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INFORMATIONAL AND TECHNICAL METHODS OF ENVIRONMENTAL MONITORING IN CONDITON OF TECHNOGENIC EMERGENCY SITUATION

Work dedicated to the environmental monitoring, in condition of technogenic emergency situation. Described reasons of such situation occurrence and consequences from such situations. Based on the scale of consequences classification of such situation had been presented: origination, initiation culmination and attenuation. Considered peculiarities of monitoring system and system of prognose which are used for prevention and liquidation of emergency situations. Existing methods of environmental monitoring are investigated. It is shown, for now the absence of methods for environmental monitoring are observed, in condition of technogenic emergency situations. Such methods would allow solving correspondent tasks, from the point of view of management theory. To overcome this problem, in article were proposed new methods of environmental monitoring, that are called informational and technical methods. In article presented and described their typical structure and benefits from their using.

Keywords: *technogenic emergency situation, environment ,monitoring, informational and technical methods, management.*

Introduction

Formulation of the problem. Contradiction between needs of socio-economic development and necessity of environmental protection - is one from the main problems confronting humanity.

Scientific and technical progress cause not only positive changes (increasing of productivity and improvement of working conditions, increasing material well-being and intellectual potential of society), but also cause some negative changes (increased risk of big technical systems emergencies). Last connected with increasing of complexity in system of designs, increasing of system number, increasing of power units on industrial and power facilities, their territorial concentration.

Suffice it to mention the accident on NPP in Three Mile Island (USA), in Chernobyl (Ukraine), in Fucusima (Japan), on chemical enterprises Flixboro (UK), Sevezo (Italy), Bhopale (India), large transport and industrial catastrophe in Arzamas, Sverdlovsk, Ufa, spills of oil in result of accident on tanker. Also can mention recent fire on oil base in Vasilkiv region of Kyiv oblast [1].

Destructive force of technogenic catastrophes and natural disasters in some cases can compare with military activity, and number of suffered, significantly depends from type, scale, place and pace of situation development, peculiarities of region and settlements, located in region of activity (or objects of economic activity). Unexpected development of events leads to the significant reduction of time, used for preparing and conduction of rescue works.

Technogenic risks management are not possible without informational support, preparation and adoption of management decisions, concerned emergency situations prevention and liquidation. One from the most important parameters used for technogenic risk management are monitoring of environmental state and object of technosphere, and analysis of risks and prognoses of ES.

The functioning of ES monitoring system based on using of different methods and approaches. In given article on conceptual level considering issue concerned development of informational and technical methods of environmental monitoring in condition of technogenic ES.

Literature review. Important contribution to the solution of theoretical and practical issues concerned prevention and liquidation of nature and technogenic ES made such sciences as V.M. Shobotow, V.S Sergeyev, V.A. Akimov, G.L. Koff, B.S. Mastriukow, S.O. Guriev and other [1-8]. But in works of given scientists predominantly described issues of organizational character and not paid attention for development of methods for environmental monitoring in condition of technogenic ES, from the point of view of management theory.

Aim of articles is development of typical structure and describing of possibilities of using of new informational and technical methods of environmental monitoring in condition of technogenic emergency situation.

Main material of research

Increasing of economic activity scales, and number of big enterprises complexes, concentration on it aggregates and installation of powerful and very powerful capacities, usage of significant number of hazardous materials in production process - all this increase possibility of technogenic situations occurance. Emergency situations of technogenic character contains in it hazards

for human, economy, and environment, or cam form such hazards, due to possible explosion, fire, flooding or pollution (infection) of environment.

Emergency situations as a rule appears on potentially hazard enterprises. To such enterprises belongs chemically dangerous objects, explosiveness or fire hazard objects, and also hydrodynamic objects. In last year's also increased hazard from accidents and catastrophes on transport.

