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PREVENTING OF TECHNOGENIC RISKS IN THE FUNCTIONING OF AN INDUSTRIAL ENTERPRISE

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ABSTRACT

Providing safety of human life is inextricably linked to the study and analysis of the various emergency situations. At the same time a special place in this analysis is given to research the effect of the natural diseases on th ability of the possibility of occurrence and spread of the technogenic risk in the functioning of the industrial enterprise. To solve a problem The paper considers the basic principles of construction of distributed geographic information system for the management of technological risks in the functioning of industrial enterprise in case of natural emergencies. Disclosed some issues of functioning of specialized geo information systems preventing of technogenic risks in the functioning of an industrial enterprise.

Key words: Information, Monitoring, Data Analysis, Enterprise, Industrial Risks, Geographic Information System

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1. INTRODUCTION

Human activity is largely determined by influence of external factors. Thus, among such factors notably the ones those are associated with the violation of steady state of the environment objects. These factors include: avalanches and mudflows, landslides, earthquakes, tsunamis, volcanic eruptions, floods, fires, hurricanes, and tornadoes [1, 2]. In some cases, these factors can be catastrophic, which ultimately leads to economic, social and human losses. Therefore, based on the safety of human life, there is constant monitoring of the various emergency situations of natural character and the accumulation of data on the processes of their emergence and development.

One of the priorities of the security of human life should be prevention of technogenic risks of industrial enterprise operation [3, 4, 5]. This is due to the fact that the emergence and spread of technological risk multiple increases in the case of natural emergency exposure. Implementation appropriate technogenic risks warning system, that arise as a result of exposure to natural emergencies, enables better and faster to assess the effectiveness of decisions to ensure the safety operation of the business, economic feasibility and risk dynamics changes in emergency situations during a significant time span.

Effective decision-making with respect to those or other actions for the prevention and the prevention of technogenic risks, industrial enterprise functioning is impossible without regard to appropriate information both on the conditions of operation of such a venture, as well as the possible impact of the conditions of emergency situations of natural character of the company's activity [6]. This, ultimately, is determined and the main purpose of this study.

2. TECHNOLOGICAL RISK PREVENTION SYSTEMS IN THE FUNCTIONING OF INDUSTRIAL ENTERPRISE AS A SPECIALIZED GEOINFORMATION SYSTEM

The data accumulated about real objects and events in our world, in one way or another include a so-called "spatial" component. The spatial dimension to information are buildings and structures, land, water, forest and other natural resources, highways and utilities. Accidents in the communications, avalanches, landslides, earthquakes are also associated with a particular point in space. Thus, all information may be constant or variable spatial coordinates. To ensure the effective handling of such information on the area, facilities and processes occurring are called Geographic Information Systems (GIS) [7].

Thus, GIS - is an information system designed to collect, store, retrieve and manipulate data on the regional sites. An important feature of GIS can is that it is possible to carry out real-time simulation of certain situations (including emergency), with real-time display of objects that fall under the state of emergency.

The above, can be considered a generalized scheme of constructing technogenic risks warning system in the operation of industrial enterprise as shown in Figure. 1.

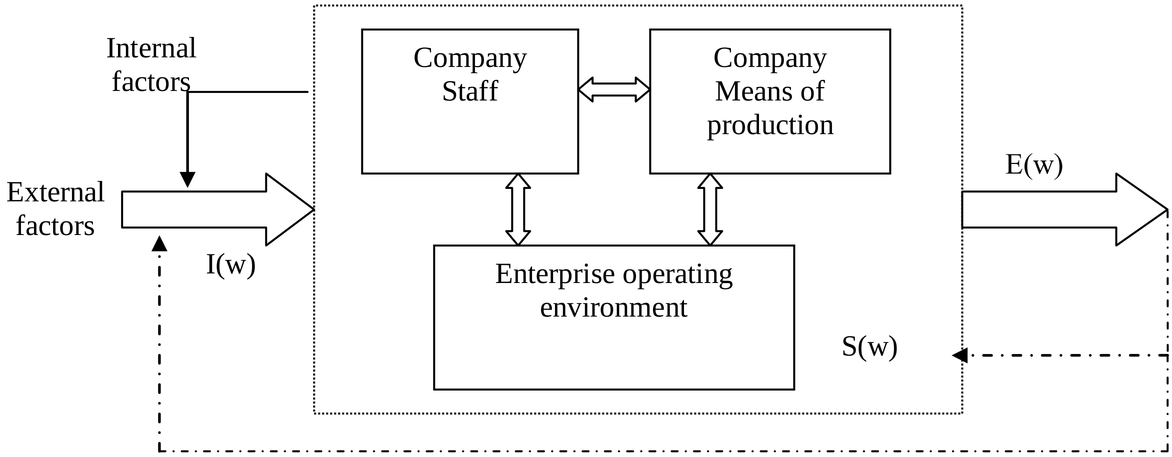

Figure 1 Generalized scheme of the technogenic risks warning system in the operation of industrial enterprise

