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S.S Timofeeva. A.A Boboyev

Professional specialists in risk monitoring, methodology and training**. – 2023. -162 p.**

The monograph proposes environmental monitoring of the mining industry: the main methods of obtaining information about the state of various natural environments, emissions of pollutants, assessment of the state of the environment. Analyses of the modern legislation of Uzbekistan in the field of professional risk assessment have been carried out. Using the example of the NMMC central research laboratory, the occupational risks of the main laboratories are identified and ranked. It is established that the risks belong to the categories of high and medium. The risks are acceptable if the regulatory requirements are met. Management solutions for their reduction are proposed.

Compiled in accordance with the requirements of the state educational standard in the bachelor's degree areas "Life Safety" and "Ecology", as well as undergraduates in the relevant areas.

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Introduction

In the process of studying the risks and emergencies that can occur in the mining industry on a global scale, as well as environmental conditions, official reports on the environmental situation in the world indicate that as a result of the production activities of mining and processing industry enterprises, the annual release of more than 40 million tons of harmful substances into the atmosphere, it has also been found that an increase in the volume of various hazardous solid waste over 7.5 billion tons on the surface of the Earth has its own negative impact on the ecological and radiation environment. In the world, there is a serious need to carry out large-scale research work on the development of a methodology for monitoring and assessing professional risks in the mining industry, where the extraction and processing of gold and uranium-containing mines is calculated from professional and environmentally hazardous production.

Based on the growing requirements of international standards in Uzbekistan, great attention is paid to solving the problems of sustainable development, first of all, the mining industry, setting the task of integration into international corporations. Against the background of an increase in the volume of mining of minerals, a decrease in the cost of finished products and an increase in the annual volume of production of exported products, a number of special programs have been adopted to ensure production and environmental monitoring. With the help of modeling the pollution processes of atmospheric air, a number of problems have been eliminated, while determining the degree of pollution of a specific industrial object in Real time, monitoring and assessing risks in order to take measures to control the moderation of discharges is of great importance.

An analysis of the scientific and technical literature of recent years, which belongs to research on the development of a methodology for monitoring and assessing professional risks in the mining industry, shows that theoretical and practical results have been achieved at a significant level in this area.

In order to ensure maximum efficiency in reducing the burden on the environment in technically improved areas where gold and uranium deposits are being created and exploited, it is necessary to carry out the following actions: conduct comprehensive basic and practical exploration work, develop methodological approaches to assessing risks, as well as a complex of solutions aimed at minimizing them.

The monograph emphasizes the development of theoretical, scientific and methodological foundations for assessing and managing the environmental, professional risks of mining workers working under the influence of harmful, dangerous, radiation production factors in gold and uranium mining, as well as methods for monitoring and assessing professional risks in the mining industry.

The methodology for assessing the professional risks of workers working in the field of mining of the Republic of Uzbekistan has been improved and a number of mathematical models have been created to assess the possibility of reducing the annual effective dose capacities of workers working in a radiation environment, reducing the environmental risk of surface water, air and soil pollution in mining, the presence of heavy metals in the water has been established, and as a result of forecasts, it has been proven that the carcinogenic risk of lead and cadmium is higher than the established value, and it has been clarified that it is higher than the norm (10^{-5}) adopted by the World Health Organization.

CHAPTER I. ANALYSIS OF THE MODERN STATE OF MINING INDUSTRY ITS IMPACT ON THE ENVIRONMENT

1.1. Brief description of the state and main trends in the development of the mining industry

Economically, new Uzbekistan now occupies one of the leading positions among the countries of Central Asia, and among the countries of the world on the extraction of gold and uranium

Ranks 7-8, 14th in terms of natural gas production. According to statistics from 2021, the country ranks 26 the in the world in terms of the growth rate of the economy, and today there are 66.6 thousand enterprises in our country, among which mining enterprises occupy a special place, since there are 3,000 mining departments in the Republic. The country's raw material potential is estimated at 11 trillion dollars, and in terms of gold reserves of 4 thousand tons, the country ranked 4-5 on the planet. The center of gold mining is the Muruntov area [14; 15; 42;1-7-pp., 50; 104; 107-111-pp., 122; 25-28-pp.].

Muruntov Navoi region is located in the south-west of the Kyzylkum Desert. The development of this territory began in 1967, and the extraction of gold is carried out in an open way. To date, more than 1.5 billion tons of mountaineers have been mined from the quarry.

The growth of the gold mining industry and the increase in the production of precious metals is one of the most important priorities of the Government of Uzbekistan. On the basis of the decision of the president of the Republic of Uzbekistan Sh Mirziyoyev on January 17, 2019 “On the net of measures for the further development of the mining industry”, a roadmap for the development of the mining and metallurgical industry was developed [25].

In gold mining, technologies for separating rare metals from mineral mixtures are used, in such cases, the release of toxic substances into the atmosphere occurs, and the presence of radioactive radiation in the emissions of uranium mining deposits has been observed.

Chemical reagents are used in large quantities to extract gold from Mountain Ash. Of the chemical reagents for the extraction of gold, sodium thiazide is widely used, calcium hypochlorite thiazide is used to neutralize industrial wastewater, and sulfuric acid is used to restore the sorbent, to reduce or prevent the release of hydrocyanic acid from the composition of the caustic soda separator solution [36; 29-33-pp., 90; 42-46-pp., 92; 52-55-pp.].

A reduction in the life expectancy of gold-producing workers, as well as an increase in cancer, silicosis and pleural diseases, decreased hearing due to noise, blood, skin and musculoskeletal disorders, has been observed in them [88; 1691-1699-pp., 104; 107-111-pp., 118; 78-91-pp.].

Uranium mining is another important factor in the economy of Uzbekistan. Uzbekistan ranks 5 the in the world in terms of uranium production and 10 the in terms of reserves. 3,500 tons of uranium mines are mined in the country per year, since uranium is not processed in the country, raw materials are exported completely abroad [51; 58; 89; 104; 107-111-pp.].

Navoi Mining Metallurgical Combine (NMMC) is an enterprise engaged in the extraction of uranium and gold mines and the sale of finished products in the form of uranium immature oxide (U_3O_8).

In the extraction of the product, the saturation of uranium-retaining materials in the composition is carried out using atmospheric oxygen and technical oxygen. In uranium exports, of the NCC's closest partners at the moment, these are large Japanese corporations Itochu and Marubeni, as well as the US company Nukem Inc.

Relations are also developing with the KHNP company of the Republic of South Korea, which began work in 2020, and the Atomic Energy Department of India, which will begin work in 2023, on the future export of natural uranium [28; 42-46-pp., 35; 84-91-pp., 104; 107-111-pp.].

Thus, today NMMC is one of the largest producers of gold and uranium in the world. The activities of NMMC are aimed at further improving the efficiency of the use of mineral resources, increasing the number of high-quality industrial enterprises produced and ensuring stable growth and social stability of the economic potential of the Republic of Uzbekistan through intensive development of new products.

The NMMC includes mining and metallurgical enterprises in Navoi, Uchkuduk, Zarafshan, Nurabad, Zafarabad, and now the NMMC is engaged in excavations in four regions of the republic.

In this research paper, attention is paid to the risk-oriented approach in the activities of mining enterprises, which is currently being implemented at modern production facilities [104; 107-111-pp.].

1.2. Risk-oriented approach in modern conditions

The risk-phased approach (RPA) provides for ranking according to the degree of negative impact on the health and environmental condition of workers of industrial facilities. Such a modern approach has not been used, if we consider the example of NMMC, for the first time in this research work, an assessment of risks in the extraction of gold and uranium, their management procedures and minimization technologies were developed [13; 56-60-pp., 63; 101; 177-pp., 117; 150-pp.].

The active application of the risk-phased approach (RBA) in management and control activities has begun. Initially, the risk-phased approach was considered relevant only in economics and finance, where the concept of risk management appeared, but over time the methodology of this approach has spread to other areas.

The concept of a risk-phased approach to the management and monitoring of activities is itself an organizational and practical method of state control, in which the form of verification for a particular legal entity carrying out controlled activities depends on the risk category of the enterprise where it is carried out.

The organization's activities in the field of ensuring safe working conditions are inextricably linked with internal inspections and audits, all of which are based on inspections at the level of the management and control body of the (RBA) [23; 83-87-pp., 31.].

RBA of industrial safety management is a system based on decision-making depending on the level of risk. In this case, the risk is an indicator of the probability of exposure to a person in the course of production activities, as well as an indicator of possible consequences as a result of the implementation of certain risks.

The purpose of the risk-phased approach is not only to identify, but also to reduce risks. This makes it possible to take the necessary measures in a timely manner to minimize or eliminate the risk, as well as to save all the resources of the enterprise operating in the RBA. Direct risk analysis and analysis of the probability of an emergency situation at the facility is carried out on the basis of the Risk Analysis Plan of the facility [4; 61-64-pp., 8; 32; 33-35-pp.].

One of the main tasks of risk-phased approach is to set goals aimed at reducing any risk and achieving this goal. In the (RBA) system, special attention is paid to areas with maximum risks, as a result of which timely identification and elimination or minimization of risks can be carried out. RBA has its own principles. (See Table 1.1).

The RBA is aimed at eliminating various levels of risk. Thus, in relation to the volume of state-controlled (RBA), small production, the control body is the simplest in assessing risks, that is, it can limit itself only to checking documents, and vice versa: a more complex, complex verification procedure can be applied to a large enterprise [10; 55-60-pp.].

Table 1.1

The basic principles of the risk-phased approach

Principles of RBA	Features
Resource allocation	Resources (time, employee, etc.) are distributed depending on the indicator of the size of the risk, which affects the duration and scale of the checks.
Proportionality	Control measures directly depend on the size of the risk
Flexibility	A risk reassessment is carried out in order to constantly identify new factors and threats to production.
Legality	All actions of the controlling body are based on legislation
Openness	Openness of standards for risk assessment

Any verification by the controlling organization depends on the degree of risk of the controlled object

(Table 1.2).

The degree of risk of the controlled object

Risk assessment	Risk level	
	High	**Lower**
Monitoring type	Conducting daily monitoring without the involvement of automated verification tools, in-depth analysis of the collected information about the facility, emphasis on suspicious factors that may threaten production, bringing the results of the inspection directly to the facility management apparatus.	A lower indicator of the duration of verification, the use of intelligent automated systems

Type of check	Collection of additional information for a comprehensive implementation of risk assessment	Conducting a narrow check with the possibility of remote work

Decisions of the president of the Republic of Uzbekistan dated August 02, 2019 No. 4412 “On measures to further improve taxpayer accounting and simplify the procedure for reimbursement of Value Added Tax” and “Measures to reform the insurance market of the Republic of Uzbekistan and ensure its rapid development” were adopted in the Republic of Uzbekistan [24] and directions for reforming the insurance The order of control on the basis of risk-phased approach was established by the tax authorities. The gradual transition to risk-phased approach requires the development of risk assessment procedures and their analysis both directly in the financial sphere and in the man-made risks resulting from the impact of industrial facilities on human health and the state of the environment.

1.3. Assessment of man-made and environmental risks of mining enterprises

Risk assessment is a process used to determine the degree of risk to be analyzed for human health, property, or the environment. Risk assessment includes a frequency analysis [69; 160-pp.].

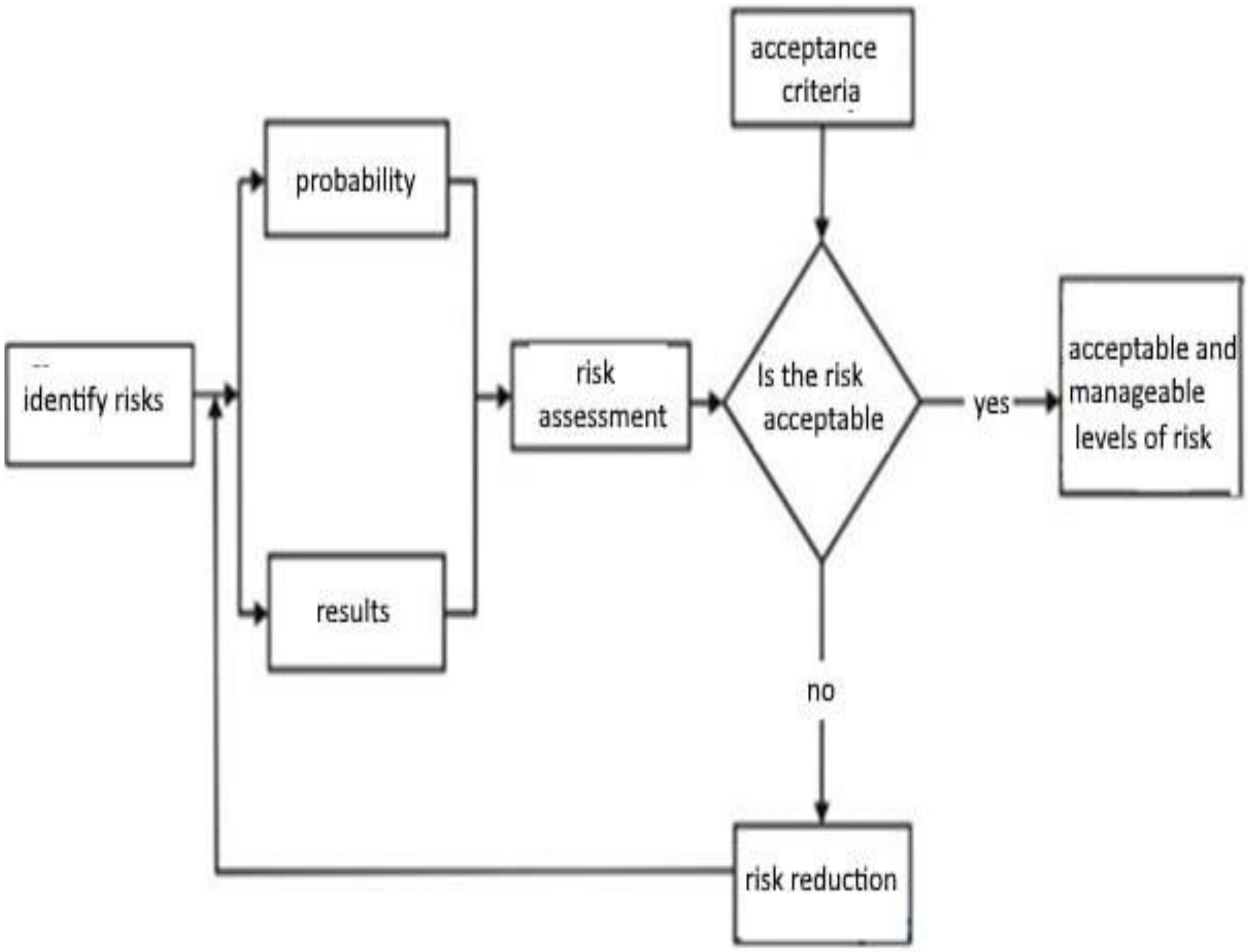
Methods for assessing techno genic risks are based on statistical data and the application of probability theory methods. Deterministic and probabilistic models are used to predict dangerous events. In the deterministic model, a certain amount of the negative impact of the damaging factor corresponds to a certain level of damage to people and material resources [100; 97-101-pp., 102; 178-pp., 103; 128-pp.].

