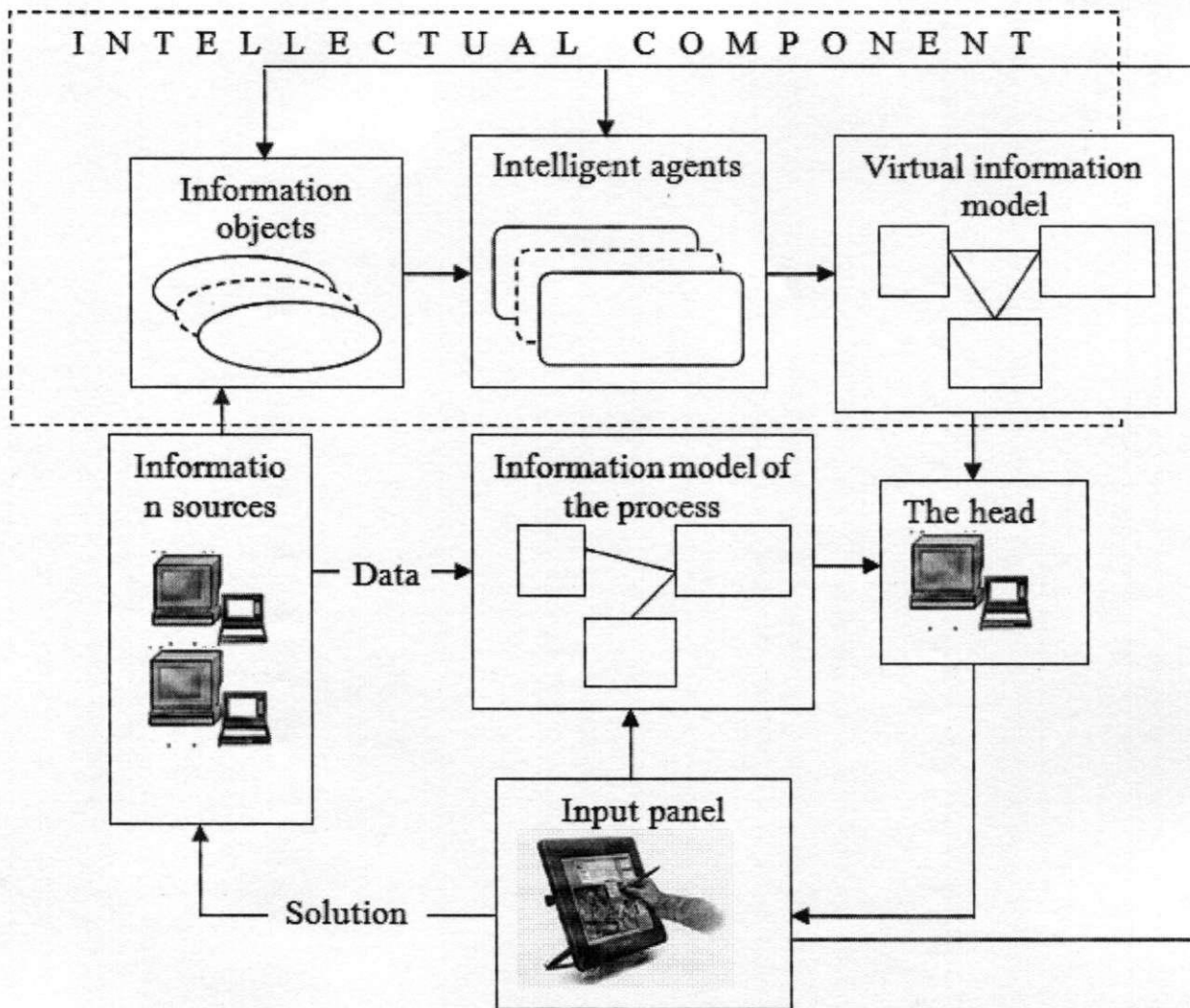
Fig. 2. Scheme of interaction of the head and IIA SOSM

possible reasons for occurrence of emergency risk are developed. According to the emerged problematic situation, a virtual model automatically is formed containing detailed data on the emerged situation and recommendations to the head of the occupational safety service (department) for planning decision as to totality of occupational safety measures.

The considered interaction pattern allows to imagine IIA SOSM and the head of occupational safety department (service) as two partners simultaneously participating in solution development. It gives an opportunity to use advantages of each partner and ensures high quality of decisions made.

The conducted analysis of the decision-making process allows to move to substantiation of IIA SOSM effectiveness rates and methods of their calculation.