Figure 1 shows:

- I(w) – input actions to prevent the reaction of the system: dedicated resources, the required conditions of work, given the functions set intervals, external factors. At the time point w;
- E(w) – warning system response technology risk the functioning of the enterprise. At the time point w;
- S(w) - The main components of exposure to technogenic risks warning system. At time point w.

Thus, on the basis of the present context of GIS application, it is advisable to include the following based its objectives:

- Real-time monitoring and processing a large number of different types of information sources;

- Storage of information in the knowledge base, providing random access to information about the previous state of the risk environment, the ability to re-analyze the data for an arbitrary period of time;

- Work with many different types of markers;

- Intelligent context-sensitive output.

3. ANALYSIS TOOLS FOR THE PREVENTION OF TECHNOLOGICAL RISKS INDUSTRIAL ENTERPRISE FUNCTIONING

An important place in the quantitative prediction and evaluation of the acceptability of the risk of man-made, associated with the creation, operation and liquidation of dangerous manufactures, it belongs to both forecast and assessment methods, as well as the aggregate quantity indicators, based on which it is possible to make a prediction. In this study the composition of these indicators should take into account the following basic requirements [7, 8]:

- Have a clear physical meaning and universality;

- Reflect the link with the quality and duration of functioning enterprises both directly, man-made risks that alerts and warnings of such systems;

- To provide a record of all the essential properties of the main components of preventing technological risks industrial enterprise functioning;

- Have sensitivity to a change in the parameters of other indicators warning system;

- Be able to objective methods of assessment;

- Be suitable for use as an optimized parameters, constraints and optimization criteria.

To directly do prediction is possible to apply different techniques and models that can be divided into several classes [2, 7]:

1. Logical and probabilistic models that interpret the various options of occurrence and development of accidents in the form of diagrams of causality of the «tree» («fault tree», «event tree»), «graph» (streaming or states and transitions), «network» (stochastic structure). After a further formalization of such structures allow to obtain mathematical relationships (structural functions of the algebra of events and the calculated probability polynomials), convenient for system analysis of the process occurrence of technogenic and technological damage risk prediction.
2. Analytical models:

a) Parametric analysis formula for pressure drop in the atmosphere model or Gaussian scattering therein pollutant;

b) Integrated model based on the laws of conservation of mass and energy and described by ordinary differential equations;

c) Models built on the notion of state parameters or energy-mass in their original form and implemented systems of differential equations in partial derivatives.

3. The methods of logical and linguistic, simulation, statistical and numerical modeling, based on the use of random (including ill-defined) set of parameters of distributions of different models and taking into account constantly changing factors of technological risks and natural emergencies.

In terms of purpose or application, the above models and methods can be distributed in accordance with the main directions of accounting causing damage to technogenic:

- The emergence and development of the causal chain incident prerequisites are necessary and sufficient to begin an uncontrolled release of energy and / or substance, as a constituent of technogenic risks;

- Issue, distribution and transformation of those streams of energy and / or substances in the environment;

- The impact of damaging factors caused by the uncontrolled release of energy and / or substance on the unprotected human, material and natural resources.

Thus one of the key aspects of effective functioning of the technogenic risks warning system in the functioning of industrial enterprise in the event of impact of emergency situations of natural character is the account of the time factor. This makes it necessary to, first of all, consider the temporal aspect of the use of GIS for the prevention of technological risks.

4. THE TIME ASPECT OF GIS WORK

In general, the temporal aspect of GIS application in order to prevent man-made risks in the operation of industrial enterprise (X) is considered time-consuming to retrieve the necessary information for decision making.