The process of conducting risk analysis can be presented in the form of a flowchart (see Figure 1.1).

As can be seen from this diagram, the assessment process consists of three stages: problem statement, analysis and description risk management and risk management.

Studying the scheme of the maximum possible flow of a substance in the process of empirical risk description involves determining the geographical boundaries of the possible impact of a particular pollutant [110; 152-157-pp.].

The process of determining risk characteristics analyzes the intensity and importance of toxic effects, their variability or immutability.



Picture 1.1. Risk analysis block scheme

The risk management process involves the selection and application of risk reduction measures. If the effects obtained in previous periods turned out to be unsatisfactory or unreliable, then it will be necessary to use the iteration process from the empirical risk assessment stage, that is, it is necessary to repeat the monitoring of environmental risk assessment [48; 328-pp, 49; 84-91-pp.].

Currently, a large number of regulatory documents have been adopted in the world regulating procedures for assessing professional risks and risks to the environment, and technologies have been created for monitoring risks affecting people and components of life at different stages of the life cycle, in the conditions of operation of industrial facilities.

In 2018, the international standard ISO 45001:2018 "health and occupational safety management system" was developed [72]. This standard is structured similarly to ISO 9001: 2015 "Quality Management System" and ISO 14001: 2015 "Environmental Management System" Standards. It allows industrial enterprises to create an integrated management system based on the concept and process approach (planning-verification-action) PVA.

In accordance with the standard, the following Basic Rules should be implemented in each enterprise: risk identification, risk assessment and Risk Reduction, and development of a plan for the implementation of opportunities; understanding and accounting for the requirements of the needs of workers and citizens; constant monitoring of the effectiveness and result of the system; development of corrective measures and improvement of processes. Organizations certified under the OHSAS 18001 standard can undergo certification under the new standard within 3 years [62; 11-pp, 105; 3-9-pp.].

Risks-the degree of expected problems in activity, risks that can affect the normal state of a person's life and health, as a rule, are phenomena that lead to material losses. The risks themselves are dangerous, sudden, and large-scale, requiring immediate response in terms of eliminating risks or minimizing the consequences [73; 11-pp., 74; 7-8-pp.].

Risks-a proven quantitative statistical indicator of the results of the implementation of risks in human activities.

With the advent of a risk-phased approach to the Techno sphere, the word "risk" is increasingly used in the context of assessing the influence of negative production factors. The risk is determined by the quantitative description of the implementation of risks. It is very convenient to use the concept of risk to determine the suitability of working conditions, economic damage, based on the frequency and degree of damage experienced by employees from incapacity for work or economic losses as a result of accidents. Specialists of the Research Institute for supervision and diagnostics of technical systems were noted in GOST 51901-2002 "Reliability management. Risk analysis technological systems" have developed a method of risk assessment.

This method is a risk analysis algorithm, which is an algorithm in which the final result of the implementation determines the possible consequences and their likelihood when carrying out a particular risk. In this method, unpleasant consequences are considered, that is, damage to the life and health of people, property and the environment.

There is a wide variety of risk assessment methods, but the model for creating an algorithm of actions in any of the methods is approximately the same:

- directly identify the object of research;
- features of the object of research in terms of its danger through the study of documents for object;
- analysis of statistical data on accidents, fire hazard, etc. on the same type of object under investigation;
- primary analysis of the collected data;
- identification of all types of potential risks with the possibility of implementation at the research facility;
- creation of a list of potential risks for the object of research.

The research method chosen for a particular object must meet the following criteria: the scientific validity and logical ratio of the method and the object; full efficiency, that is, the ability to obtain results in the most suitable and understandable form for the object of research; any method must be approved by verification [11; 238-239-pp., 91; 209-216-pp., 95.].

There are the following methods:

1. Analysis of the methods, types of violations and consequences of the inspection sheet.
2. Order risks and determine the level of risks of an industrial facility.
3. Working capacity and risk monitoring.
4. Analysis of the structure of disorders and phenomena.
5. Probability method of events.

Risk assessment methods can exist both as a separate tool for analysis and in the form of a set of research methods, therefore, methods can contain quantitative risk criteria, in turn, a complete quantitative risk analysis can include all the indicated methods.

As a result of the risk assessment, a list of development scenarios is formed in a particular case for the implementation of each risk. Each of the consequences in turn has such characteristics as the frequency of manifestation and the degree of severity [29; 34-pp., 5-12-pp.].

Particular attention is paid to the fact that for a particular production, the most monotheistic and rational methods of risk assessment and management should be created and applied, taking into account their specifics. In addition, the study of the environmental impact of environmental risks in mining and processing in the mining industry is considered important for the health of the population.

1.4. The current state of the ecological and radio ecological situation in the regions of the mining industry.

Like any mining enterprise, NMMC has a negative impact on the environment, therefore, during the activities of the enterprise, great attention is paid to the control of the environment of the units of mining facilities.

One of the main tasks in uranium mining in Navoi NMMC is to assess the current state of the radiation situation in the areas of mining and processing of minerals [79; 227-229-pp., 80; 15-18-pp.].

In this work, studies were carried out to determine the total specific effective activity for the analysis of the radiation situation (A_{eff}) and the natural radionuclides comparative activity (^{40}K, ^{226}Ra) using the ^{232}Th gamma-spectrometric method

Samples were taken as research objects:

- soil, taken at a depth of 0-0,5 m at the measurement site, the equivalent dose capacity of gamma radiation (EDC);
- air, environment of settlements and taken directly from work areas [81; 27-31-pp, 83; 130-134-pp.].
- In air samples, the following were identified:
- powder concentration by weight method, HCN, NN_3, NO_2, SO_2, H_2S, N_2SO_4, Pb, R_2O_5;
- volumetric activity of radon and Taron in photocolorimetric way, or SRR-68 radiometers or DKS-96 dosimeters-in working rooms and equipment with radiometers (EDC);
- -Working room environment and settlements where the alpha-GUARD device is located, volumetric activity of radon in atmospheric air (VAR);
- -to obtain samples of long-term living Alpha-nuclides (LLAN) settlements from the atmospheric air and from the working room air, aspiration filter when controlling the release of aerosols into the atmosphere [81; 27-31-pp., 83; 130-134-pp.].

• - the power of gamma radiation in continuous mode to control the emission of aerosols into the atmosphere;

• In drinking, underground and industrial wastewater, the following are identified:

• - dry residue, hanging substances, pH;

• - anions Cl^-, NO_2^-, NO_3^-, CO_3^{2-}, HCO_3^-, SO_4^{2-}

• - cations – Ca^{2+} and Mg^{2+};

• - by titration method, Ci $^{4+}$, F+, As $^{3+}$, Mo $^{2+}$, Al $^{3+}$;

• - photocolorimetric method, nitrites, K^{+}, Na^{+}, Fe^{3+}, Cu^{2+}, Mn^{2+}, , Co^{2+}, Ni^{2+}, Zn^{2+}, Cr^{3+};;

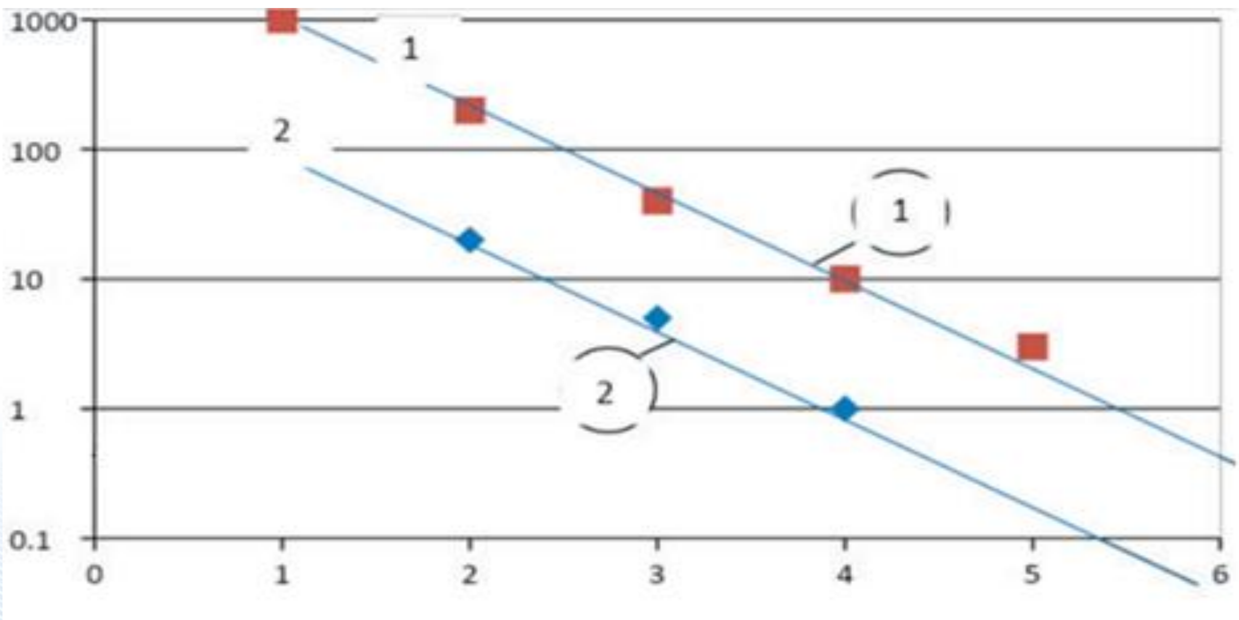
• - by the method of atomic absorption, sampling from water and ordinary uranium, radium -226, polonium -210, thorium -232, radon;

-general activity of Alpha and beta in the emanation method and UMF-2000 device [81; 27-31-pp., 83; 130-134-pp.].

It turns out that in man-made objects, quarries with partially man-made elements, the first stages of soil enrichment were carried out at a depth of 200 meters. During blasting work, solid scattering particles from the quarry surface rotate around the quarry towards the wind path.

Later, due to the deepening of the open quarry, the impact of pollution decreases, and at the present time (when the depth of the open quarry is more than 600 m), ore particles rising into the air during the explosion again come to the open quarry.

As a result, contamination of the soil and soil around the quarry with man-made compounds is hardly observed [83; 130-134-pp.]. Distance from source of pollution Element enrichment coefficient



1.2-picture. Technological centrationsining moving an element over long distances environmental pollution:

1 – Sand - arsenic, 2 - Sand - gold.

As can be seen in picture 1.2, the average concentration of elements 1.1 (arsenic and gold) decreases at a distance from different distances to the source, and when they increase at a certain distance (4 km), their concentration becomes equal to Clark. This means that the impact of more than 4 km of artificial objects on the ecosystem is maximally reduced. The value of the equivalent dose of gamma radiation EDG *μZv/h* is values of the main factor indicating the degree of influence of uranium objects on the radiation situation in the field of uranium production. To assess the hazardous effects of uranium production on the radiation environment, radiation dose rates were measured at more than 40 observation points located at different distances from the radiation source. equivalent dose value of EDG *μZv/h* equivalent equilibrium volumetric activity of EEVA and long-lived alpha-nuclides the values of LLAN indicators were measured at more than 200 observation points, their maximum values are given in table 1.3.

Table 1.3.

Radioactivity indicators at observation points in the area of influence of uranium production

№	**EDG *μZv/s***	**EEVA, *Bk/m³***	**LLAN, μBk/m³**
1	0,11	10	0,92
2	0,12	12	1.53
3	0,11	9	1.97
4	0,09	8	2.21
5	0,10	12	1.52
6	0,12	12	0,97
7	0,11	4	2.19
8	0,13	6	1.36
9	0,12	3	1.20

10	0,10	9	1.90
11	0,12	8	2.46
12	0,13	9	2.67
13	0,13	7	2.50
14	0,12	6	3.20

Analysis of the data obtained shows that the radioactivity of objects in the environment is the same and much more stable. Comparing them with the results of the last 10 years of observations shows that for all three indicators they are at the level of background values characteristic of their area near uranium mining.

Thus, the operating enterprise does not have a harmful radioactive impact on the environment, the impact of which does not go beyond the boundaries of the industrial territory. To assess the impact of man–made radiation hazardous objects on the radiation background of the environment, measurements of EDG, EEVA and LLAN indicators were carried out at various production facilities - in places of uranium transfer to underground solution, in places of storage of uranium waste and deposits. As expected, the radioactivity indicators of various man-made objects exceed the value measured at observation points on the territory of territories adjacent to the enterprise (Table 1.4).

Analysis of the results obtained for all indicators of radioactivity of man-made objects shows that uranium has minimum, average and extreme values in places of selective underground smelting, but in addition to the balance, it was found that it is at the maximum level in the waste of madan. At the same time, all the obtained values of EDG, EEVA and LLAN do not exceed the established regulatory level adopted in Sangwam No. 0196-06 [1; 69-74-pp., 30; 27-29-pp., 95.].

Based on these results, it can be concluded that the radiation situation in the uranium mining areas, as well as in natural areas near the enterprise, complies with established international and republican radiation safety standards. Monitoring data of EDG, EEVA and LLAN indicators at observation points in the affected area of uranium production and allows calculating the annual effective dose for the population and employees at these facilities, employees at man-made facilities of the enterprise.

A certain amount of radioactive radons is contained in the air of working rooms where chemical concentrates of radioactive cultures, materials, products - uranium, uranium oxide and compounds are stored.

The element radon is part of the uranium decay chain. It is toxic and dangerous for both human health and the environment. The determination of the equivalent balanced volumetric activity (EBVA) of radon in rooms for the storage of uranium products showed that the longer they are stored indoors, the more radon accumulates.