Commonly accepted rates of management system effectiveness are operativeness of decision making and their quality (accuracy, correctness, optimality) [12]. Integrated index considering both operativeness and quality of solutions is probability of timely and correct decision making.

$$P = P_t \cdot P_q, \qquad (1)$$

where P_t, P_q – probabilities of timely and qualitative decision correspondingly.

However, it should be noted that expression (1) is fair only under the condition of independence of P_t and P_q probabilities that is almost impossible. That's why, it's more reasonable to consider methods for calculation of P_t timeliness (operativeness) and P_t quality rates of the decisions made.

Operativeness of the decisions made can be evaluated based on experimental researches, analytically or using the methods of simulation modeling. In order to estimation operativeness as to accepted set of occupational safety measures at pharmaceutical industry enterprises experimentally, let's use the following correlation

$$P_t = \frac{m(t \le t_{dec})}{n(t)}, \tag{2}$$

where $n(t)$ – total number of the decisions, which had to be made during time t; $m\ (t <= t_{dec})$ – number of the decisions made in time (at a reasonable time t_{dec}).

Experimental estimation of P_t, naturally is possible only under the condition of actual operation of IIA SOSM.

At the stage of IIA SOSM design, it's more reasonable to apply analytical methods of P_t evaluation. Herewith, depending on available outgoing information about time characteristics of management tasks, fuzzy or probabilistic calculation models may be used. In the first case, expert information is used as outgoing data, in the second – statistical data on problem characteristics.

Simulation modelling for P_t operativeness estimation is applied at all stages of IIA SOSM design. P_t probability is calculated according to the expression (2).

There are several approaches to a-priori comparative estimate of quality of the decisions made: variant method; method of evaluation by external criterion (criterion of manageable system effectiveness); probabilistic method.

In the variant method, quality of decisions is estimated by correlation of number of decisions with acceptable quality to general probable number of decisions. As a rule, number of decision variants is set based on subjective considerations, that's why P_q probability estimation is not objective.

Method of evaluation by external criterion is based on determination of degree of approaching the selected solution to optimum by the value of criterion of manageable system effectiveness. For assessment of solution quality by this method it is necessary, firstly, to know the system effectiveness by different variants of solutions on its management that requires significant organizational and time losses. Secondly, it is necessary to know the system effectiveness by optimum solution, which may be discovered only by final results of the system operation.

In probabilistic method solution quality is determined as a probability of optimum solution selection, that is, the method also assumes knowledge of optimum solution. Besides, it is impossible to determine quality of unique solutions as probability of optimum solution selection, as unique decisions are not mass.

Evaluation of IIA SOSM effectiveness will be carried out based on probabilistic flow chart.

Analyzing work of the head of occupational safety department (service), some totalities of elementary operations combined with a common goal. Such totality of

operations is usually called a problem. The problem has higher classification degree than elementary operation.

Final goal of any activity is receipt of useful effect, in other words reduction of emergency risk at pharmaceutical industry enterprises to the degree corresponding to the accepted risk due to selection of optimal totality of occupational safety measures. Final goal is achieved on a step-by-step basis via performing partial tasks.

Here not only algorithm of solving certain problem should be mentioned, but also algorithm of actions of the head of the department (service) at pharmaceutical industry enterprises.

In descriptive manner algorithm of actions of IIA SOSM head may be presented as a consecutive statement of all actions of the head and their order depending on whichever conditions. Any detailed operating manual or instruction on use of certain works is, as a matter of fact, such an algorithm. The difference between instruction and descriptive form of algorithm applied in the process of psychophysiological analysis of activities of the head is that in the latter case, problem dividing is done compulsorily before discovery of separate "operative units". This procedure is transient between job specification and drawing logic diagrams of algorithm in an operator form.

The next steps are the development of activities and their implementation, taking into account the rank of the identified danger. In our opinion, this technique can be applied at small enterprises, as well as at different stages of the functioning of medium and large pharmaceutical enterprises.

Conclusions. The use of the intellectual information and analytical system of occupational safety management at pharmaceutical industry enterprises in traditional internal audit procedures will allow the prosecutor to improve the system of management of labor protection in the pharmaceutical enterprises. The proposed мethods of assessment of operating effectiveness of the intellectual information and analytical system of occupational safety management at pharmaceutical industry enterprises assessment is positioned as a simple and scientific system that does not require significant technical and intellectual resources for evaluation. The introduction of a comprehensive and periodic system for assessing the level of safety at work will reduce the economic costs of the enterprise, which, in turn, is a motivating factor for the owner of the enterprise.