A formalized assessment of time extracting the necessary information can be represented by the following formula:

$$t(X) = t_{мс} + \frac{s(X_n)}{v \cdot \min\left(n, \left[\frac{s(X_n)}{s_{\min}} + 0.5\right]\right)}, \quad (1)$$

Where

$t_{мс}$ – sampling information on the time on which of GIS units contain the necessary information for further analysis;

$s(X_n)$ – function of the volume of this section (n) analyzed data ($X = \{X_n\}$).The numerical value of this function describes the number of objects needed to make a decision in a particular situation, the risk of technogenic, such as «dangerous», «pre-emergency», «alarm», «postalarm»;

v – Data transfer rate between the individual nodes of of GIS;

$s_{\min}$ – The maximum amount of data sent in one package. The introduction of this option due to the fact that the relationship between the individual nodes of GIS is expedient to carry out a batch manner [7]. Each package can be packaged from 1 to $s_{\min}$ objects. Thus, $s_{\min} + 1$ – redistribution of fragmentation packet.

The use of the temporary assessment in accordance with the formula (1) allows to obtain the value of of GIS delays when retrieving data and in a timely manner to optimize the system for the prevention of the conditions of man-made risks due to exposure to natural emergencies.

An important task is to synchronize data between different of GIS nodes, which provide a variety of information for decision making. It should be borne in mind that ubiquitous replication technology, in one way or another connected with the organization of locks at the level of the storage tables. Therefore, work on remote nodes of GIS is advisable to use a limited set of data. In this regard, the work of the specialized GIS for the prevention of technogenic risk the concept of «activity data» is entered in the functioning of industrial enterprise. Activity data determines how often changes the information in the data. It can be assumed that the least active are the data on the location of the company building, his communications. The most active can be, for example, information about weather parameters, seismic situation, moving vehicles. However, the status data activity over time can vary. Therefore, upon the expiry of data activity, such activity is updated. For example, if the period of activity of these «relief» is set to 24 hours, and the data «weather» in 5 minutes, then every 5 minutes the update will take weather data. However, when data synchronization «relief» synchronization «weather» the data can be delayed for more rapid synchronization of large data volume.

5. CONTEXT-SENSITIVE ENTRY OF INFORMATION IN THE GIS

As an example, consider the of GIS information richness context sensitive input relevant information. To this end, we describe some emergency situations of natural character in terms of the knowledge base:

$$Sit = \langle x, y, POL, S, t \rangle,\ S = s_1 \ldots s_k, \tag{2}$$

Where,

x, y – Coordinates of the center (distribution center) emergency;

POL – Polygon area covered by an emergency (for example - the area of distribution of chemical contamination, the contour of the burning forests);

S – The current status of monitoring of the environment (the territory in the area where functioning GIS sensors). Status formed as a superposition of states $s_1 \ldots s_k$ representing, in turn, sets the status of sensors in monitoring points k.

The key parameter is the characteristic of the emergency type of emergency. This feature describes a scenario in which the expected developments in this emergency [9, 10]. Examples of such situations may be «fire», «flooding», «avalanche», etc. The information on the occurrence of an emergency can be obtained directly on the basis of sensor data, as well as by user input (in case of failure of sensors and at the nearby vicinity of an emergency or if "simulation" of events). The script is a list of actions and resources needed for them to deal with emergencies of this type.

On the basis of the area covered and the type of emergency calculates the maximum allowable response time for each of the points of the script. Then, under the reaction time should be understood period between the notification of the resource provider to its arrival at the place of an emergency. Thus, in the case of the scenario «fire» resource providers are fire brigade, fire ponds, reservoirs, ambulance stations, etc. Based on these calculations, it creates a list of available primary resources, which are transferred for display in GIS. Facilities that this emergency situation does not affect, as well as those who can not participate in the provision of the necessary resources for the elimination of the situation are automatically hidden.

On the basis of the resources available at the graduation immediately available for a period of recovery, inaccessible and automatic construction of group contexts classification by type of resources made and outputs the formed groups in the user interface, allowing the operative connection and disconnection of group contexts.

The procedure involves filling of GIS information objects binding information environment (enterprises, buildings, roads, relief elements, etc.) to the grid. In this regard, it proposed the introduction of an automated tool which allows to carry out a correction unit (the subject is moving, the change in contour, route correction), and automated change a large number of objects (As topological binding executed session, the distortion in the same session is usually of the same type and can be eliminated by mass editing - auto-correct).

Under the automatic correction will understand the following procedure:

$$Obj(x_k, y_k) = F(Obj(x, y), N(Obj, k)), \tag{3}$$

Where

$Obj(x_k, y_k)$ – The new coordinates of the monitoring object,

$Obj(x, y)$ – Old Coordinates the monitoring object,

$N(Obj(x, y), k)$ – Function that returns k nearest neighbor of object Obj.