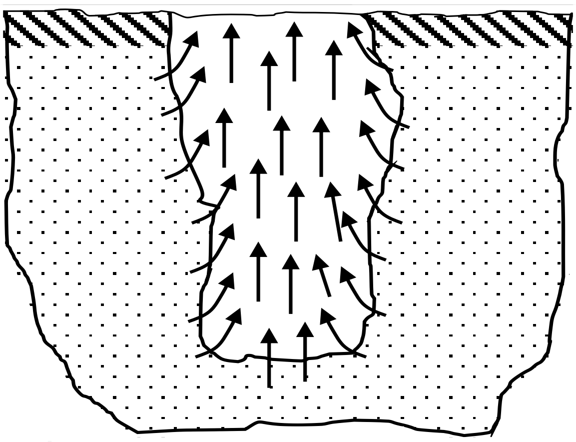
Table 1.4

Radioactivity indicators at production facilities

EDG ***μZv/s***	**EEVA,** ***Bk/m³***	**LLAN, μBk/m³**
	Areas of transition to underground selective uranium solution	
2.00	28	15.55
1.70	32	9.97
2.00	57	21,60
2.40	68	21.5
2.20	82	4.58
	dump	
2.00	31	9.95
3.65	46	10.77
3.23	64	32.8
3.05	56	7.32
4.22	38	4.61
	Balances of balanced mines	
10.8	56	22.91
5.60	68	24.40

6.8	65	11.85
4.65	55	6.73
4.35	90	64.4

It was found that the EBVA values are correctly proportional to the density of the radon flux emanating from the soil of the studied objects. When the value of the radon flux density coming out of the soil changes from 15,000 to 60,000 *MBQ/sm*^{2}*·sec*, the EMH values in the air change from 40 to 110 *Bq/m*^{3}. (See Figure 1.3). Under such conditions, atmospheric pressure values fluctuate in small ranges from 727 mmHg to 728 mmHg (EBVA). The intensity decreases in a number of rocks, which is observed at uranium landfills, in places of underground selective melting of uranium (picture 1.4).



Pic 1.3. Radon flux density measurement method and its schematic representation

Pic 1.4. Underground selective smelting locations

Thus, as a result of monitoring of this level of radioactive radiation in the atmospheric air on the territory of the influence of the enterprise, in the air of working premises in buildings for processing and storage of uranium material, in the regions where industrial waste and waste are located, it was not found that uranium would exceed the normative values adopted at the facilities, it was found that the volume activity of radon in the air of the working area at industrial facilities positively correlates with the density of radon flow in soils.

Thus, as a result of monitoring of this level of radioactive radiation in the atmospheric air on the territory of the influence of the enterprise, in the air of working premises in buildings for processing and storage of uranium material, in the regions where industrial waste and waste are located, it was not found that uranium would exceed the normative values adopted at the facilities, it was found that the volume activity of radon in the air of the working area at industrial facilities positively correlates with the density of radon flow in soils. It is shown that the intensity of radon volumetric activity increases in a number of objects, in places of selective melting of uranium underground, in uranium emissions. In conclusion, the radiation situation inside and around the objects of the investigated uranium enterprise

In accordance with the regulatory requirements of sanitary rules and norms - 0193-06, it does not have a negative impact on the health of the population, employees of the enterprise and the environment [30; 27-29-pp.].

1.5. The current state of occupational risks and riskiness in the mining industries is shown by the example of NMMC.

The legislation of Uzbekistan also provides for risk assessment in accordance with regulatory requirements [64; 105; 3-9-pp.].

Risk assessment is part of the risk management process and is a systematic process that analyzes the consequences and probabilities of dangerous events in order to determine ways to achieve the goals set, to make a decision on the need for risk management.

Risk assessment focuses on reducing the likelihood that dangerous events may occur and their causes, consequences, probability of occurrence, factors to reduce adverse consequences or the likelihood that dangerous situations may occur [105; 3-9-pp.].

S.S. Timofeeva's research shows that the risks at gold mining enterprises were attributed to the middle class. However, at certain stages of technological processes, much higher risks are noted, especially in terms of the dust factor. The results of our study corresponded to the data of foreign researchers who studied gold mining in other countries in detail [105; 3-9-pp.].

Among the physical negative factors of the production environment, noise occupies a high place (the maximum noise level of 112 dB is located at the Sukari deposit (Egypt)), and among the chemical negative factors – a high concentration of hydrogen cyanide HCN (especially at the point of transition to a selective solution) will be [41; 61-64 - b., 106; 3-9-pp.].

According to the statistics of accidents in the mining industry of Ghana, mining equipment accounts for about the same number of victims

The cause of 85% and 90% of all deaths in this list also includes mobile equipment, parts of its components and hand tools. Most often, injuries occurred in quarries and at crushing sites during mining. A quarter of the affected workers in Ghana were injured as a result of harsh working conditions, two-fifths believe that injuries can be prevented, and many point to personal protective equipment as a solution to the problem. About a quarter of Ghanaian gold miners reported that their employers had never been interested in the well-ppeing or safety of their employees [5; 7922-7937-pp., 12; 28-35-pp, 96; 97; 1-9-pp; 105; 3-9-pp.].

Gold miners in gold mining areas in the Philippines have faced serious health problems, 21% of whom suffer from visual impairment, 18% suffer from eye pain and redness of the eyes, ear pain (12%), chest pain (23%), shortness of breath during exercise (23%), lower pain back pain (23%), bone and joint pain and joint redness (32%). In total, there are cases of arterial hypertension, with 41% having a prehypertensive stage and 29% having stage 1 [18; 15-17-pp., 19; 84-88-pp., 105; 3-9-pp.].

Diseases of the musculoskeletal system are often found in workers of the Obuasi gold mine, owned by the global company AngloGold Ashanti in South Africa. According to the study and a survey of 205 employees, it was found that the prevalence of these diseases was 85.5%, among the most affected segments of the body - the lower back (30% of employees). observed. A similar situation is observed in Peru and other countries [59; 105; 3-9-pp.].

Occupational risks arising from employees of enterprises are divided into:

- influencing risks: accidental probable consequences of dangerous effects on the employee's body as a result of such effects;
- risks of arousal: a combination of the significance of the consequences of a dangerous situation in which the probability of accidental occurrence and the risk of exposure are not excluded, and new risks may arise with the risk of corresponding exposure or occurrence [105; 3-9-pp.].

The risk-taking procedure involves understanding the level of risk and assigning it a score or verbal level. Risks of an ordered type - when measured on an order scale, they can be sorted according to a decrease or increase in any of their qualitative characteristics. The degree of risk is a score or a verbal measure of risk that marks the position of a particular risk among other risks on the order scale.

According to the degree of risk , they are divided into:

- a slightly low level of risk: non-use of specially provided measures and tools to ensure safety in practice, allowing employees to perform work performed within the framework of general measures of safe labor practice, which can be ignored without taking any special measures to ensure safety; [71].
- acceptable level of risk (acceptable risk): the level of risk at which an organization can allow its employees to perform work, but use only regulated security measures and tools, strictly observing the performance of current work in accordance with the established procedure; [71].
- unacceptable risk level (unacceptable risks): due to the possible occurrence of a serious accident in the organization, there are socially significant risk levels that cannot allow employees to work with appropriate work procedures, regulated measures and safety equipment [105; 3-9-pp.].

As a result of the risk assessment, the organization must take:

- the most objective information about the state of working conditions, existing risks and the risks of their impact on employees;
- a list of risks sorted by risk level, which allows you to identify the most vulnerable points of labor protection, develop consistent measures for risk management and reliable employee safety;
- the most detailed information that allows you to develop and implement preventive and regulatory measures to make informed decisions on risk management and protect employees from risks [71].

Along with the risk assessment, the impact of adverse environmental factors on the environment in the event of an emergency was also studied.

CHAPTER II. DETERMINATION AND ASSESSMENT OF THE STATE OF PROFESSIONAL RISKS IN THE MINING INDUSTRY.

2.1. Explosion of the atmosphere of underground works property evaluation.

The negative impact of environmental factors is mainly manifested in emergency situations. These conditions can be the result of natural disasters or human industrial activity. In order to localize and eliminate the negative effects arising in emergency situations, special services have been established, legal bases for their activities have been developed, and material means are being created.

During the past five years (2017-2021), 749 emergency situations were recorded in the Republic of Uzbekistan (table 1.5), of which 490 were natural and 259 were man-made. In these emergency situations, 1,592 citizens died, and 2,151 people were taken to medical institutions with various degrees of injuries. The amount of material damage was 372,382,513 thousand soums.

1.5 degrees

Statistics of emergency situations for the past five years (2017-2021) in the Republic of Uzbekistan (in the section of Regions).

Regions	2017 y			2018 y			2019 y			2020 y			2021 y		
	ES	died	injury	ES	died	injury	ES	died	injury	ES	died	injury	ES	died	injury
Samarkand	21	47	21	14	35	41	16	32	79	12	23	27	**20**	**47**	**33**
Kashkadarya	16	44	16	22	41	79	15	27	35	18	33	29	**17**	**54**	**13**
Fargona	13	34	13	10	22	15	10	13	14	13	22	26	**16**	**35**	**33**
Toshkent r.	22	49	22	15	27	104	17	38	37	17	33	19	**14**	**34**	**42**
K.R.	4	9	4	11	43	22	5	12	16	7	22	8	**13**	**42**	**14**
Toshkent c.	15	18	15	15	25	84	19	20	94	14	18	26	**11**	**15**	**34**
Navoi	4	12	4	11	22	57	8	19	9	3	3	0	**10**	**34**	**13**
Namangan	12	30	12	11	18	57	13	30	25	12	30	12	**10**	**21**	**36**
Andijan	10	9	10	3	3	3	11	17	130	4	6	7	**8**	**5**	**21**
Jizzakh	13	42	13	15	34	28	12	29	16	10	20	11	**8**	**15**	**11**

Xorazm	6	16	6	5	8	8	7	17	14	5	12	0	**7**	**17**	**7**
Surxandaryo	13	36	13	10	24	22	12	20	8	3	10	4	**4**	**7**	**17**
Sirdaryo	4	6	4	4	3	13	4	7	31	10	30	26	**3**	**5**	**5**
Buxoro	4	2	4	12	32	28	8	11	21	5	12	34	**3**	**4**	**0**
Total:	**157**	**354**	**157**	**158**	**337**	**561**	**157**	**292**	**529**	**133**	**274**	**229**	**144**	**335**	**279**

1.6 table

FVS related to fires in buildings and structures of the Republic for residential, social and cultural purposes in 2017-2022:

Regions	**2017 y.**			**2018 y.**			**2019 y.**			**2020 y.**			**2021 y.**		
	ES	**died**	**injury**	**ES**	**died**	**injury**	**ES**	**died**	**injury**	**ES**	**died**	**injury**	**ES**	**died**	**injury**
K.R.	1	2	0	1	4	0				1	1	2			
Andijan	1	1	3	1	2	0	2	4	0	1	3	1			
Buxoro	2	2	0				1	0	3						
Jizzakh	1	2	0							1	2	1			
Kashkadarya	1	2	0				1	0	3	1	0	3			
Navoi							1	3	2						
Namangan	1	2	1	2	4	0	1	0	0				1	2	0
Samarkand	3	7	11	2	5	1	1	5	0				2	3	4
Sirdaryo	2	3	1							3	8	5			
Surxandaryo	2	4	0												
Toshkent r.				2	3	2	4	11	0	2	2	0	1	0	3
Toshkent c.	4	4	13	3	9	4	3	5	3	2	2	0	1	1	3
Fargona	2	5	0	1	0	3	1	0	0	1	2	0	1	2	0
Xorazm				1	0	3				1	2	0			
Total:	**20**	**35**	**29**	**13**	**27**	**13**	**15**	**28**	**11**	**13**	**22**	**11**	**6**	**8**	**10**

The number of ES and the rate of their growth (decline) in the course of years

In 2017, the number of FV was 157 , while those who died in them were 553 people , and the injured were 354;

In 2018, in 158 FV, 337 people died and 561 were injured. The number of FVS was reduced by 1 compared to the previous year, while the injured grew to 207, while the number of people who died in them decreased to 216;

In 2019, in 157 FV, the number of people who died was 292 people, the injured were 529 people, and those who died in the past-dated relative FVS were reduced to 45 people, the injured were reduced to 32 people;

In 2020, the FVS accounted for 133 people, the number of people who died was 274, and the injured were 229. The number of FVS was reduced to 24 compared to the previous year, those who died in them-to 18, and the number of injured-to 300;

In 2021, there was an increase in the number of these pointers, the FVS were 144, the people who died in them were 335 people, the injured were 279 people, the number of relative FVS passed was 11, the deceased grew to 61 people, and the injured to 50.

During 2017 – 2022y 58162 fires were recorded in the Republic (table 1.6), in which 652 citizens died, 1,560 people suffered burns, and the amount of material damage was 372 382 513 soums. In the cut of years:

In 2017, there were 12,721 people, the number of people who died in them was 165 people, and those who were injured were 401 people (material damage was 68854350173 soums);

In 2018, there were 11,979 (-742), the number of people who died in them was 138 people (-27 people), and the victims were 371 people (-30 people), material damage was 88072797640 soums (+19218447467 soums;

In 2019, there were 11,705 (-272), the number of people who died in them was 111 people (-27 people), and the victims were 288 people (-83 people), material damage was 95684499347 soums (+7611701707 soums;

In 2020, there were 11,090 (-615), the number of people who died in them was 126 people (+15 people), and the victims were 260 people (-28 people), material damage was 146385125885 soums (+57700626538 soums;

In 2021, there were 10,667 (-423), the number of people who died in them was 112 people (-14 people), and the victims were 240 people (-20 people), material damage was 209650708584 soums (+63265582699 soums).

Explosions or fires in deposits in the mining industry are considered one of the most dangerous risks for miners and mining rescuers. Thus, determining the consequences of explosions and its development is essential to control the success of rescue operations or the state of the mine. However, while there are a number of methods that can be used to detect an explosion, none of them can show exactly when and in what situation the risk of an explosion is. This is due to the fact that the shells of the atmosphere of the underground layer are very complex, and various factors influence their dynamic change. Taking all this into account, it can be said that there is no single selected method, moreover, the explosion process is potentially (hidden) in danger. Therefore, knowing exactly the atmospheric state of the mine is also a very difficult task for mining engineers. For the atmosphere of underground closed layers, it is extremely necessary to analyze and implement methods for determining the explosion safety threshold. In order for the mining industry to fully analyze the development of explosion hazard in the atmosphere of underground deposits, it was felt the need to develop theoretical models for assessing the risk of explosion. The models are based on the characteristics of the explosive diagram of a combination of mathematical analysis approaches to solve the following problems: 1 - for an atmosphere in which “explosions do not occur”, an assessment of the development of the explosion hazard and a change in its condition consists in the assessment of the "minimum" time interval of exit from the explosive area for Such research efforts will help not only miners working in open and closed fields to understand the explosion hazard of the mine atmosphere, Bal will pay special attention to the fact that any hazard explosive atmosphere will be provided with a useful tool for remote forecasting. [66; 77; 104-pp., 85;176-183-pp., 121; 487-pp.].