References:

1. Yarosh M.B., Evtushenko O.V. (2018). Systema upravlinnia okhoronoiu pratsi na farmatsevtychnykh pidpryiemstvakh [System of management of labor protection at pharmaceutical enterprises] in *Maibutnii naukovets* [Future scholar], materialy vseukr. nauk.-prakt. konferentsii, 14 hrudnia 2018 r. – Sievierodonetsk: Skhidnoukr. Un-t im. V. Dalia, pp. 96-97.

2. Evtushenko O., Siryc A., Porodko P. (2016). Development of the occupational safety in the food industry with regard for the risk-based approach. In *Ukrainian Food Journal*. Vol. 5., Is. 1, pp. 174-186.

3. Evtushenko, O. Siryc A., Porodko P. (2016). Increase in the Level of occupationl safety in the food industry with regard tof the risk-oriented approach. In

Ukrainian Journal of Food Science. Vol. 5, Is.1, pp. 174–186.

4. Evtushenko O.V., Siryc A.O., Porodko P.V. (2017). Evaluation procedure for economic efficiency of occupational injuries preventive measures with risk-based approach, in *Scientific works SWorld*, issue 46, vol.1, pp. 4-10.

5. Mashkov O.A., Artyushin L.M. (1991). Optimizatsiya tsifrovih avtomaticheskih sistem, ustoychivyih k otkazam [Optimization of digital fault tolerant automated systems] in *KVVAIU*, 89 p.

6. Barabash O.V. (2004). Postroenie funktsIonalno ustoychivyih raspredelitelnyih informatsionnyih system [Construction of functionally stable distribution information systems] in *NAOU*, 226 p.

7. Barabash O.V., Obidin D.M., Musiienko A.P. (2014). Alhorytm samo diahnostuvannia tekhnichnoho stanu vuzliv komutatsii informatsiinykh system [Algorithm of self-diagnostics of the technical state of the nodes of switching information systems] in *Suchasnyi zakhyst informatsii* [Modern information protection] №2, pp. 114-121.

8. Barabash O.V. Obidin D.M., Musiienko A.P. (2014). Model bazy znan intelektualnoi systemy upravlinnia vysokoshvydkisnoho rukhomoho obiekta na osnovi yii veryfikatsii [The model of the knowledge base of the intelligent control system of high-speed moving object on the basis of its verification] in *Systemy obrobky informatsii* [Information processing systems]. №5 (121), pp. 3-6.

9. Evtushenko, O. V. (2018). Intelektualizatsiia informatsiino-analitychnoi systemy upravlinnia okhoronoiu pratsi na kharchovomu pidpryiemstvi [Intellectualization of the information-analytical system of labor protection management at the food enterprise] in *Naukovi pratsi Natsionalnoho universytetu kharchovykh tekhnolohii* [Scientific works of the University of Food Technologies]. issue. 24, № 3, pp. 100-112.

10. Siryk A. O. (2018). Modeli ta metody pidvyshchennia rivnia bezpeky pratsi v enerhetychnomu hospodarstvi pidpryiemstv kharchovoi promyslovosti na osnovi vykorystannia systemy pidtrymky pryiniattia rishen : avtoref. dys. ... kand. tekhn. nauk : spets. 05.26.01 – okhorona pratsi [Models and methods of raising the level of labor safety in the energy industry of food industry enterprises based on the use of decision support system: author's abstract. dis ... Candidate tech Sciences: specialty 05.26.01 - labor protection] in *DU «Natsional'nyy Naukovo-Doslidnyy Instytut Promyslovoyi Bezpeky Ta Okhorony Pratsi»* ["National Research Institute of Industrial Safety"], 20 p.

11. Siryk A.O., Evtushenko O.V., Barabash O. V. (2016). Metodyka otsinky efektyvnosti orhanizatsiino-tekhnichnykh zakhodiv zabezpechennia zadanoho rivnia bezpeky pratsi v enerhetychnomu hospodarstvi pidpryiemstv [Methodology for assessing the effectiveness of organizational and technical measures to ensure a given level of labor safety in the energy economy of enterprises] in *Systemy obrobky informatsii* [Information processing systems] № 8, pp. 191–193.

12. Evtushenko O.V. Siryk A.O., Porodko P.V. (2015). Vyznachennia ekonomichnoi efektyvnosti zakhodiv z polipshenniam umov pratsi na pidpryiemstvi kharchovoi promyslovosti [Determination of the economic efficiency of measures to improve the working conditions at the enterprise of the food industry] in *Kharchova*

promyslovist [Food Industry] № 17, pp. 132–136.