Thus, it becomes possible to describe the various distortions in the transfer of the monitoring data object.

6. GENERALIZED METHOD OF ESTIMATION AND FORECASTING OF TECHNOGENIC RISKS

As a general rule, baseline, most fully characterizes the measure of danger and suitable for effective response to technogenic risks warning system in the operation of industrial enterprise, It can serve as a mathematical expectation $M_\tau[Y]$ the value of the social and economic damage from man-made possible within the specified time accidents and continuous emissions [11, 12].

As other indicators needed to assess the effectiveness of functioning of GIS for a technological risk prevention tool in the functioning of industrial enterprise, can be the following [2, 13, 14]:

$Q[\tau]$ – Probability of at least one specific type of incident (accident, accident, etc.) during τ;

$M_\tau[Z]$ – expected average delay time of suspension of the process due to possible accidents;

$M_\tau[S]$ – expected at the same time to prevent the average costs and reducing the severity of accidents and continuous emission.

Given the massive scale of similar processes in the enterprise, as well as a well-developed system for collecting information on accidents and injuries, the use of selected indicators for the posterior quantify the risk technogenic and a decision on its degree of acceptability As a rule, it does not cause difficulties in principle. It's enough to register [7]:

a) Intensity and duration of the process,

b) Costs and labor costs for providing security,

c) The number and severity of accidents occurring, and then perform calculations on the statistical evaluation of selected indicators and compare them with the required or desired values.

Much more difficult to carry out an a priori estimate of the proposed indicators, as it requires complex models, connecting the selected indicators not only of GIS specific parameters, but also the surrounding environment. To overcome these difficulties, it is sometimes expedient to operate with the concept of «average expected damage» from the technogenic incidents of a particular type within a certain time of operation of potentially dangerous production. Given these assumptions, the expected value of the average damage caused by human, material and natural resources for a certain period of operation time can be estimated using the following formula:

$$R_\tau = M_\tau[Y] = \sum_{a=1}^{m}\sum_{b=1}^{k} Q_{ab}^{1} Y_{ab}^{1} + \sum_{a=1}^{m}\sum_{b=1}^{k} Q_{ab}^{2} Y_{ab}^{2} + \sum_{v=1}^{n} Q_v Y_v \quad (4)$$

Where

a = 1..m – the number of types of possible technogenic accidents: accident (a = 1), the accident (a = 2), fire (a = 3), etc. – forms of causing direct and indirect damage to human, material and natural resources;

b = 1. kk - The estimated number of scenarios of occurrence and development of various types of accidents (usually the most likely and the most severe consequences on);

$Q_{ab}^{1},\ Y_{ab}^{1}, Q_{ab}^{2},\ Y_{ab}^{2}$ – Probability of occurrence during a particular type and size due to their direct (1) and indirect (2) damages, respectively;

v = 1.. nn – The number of species of continuous and / or systematic harmful energy (noise, vibration, electromagnetic radiation) and material (contaminants, waste) emissions in the operation of a particular technology;

$Q_v,\ Y_v$ – The probability of occurrence during each type of continuous or systematic emissions and dimensions are possible by the direct and indirect damages.

Such statistics can be obtained by analyzing the available data and expert assessments on the basis of data on the functioning of the enterprise.

Using this assessment allows numerically characterize the likelihood of risks in such a system. Used standardized criteria allows to evaluate the extent of the risk effectively. Also, using the data on how the introduction of a technology reduces the likelihood and extent of damage $Q_{ab}^{1},\ Y_{ab}^{1}, Q_{ab}^{2},\ Y_{ab}^{2}$ accordingly, it is possible to quantify the effectiveness of the measures.

7. CONCLUSIONS

Thus, we examined the main directions and approaches for building of GIS prevent man-made risks in the operation of industrial enterprise. Particular attention is paid to the functioning of distributed of GIS, which allows to avoid deadlocks between individual of GIS nodes when adding and updating information. This is achieved by entering into consideration such things as «active data». Through this approach, it becomes possible estimated calculation of the average response time of the system in an emergency. Consideration on the basis of their activity data also makes it possible to improve the accuracy and reliability of quantitative analysis of information available in the GIS.

Considered the main group of tools for contextual information input in of GIS and the procedure followed by the correction of such information.

The general ideology of the forecast and assessment of technical risk, which provides the ability to make effective decisions to minimize the consequences of man-made risks in the operation of industrial enterprise.

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