Previous studies focused on the basics of the explosion mechanism as a basis for analyzing the risk of explosion. In addition, for engineering reasons, a number of flammability diagrams have also been developed and used. Such methods can indicate both the Gas Point and the area of the explosion in the diagram. This not only clearly shows the detonation capacity of the gas sample, but is also very important to take into account the detonation capacity of multi-component gas mixtures. However, in the presence of an analysis of each new sample, the position point in the diagrams moves, and the explosive triangles also change their shape and position. For example, the methane-air-inert gas mixture must correspond to one of three categories: (A) explosive, (B) explosive when mixed with air, or (C) divided by the proportion of methane. Predicting the development of an explosive atmosphere in the underground conditions of mining production is still one of the problems that must be answered by mining engineers or mine rescuers. It is highly dependent on the mine atmosphere within the mining, the oxygen contained in combustible and inert gases with explosive properties. It should be noted that the compositions in the impenetrable closed area of the mine change over time under the influence of the ingress or release of combustible gases, air currents and inert gases, which also creates difficulties in assessing the consequences of a sharp explosion. To solve problems, a number of models are presented based on the graphical method and the derivative of equations. The main advantages of these models are as follows:

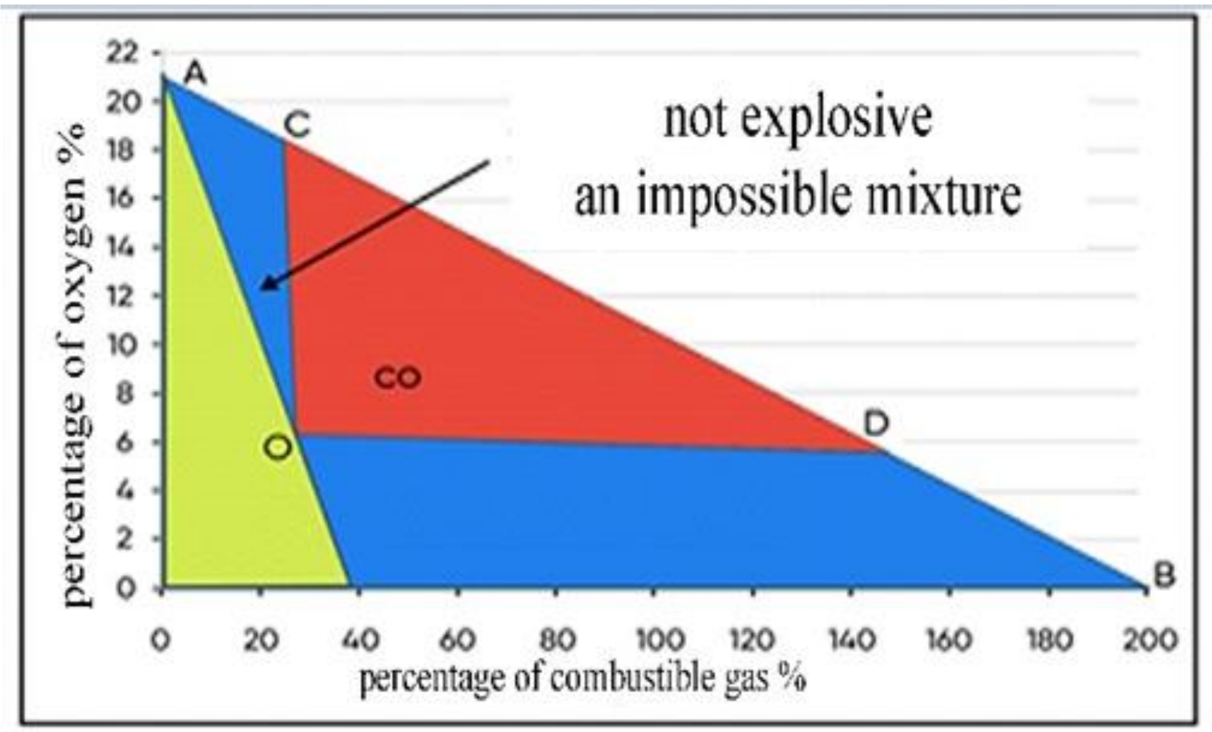
-Quantitative analysis methods are provided for the “explosion-free” atmosphere of the deposits in order to optimize the directions for reducing the risk of explosion.

- Change in the time interval between “non-explosive” and “explosive” to provide any necessary “early warning” messages.

Such research efforts can not only improve the development of the explosive atmosphere of the mine, but are also very important for life safety for all underground miners.

Using the explosive triangle diagram is a quick and easy way to determine the detonation capacity of a gas mixture in the mining industry. The diagram is divided into four different areas, which are listed as a non-intervening area, an explosive area, a non-explosive area (but can be EXPLOSIVE if more flammable substances or air are added), and another non-explosive area. Figure 1.5 shows an explosive triangle of carbon monoxide (so). Samples of the gas mixture obtained from the mine atmosphere were analyzed, and this result was frightened in the diagram. [66; 77; 104-pp., 85;176-183-pp., 121; 487-pp.].

The diagram can accurately determine the explosive ability of the gas mixture. But he cannot assess the detonation capacity of the gas mixture inside r at very short intervals, and he does not provide information about the safety margin. This shows how the point of the state of the gas mixture is close to the explosive area. Therefore, the concept of the explosion safety coefficient was proposed as one of the first ways to solve such problems.



1.5 painting. Analysis of the explosive triangle carbon II oxide (so).

2.2. Environmental risks to public health in gold mining areas.

In order to preserve the health of citizens working and living in the area, it is important to determine the quality of drinking water harmful carcinogenic risks in the composition of water, while identifying the factors that cause the explosion in the mining industry and evacuating the risks. In the research experiment, the concentration of heavy metals in water was determined based on water quality monitoring, and when water was used for drinking, both carcinogenic and non-carcinogenic risks to public health were identified [76; 393-395-pp., 84; 78-83-pp.] Table 1.7 shows the results of calculating carcinogenic risks for the two most dangerous metals, lead and cadmium.

The carcinogenic risk for metals under study exceeds the value assumed by the WHO (10-5). Consequently, it it is necessary to make management decisions aimed at reducing.

Table 1.7

Carcinogenic risk of drinking water.

№	Article	Concentration of the substance in water mg / l	Drinking water intake mg/kg (per day)	carcinogenic potential factor (SFo), mg / kg (per day)	Personal risk
1	**Lead**	0,167	0,0018	0,047	$8{,}6\cdot10^{-5}$
2	**Cadmium**	0,065	0,0007	0,38	$7{,}1\cdot10^{-5}$

The non-carcinogenic risk for the well-being of the population when using water the risk indicator for various substances is determined by the following formula:

$$ND = TR / RgD, \qquad (1.1)$$

In this:

ND - risk indicator;

TR - average daily share of substance consumption, mg/kg;

RgD - relative (safe) dose, mg/kg.

The average daily dose of oral administration of chemicals is calculated by the following formula:

$$Z = (Wc \cdot V \cdot FE \cdot DE)/(WB \cdot TA \cdot 365) \qquad (1.2)$$

Where: Z - drop in drinking water, mg / (kg / day);

Wc - concentration of the substance in the water, mg / l;

V - volume of water consumption, l / day;

FE - frequency of exposure, day / year;

DE - duration of exposure, years; *WB* - body weight, mg/kg;

TA - average time of exposure, years.

Table 1.8

Risk factors when using drinking water with a metal content.

№	Article	Relative safe dose, mg / kg	Risk coefficient
1	Copper	0,019	23,7
2	Cadmium	0,0005	9.1
3	Iron	0.3	7.5
4	Lead	0,0035	1.8
5	Nickel	0,02	1.5
6	Rox	0.3	0,8

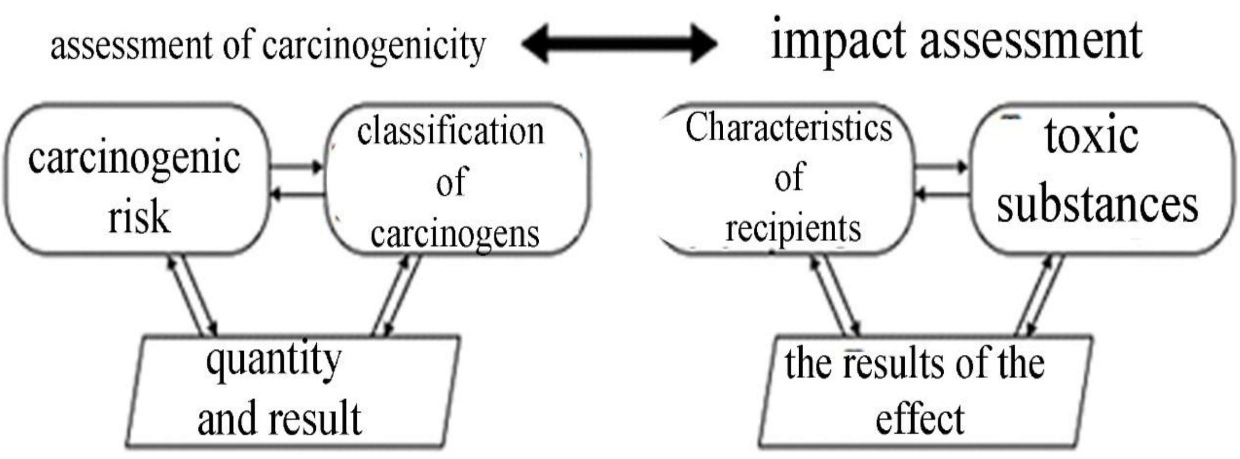


Figure 1.6. Algorithm for analyzing the risk of human health from the effects of harmful carcinogens in water.

The highest values of risk factors calculated for oral administration are characteristic of copper, cadmium, iron (table 1.8), which indicates a high non-carcinogenic risk for the population consuming contaminated water, and this is shown in the algorithm for analyzing the risk of human health from the effects of harmful carcinogens in water in Figure 1.6 [93; 41-43-pp., 108; 26-27-pp.].

Thus, the implementation of risk calculations for the health of the population is necessary to make management decisions in Samarkand, Bukhara and Navoi regions of Uzbekistan, which will make it possible to optimize the conditions for the use of water by the population.

1. From the analysis of the state of monitoring and assessment of professional risks in the mining industry, as well as development trends, it was found that at present there are problems with ensuring radiation and fire safety.

2. From the analyzed cases, the need to create a methodology for monitoring professional risks in the mining industry and put them into practice was studied.

3. To achieve the purpose of the study, the need to solve the following issues was determined:

examining the analysis of the state of professional risks in the mining industry;

assessment of environmental risks for employees operating in the mining sector;

assessment of the volume of environmental impact of gold and radiation uranium mines, as well as the Real working conditions of workers engaged in the search for these mines;

development of a mathematical model for monitoring professional and environmental risks in the production of gold and uranium in industrial conditions;

development of a mathematical model for assessing the reduction of environmental risks of air, surface water and soil pollution in the field of mining;

development of methods for determining radioecological factors in Uranium man-made objects;

development of a single scheme for monitoring industrial facilities with special radiative properties.

development of a methodology for monitoring and assessing professional risks that affect the efficiency of obtaining Fire and explosion hazards in the mining industry.

2.3. Assessment of the professional risks of employees employed in open mining.

In the conditions of globalization, the rapid changes taking place in the economy, production and business have a significant impact on the sphere of Technosphere security, first of all, labor protection. The acceleration of scientific and technological progress, the rapid accumulation of new scientific information leads to the development of integration processes and the need to apply uniform approaches to assessing working conditions at industrial enterprises. Modern companies are developing and implementing integrated control systems that meet the requirements of international standards ISO 9001 and ISO 14001, ensuring its smooth operation. One of the requirements of such a system is to maintain the health and productivity of employees. The enterprise and the employer will have to take any measures to prevent and eliminate the most valuable resources, the causes that lead to accidents and professional diseases. To prevent the occurrence of dangerous conditions, it is necessary to study the potential causes that can lead to negative consequences. Therefore, it is necessary to establish a professional risk management system in order to identify professional risks in the organization, assess situations that can lead to negative consequences, develop measures to minimize them [6; 326-pp., 75; 106; 293-301-pp.].

Much attention is paid to the development of national legislation by the government of Uzbekistan, its improvement on the basis of international documents adopted as international conventions. Today, Uzbekistan has ratified 13 international conventions.

The Basic Law of Uzbekistan in the field of labor protection is expressed in the Decree No. 410 of September 22, 2016 “on labor protection”, which determines the directions of state policy in the field of labor protection [26; 60;.]. In Uzbekistan, a number of legislative acts have been adopted regulating the procedure for certification of jobs, methods for setting classes of working conditions and guidelines for assessing professional risks. The functions of developing a methodology for assessing Professional risks are assigned to the Ministry of health of the Republic of Uzbekistan. International practice of Russia and Uzbekistan shows that the level of threat against the background of industry is not only decreasing, but also increasing every year. To prevent this, it is necessary to create a system of control over professional risks [106; 293-301-pp.].

The concept of “professional risk” as a result of the influence of factors of production in Uzbekistan as an opportunity to harm health was enshrined in legislation in April 2017. Interstate standard "GOST 12.0.230-2007 “in Uzbekistan in March 2007. System of labor safety standards. The Standard” Work Safety Management Systems " is adopted. To a full extent, it fully complies with the guide of the International Labor Organization (ILO) on the basics of Occupational Safety and health management (ILO-osh 2001) and the provisions outlined in the Convention No. 187 of the ILO. In the development of this standard Uzbekistan since July 1, 2018 GOST 12.0.230.4-2018 and GOST 12.0.230.5-2018 "system of labor safety standards. Professional security and health management systems. Methods for determining risk for different periods of work" and "system of labor safety standards. Health management systems. Risk assessment methods were among the countries of the vote to adopt interstate standards " to ensure job security[54; 55; 56; 61; 612-pp., 106; 293-301-pp.].

In accordance with international standards, the organization of production processes and labor operations presupposes heavy and harmful production factors, in general, there is no completely safe process for the worker in Ogan, since almost always a chance of accidental occurrence of situations that pose a threat to the health of the worker becomes inevitable.

Such random possibilities of adverse events, taking into account the importance of their consequences, are called risks. Their identification, analysis and assessment is a mandatory and central point of the labor protection management system. Standards provide methodological tools for applying risk analysis methods [37; 23-29-pp., 107; 293-301-pp.].

In the process of gold mining in the mines, professional risk assessment and measures to reduce them have been developed for miners, which are affected by harmful and dangerous production factors.

As preliminary data, materials were used to conduct attestations of workplaces compiled for units working in an open quarry at the Muruntau mine. As a period of continuity of life in the working conditions of mining workers, that is, bulldozer driver, truck drivers (participate in the transportation of in the technological process), drilling unit driver, excavator driver, crane driver, pump unit drivers work activities are considered [106; 293-301-pp.].

