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PROBLEMS OF ENVIRONMENTAL MONITORING PROCESSES BUILDING PRODUCTION

Abstract

The article highlights the problems and scientific substantiation of the creation and functioning of ecological monitoring of construction production processes, which allows to monitor in real time the controlled parameters of environmental elements, capture moments and exceedances of the maximum permissible levels of emissions of pollutants and negative impacts. The basis for the creation and functioning of environmental monitoring is the proposed model of its organizational and functional structure. To ensure the environmental monitoring process during the construction works at the construction site, it is proposed to create an environmental safety facility that operates throughout the life of the facility. The functions of the head of the environmental safety point are given to the responsible contractor (superintendent, head of the site), the responsible executor to the master (superintendent), and the executor to the electronics engineer who is involved in permanent work at the construction site. Expenditures for the maintenance of the point of ecological safety and additional works and measures for the revitalization of construction production processes performed by construction workers engaged in the execution of construction works are reimbursed at the expense of general construction costs. The timely receipt of environmental information is ensured by the operation of an automated environmental monitoring system (ASEM), as an information and control system within a hardware and software system in the form of a computer system of required performance and a system of connected sensors, capturing the values of controlled parameters in real time. The magnitudes of the controlled parameters of the environmental elements (air, surface and groundwater, vegetation layer, soil, etc.) are automatically processed with the calculation of average variable values and are issued in the proposed application subroutine. This subroutine is external to the information management system and is intended for statistical analysis of the obtained values of the controlled parameters. With the help of a subroutine, the values of the controlled parameters are statistically processed, verified with the maximum permissible levels, and graphs are created to illustrate the dynamics of the parameter in time by magnitude and the available moments and the level of exceedances relative to the maximum permissible levels. Operational localization of the negative impact is carried out by performing additional revitalization works and measures, including the use of an existing set of equipment for the immediate and quick removal of dangerous contaminants. Models of organizational and functional structures include the purpose of creation and main purpose (function) of the structure, organizational or functional scheme, as well as elements of logistics.

Keywords: *construction processes, environmental safety point, automated environmental monitoring system.*

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ПРОБЛЕМИ ОРГАНІЗАЦІЇ ЕКОЛОГІЧНОГО МОНІТОРИНГУ ПРОЦЕСІВ БУДІВЕЛЬНОГО ВИРОБНИЦТВА

Анотація

В статті висвітлені проблеми та виконані наукові обґрунтування створення та функціонування екологічного моніторингу процесів будівельного виробництва, якій дозволяє в режимі реального часу відстежувати контрольовані параметри елементів довкілля, фіксувати моменти та перевищення відносно гранично-допустимих рівнів викиду забруднюючих речових та негативних впливів. Основою створення та функціювання екологічного моніторингу є запропоновані моделі його організаційної та функціональної структури. Для забезпечення процесу моніторингу довкілля під час виконання будівельно-монтажних робіт на будівельному майданчику пропонується створення пункту екологічної безпеки, що функціонує на протязі всього терміну будівництва об'єкту. Функції голови пункту екологічної безпеки надаються відповідальному виконавцю робіт (виконробу, начальнику дільниці), відповідального виконавця – майстру (виконробу), а виконавця – інженеру-електроннику, якій залучається до постійної роботи на будівельному майданчику. Витрати на утримання пункту екологічної безпеки та додаткові роботи і заходи з ревіталізації процесів будівельного виробництва, які виконуються будівельними робітниками, що зайняті на виконанні будівельно-монтажних робіт, відшкодовуються за рахунок загальнобудівельних витрат. Своєчасне отримання інформації про стан довкілля забезпечується функціонуванням автоматизованої системи екологічного моніторингу (АСЕМ), як інформаційної-керуючої системи у складі апаратно-програмного комплексу у вигляді комп'ютерної системи потрібної продуктивності та системи під'єднаних датчиків, фіксуючих величини контрольованих параметрів в режимі реального часу. Величини контрольованих параметрів елементів довкілля у автоматичному режимі обробляються з розрахунком середньо змінних значень і видаються в запропоновану прикладну підпрограму. Ця підпрограма є зовнішньою до інформаційно-керуючої системи та призначена для статистичного аналізу отриманих величин контрольованих параметрів. За допомогою підпрограми величини контрольованих параметрів статистично обробляються, звіряються з гранично допустимими рівнями та будуються графіки, що ілюструють динаміку параметру у часі за величиною та наявні моменти і рівень перевищень відносна гранично допустимих рівнів. Оперативна локалізація негативного впливу здійснюється шляхом виконання додаткових ревіталізаційних робіт і заходів. Моделі організаційної і функціональної структур включають мету створення та головне

призначення (функція) структури, організаційну або функціональну схеми, а також елементи матеріально-технічного забезпечення.

