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Ensuring requirements of regulatory documents on environmental safety in the implementation of technological process projects

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Abstract: The article presents the findings of research conducted on the issue of environmental safety for the population and the local techno sphere during the implementation of projects. The study provides scientific and methodological approaches to addressing the pressing issue of technical support for the author's supervision of the safe implementation of production process projects. It is demonstrated that a set of methods consisting of integrated system analysis and mathematical modelling should be employed as a fundamental analytical tool when constructing the proposed structure. The article goes on to propose the use of non-destructive testing techniques for conducting diagnostics of the environment and the quality of implemented processes. The article also develops substantiated proposals for the establishment of a unified system for the conducting and documenting of control measures, which would allow for the achievement of a reliability of safety control results at the level of 85-90%..
Key words: environmental safety, technological process projects, implementation, author's supervision, system analysis, monitoring.

The creation of comfortable and safe living conditions for the population, in accordance with the decree of the President of Russia, is one of the national goals of the country's development in the near and medium term (Ministry of Construction of the Russian Federation, 2023). The specialists of our country rightly believe that the introduction of innovative technological processes and high-performance equipment characterized by low pollution of the living environment is an effective means of achieving the target indicators established by the decree. However, it should be noted that the utilization of technologies and equipment, the parameters and functional behavior of which remain to be thoroughly studied, is a common practice among enterprises.

In order to exclude the implementation of such negative events that seriously violate the ecological safety of the environment, production factors are controlled, and the assessment of the impact of fabricated threats is a very wide and diverse range of theoretical and experimental issues. A solid number of fundamental and applied publications are devoted to the scientific substantiation of solving theoretical and practical problems in the context of the research topic. Notable

contributions in this area include the works of prominent scientists such as Voznesensky A.S., Zagorsky L.S., Ruban A.D., Cherepetskaya E.B., and Shkuratnik V.L. [1-2]. The reviewed scientific publications present a sufficient level of detail on the research materials to allow for a comprehensive analysis of the technogenic impact of production technologies and processes on the safety of local natural-technogenic systems (NTS). The authors conducted an analytical review of published scientific works, which led to the conclusion that the aforementioned scientists have made a significant contribution to the development of the theory of environmental control of the state of NTS.

In principle, a number of specialists in the fields of ecology and geophysics have demonstrated that methods and technologies of industrial and environmental control enable the quantitative assessment of the level of impact of harmful and hazardous production factors (HHPF) on the environment and the quality of life of the local population. However, the reliability of practical results is limited to 75%. However, in the context of contemporary intensive economic development in Russia, it is imperative to enhance this figure to 85-90%, thereby facilitating the prompt implementation of more balanced management decisions .

The primary objective of the research work (RW) that has been completed is to provide substantiation for and to construct a control system at the stage of implementation of production process projects. The researchers found that the comprehensively developed industry of the Rostov region, which comprises highly productive coal mines, chemical and metallurgical plants, makes a significant negative contribution to the pollution of all shells of the regional technosphere. Concurrently, substantial emissions and discharges of pollutants (PP) are observed approximately large territorial production complexes. As part of the analysis, it was found that municipal and regional environmental services record significant complex impacts of OPPF in almost all cases. The performers of RW are supporters of the use of system analysis (SA) in the study of complex production

facilities and processes [3-5]. The authors, like most specialists in the field, believe that the use of SA ensures the necessary quality of diagnostics due to the basis of the theory on a set of fundamental principles (Fig. 1).