Employees who provide for the implementation of technological processes are influenced by workloads caused by unfavorable factors of the work environment, both chemical, physical and psychophysiological. The dust factor is mainly represented by dust of a complex chemical composition with the predominance of aerosols with a fibrogenic effect. As an example, the amount of Sio2 varies in the range from 10% to 70%. The separation of harmful gases into the air of the workplace comes from the gases of vehicles operating in the blasting areas. Employees involved in the transportation of mountaineers are jointly exposed to the effects of physical factors such as noise, infrasound, general vibration, resulting in significant stresses.

Gold mining is mainly carried out in an open way. Therefore, drilling and blasting work is carried out in stages in open fields. Drilling is carried out in the area where the wells are initially being prepared for detonation in accordance with the act of drilling and detonation, then they are charged and prepared for detonation [105; 3-9-pp., 109; 1-7-pp.].

Figure 2.1 presents the main technological operations for the extraction of gold-ppearing mines

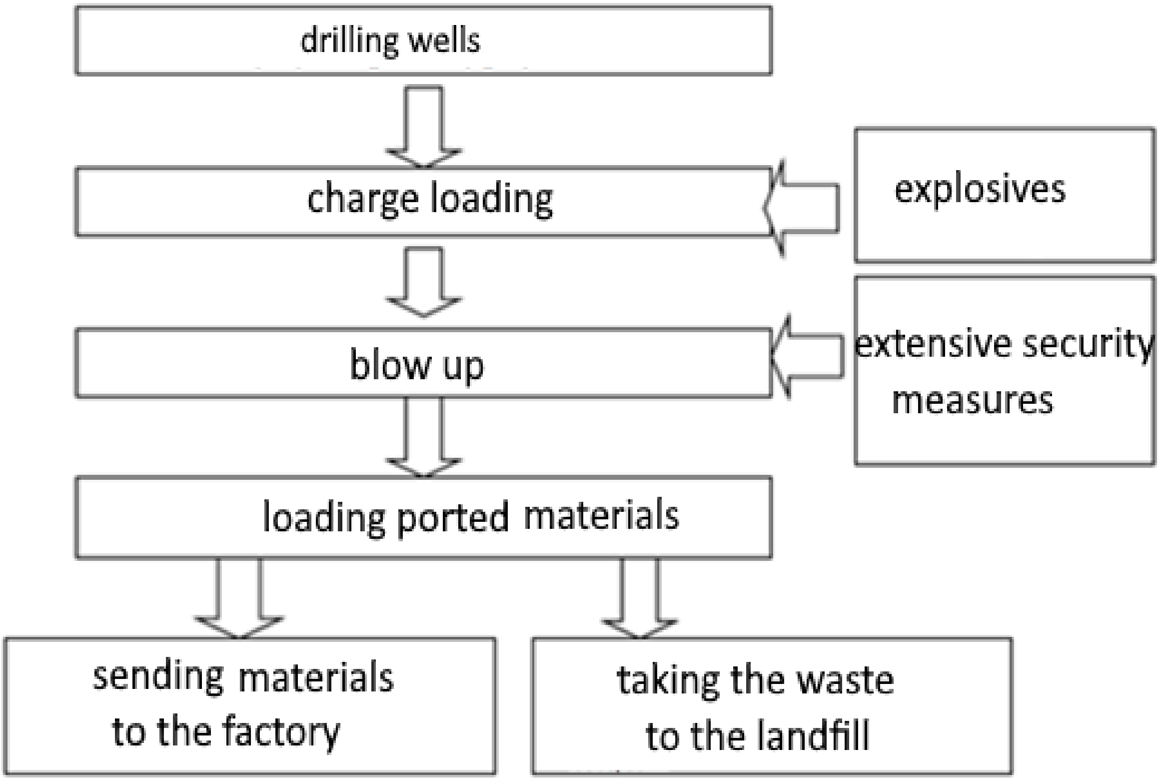


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Figure 2.1. Scheme of the technological process of gold mining in open fields.

At the time of the explosion, all work in the quarry is stopped. After a large explosion, the crushed stone mass is loaded into vehicles, and then transported to a enrichment plant or landfill.

Pure mines are transported through motor vehicles to a crushing and sorting bunker. From the bunker madan is given to the jaw crusher [105; 3-9-pp., 109; 1-7-pp.].

Crushed mines are given to the warehouse that makes up the storage space.

Table 2.1 provides identification, description of sources of origin of harmful and dangerous production factors affecting workers in the technological process of gold mining in open fields.

Table 2.1

Identification of harmful and radio-hazardous factors affecting workers in the process of gold mining in open fields.

Harmful production the name of the factor	Dangerous and harmful production factors with physical effects on the human body		
	The reason for the appearance	Effects on humans	Preventive measures
Harmful production factors associated with abnormal microclimate parameters of the air environment at the location of the worker: temperature and relative humidity, air speed (movement) relative to the worker's body, as well as thermal radiation from surrounding surfaces, burning areas, the front of the fire, solar radiation:			
A decrease in ambient temperature	Low ambient temperature. Main and auxiliary equipment operating at subzero temperatures	Hypothermia. Disorders in the nervous and vascular systems of the human body	Use of PPE (insulated suits, boots, gloves) to limit workers' exposure to low temperatures.
An increase in ambient temperature	High ambient temperature. Main and auxiliary equipment operating at high temperatures	Hyperthermia. Disruption of heat transfer. Disorders in the work of the nervous and vascular systems of the human body.	Use of personal protective equipment to limit the thermal conductivity of the equipment used in the production process, limit the time of workers at high temperatures/
High humidity of the environment	High humidity of the environment, accumulation of underground water, disruption of heat exchange in the room, heavy precipitation	Decreased immunity.	Organization of ventilation of buildings.
Harmful production factors associated with excessive air pollution in the breathing zone, i.e. abnormal physical condition of air:			
Gas pollution of the environment	Operation of internal combustion engines in mining and auxiliary equipment	Dizziness, vomiting, difficulties with a person's respiratory tract	Dizziness, vomiting, difficulties with a person's respiratory tract
Pollination of the environment	Use of mining and auxiliary equipment along technological roads and public roads. Rock loading, drilling and blasting	Allergy of the respiratory system and vision, pneumosclerosis	Use of PPE (respirators with a filtering system), use of dust suppression systems on drilling equipment, irrigation of technological roads in the quarry.
Harmful substances in the environment during metal melting and cutting	Harmful substances in the environment during metal melting and cutting	Damage to the central nervous system, lung, liver and circulatory system	Use of respirators (respirators with a filtering system), use of ventilation systems
Harmful production factors associated with mechanical vibrations of solids and their surfaces:			

Increased general vibration	Operation of mining and auxiliary equipment	Fatigue, diseases of the musculoskeletal system, vascular and other diseases.	Reducing the time of the vibration source per person, using vibration mitigation systems
An increase in the level of local vibration	Power tools, locksmith tools, mining equipment controls	Fatigue, diseases of the musculoskeletal system, blood vessels and other diseases of the hands, mobility problems of fingers, wrists, joints	Use of SHV (vibrating gloves), eliminating direct contact with vibration equipment using a remote control
Harmful production factors related to acoustic vibrations in the production environment:			
Increased noise level	Mining and auxiliary equipment operation, drilling and blasting, rock mass loading, sand washing, plumber work	Diseases of the auditory system diseases of the nervous system, blood vessels and other diseases	Use of personal protective equipment for hearing organs, elimination of the source of noise (if possible), use of sound reduction systems, sound absorption, setting regulated breaks
Harmful production factors associated with electromagnetic fields that do not ionize the tissues of the human body:			
The presence of electromagnetic fields of industrial frequencies (about 50-60 Hz)	High voltage electrical installations	Diseases of the nervous system, vascular and other diseases, diseases of the hearing system	Use of personal protective equipment (individual protection kits), establishment of a sanitary protection area, shielding of the radiation source, grounding of electrical installations;
Harmful production factors associated with the light environment			
Lack of adequate artificial lighting	Repair shops, excavator faces, drilling blocks	There is visual fatigue, pain in the eyes, general lethargy, decreased attention	Organization of local lighting in workshops according to requirements, installation of additional lighting devices

Based on these factors, professional risks for workers at each stage of the technological processes of mining of gold-ppearing Madan in open mining were calculated using two methods: the first according to the Fayna Kinni method (figure 2.2), and the second according to the generalized degree of risk (method of scoring) (figure 2.3) [105; 3-9-pp., 119; 100-108-pp.].

As can be seen from the above data, the most dangerous stage of open – pit mining of gold mines is the process of transporting the mine, the least dangerous process is the charging and detonation of Wells. In these two stages, risk indicators are below average [3;237-pp.].

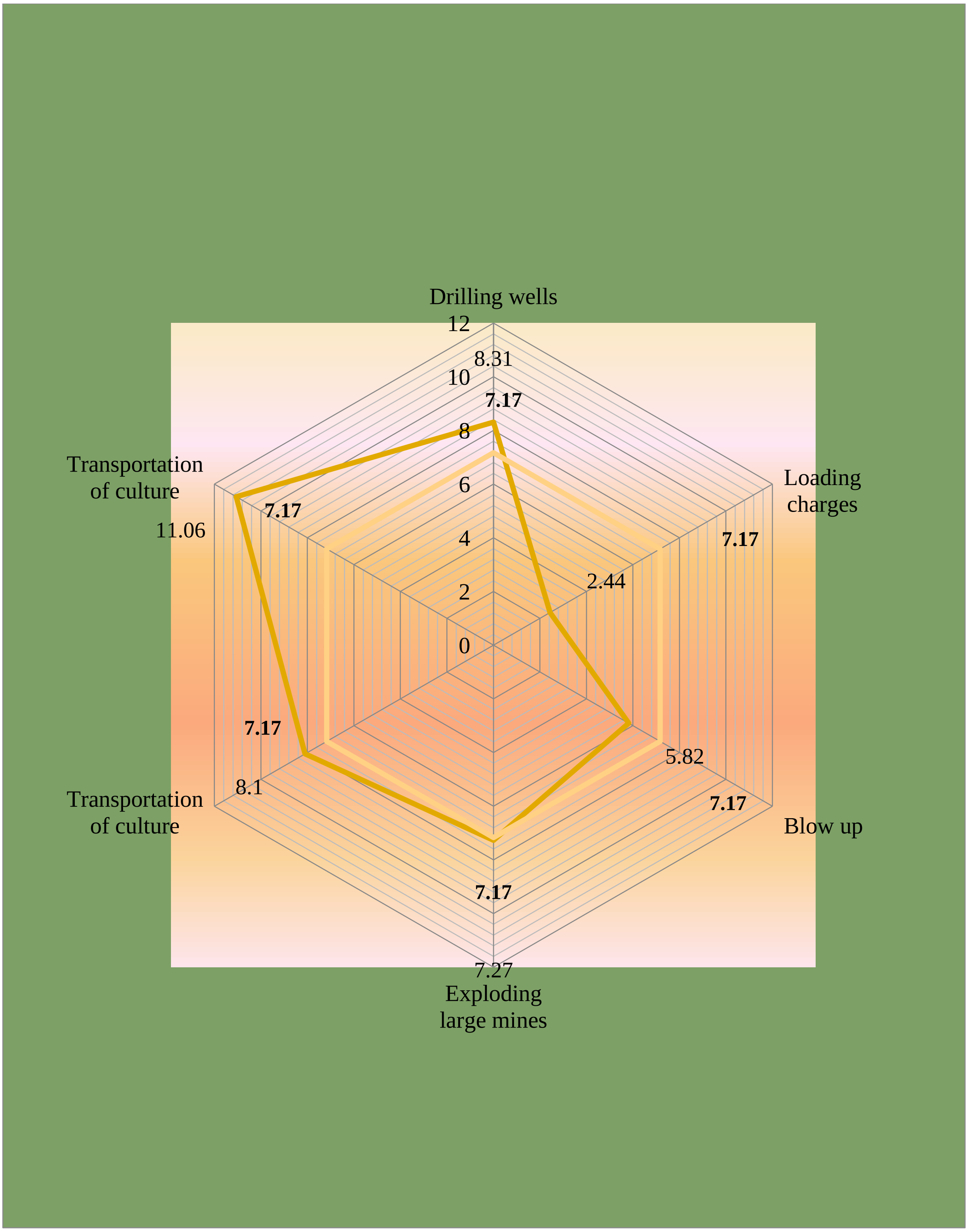


Figure 2.2. The risk levels of the stages of the technological process of open-pit mining of gold-ppearing mines in the composition are experimental results.

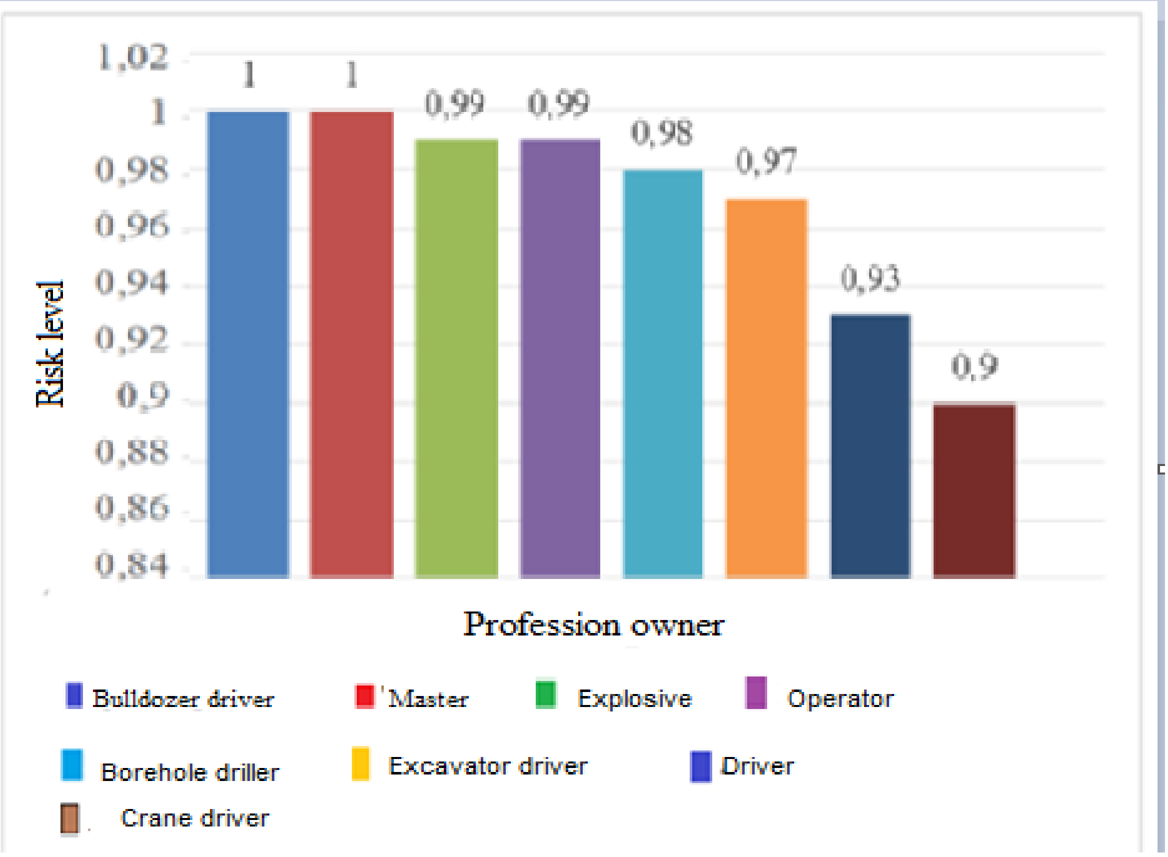


Figure 2.3. Determination of the risk of working professions for an open mining area by a generalized level of Professional risk test results.