Ключові слова: *процеси будівельного виробництва, пункт екологічної безпеки, автоматизована система екологічного моніторингу.*

1. Formulation of the problem

The priority direction of the world technological and social development is the protection of the Earth's biosphere, which is caused by a deep ecological global crisis. The factors of this crisis began to manifest themselves systematically in the second half of the twentieth century, which was reflected in the decisions of the international community. Thus, in accordance with the decisions of the United Nations Environment Program (UNEP) of 1972 [1] and the Kyoto Protocol of 1992 [2], systematic measures have been envisaged and recently implemented to protect environmental objects, such as ambient air, aquatic environment, soil, flora and fauna and geological environment. In 1982, the UN General Assembly adopted the World Charter for Nature [3] and the World Strategy for Nature Conservation, developed (1980) [4]. In the last decades of the twentieth century. under the auspices of the UN, the Concept of Sustainable Development [5] has been developed, which envisages global approaches to environmental protection.

These and other measures to protect the Earth's biosphere have been joined by almost all countries in the world, including Ukraine, which, along with the rest of the world, has committed itself to the practical implementation of relevant environmental measures. In 1991, the National Ecological Center of Ukraine was established and is currently operating in order to comprehensively address environmental issues in our country. atmospheres by means of transport and the contribution of large industrial livestock to environmental degradation. The Center is part of the International Union for Conservation of Nature (IUCN) [7], which is dedicated to assisting communities working on biodiversity conservation and the implementation of clean and sustainable use of natural resources.

Construction as a branch of material production occupies a leading position in the economy of Ukraine, forming a significant share of the national wealth of society. According to the State Statistics Service of Ukraine [8], the total volume of construction in Ukraine in recent years was about 10.5... 11.5 ml. m2. These volumes of construction are massive and characteristic for the countries with developed industry, to which our state belongs.

Since the early 2000s, there has been a gradual increase in the total volume of construction in Ukraine, with this trend being observed in residential and other types of construction. The volume of construction is expected to increase further. At the end of 2025 they can reach 14 - 15 ml. m2 But in the process of mass construction of artificial structures, the destruction of natural complexes (environment, ecosystems, forests, tracts, etc.), which worsens the ecological status and adversely affects human health. This is due to the fact that the overwhelming number of construction processes and materials have a negative impact on the environment and human health during the construction or operation of construction structures. For example, during roofing under the influence of solar radiation, the harmful substances that are part of the bitumen evaporate, in the preparation of concrete mix cement is sprayed in the air, metal fumes (electric welding), concentrated dust and aerosols (soil development), air in the chemical processes of polymerization of paints and varnishes, noise is generated from working construction machines and mechanisms, electromagnetic and magnetic radiation (work of electrical equipment), yuyetsya natural temperature and lighting (microclimate parameters) and others.

The volume of construction in Ukraine, as a country with developed industry, is characterized as large-scale, which is why the construction industry occupies an important place among the factors of transformation and environmental pollution. However, existing organizational and technological solutions and measures for environmental protection in the process of construction of industrial and civil objects are insufficiently developed and de-tailored, not integrated into an orderly system, which significantly increases the costs of construction entities for their reconstruction. The issues of operational environmental monitoring and decision-making regarding the localization of identified negative emissions of substances and impacts remain open.

2. Analysis of research and publications

Various aspects of the problematic question raised, concerning the improvement of the basics of environmental protection measures in construction, including the organization of environmental monitoring, are covered in the works of authors [1-5] and other works of scientists of the world community.

Monitoring of air pollution, problems of ecological safety, safety of life and rational use of nature were investigated by OS Voloshkin [14], V. Yu. GA Obikhod [16], SP Ivanyuta and AB Kachinsky [17].

The scientific and applied problems of research of foreign authors in general are similar to the problems posed and developed by domestic authors. The most significant works on this subject are the works of F. Moydinger [18], S. Tsipri [19], K. Gors and D. Highfield [20], D. Eudelson [21], D. Friedman [22], D. Barton [23], M. Riley [24].