Emergency situations of technogenic character classifies by following basic features [9]:

- By scale of consequences (object, local, regional and state levels);
- By industry basis (emergency situations in agriculture; forestry; in protected areas - objects of special conservation value; in water; in material objects - infrastructure objects, industry, transport, housing and communal services and population);
- By speed of distribution (sudden: explosions, traffic accidents, rapid fire, hydrodynamic accident, accidents with releasing of hazardous chemicals, with using of chemical weapons; moderate: accident with radioactive substances releasing; flowing: accident at the industrial wastewater treatment plants, contamination of soil and water by harmful substances, using of ethnic and gene weapons).

To the classification of technogenic emergencies also include such criteria as size of caused or expected economic losses.

In a result of technogenic accidents and disasters occurs emergency situations. Sudden occurrence of ES leads to significant environmental and socio-economic losses, forms needs of people protection from consequences of ES (influence of hazardous factors on health's), performing of rescue, and emergency medical and evacuation activity, and also liquidation of occurred negative consequences.

Technogenic emergencies in its development passes through four typical stages: birth, initiation, culmination, and attenuation. Lets consider each stage [1, 4].

On a stage of generation forms preconditions for future ES: performs activation of unfavorable natural processes, accumulated technological defects, and design-manufacturing defects, occurs failures in equipment, working procedure of technical staff, etc. To it number also belong large amounts of storaging and processing of materials (flammable, combustible, volatile, corrosive (caustic), highly reactive, toxic, dust, and other inert materials) and extreme physical conditions during production process (high and low temperature, high pressure, vacuum cyclic changes in temperature and pressure, hydraulic shocks etc).

Duration of generation stage may be defined very roughly, with using the methodology of technical systems reliability theory, risk theory, catastrophe theory, the theory of regular failure statistics, theory of "local" accidents, etc.

At the stage of ES initiation forms technological disorders, connected with process of parameters output (output of pressure, temperature, concentration, reaction rate, flow agents, etc.) over the critical values. Formes spontaneous reaction, depressurization of pipelines, reservoirs, possible failure of the gaskets, corrosive damaging of walls.

Possible violation of equipment work (pumps, valves, instrumentation, sensors, locks). Detects a malfunction of ensuring systems (electric, water supply, cooling, heat, ventilation, etc.). Can not exclude external events, which should include extreme weather conditions, natural disasters, acts of vandalism, sabotage, and so on. Most important is the human factor, since over 60% of accidents occurs due to errors in design process, during construction, operation, and technical servicing.

At the stage of culmination release of large amounts of energy and mass, and even a small initiational event can activate chain mechanism with multiple increasing of capacities and scales of accidents ("domino effect"). At this stage is very important perform prediction of accident scenario. Such activity allows define and accept effective protection measures, for avoiding of human casualties or reduce their number, and also reduce the inflicted damage.

Stage of ES decaying is continues from the moment of danger source elimination to the complete liquidation of accident consequences, which can continues years or even decades (for example, the Chernobyl disaster).

Knowledge of causal and effect chain of ES formation in specific conditions, will allows to reduce risks from such situation in future and, consequently, increase the safety in condition of ES.

Providing of livelihoods safety in ES condition is complex of organizational, technical activities and means, aimed on preserving of human life and health, in all areas of its activity.

Main directions in solution of problems connected with providing of life safety in ES condition are: prediction and evaluation of possible consequences from ES; planning of measures, for prevention or reduction of ES formation and for reduction of consequences from ES; providing of sustainable work of natural economy objects in ES; training of personnel and the public to specific actions in ES; liquidation of ES consequences [1, 2, 4].

Environmental monitoring in terms of technogenic ES

In modern world system of emergency situation monitoring and prognoses occupy first place in control of technogenic disasters, and nature cataclisms. Perspective of its direction are obvious**.** In sphere of population and territory protection, monitoring and prognoses of

ES play important role, because observation, analysis and assessment of state and changing of determined and potential sources of emergency situations, and also prognoses of influence on safety of population, organizations, natural environment, allows develop and realize measures directed on prevention and liquidation of ES, and for minimization of socio-economical and environmental consequences [10, 11].

Results of monitoring and forecasting of ES- is one from defining criteria, which used for decision-making in organs and departments of ES. Accurate and timely information about hazard natural phenomenon, accidents or dangerous technogenic accident, etc., outstripping reflection of probability of occurrence and development of ES ,based on analysis of the possible reasons for its appearance, its source in past and present, will allows qualities and effectively develop plans and programs , and make effective decisions concerning prevention and liquidation of ES [1, 12].