The average level of risk in mining is 7.17 points, which is the optimal level for all harmful and dangerous factors, except for dust factors. Based on the instrumental measurement of the actual parameters of the occupational environment and their comparison with hygienic standards, the level of general safety of the working environment was determined by the ball method.

The general indicator of labor safety conditions in individual jobs is the same, which is equal to a multiple of all indicators of labor safety in individual cases of the productive environment and separately for each profession. Figure 2.3 shows the values the level of general professional hazard for individual professions of the working profession for an open mining area.

Thus, the assessment of the work was based on the attested materials of workers and Jobs (point method) and the calculation of the risks carried out based on the Fayna and Kinni method showed that professional risks for employees fall into the upper and middle category and it is necessary to carry out organizational and technical measures to minimize them.

Among the technical measures, first of all, it is necessary to carry out mandatory control over the current operation of equipment and quarry equipment, including maintenance and repair, the introduction of automated systems for the management of mining transport complexes. The security of miners can be ensured not only with the help of personal protective equipment, but also with the help of new digital technologies. It was found that the main direction in the development of digital technologies for labor protection is the effective vasita for creating facilities for employees to move regularly and in case of an accident. In addition, the mining industrialininger is necessary for engineering systems to ensure fire safety in underground mines.

2.4. Modern engineering needs for underground fire works.

During the study, it was found that fires in the mining industry due to problems with spontaneous occurrence, it is important to close the deposits at an airtight (hermetically) level in order to avoid the risk of fire or explosion in underground deposits. A closed atmosphere in an underground mine is a volume controlled by a certain level of boundary conditions, the study of which is expedient.

During the extraction process, methane will have an explosion hazard range of 5% to 15%, and the concentration of 9.5% can lead to the most dangerous consequences due to the complete combustion of the air-methane mixture, that is, in a short time, the closed atmosphere can lead primarily to an explosion State, during the processes the explosion State is sharply reduced due to, 99; 1-9-pp., 66; 23-27-pp.].

It is very common to use inert gases to extinguish fires or control explosions that can occur in mines. In general, N_2 inert gas is usually used to pour into a closed area of the mine to store or create an atmosphere that does not explode. At the same time, it is necessary to carefully monitor the risk of an explosion caused by the release of methane from the surrounding layers and the possible significant change in the composition of the atmosphere of a closed mine with N2 injection from the outside.

Based on the forecast of the development of the atmosphere with a complex composition in the open and closed field area, a severe course of monitoring the ventilation of the atmosphere of the closed hermetically sealed mine is observed.

At the same time, it will be necessary to identify two important factors:

1). how long is methane concentration stored in a closed hermetically sealed atmosphere at a stage that does not have an explosion hazard state, and when does it enter the explosion stage?

2). for an atmosphere that does not have an explosion hazard state, it is required to determine the intermediate distance that is, the increased or decreased risk.

This is very important in the process of successfully performing mining fire extinguishing operations and allowing rescuers to safely enter underground so that they can continue their work.

Gas exchange in the volume of its deposits consists of the following three categories of gases. These are methane flow, inert gas (N_2) flow and fresh air flow.

Figure 2.4 shows the volume in the closed mine of mining and the exchange of mass around it.

All this can be expressed using the explosion diagram. Figure 2.5 shows that the directions of the State point may shift with the addition of combustible gas, more air, or more inert gas. The point representing the airtight atmosphere moves along the line connecting the current state point with the 100% flammability point. If, instead of adding or removing combustible gas, air is added to a closed atmosphere while maintaining a constant ratio between combustible gas and inert gas, it has been found that the point can move from the current state point to a simple clean air Point [85; 176-183-pp., 99; 1-9-pp, 112; 57-68-pp.].

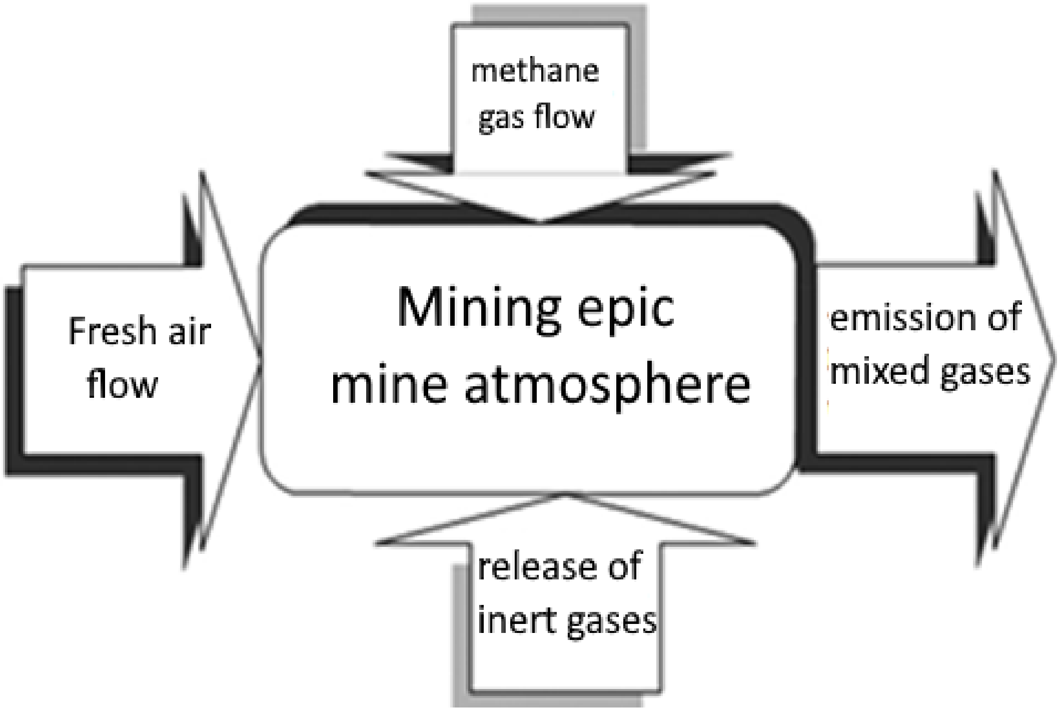


Figure 2.4. Changes in the composition of the atmosphere in the closed mine of mining are significant.

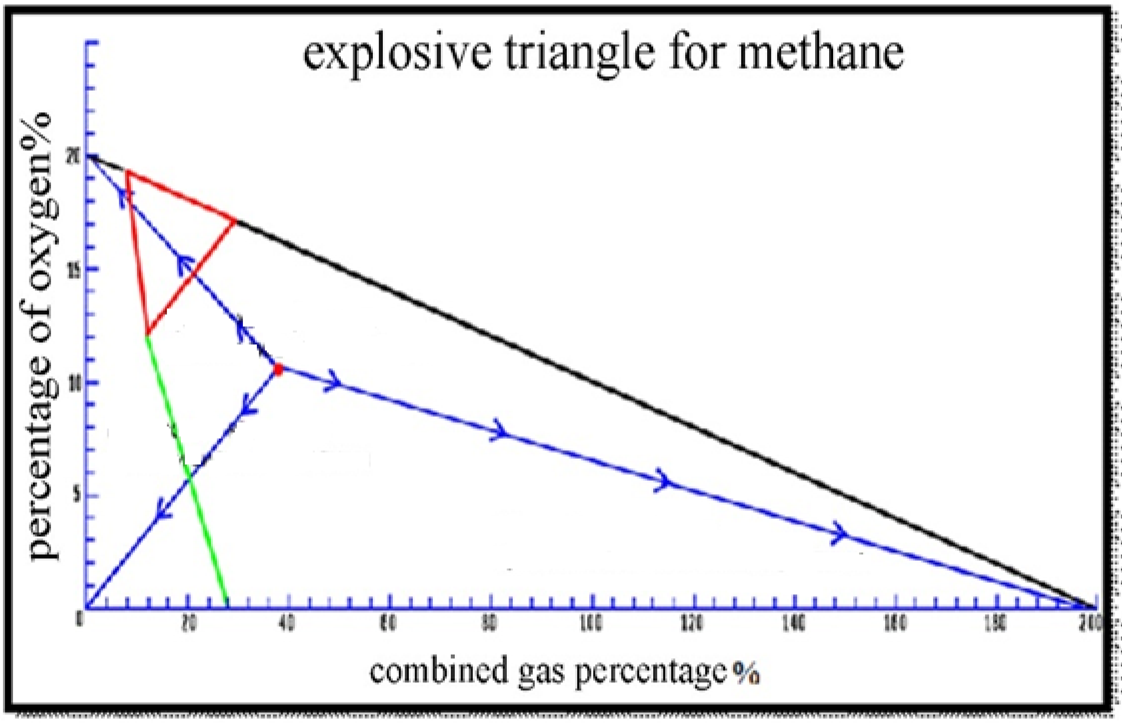


Figure 2.5. Explosive triangle diagram for methane gas.

2.5 as seen in the picture:

• A territory. This is the territory of the explosion, which can again be called an explosive triangle. The mining industry in this area shows the state of mine radiation and gas, the explosive environment of the mine. In this case, in order to move the point position beyond the Triangle, miners need to load inert gas to quickly phlegmatize the air in the mine.

* B Area. This is a non-hazardous area, but the status point in this area has its own characteristic. By analyzing its potential course of action, it can be determined whether the atmosphere remains in a "explosion hazard state" or remains in a "no explosion hazard" state, depending on the methane and fresh air flow mixed in the mine's atmosphere.

* S territory. This is considered to be a higher level than a non-hazardous area such as Area B mentioned. The state of the atmosphere can turn into a "explosion hazard state"area as soon as the methane flow rate is large enough.

* N territory. This is an area that is not in a state of explosion danger and can be considered "real", absolute safe.

* Safe area. In this case, any radiation States, regardless of the combination of gases (methane, inert gas or fresh air), the direction of movement of the safe point does not cross the explosive triangle.

CHAPTER III. EXPERIMENTAL BASIS FOR DETERMINING AND ASSESSING THE STATE OF ENVIRONMENTAL AND RADIOECOLOGICAL FACTORS

3.1. Risks at the stage of technological control.

In the NMMC, all technological processes in identifying safe areas and ensuring the safety of employees are carried out with the direct participation of employees of the central laboratory of the combine. To assess risk indicators in relation to this category of employees , a risk assessment methodology was used, and calculated according to the following formula

$$R_{ps} = 1 - \prod_{i-1}^{n} V_{mni} \qquad (3.1)$$

Here: *n* is the number of environmental factors taken into account;

V_{mni}- safety indicator, *i*- risks of the production environment, it can be determined by the following formula

$$S_{nc_i} = \frac{(x_{\max} + 1) - x}{x_{\max}} \qquad (3.2)$$

Here: - the highest level of assessment (in accordance with the methodology of the Labor Research Institute) = VI;

- the criterion of conditions for the -factor of the environment is formed according to the level of working conditions similar to the data. Criterion I - ideal working environment (class 1); Criterion II - good working environment (class 2); Criterion III - somewhat favorable working conditions (class 3.1); Criterion IV - negative work environment (class 3.2); Criterion V - more than a negative working environment (class 3.3); Criterion VI - pre-emergency, critical work environment (class 3.4). Safety levels and risk levels were evaluated according to tables 3.1, 3.2; deviations of the actual values from the standard, maximum permissible value are given

3.1-table

Security level.

№	Class of working conditions	Security level
1	2	0,83
2	3.1	0,67
3	3.2	0,5
4	3.3	0,33
5	3.4	0,17

3.2- table

Risk level

№	Deviation	Risk level
1	less than 10%	Low risk
2	10 - 30%	Moderate risk
3	30 - 60%	High risk
4	More than 60%	Very high risk

3.3- table

Assessment of predictors of occupational risk in key departments of a central research laboratory.