Анотація. *У статті розглянута методика оцінки ефективності функціонування інтелектуальної інформаційно-аналітичної системи управління охороною праці на підприємствах фармацевтичної промисловості. Впровадження даної методики на підприємствах фармацевтичної промисловості в традиційних процедурах внутрішнього аудиту дозволить досягти нової якості функціонування автоматизованих інформаційно-аналітичних систем управління охороною праці та істотно підвищить оперативність обробки інформації в процесах прийняття рішень за рахунок оперативності та правильності вибору оптимальної сукупності заходів забезпечення безпеки праці.*

Розвиток фармацевтичної галузі України має стратегічно важливе значення, оскільки вона є одним з елементів забезпечення національної безпеки та виробником продукції високої соціальної значущості. Фармацевтична промисловість України є однією з найбільш швидкозростаючих та високоприбуткових галузей. Якість фармацевтичного товару, як специфічного продукту, була і буде в полі зору виробника, посередника, споживача, держави. Кожна країна, яка випускає і постачає фармацевтичну продукцію, має свої досить жорсткі вимоги щодо організації і управління виробництвом та контролем якості ліків.

За результатами аналізу виробничого травматизму на підприємствах фармацевтичної промисловості України, було виявлено, що більшість нещасних випадків відбуваються в результаті неправильних дій і помилок через невірний вибір сукупності заходів для підвищення рівня безпеки праці з боку керівника структурного підрозділу. Основною причиною неправильних дій є формальне відношення працівників до правил безпеки, або-ж недосконале знання нормативно-технічної документації керівниками структурних підрозділів фармацевтичних підприємств, обсяг яких значний; або їх ігнорування, а також невміння успішно застосовувати потрібні знання в конкретній, особливо нештатній, ситуації.

На сучасних підприємствах фармацевтичної промисловості, широко використовуються інформаційно-аналітичні системи. За допомогою таких систем начальник відділу (служби) охорони праці спілкується з керівниками структурних підрозділів підприємств фармацевтичної промисловості. Крім того, дані системи можуть бути використані для пошуку рішення щодо вибору сукупності заходів для підвищення рівня безпеки праці підприємств фармацевтичної промисловості.

Суть оцінки ефективності інтелектуальної інформаційно-аналітичної системи управління (ІІА СУОП) полягає в порівнянні якості рішень, прийнятих керівником без ІІА СУОП або з її використанням.

Експериментальні дослідження показують, що часові витрати можуть досягати половини й більше загального наявного часу на прийняття рішення, що неприпустимо в умовах гострого дефіциту часу на усунення нештатної ситуації на фармацевтичному підприємстві. Це дозволяє зробити висновок про необхідність автоматизації процесу інформаційної підготовки прийняття рішень, переходу до принципово нової схеми взаємодії керівником та ІК СУОП при виникненні нештатної ситуації, що базується на діалозі між ними з використанням засобів штучного інтелекту на основі системи підтримки прийняття рішень.

Формування варіантів рішень здійснюється в такий спосіб. На основі даних про поточний стан керованого процесу стану охорони праці на підприємстві фармацевтичної промисловості, що надходять із системи, автоматично за допомогою інтелектуальних компонентів (або автоматизовано за участю інтелектуальних компонентів та керівника) виробляється варіант сукупності заходів забезпечення безпеки праці. Потім на основі використання досвіду, накопиченого при експлуатації системи, виробляються гіпотези про можливі причини настання ризику позаштатної ситуації. Відповідно до проблемної ситуації автоматично формується віртуальна модель, що містить детальні відомості

щодо даної ситуації й рекомендації начальника служби (відділу) охорони праці для планування рішення щодо сукупності заходів забезпечення безпеки праці.

Розглянута схема взаємодії дозволяє представити ІІА СУОП і керівника як двох партнерів, що одночасно беруть участь у виробленні рішення. Це дає можливість використовувати переваги кожного з партнерів і забезпечує високу якість прийнятих рішень. Оцінка ефективності ІІА СУОП проведена на основі імовірнісного графа алгоритму.

Використання ІІА СУОП на підприємствах фармацевтичної промисловості в традиційних процедурах внутрішнього аудиту дозволить вдосконалити систему управління охороною праці на підприємстві.

Ключові слова: безпека, праця, охорона праці, інформаційно-аналітична система, фармацевтичне підприємство.