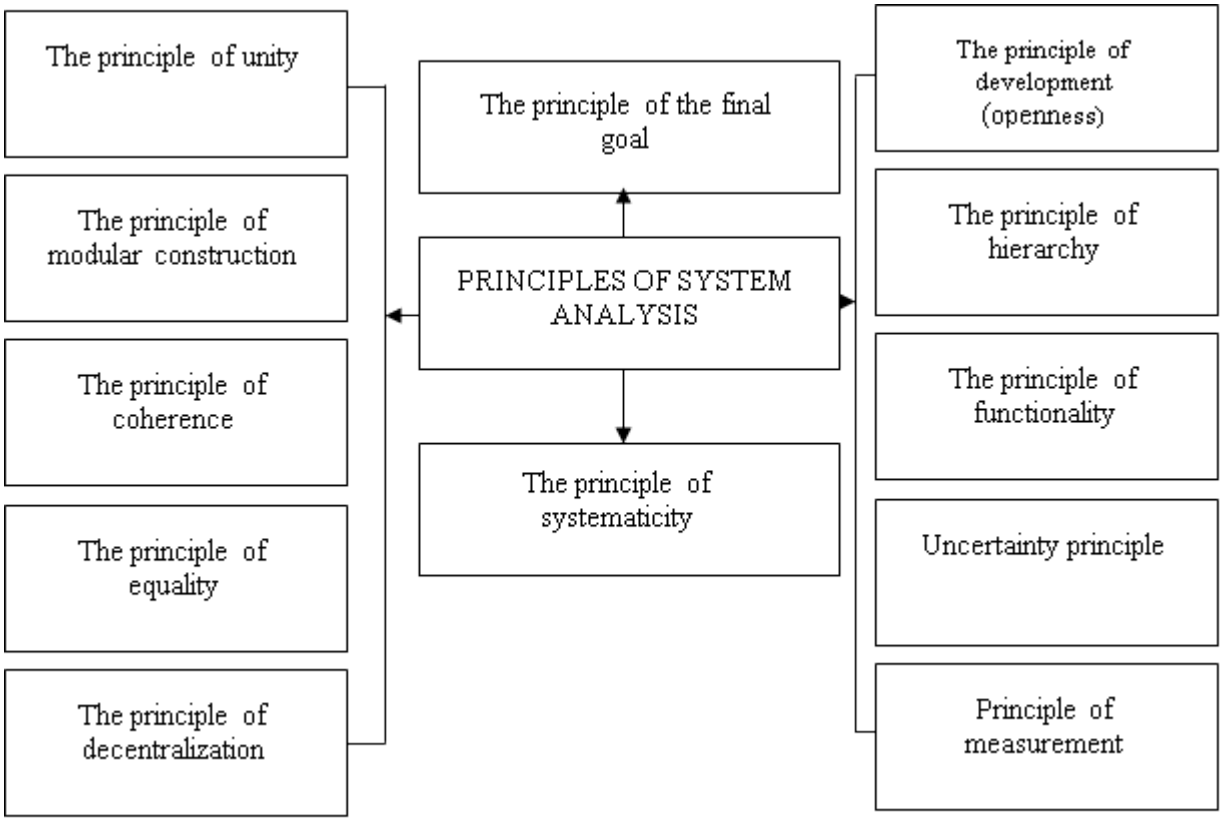

Fig. 1. – Principles of systems analysis

In accordance with the SA theory, a comprehensive analytical procedure is carried out for a detailed examination of the structure, interrelations and behavior of all enterprise objects that contribute to environmental pollution [6-7]. The authors consider the simultaneous recording of the parameters of the negative process throughout the entire study area to be an integral element of this work. In the context of the presentation and for the convenience of naming the stages, a special term, “synchronous mapping of parameters,” was introduced. This methodological approach, in the authors’ opinion, provides the required reliable assessment of the environment surrounding the enterprise.

In the following discussion, we will present a concise overview of the author's methodology for studying technosphere safety, as implemented in practice. In accordance with the prevailing Russian legislative framework, employees of the design firm are obligated to supervise the strict compliance of production process projects with all applicable requirements, including those pertaining to safety. Concurrently, the implementation of the following procedures is imperative for ensuring the safe execution of any developed project, including:

-The program of observations is to be conducted at the designated facility, with the objective of acquiring data on the status of techno genic pollution sources.

-A comprehensive analysis is to be undertaken of the levels of impact of harmful and hazardous production factors on the ecology of the environment.

-Organizational and technical measures are to be adjusted and implemented with the aim of achieving regulatory environmental indicators.

-There is to be detailed control over the implementation of corrective measures and parameters of PV.

A comparison of the goals and objectives stated in the preamble on the topic of research with the accumulated scientific and technical experience of the authors was made, which allowed the following strategic conclusion to be drawn: the implementation of production process projects in accordance with the author's solutions can only be ensured by involving monitoring of all enterprise facilities.