Developed by the author of the classification of factors [6] and major sources of negative impact [7], as well as a system of typical organizational and technological solutions for the revitalization of construction production processes, ordered by the importance of protected and restored environmental objects [8], are sufficient only for effective use when designing technology and organizing the construction of facilities. Therefore, the issues of prompt elimination of the effects of environmental pollution during construction remain open.

3. Basic material

The scientific substantiation of the organizational and functional structure of environmental monitoring during the construction of structures was chosen for the purpose of this article. The purpose of environmental monitoring is to respond promptly to changes in controlled parameters that describe the current state of the environment where the construction takes place. Therefore, the task of monitoring is, firstly, to receive timely information on the state of the environment and, secondly, to localize the negative impact quickly.

The substantiation of the organizational and functional structure of environmental monitoring is carried out by experimental modeling of possible organizational and technological decisions; the subject of modeling were:

A. Organizational structure of the environmental safety point (PEB) with an automated environmental monitoring system (ASEM);

B. Functional structure of environmental monitoring.

Models of organizational and functional structures include: 1. The purpose of creating a structure; 2. The main purpose (function) of the structure; 3. Organizational or functional scheme; 4. Logistical support.

A. Organizational structure of the environmental safety point (PEB) with an automated environmental monitoring system (ASEM).

1. The goal of creating and operating an environmental safety facility is to protect environmental objects from the adverse effects of construction processes.

An environmental safety facility is created at each site and operates throughout the life of the facility.

2. The main purpose of the environmental safety point is the immediate and rapid removal of hazardous contaminants from the construction site and prompt localization of the negative impact revealed by the environmental monitoring means.

3. Organizational scheme of PEB (Fig. 1).

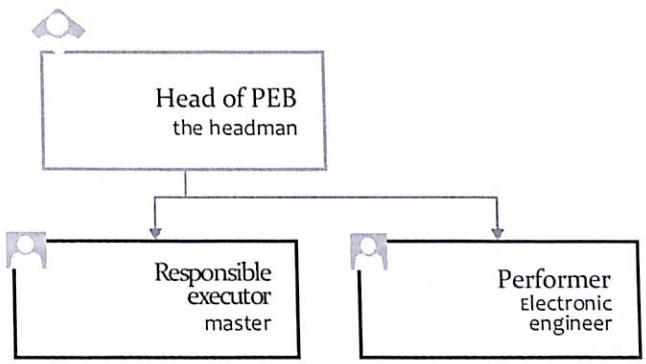

Fig. 1. Organizational chart of the environmental safety point (PEB)

The personnel of the point of environmental safety is appointed by order of the head of the construction organization, whose staff is formed within the existing staffing of the construction organization.

The functions of the PEB chairman are given to the responsible contractor (superintendent, head of the site), the responsible contractor to the master (superintendent), and the executor to the electronic engineer who is involved in permanent work at the construction site.

Additional revitalization works and activities are performed by construction workers engaged in construction and assembly work and are reimbursed at the expense of general construction costs.

2. Logistics of PEB.

Logistical support is provided on the basis of picking up of PEB with a complex of specially selected inventory, devices and equipment and consisting of:

1. A complete set of equipment for immediate and quick removal of dangerous contaminants; containers with sorbents, containers for the transport of radiation substances, containers with sand for the collection of oil, fuel, chemical additives;

2. Complete set of instruments and laboratory equipment: - gas, dust and noise analyzers, electromagnetic radiation and radiation meters, integrated into an automated information collection and analysis system (ACEM) for ongoing monitoring of the state of degraded environmental elements - extent pollution of atmospheric air, waters of reservoirs, soil and groundwater, levels of noise impact, electromagnetic and radiation radiation, nature and levels of damage to vegetation and fauna.

The structure of these kits by their composition and quantity depends on the volume of possible release of hazardous substances, construction conditions, the nature of its distribution into technological zones and the accepted composition of contractors - the number of simultaneously working units of workers.

B. Functional structure of environmental monitoring regulates the interaction of the information and control system with the sensor system and the object of construction (Fig. 2).

The values of the controlled parameters of the elements of the environment (air, surface and groundwater, vegetation layer, soil, noise, etc.) of the fixing in real time and in automatic mode are processed with the calculation of the average time, average variables or average daily values and are presented in the proposed application

PPDovkillia^{OsypovaAnastasia}. This subroutine is external to the information management system and is intended for statistical analysis of the obtained values of controlled parameters and storage in the database (see Fig. 2).