That's why, monitoring and prognoses of emergency situations - one from prioritized direction of activity of relevant ministries and departments of industrialized developed countries [11, 13].

Emergency situation monitoring - is system of continuous observation, laboratory and other controls for assessment state of population and territory and hazardous processes that could lead to threats or formation of ES, and also timely detection of trends to their changes.

Observations, laboratory and other control include collection, processing and transmission of information about state of environment, pollution of food product, raw food, feed, water by radioactive chemicals substances, contamination by infectious agents and other dangerous biological agents.

Depending from the scale of ES, is defined five levels (degrees) of monitoring: global, national, regional, placed, local. Everyone from below level of monitoring are included in higher one [1, 2].

For performing of monitor of external environment as a result technogenic ES, used different methods and tools for measuring the parameters of its main components (air, water, soil) [7, 14].

With the help of devices usually measure the physical and chemical parameters of environment: size and range of noise, temperature, characteristics of electromagnetic fields, characteristics of radioactive pollution of environment, characteristics of geophysical phenomena, concentration of chemical contamination in air, water, soil, and others.

With the help of instruments also determine numerous characteristics of biological systems. Widely used remote studying of ecological systems from aircraft, artificial satellites, spaceships.

Methods of monitoring are divided into qualitative and quantitative. Task of qualitative analysis are identefication of specific chemical element or compound, or definition of investigated substance composition.

Quantitative used for determination of numerous content of substances in investigated sample, or installation of quantitative relation between components parts of matter. Qualitative analysis is usually preceded by quantitative definition.

Based on measured parameters methods of quantitative analysis divide into chemical, physical, chemical, physical and biological [14].

Chemical methods based on using of chemical reactions for system content determination. So, using a reaction-specific ion with formation of colored complex, sediment, not enough dissociated compounds can conduct qualitative and quantitative chemical analysis.

Physico-chemical methods based on dependence of physical properties from chemical composition of analyzed environment.

Physical methods used for definition of property which directly depends from the nature of atoms and their concentration in the system, such as the intensity of radiation [4, 6].

Biological and biochemical methods of research based on reaction of plants, animals and microorganisms into the action of certain factors.

So, existing methods of environmental monitoring is narrowly focused and concerned of issues on necessary parameters measuring. Observed absence of methods which consider information and technical component of object and research process in terms of management theory. In connection with this, authors proposed new methods of monitoring, which called information-technical methods (ITM).

Information and technical methods of monitoring

Typical structure ITM monitoring of environments in the conditions of technogenic ES looks like:

1. Physical model of researched object.
2. Mathematical model of researched object.
3. Algorithm of control.
4. Hardware and software.
5. Procedure.

Physical model – installation, device or tool allowing research system through replacing of studied physical process by similar or different by physical nature.

These models can be static or dynamic. In last case, in model can realized physical phenomena or process similar to original process. During this process may have one and the same physical nature, or can have different physical nature. As a rule, similarity between physical processes established by methods of similarity theory, with using of specific criteria of similarity.

Physical model only qualitatively describes the investigated object. Based on it constructed mathematical model used for receiving of analytical dependencies.

Mathematical model - approximate description of modeled object, expressed with help of mathematical symbols. Adequate mathematical model of the object allows [8]:

- understand how arranged object of research, their structure, basic properties, laws of development and interaction with outside world (understanding);
- learn to control of object (or process) and determine the best ways of control with predetermined goals and criteria (control);
- predict the direct and indirect consequences of realization of determined methods and forms of influence into object (forecasting).

After constructing of corresponding models developed control algorithm.

Control algorithm - is set of actions (rules) for receiving of desired characteristics of process procedure or for achievements of management objectives.

Next step of ITM using are development of hardware and software monitoring means.

Hardware and software complex – is set of hardware and software means, performed atomization of environmental monitoring tasks.