The aforementioned fundamental theoretical conclusions were utilized in the development of a scientifically grounded methodology for experimental research, encompassing the author's oversight of the secure execution of production processes at diverse phases of the industrial enterprise's life cycle. Extensive experiments were conducted in the Rostov region from 2013 to 2022. In the context of the presentation of the topic, it should be noted that in order to obtain objective conclusions, the authors used the results of a retrospective analysis of statistical materials for a representative array of production facilities. Thus, the

authors performed a detailed analysis of the results of geological and geophysical observations after the implementation of production process projects at 26 coalmines, which until recently represented one of the leading industries in the region [6-7]. The array of statistical information presented in Table No. 1 serves to substantiate the validity of the conclusions drawn by the authors.

Table No. 1

Information on the implementation of experimental studies

Name of characteristics	Unit of measurement	Number of measurements
Number of explored mines	mine	26
Total area of mine fields	sq. km	1300
Total number of hydrological observations	freeze	1220
Number of geophysical measurements	physical point	1450
Observation period	year	10

The representative volume of factual materials permitted the formulation of reasonable conclusions:

1. The fabricated impacts of enterprises on the environment and the population of the territory are characterised by multifactoriality, instability over time, and the formation of complex negative combinations;

2. Objective results of the analysis of the impact of OPPF and the consequences of their implementation can only be achieved using a set of non-destructive testing methods;

3 A comprehensive understanding of the project implementation is contingent upon the judicious selection of the period and frequency of primary observations from a systemic perspective. The selection of a rational set of methods for monitoring the implementation of projects is contingent upon the technical and technological characteristics of the object under study and the parameters of the method.

Consequently, the decision of the design firm's specialists on the inclusion of a specific method in the complex should be made based on the selection algorithm, which is shown in Figure 2.

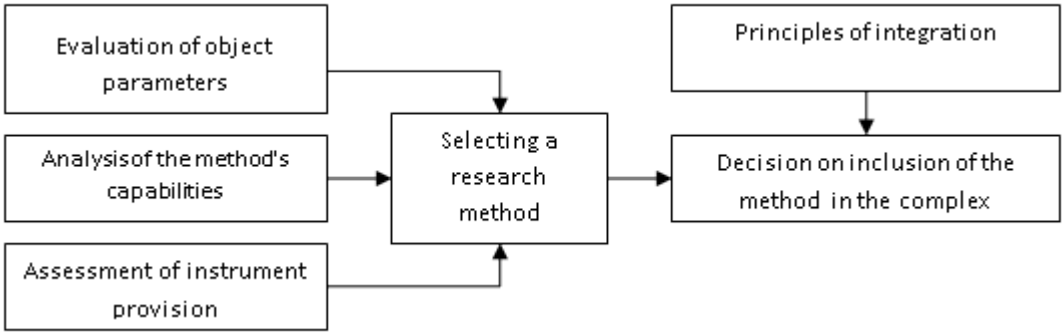

Fig. 2. – Algorithm for integrating control methods

To summarise the findings of the research analysis, it is valid to draw a general conclusion that can be incorporated into the proposed methodology. This conclusion is expressed as follows. :"The objectivity and reliability of monitoring the parameters of an object during the execution of production process projects is ensured by employing a set of diagnostic methods in the monitoring mode [8-10]. " The authors of the study propose an organisational and technical structure for the formation of monitoring for the implementation of author's supervision of the project implementation, in accordance with the theoretical calculations and materials of experimental studies. The conceptual block diagram of this structure is shown in Figure 3.

The authors of the article defined the forecasting and analytical subsystem as the leading structural part of monitoring, the sphere of functional responsibility of which includes procedures for processing and analyzing input information.

Based on the analysis and generalization of the results of the conducted research on this problem, a universal methodology for experimental work is proposed for the proper provision of the author's control of safety during the implementation of the project of production processes. The document delineates the following stages of production work:

- ubiquitous detailed control of the state of the object under study;

- assessment of the impact of negative man-made factors on the environment;

- development of recommendations based on the results of monitoring.