Using the application subroutine, the values of the controlled parameters are statistically processed, verified with the maximum permissible levels, and graphs are constructed to illustrate the dynamics of the parameter in time by magnitude and the available moments and the level of exceedances relative to the maximum permissible levels.

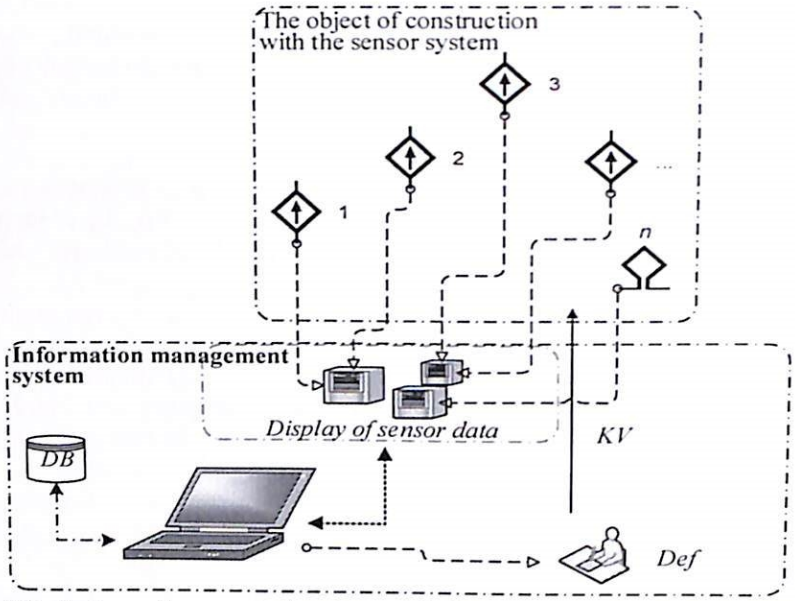

Fig. 2. Interaction of the information-control system with the sensor system and the object of construction: 1, 2, 3,..., n – sensors

The timely receipt of information about the state of the environment is ensured by the functioning of an automated environmental monitoring system (ASEM), as an information and control system within the hardware and software system in the form of a computer system of the required performance and a system of connected sensors, fixing the magnitude of the controlled parameters (Fig. 2): 1) degree of air pollution (gas and dust analyzers); 2) the degree of pollution of the waters of reservoirs, soil and groundwater (analyzers of water, soil, sediments); 3) noise exposure levels (noise analyzers); 4) levels of electromagnetic and radiation radiation (meters of electromagnetic radiation and radiation).