Job title (professions, positions)	Classes of working conditions												
	Chemical (harmful substances)	APFD	Noise	Non-	Ionizing radiation	Microclimate	Light environment	Hard work	Labor tension	Working conditionsумумий	Class of injury	Standard deviation of the actual, %	Risk level
Head of the Central Laboratory	2.0	2.0	-	1.0	-	2.0	2.0	1.0	3.3	3.3	1.0	39.15	High risk
Deputy head of the central laboratory for science - chief engineer	2.0	2.0	-	1.0	-	2.0	2.0	1.0	3.3	3.3	1.0	39.15	High risk
Deputy Head of the Central Laboratory for Technology	2.0	2.0	-	1.0	-	2.0	2.0	1.0	3.3	3.3	1.0	39.15	High risk
Laboratory of gold technology													
Head of the laboratory	3.1	3.1	2.0	1.0	-	2.0	2.0	1.0	3.3	3.3	1.0	35,99	High risk
Gold Technology Research Group													

Process Engineer	3.1	3.2	2.0	1.0	-	3.2	2.0	3.1	3.1	3.3	2.0	30.13	High risk
Chemical technological research laboratory assistant	3.1	3.2	3.2	-	-	3.2	2.0	3.2	2.0	3.3	2.0	33.28	High risk
Apparatus for the separation of rare and rare earth elements	3.1	3.2	3.2	-	-	3.3	2.0	3.3	2.0	3.4	2.0	35.52	High risk
Cleaner of industrial buildings	-	3.1	2.0	-	3.1	3.1	2.0	3.2	2.0	3.2	2.0	25.44	Moderate risk
Experimental and technological group													
Process Engineer	3.1	3.2	2.0	1.0	-	3.2	2.0	3.1	3.1	3.3	2.0	30.13	High risk
Chemical technological research laboratory assistant	3.1	3.2	3.2	-	-	3.2	2.0	3.2	2.0	3.3	2.0	33.28	High risk
Apparatus for the separation of rare and rare earth elements	3.1	3.2	3.2	-	-	3.3	2.0	3.3	2.0	3.4	2.0	35.52	High risk
Analytical laboratory													
Head of the laboratory	3.1	3.1	2.0	1.0	3.1	2.0	2.0	1.0	3.3	3.3	1.0	29.45	Moderate risk
Chemical Analysis Group													
Chief engineer	3.1	3.1	2.0	1.0	3.1	2.0	2.0	3.1	3.2	3.2	2.0	21.63	Moderate risk
Engineer	3.1	3.1	2.0	1.0	3.2	3.1	2.0	3.1	3.1	3.3	2.0	23.07	Moderate risk
Chemical analysis laboratory assistant	3.1	3.1	3.1	-	3.3	3.2	2.0	3.3	3.1	3.4	2.0	27.89	Moderate risk
X-ray and Spectral Analysis Group													
Chief engineer	3.1	3.1	2.0	1.0	3.1	2.0	2.0	3.1	3.2	3.2	2.0	21.63	Moderate risk
Engineer	3.1	3.1	2.0	1.0	3.2	3.1	2.0	3.1	3.1	3.3	2.0	23.07	Moderate risk
Spectral Analysis Laboratory Assistant	3.1	3.1	2.0	-	3.3	3.2	2.0	3.3	3.1	3.4	2.0	27.61	Moderate risk

Laboratory of X-ray spectral analysis	3.1	3.1	2.0	-	3.3	3.2	2.0	3.3	3.1	3.4	2.0	27.61	Moderate risk
Analysis group													
Chief engineer	3.1	3.1	2.0	1.0	-	3.1	2.0	3.1	3.2	3.2	2.0	27.72	Moderate risk
Engineer	3.1	3.1	2.0	1.0	-	3.2	2.0	3.1	3.1	3.3	2.0	27.72	Moderate risk
Analysis analyst	3.1	3.2	3.3	-	-	3.2	2.0	3.3	2.0	3.4	2.0	35.52	High risk
Smelting plant	3.1	3.2	3.2	-	-	3.4	2.0	3.3	2.0	3.4	2.0	36.35	High risk
Methodological Research Group													
Engineer	3.1	3.1	2.0	1.0	3.2	3.1	2.0	3.1	3.1	3.3	2.0	23.07	Moderate risk
Chemical analysis laboratory assistant	3.1	3.1	3.1	-	3.3	3.2	2.0	3.3	3.1	3.4	2.0	27.89	Moderate risk
Laboratory of environmental protection and radiation dosimetric control													
Head of the laboratory	-	2.0	-	1.0	3.2	2.0	2.0	1.0	3.3	3.3	1.0	49.42	High risk
Radiation dosimetric control group													
Chief engineer	-	2.0	-	1.0	3.2	2.0	2.0	1.0	3.2	3.3	2.0	41.41	High risk
Engineer	3.1	3.2	2.0	1.0	3.3	3.3	2.0	3.1	3.2	3.4	2.0	27.98	Moderate risk
Dosimeter	3.1	3.2	2.0	-	3.3	3.2	2.0	3.3	3.1	3.4	2.0	27.98	Moderate risk
Environmental Protection Group													
Engineer	3.1	3.2	3.2	1.0	3.3	3.3	2.0	3.1	3.2	3.4	2.0	28.42	Moderate risk
Chemical analysis laboratory assistant	3.1	3.3	3.2	-	3.3	3.2	2.0	3.3	3.1	3.4	2.0	28.64	Moderate risk

Cleaner of industrial buildings	-	3.1	2.0	-	3.1	3.1	2.0	3.2	2.0	3.2	2.0	25.44	Moderate risk
Geological laboratory													
Head of the laboratory	-	3.1	2.0	1.0	3.1	2.0	2.0	1.0	3.3	3.3	1.0	35,99	High risk
Field geological and geophysical group													
Geologist	-	3.2	3.2	1.0	3.1	3.1	2.0	2.0	3.1	3.3	2.0	30.13	High risk
Apparatus for the separation of rare and rare earth elements	-	3.2	3.2	-	3.2	3.3	2.0	3.3	2.0	3.4	2.0	35.96	High risk
Cleaner of industrial buildings	-	3.1	2.0	-	3.1	3.1	2.0	3.2	2.0	3.2	2.0	25.44	Moderate risk
Mineralogical group													
Engineer	-	2.0	-	1.0	-	2.0	2.0	1.0	3.1	3.1	1.0	17.41	Moderate risk

Table 2.4 shows the average values of the deviation of the actual value of the safety levels from the maximum permissible level and the risk level for the employees of the studied units [9; pp. 63–67].

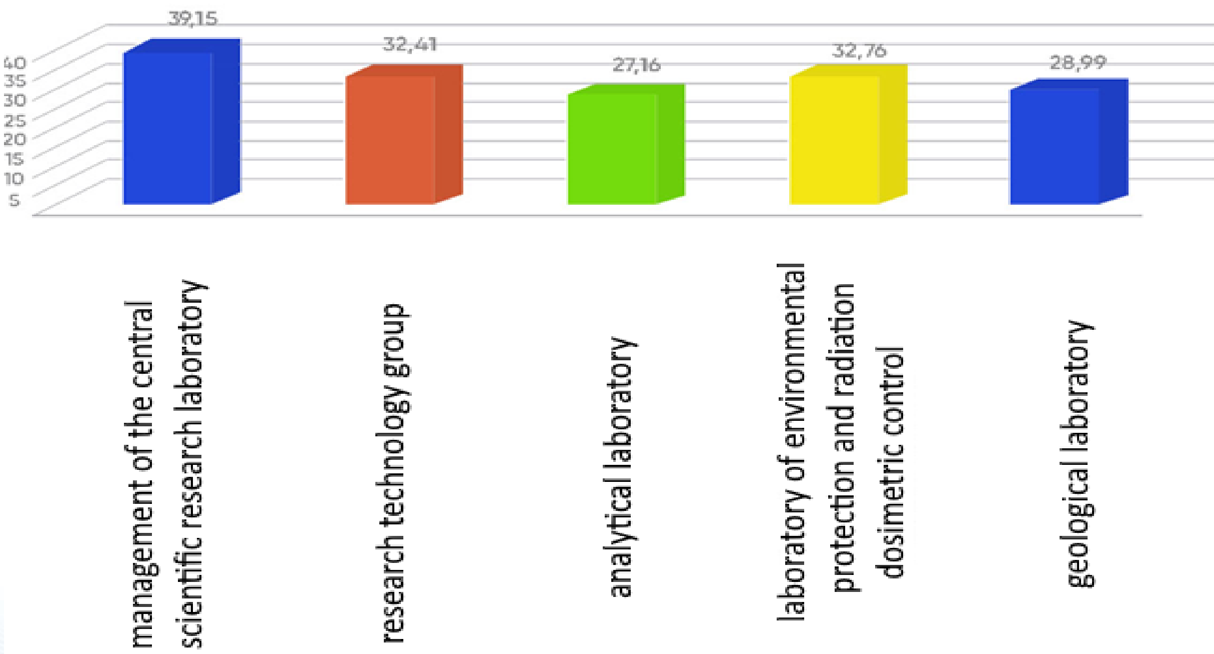


Figure 3.1. Results of the research conducted by the units of the Central Research Laboratory on general occupational risk.

Based on the above professional risk assessment, it was found that more harm to the health of laboratory workers is associated with dangerous and general production conditions, for example, increased noise levels, chemical, microclimate parameters, severity and intensity of the labor process [53; pp. 35–58]. Thus, it was determined that the most dangerous professions are managerial professions at all levels, engineers and laboratory technicians who perform analyzes on the chemical factor and noise. Figure 2.6 shows the overall risk rating of central laboratory units.

Thus, the results of experimental studies showed that increased risks are inherent to the management of the central research laboratory, the intensity of work, responsibility for the decisions made in the first place, risks for employees. In the departments of the Central Research Laboratory, occupational risks are included in the category of permissible risks, it was determined that the work should be carried out in strict compliance with the defined work procedures and that employees should be fully provided with safety equipment.

3.2. Employees of gold mining enterprises in NMMC, occupational hazards.

Extraction, processing, separation, and cleaning work in the mining industry are among the most dangerous occupations and hard labor processes. For example, in modern gold mining plants, gold extraction technology is carried out by the cyanide method, in accordance with the requirements of the cyanide code. The International Code of Practice for the Handling, Transport and Use of Cyanide in Gold Production (the Cyanide Code) was developed by a multidisciplinary steering committee under the auspices of the United Nations Environment Program (UNEP). In 2000, the International Council on Metals and the Environment (ICME). The Cyanide Code is a voluntary industry program for gold and silver mining companies designed to reduce the adverse effects of harmful cyanide concentrations on workers and the public, limit cyanide emissions to the environment, and control adverse exposure conditions and discharges [109; pp. 1–7].

The Cyanide Code is one of the first standards and certification programs developed for the mining industry. Today, it is one of the most common certification programs in the mining industry.

Sodium cyanide has been used as a gold solvent in gold mining since 1887, and gold mines use 0.01% to 0.05% sodium cyanide solutions. Cyanide must be strictly controlled in mines, and appropriate management has been implemented to limit adverse effects on workers and to prevent the release of cyanide-containing chemical solutions into the environment [105; pp. 3–9, 109; pp. 1–7].

More than 20 accidents have been recorded with the release of cyanide into the environment and the death of people, for example, in 1971, the collapse of the Devil's Tower in Romania leaked 300 thousand m^3 of water and was contaminated with cyanide, resulting in the death of 89 people, from January 30 to January 31, 2000 overnight, the sediment dam at the Aurul gold mine in Baia Mara, Romania burst due to rising water levels in the Lapos River, releasing more than 100,000 cubic meters of toxic cyanide into the river. Within two weeks, the toxic flow through the Samos and Tisza rivers through Romania, Ukraine and Hungary reached Yugoslavia, killing fish and wild animals.

In 1985, a dam burst at the Omay Mine in Canada released 3 million m3 of cyanide waste into the Omay River and then into the Essequibo River. In 1998, a truck with 1762 kg of sodium cyanide fell into the Barskoon River in Kyrgyzstan. The reagents were packed in special bags made of polypropylene film of 1000 kg each and placed in a wooden container. As a result of depressurization of packages in autumn, the mountain river was polluted, water ecosystems were damaged, and fish and fish fry died. According to the results of sampling and cyanide analysis of the Barskoon River, which is located below the site of the incident, 566 to 863 kg of sodium cyanide fell into Issyk Lake, and 189 to 255 kg of sodium cyanide fell into the water in the farm fields of Barskoon and Tamga settlements, excluding natural decay. In 2015, 1072 m3 of cyanide solution was poured into the Potrerillos River due to valve failure at the Valadero mine (Argentina) [59; p. 12–16, 70; 75; 109; pp. 1–7, 120.].

The process of extracting gold from ores is a dangerous production using highly toxic reagents, so it is necessary to control and minimize risks by applying and implementing a risk management system in the enterprise. Every modern company must assess potential risks and take them into account in its activities. In addition, today, risk assessment and management is listed as one of the target areas and is considered one of the priorities for both top management and employees themselves. The risk management process is organized according to the principle of bottom-up identification and top-down analysis [109; pp. 1–7].

Occupational safety is an absolute priority in gold mining. A modern approach to security consists of three elements: responsible leadership; zero injury culture and risk management.

The enterprise must comply with ISO 45001 international standards in its activities. In enterprises, risks are identified and assessed, as well as risk maps are formed for all production processes and facilities, after which detailed measures to reduce risks are developed. Before starting work, each employee must make sure that the workplace is safe and fill out a risk assessment map. The use of a risk assessment map increases the awareness of workers about the risks in the workplace, allows for the accuracy of risk assessment, rapid response and control. Any industrial accident is thoroughly investigated to identify deficiencies in the safety management system. After analyzing the situation and drawing a conclusion, measures are taken to eliminate the factors.

Within the framework of the ISO 14001 international standard, great attention is paid to waste storage areas as sources of emergency risks, enterprises are required to strengthen control over waste storage, develop waste storage and emergency action plans aimed at high-accuracy assessment of the probability of adverse events, as well as dam collapse and waste It has been tested whether it is appropriate to identify the possible causes of leakage, to switch to dry waste storage and to develop and implement methods of the ecological footprint reduction system.

Harmful and dangerous factors of the working environment determined for each workplace in gold mining enterprises and the classes of working conditions for each of them were analyzed. [109; pp. 1–7].

3.4-table

Harmful and dangerous factors of the working environment identified for each workplace in gold mining enterprises and classes of working conditions for each of them.

Position titles	Production name of dangerous factors								
	Chemical	Mainly has a fibrogenic effect аерозоллар	Noise	General vibration	Electromagnetic radiation	Microclimate	Light environment	Hard work	Labor tension
1	2	3	4	5	6	7	8	9	10
Management department									
Factory manager	2	2	3.1	-	2	3.2	3.1	3.1	3.3
Chief engineer	2	2	3.1	-	2	3.2	3.1	3.1	3.3
Chief engineer	2	2	3.1	-	2	3.2	3.1	3.1	3.3
Markscheider	2	2	2	-	1	2	2	3.2	3.1
Foreman of the production site	3.1	2	3.1	-	2	3.2	3.1	3.3	3.3
Grinding department									
Grinder	3.1	3.1	3.2	3.1	2	3.3	2	3.3	2
Crane driver	3.1	3.1	3.2	-	2	3.2	3.1	3.3	2
Mill Operator	3.1	3.1	3.2	3.1	2	3.3	2	3.3	2
Department of thickening and filtration (working with cyanide solutions)									
Filter	3.1	3.1	3.2	3.1	2	3.3	2	3.3	2
Hydrometallurgist	3.1	3.1	3.2	3.1	2	3.3	2	3.3	2
Apparatus for beneficiation of minerals containing gold	3.1	3.1	3.2	3.1	2	3.3	3.1	3.3	2
Department of reagents (working with cyanide solutions)									
Reactive solvent	3.1	3.1	3.1	2	2	3.3	3.1	3.3	2
Sludge department (working with cyanide solutions)									

Apparatus for beneficiation of minerals containing gold	3.1	3.1	3.1	2	2	3.3	3.1	3.3	2
Repair workshop									
Electrician (plumber) on duty and equipment repair.	3.1	3.1	3.1	2	2	3.3	3.1	3.3	3.1
Electric and gas welder	3.1	3.1	3.1	2	2	3.3	3.1	3.3	2
Compressor section									
Compressor operator	2	2	3.1	2	2	3.1	3.1	3.1	3.1
Waste storage facilities									
Department foreman	2	2	2	2	1	2	2	3.1	3.1
Adjuster	2	2	2	2	1	2	2	3.3	2
Pump station operator	2	2	3.1	2	1	3.1	2	3.1	3.1

Table 3.5 shows the results of determining the harmful and dangerous factors affecting the employees of the gold mining enterprise and the classes of working conditions for each of the measured production factors. Every modern enterprise striving to rise to the international level should replace the OHSAS 18001 standard with the ISO 45001 "Professional safety and occupational health management systems" international standard [17; 109; pp. 1–7]. The new standard defines the requirements for the labor protection and safety management system, includes instructions for their application to provide the organization with safe and comfortable working conditions, requires the implementation of procedures for the assessment of professional risks and preventive measures to reduce them.