And the final stage is development of ITM procedures, which describe procedure for solving the determined problems of environmental monitoring.

Using the ITM of environmental monitoring allows to responsible persons make effective management decisions for the prevention of technogenic ES, and in case of ES occurance - receive recommendation for liquidation of given situations.

Conclusions and prospects for further research in given direction

So, conducted research shown that today exist various methods of environmental monitoring, which using for prevention and liquidation of technogenic ES. But all they are highly specialized and directed only on measuring of required parameters on environmental components, used for adoption of management decision.

At present bay observed lack of methods for environmental monitoring under technogenic ES, which would allows solving corresponding problem in terms of management theory. All this greatly decrease effectiveness of management for prevention and liquidation of correspondent ES.

For above problem solution, authors has developed new methods of environmental monitoring, which are called ITM. In article presented typical structure of methods.Usage of given methods in condition of technogenic ES greatly reduce time for decision management adoption, which in turn increase efficiency of situation liquidation.

Further development of this theme authors see in development of ITM monitoring for correspondent components of environment (air, water environment, soil).

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ІНФОРМАЦІЙНО-ТЕХНІЧНІ МЕТОДИ МОНІТОРИНГУ НАВКОЛИШНЬОГО ПРИРОДНОГО СЕРЕДОВИЩА В УМОВАХ НАДЗВИЧАЙНОЇ СИТУАЦІЇ ТЕХНОГЕННОГО ХАРАКТЕРУ

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Робота присвячена моніторингу навколишнього природного середовища в умовах надзвичайної ситуації техногенного характеру. Описано причини та наслідки виникнення таких надзвичайних ситуацій. Наведено їх класифікацію за масштабами наслідків, галузевою ознакою та швидкістю розповсюдження. Виконано детальний аналіз стадій їх розвитку: зародження, ініціювання, кульмінація і затухання. Розглянуто особливості використання системи моніторингу та прогнозування для попередження та ліквідації надзвичайних ситуацій. Досліджено існуючі методи моніторингу навколишнього природного середовища. Показано, що на сьогоднішній день спостерігається відсутність методів моніторингу навколишнього природного середовища в умовах надзвичайних ситуацій техногенного характеру, які б дозволяли комплексно вирішувати відповідні задачі з точки зору теорії управління. Для подолання цієї проблеми в роботі запропоновано нові методи моніторингу навколишнього природного середовища, які отримали назву інформаційно-технічні методи. В статті представлено та описано їх типову структуру та переваги їх використання.

Ключові слова: *техногенна надзвичайна ситуація, навколишнє природне середовище, моніторинг, інформаційно-технічні методи, управління.*

ИНФОРМАЦИОННО-ТЕХНИЧЕСКИЕ МЕТОДЫ МОНИТОРИНГА ОКРУЖАЮЩЕЙ ПРИРОДНОЙ СРЕДЫ В УСЛОВИЯХ ЧРЕЗВЫЧАЙНОЙ СИТУАЦИИ ТЕХНОГЕННОГО ХАРАКТЕРА

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Работа посвящена мониторингу окружающей природной среды в условиях чрезвычайной ситуации техногенного характера. Описаны причины и последствия возникновения таких чрезвычайных ситуаций. Приведена их классификация по масштабам последствий, отраслевому признаку и скорости распространения. Выполнен детальный анализ стадий их развития: зарождение, инициирование, кульминация и затухание. Рассмотрены особенности использования системы мониторинга и прогнозирования для предупреждения и ликвидации чрезвычайных ситуаций. Исследованы существующие методы мониторинга окружающей природной среды. Показано, что на сегодняшний день наблюдается отсутствие методов мониторинга окружающей природной среды в условиях чрезвычайных ситуаций техногенного характера, которые бы позволяли комплексно решать соответствующие задачи с точки зрения теории управления. Для преодоления этой проблемы в работе предложены новые методы мониторинга окружающей природной среды, которые получили название информационно-технические методы. В статье представлено и описано их типовую структуру и преимущества использования.

Ключевые слова: *техногенная чрезвычайная ситуация, окружающая природная среда, мониторинг, информационно-технические методы, управление.*