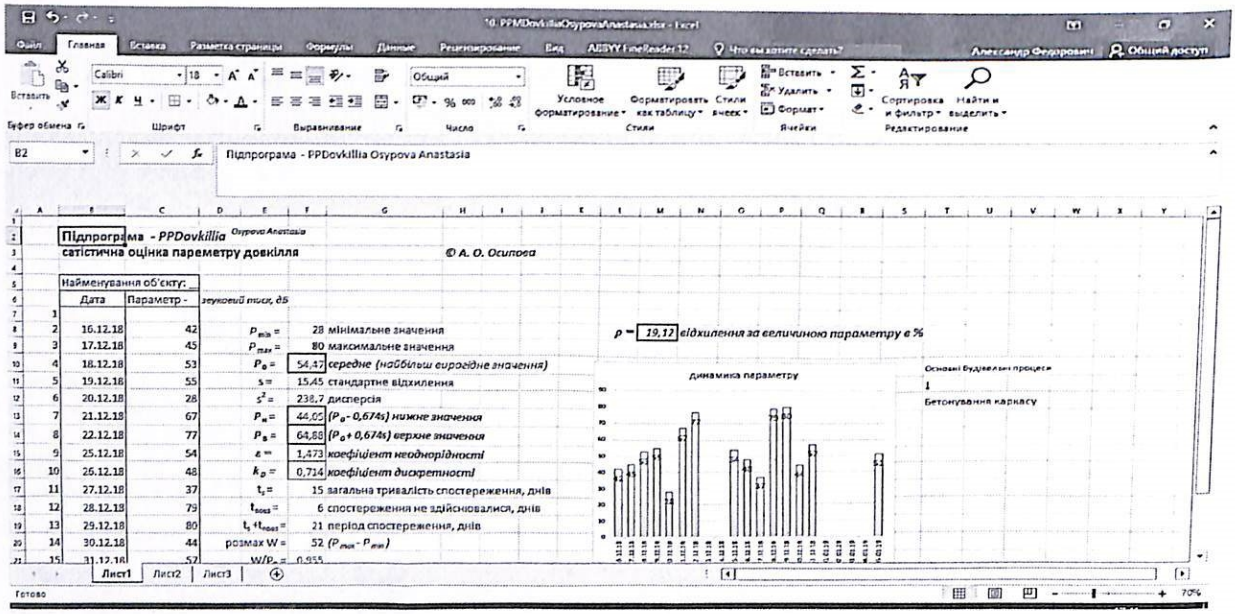

Fig. 3. Graphical shell of PPDovkillia^{OsypovaAnastasia} ***subroutine - statistical estimation of environmental parameter***

To automate the processes of gathering current information and its statistical processing, a developed application subroutine implemented in MS Excel, PPMDovkilliaOsypovaAnastasia (see Fig. 3) is used.

An example of the statistical processing of current information on the maximum daily sound pressure levels measured directly at a construction site is shown in Fig. 4.

The analysis shows that on 21 and 27 and 28 December this year, sound pressures exceeded the maximum permissible for residential development (up to 70 dB).

Operational localization of the negative impact is carried out by performing additional revitalization work and measures, including the use of an existing set of equipment for immediate and rapid removal of dangerous contaminants.

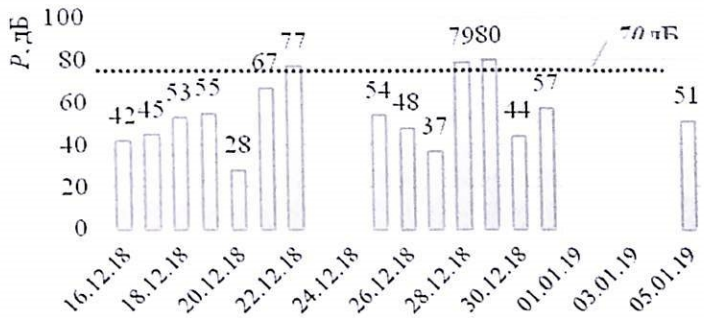

Fig. 4. Dynamics of sound pressure (P, dB) at the construction site (noise source)

Additional revitalization works and measures, in the form of managerial influence (CV, see Fig. 2), are formed by ODA on the basis of:

- information received on the current state of the environment, the presence and levels of exceedances of MPC by environment (air, water, soil, etc.) and by the levels of negative impacts (noise, light, etc.);
- volumes of revitalization works and measures actually completed in the preparatory period;
- Databases (DBs) about typical OTP-complexes [7] and data on earlier performed revitalization measures at other objects of the construction organization.

For example, an analysis of the dynamics of sound pressures at a construction site (see Figure 4) and the sources of their origin (be it the work of hand-held perforators) need to equip jobs with sound-absorbing screens.

The structure and quantitative composition of the sensor system and their location on a particular construction takes into account:

1) there are negative emissions and impacts generated during the execution of the processes of selective-extreme structure;
2) physical and geographical location, microclimatic, geological and hydrological characteristics of the construction site; are determined according to the relevant sections of the EIA developed within the work project;
3) urban planning features: the type of anthropogenic landscape that is being transformed (quiet or noisy street, park area, etc.);
4) proximity to nature, residential and industrial areas, architectural and historical monuments and more.

An example of the location of the environmental monitoring system is shown in Fig. 5, and their recommended typical structure - in Table. 1.

