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DEFINITION OF FUNCTIONING INDICATORS OF THE SAFETY
MANAGEMENT SYSTEM IN EMERGENCY SITUATIONS
ВИЗНАЧЕННЯ ПОКАЗНИКІВ ФУНКЦІОНУВАННЯ СИСТЕМИ
УПРАВЛІННЯ БЕЗПЕКОЮ У НАДЗВИЧАЙНИХ СИТУАЦІЯХ

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Abstract. *The sources, that carrier of various hazards are natural processes and phenomena, technogenic environment, and human activities (human factor). When hazards identifying that were in finding type of danger and establishing its characteristics, usually based on the principle "everything was effects on everything", that danger may be all living and a lifeless, but also can be subject to risk all the living and the lifeless. The process of identification is needed to develop the measures for the organization and the effective elimination of the consequences, especially for the prevention of the accidents in the industry enterprises.*

The aim of the work: to develop a method of the safety management of industrial enterprise (object) in emergency situations to prevent accidents both at work and for people was living close to industrial objects.

Have been determined the quantitative evaluation indicators of the safety management system of industrial enterprise (object) emergency and criteria of regarding the level of functioning efficiency of the system.

Keywords: *protection, emergency situation, safety, management efficiency.*

Анотація. *Джерелами, тобто носіями різноманітних небезпек є природні*



процеси і явища, техногенне середовище, а також діяльність людини (людський фактор). При ідентифікації небезпек, тобто при знаходженні типу небезпеки та встановленні її характеристик, звичайно виходять з принципу “все впливає на все”, тобто джерелом небезпеки може бути все живе й неживе, а підлягати небезпеці також може все живе й неживе. При цьому процес ідентифікації необхідний для розробки заходів щодо організації і здійснення ефективної ліквідації відповідних наслідків, особливо для попередження нещасних випадків на промислових підприємствах.

В представленій роботі визначено показники кількісного оцінювання системи управління безпекою промислового підприємства (об’єкта) у надзвичайних ситуаціях та критерію щодо рівня ефективності функціонування цієї системи.

Метою дослідження є розроблення методики управління безпекою промислового підприємства (об’єкта) при виникненні надзвичайних ситуацій з метою попередження нещасних випадків, як на виробництві, так і для населення, що мешкає поруч з промисловими об’єктами.

Ключові слова: захист, надзвичайна ситуація, безпека, ефективність управління.

Introduction. To evaluate the contribution of the safety management system of industrial enterprise (object) in emergency situations of different character must have a method, with which it is possible not only assess the degree of functioning of the management system at the liquidation of consequences of emergency situations of different character, but to substantiate the complex recommendations for its improvement.

In addition, the development of appropriate methods is required to solve the following tasks:

- at first, identify the conformity of functioning of the safety management system of industrial enterprise (object) current requirements that apply for the work of management at liquidation of consequences emergencies;
- the second, determine the impact of components of the safety management



system of industrial enterprise (object) on the efficiency of the tasks faced by operative reacting during the liquidation of emergencies consequences;

- third, before carrying out actions which aimed at improving of the safety management system of industrial enterprise (object) to evaluate and predict the contribution to improve its functioning.

Basic research materials: Evaluation of the efficiency of the safety management system of industrial enterprise (object) is carried out by the method of forecasting when the aim is to get a priori aims performance indicators. This problem is solved by mathematical modeling, in which are obtained both are evaluating the effectiveness of the management authorities and tools, as well as evaluating the impact the safety management system of industrial enterprise (object) on the effectiveness of its forces and means (E_R^{SIO}) [1, 2, 5].

Research has established that the share of the effectiveness of application of safety forces and means of the industrial enterprise (object) account for its management system and the rest – to other subsystems. The effectiveness of operative reaction of means can be defined according to the formula:

$$E_R^{SIO} = f(E^{SIO}, T^{SIO}, M^{SIO}), \quad (1)$$

where E_R^{SIO} – the potential of existing of safety means of industrial enterprise (object) to solve problems in daily functioning mode; T^{SIO} – indicator of the efficiency of the safety system of industrial enterprises (object) in emergency mode; M^{SIO} – indicator of the efficiency of the safety management system of industrial enterprise (object) in emergency mode.

Because the only article examines the safety management system of industrial enterprise (object), it can be assumed that the efficiency of its subsystems during elimination the emergency consequences and existing means capabilities to solve their tasks are taken as they are [3, 4]. That:

$$E_R^{SIO} = E_I^{SIO} \cdot (0,67 + 0,33 \cdot M^{SIO}), \quad (2)$$

where 0,67 – the destiny of impact of the ensure subsystems to the effectiveness



of the operative reaction of means of safety of industrial object; 0,33 – the influence fate of the safety management system of industrial object to the effectiveness of the operative reacting tools.

To evaluate the effectiveness increase of operative reacting tools by improving the efficiency functioning of the management system (ΔE^{SIO}) it is possible by the formula:

$$\Delta E^{SIO} = \frac{E \frac{SIO}{r} l - E \frac{SIO}{r}}{E \frac{SIO}{r}} \cdot 100\% \quad (3)$$

where $E \frac{SIO}{r} l$ – effectiveness of using the operative reacting tools safety of industrial object on the recommendations to improve the effectiveness of functioning of the management system; $E \frac{SIO}{r}$ – the existing effectiveness of using operative reacting tools.