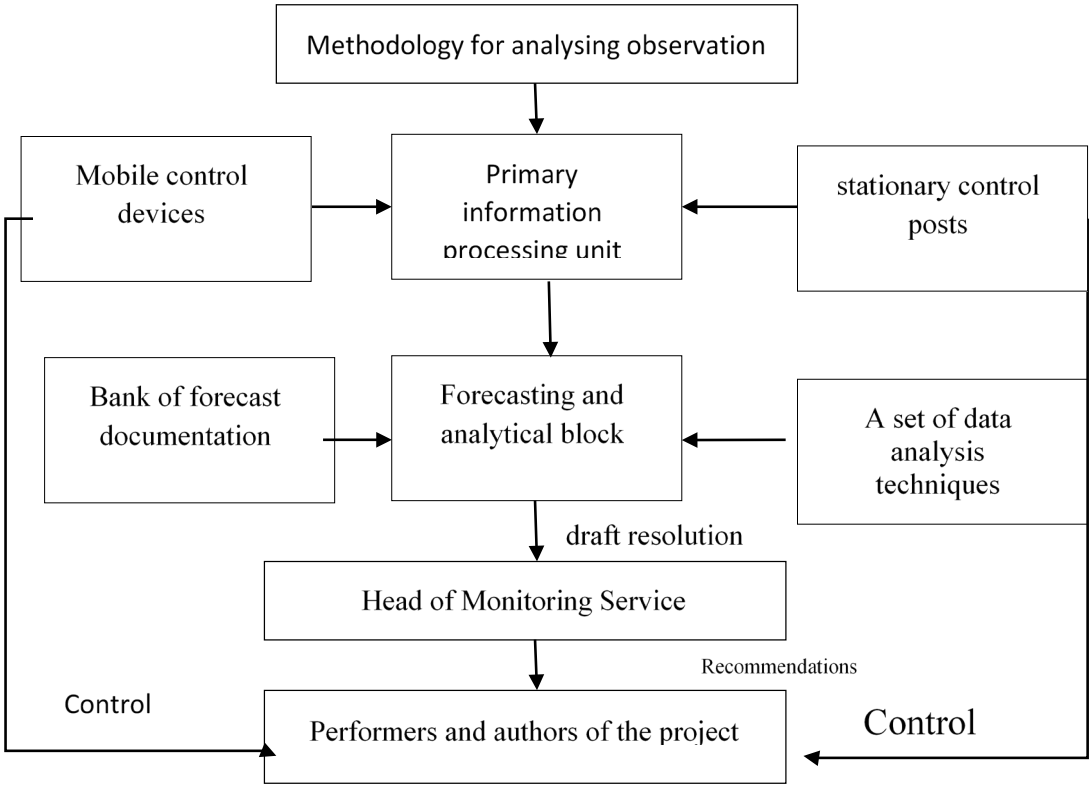

Fig. 3. – Structural block diagram of project implementation monitoring

In case the efficacy of the implemented measures at rectifying the adverse ecological circumstances is found to be inadequate, it is recommended that the measures be subjected to repeated adjustments and subsequent monitoring. The utilization of a monitoring system for control purposes is identified as a notable organizational and technical advantage of the proposed solution by the authors. To enhance the efficiency of document management, the introduction of automated

monitoring of documents in process is proposed. The implementation of this proposal involves the use of a standard application computer program.

Following the implementation of a series of experimental and theoretical studies, a range of methods and analytical tools were substantiated and developed within the framework of the organization of the control and management system. The organizational structure developed by the authors is designed to function in the monitoring mode, which allows its users to effectively and efficiently provide author's control during the implementation of production process projects in the "safety" section.

The implementation of control and supervisory activities involving system of monitoring will enable designers to promptly predict environmental and manufactured risks and prevent negative consequences for a specific facility. The synchronous functioning of the organizational, technical and analytical components of the proposed system, as demonstrated by the analysis of experimental data, has been shown to reduce the time required to develop and implement corrective management decisions in the event of a violation of the project parameters. Consequently, any deviations from the design requirements are promptly eliminated.

In the context of the analytical assessment of the completed studies, it is legitimate to focus on the fact that all theoretical and methodological proposals were duly tested in the practice of the environmental services of the region and municipalities of the Rostov Region. Based on the results of the analysis of real statistical materials obtained over a long period of time, the reliability of the assessment of the state of environmental safety is 85-90% [10].

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