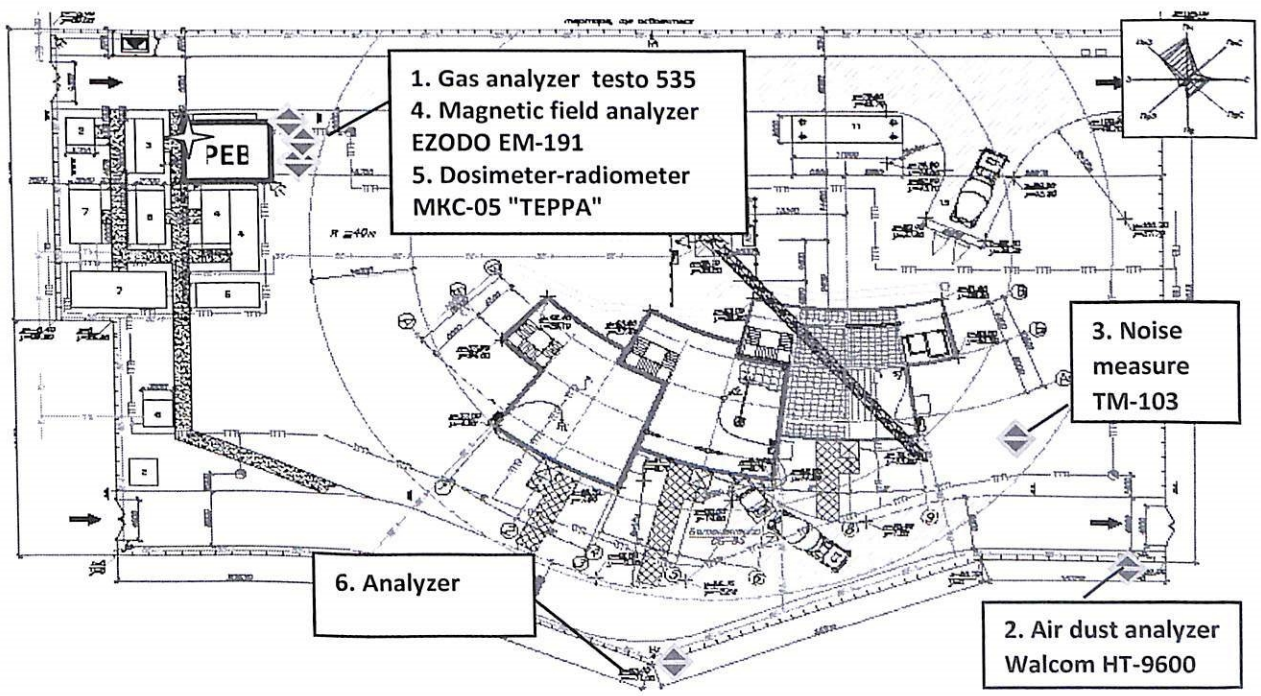

Fig. 5. Scheme of location of control points (sensors) at the construction site:
1, 2, … 6 - parameter control sensors – see. tab. 1;
PEB - point of ecological safety (office of the recruiter, control room)

The location of the sensors takes into account the wind direction (sensor No 2 - Walcom HT-9600 air dust analyzer) and the available natural terrain - sensor No. 6, which controls surface and groundwater located in the monitoring well at the foot of the slope, and the sound level meter TM 103 .

Table 1. Typical structure of sensors-devices is recommended of environmental safety

Appliance name and scope	Notes
1. Gas analyzer testo 535, industrial gas analyzer testo 350 Price*: 267,60 - 10 278,55 USD. Control of air pollution by the exhaust gases	
1. Walcom HT-9600 dust dust analyzer Price *: 208,04 USD Assessment of air quality by determining the reducing microdispersed dust particles and inhalation dust particles in the air, as well as for measuring temperature and relative humidity	
1. Sound recorder with PC connection Tenmars TM-103 Price *: 7000,00 UAH Control of noise pollution in the general frequency range 30 ... 130 dB	
1. EZODO EM-191 industrial frequency magnetic field intensity analyzer Price *: 2230.00 UAH Measurement of magnetic induction in the low frequency range (EMF) from 30 to 300 Hz.	
1. MKS-05 "TERRA" dosimeter radiometer Price *: 7896,00 UAH Dosimetric and radiometric monitoring at the construction site	
1. TSS PORTABLE analyzer Price *: 7530,00 UAH Surface water, soil and groundwater monitoring in ditches, vegetation and sediment analysis	

* - the price is given at the beginning of April 2019 (the total cost of a set of devices - 36,2... 37,0 thousand UAH)

Conclusion

Established and developed organizational and functional structures are applied bases of organization of ecological monitoring of construction aimed at eliminating the causes of negative impact of construction production processes on the environment. For the first time, it is proposed to create an environmental safety point at the construction site, which operates throughout the construction period of the construction site, and environmental monitoring to be carried out by an automated environmental monitoring system (ASEM), which is an information and management system within the hardware and software complex the required performance system and a system of connected sensors that capture the magnitude of the controlled parameters.

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