To determine the functioning effectiveness of using increase of operative reacting tools by increasing the efficiency of the safety management system of industrial object it is necessary to make its evaluation. This evaluation is made in the position of compliance requirements was imposed on it at liquidation of consequences of an emergency [3-5].

Indicator of efficiency of the safety management system of the industrial object at liquidation of consequences of any emergency can be represented as a function of interoperability, efficiency and sustainability:

$$M^{SIO} = f(\text{inter}, Ct, On), \quad (4)$$

Indicator K^{SMSIO} was characterizing the compliance of safety management system of industrial object to requirements it imposed at liquidation of consequences emergencies. This value can be varied within:

$$0 < K^{SMSIO} \leq 1.$$

For indicator for assessing the efficiency of functioning of safety management system of the industrial object at liquidation of consequences of any emergency was



selected the condition at which the level of efficiency of the control system should not be less than necessary:

$$K^{SMSIO} \geq K^{SMSIO^N}, \quad (5)$$

where K^{SMSIO^N} – the necessary values of adaptability of safety management systems of industrial object to operating conditions in emergency mode.

The necessary value of adaptability coefficient of system of management of civil protection at liquidation of consequences of an emergency is not constant and will have specific meaning in each case.

The efficiency of functioning safety management system of industrial object was proposed carry out by conformity assessment system through requirements that most affect the efficiency of its functioning in emergency mode.

Considering those circumstances, as the partial indicators for assessing the efficiency of control system was selected:

1. The indicator interoperability was selected the compatible coefficient of functioning safety management systems of industrial object structures of industry object that are part of the operational group of the appropriate forces (K_{inter}), which characterizes the ability of management system to function in a single information space with systems management of structures are in operative reacting at liquidation of consequences of an emergency.

This indicator was calculated by the following mathematical expression [5]:

$$K_{inter} = \frac{1}{n} \sum_{i=1}^n K_{interin} \cdot W_{in}, \quad (6)$$

where $i=0, 1, 2, \dots, n$; $K_{interin}$ – single dimension n-th figure was lying on the i-th level; n – number of indicators on the i-th level; W_{in} – the weight of each indicator on i-th level, which characterizes its share in the total amount of indicators, with $\sum W_i = 1$.

2. An indicator of the functioning efficiency of the safety management system of industrial object was chosen the probability of management challenges by safety



management authorities of industrial object during the time, what not exceeding critical (r_{itm}^{maSIO}), which characterizes the ability of safety management authorities of industrial object to serve the conditions when the rate of information aging will not lead to lower quality of implementation of the task management in emergency mode.

3. An indicator of sustainability of management system functioning was selected the rate of meet the challenges stability of the safety management of industrial object (K^{ct}), which characterized by the probability of sustainable functioning of i-th item of the safety management of industrial object (R_i), as a key element of management system operational response where employing appropriate controls and focus management tools, which in turn is determined by the survivability of command and control operational response (R_l), interference immunity (R_i) and technical and operational reliability (R_{tr}).

The coefficient compatible of functioning management system structures that are part of operative reacting (K_{inter}) which characterizes interoperability of safety management system of industrial object at the emergency consequences elimination; the probability of management challenges by operative reacting (r_{itm}^{maSIO}) for a time not exceeding critical, characterizing functioning efficiency of the safety management system of industry object; the likelihood of sustainable functioning of i-th control point (R_i) characterizing resistance of solving problems of safety management of industrial object (K^{ct}). All these coefficients by its nature are probabilistic nature.

Because effective functioning of safety management system of industrial object at the emergency consequences elimination is essentially simultaneously serving of relatively independent events – interoperability and sustainable functioning, its indicator can be represented by the multiplied of indicators that characterize these events:

$$K^{maSIO} = K_{inter} \cdot K^{ct}, \text{ with } r_{itm}^{maSIO} \geq r_{itm}^{maSIO}^N \quad (7)$$



Physical meaning (K_{inter}) is that it reflects the degree of capacity of safety management system of industrial object of function in a single information space with management of structures systems that are part of operative reacting during emergency consequences elimination and its significance is in the range $0 \leq K_{inter} \leq 1$.

Physical meaning (K_{ct}) is that it reflects the degree of solving problems of safety management of industrial object at i-th point, and control that is part of the operative reacting at liquidation of the emergency consequences, and its significance is in the range $1 \leq K_{ct} \leq 1$.

Physical meaning (r_{itm}^{maSIO}) is that it reflects the ability of safety management of industrial object to serve the conditions when the rate of aging information will not lead to lower quality of task management with operative reacting at emergency consequences elimination, and its significance is in the range $0 \leq r_{itm}^{maSIO} \leq 1$.

Conclusions. The proposed indicators allow with a precision that is allowed to assess not only the degree of compliance with the eligibility criteria of the safety management system of the industrial object at liquidation of consequences emergency situations of different nature, but also to develop informed recommendations for improving the effectiveness of its functioning in emergency mode situation.

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