According to international standards, the most popular approach to professional risk assessment is called the “five-step system”.

Step 1. Identify the risks that cause threats. At this stage, it was studied to identify workers who could be potentially harmed and at risk.

Step 2. Analysis of risks and knowing their "level" (their value, ability, etc.), distribution by importance.

Step 3. Find warning measures. In this step, the need to eliminate risks and manage risks and apply appropriate measures is explored.

Step 4. Application of measures. The plan for the implementation of protective and preventive measures, who will implement them and when, and what means are provided for the implementation of the planned measures have been determined.

Step 5. Monitoring and inspection. When there are serious changes in the organization of production, a continuous analysis of emergency situations was carried out [86; pp. 21–32, 109; pp. 1–7].

The matrix method was used to identify hazardous events, risks and hazards (Table 2.6). The risk is calculated according to the following formula:

$$R = P * S \tag{3.3}$$

In this R - risk, score;

P - risk probability, score;

S - severity of the consequences of risk exposure, score.

P **risk probability criteria according to:**

- It was determined in the 1-point system that it is impossible to predict that such a factor may appear in the experiment.

- the occurrence of similar conditions remains low, but the probability of this is small - it was determined in the 2-point system. [52; pp. 30–69].

- the conditions for this appear real and unexpectedly - 3 b is determined in the point system

- such conditions are very constant or appear over a certain period of time - determined in the 4b point system

- conditions, of course, occur for a long time - determined in the 5b point system [52; pp. 32–76, 110; pp. 1–7].

Criteria for the significance of the consequences of exposure to risk, (1-5 b):

1. Minimal - small effect.

2. Moderate - no danger to life.

3. Important - there is a potential health hazard.

4. Group events with serious consequences

5. Catastrophic - a series of fatal accidents

3.5-table

Risk classification matrix.

Consequences of risk exposure (S) value, score	Risk (R), score				
	P= 1	P= 2	P = 3	P= 4	P= 5
5- (fatal danger)	5	10	15	20	25
4-(severe risk)	4	8	12	16	20
3- (above average risk)	3	6	9	12	15
2 - (moderate risk)	2	4	6	8	10
1 - (minimum risk)	1	2	3	4	5

3.6-table

Risk for enterprise units - risk map.

1	1. Mechanical hazards:	P	S	R	Risk category
1.1	Loss of balance when moving on slippery surfaces or wet floors, including the risk of falling due to tripping or slipping	4	3	15	high
1.2	Due to the risk of falling from a height, including the absence of a guard	4	3	12	high
2. Electrical hazards:					
2.1	Contact with faulty conductor parts during power-up (indirect contact)	1	1	1	short
3. Thermal hazards leading to the following:					
3.1	Burns or other injuries caused by contact with high-temperature objects or materials due to combustion and heat radiation	2	2	4	short
3.2	Health damage due to hot or cold working environment	4	4	6	high
4. Dangers from noise:					
4.1	Hearing loss (deafness), other physiological disorders (for example, loss of balance, impaired concentration)	2	3	6	average
5. Hazards caused by vibration:					
5.1	Vibrations of the whole body, especially in an uncomfortable position	2	2	4	short

6. Risk of materials and substances (and their components) used in technology					
6.1	Risk of contact or inhalation of harmful liquids, gases, dust, mist, smoke vapors	5	4	20	high
6.2	fire or explosion hazard	1	1	1	short
7. Unexpected starts, turns, crawls (or any similar abnormal conditions):					
7.1	Носозликлар ёки бошқарув тизимларининг шикастланиши	1	1	1	short
7.2	Other external influences (gravity, wind, etc.)				
8 Risks associated with control systems:					
8.1	Poor control placement	1	2	2	short

Assessment of professional risks in the studied facility is carried out by assessing two predictive risks according to the previously used matrix method table 2.6) according to the results of attestation of workplaces (table 2.7).

Based on the results of attestation of workplaces, in the assessment of risks using the predictive method, this production is suitable for all occupations, i.e. foreman, miller in mining, miller, electrician, filter operator, hydrometallurgist, gold ore beneficiation operator, reagent smelter, welder, plant manager, chief It was determined by risk scoring that it was characterized by extremely high and high risk levels for the engineer, chief mechanical engineer, crane driver (crane operator), operator of the compressor device, operator of the pump unit, manager, mark shader, site foremen (Fig. 2.7).

When ranking the divisions of gold mining enterprises, the highest risk levels specific to the repair shop, crushing department, thickening and filtering department, liquid department, reagent department, control department, compressor department, waste management department were determined using the method of scoring [109; pp. 1–7] (Fig. 2.8).

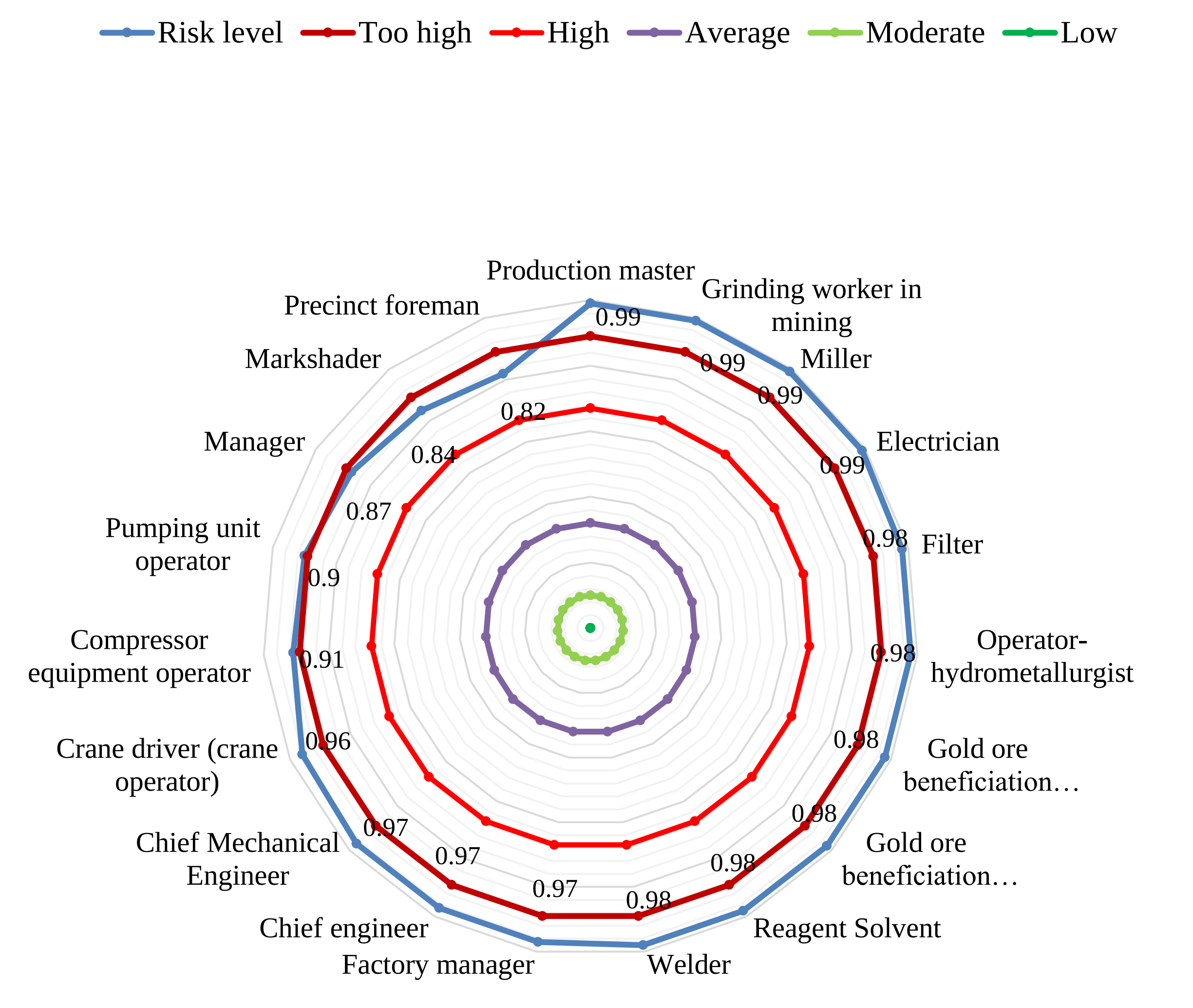


Figure 3.2. Results of a survey of the occupational risk levels of the main occupations of gold mining enterprises.

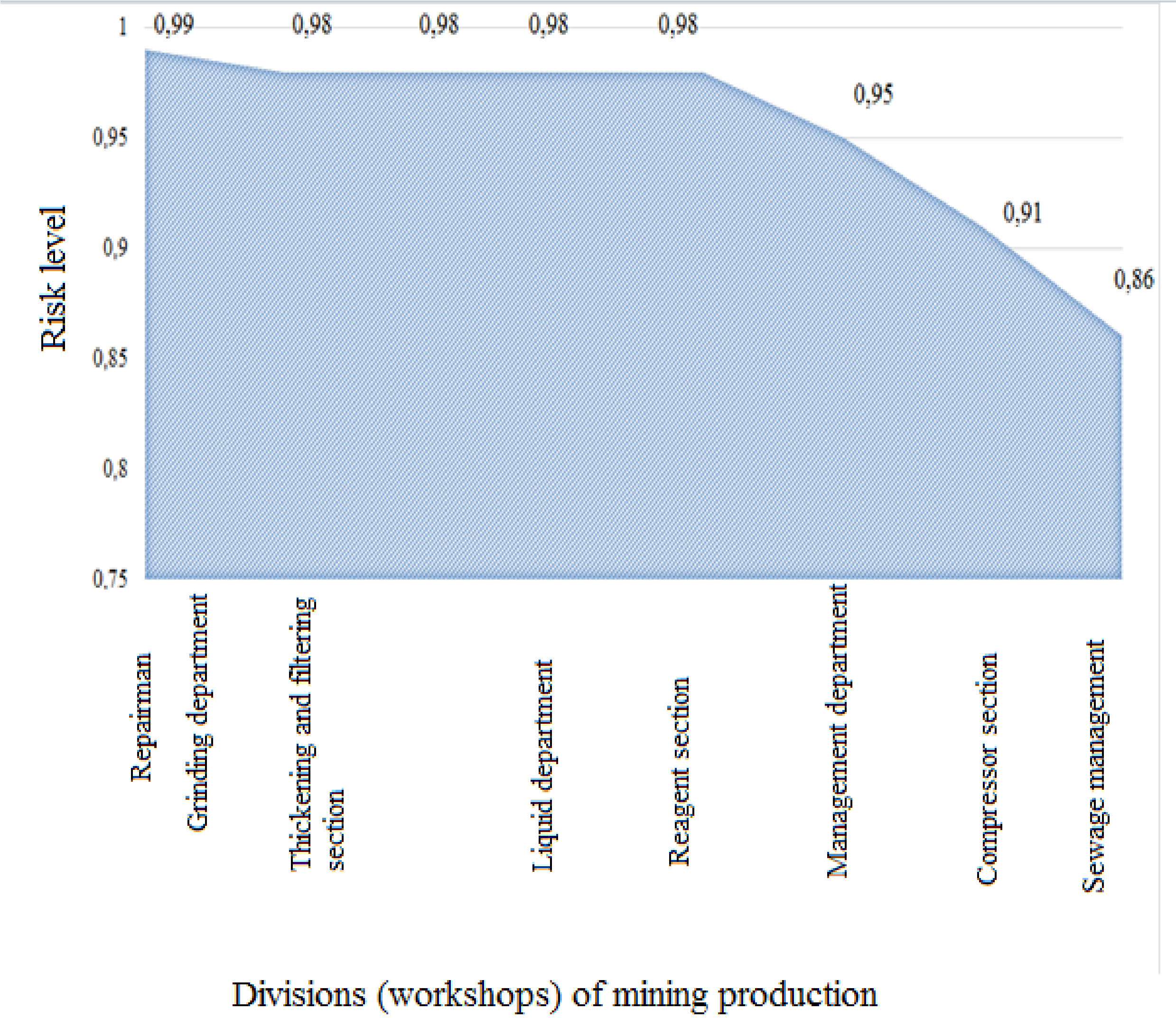


Figure 3.3. The results of the rating of divisions according to the level of professional risks.

In short, in this work, it was determined for the first time that professional risks, assessed on the basis of a number of methods widely used in modern gold mining enterprises, depend on working conditions, equipment and reagents used in technological processes. It was scientifically proven that harmful and dangerous production factors should be taken into account at each stage of the technological process and measures should be taken to manage professional risks [109; pp. 1–7].

3.3. Recommendations for professional risk management in the example of NMMC.

Professional risk management is a set of measures to identify, assess and reduce the level of professional risk. This complex is part of the general labor protection system. The purpose of occupational risk assessment and management is to ensure the safety and health of the employee during the work process [67; 11 p., 68; p. 25]. Assessment and management of professional risks is a component of the organization's labor protection system, which aims to optimize risks and risks, including the formation and provision of preventive measures for the prevention of accidents, injuries and professional occupational diseases.

[40; pp. 105–107, 82; pp. 65–68]. The algorithm of these measures is shown in Figure 2.9.

According to the current legislation of Uzbekistan, professional risks must be studied from the point of view of labor protection, medicine and safety:

- occupational risks from the point of view of health and occupational disease are considered as the study of the quantitative laws of the occurrence of occupational disease in workers and the development of mechanisms for its prevention. Factors of working conditions are studied as sources of damage to workers' health.

- taking into account the influence of factors and dangerous aspects of working conditions, the level of risk is determined by comparing diseases for certain occupational groups working in certain working conditions [87; pp. 1112–1119].

- professional risks from the point of view of labor protection and safety, technical (machines and equipment, technological process and type of production) and organizational (labor organization, professional training of employees and preventive work on labor protection) risk factors affect the level of production injury [87; pp. 1112–1119].

In Uzbekistan, existing methods dedicated to determining and substantiating the relationship between the long-term effects of dangerous and harmful production factors of working conditions, which are occupational risk factors, and the possibility of harming the life and health of an employee, are designed to identify a number of correlations. The most important of them are the following [87; pp. 1112–1119].;

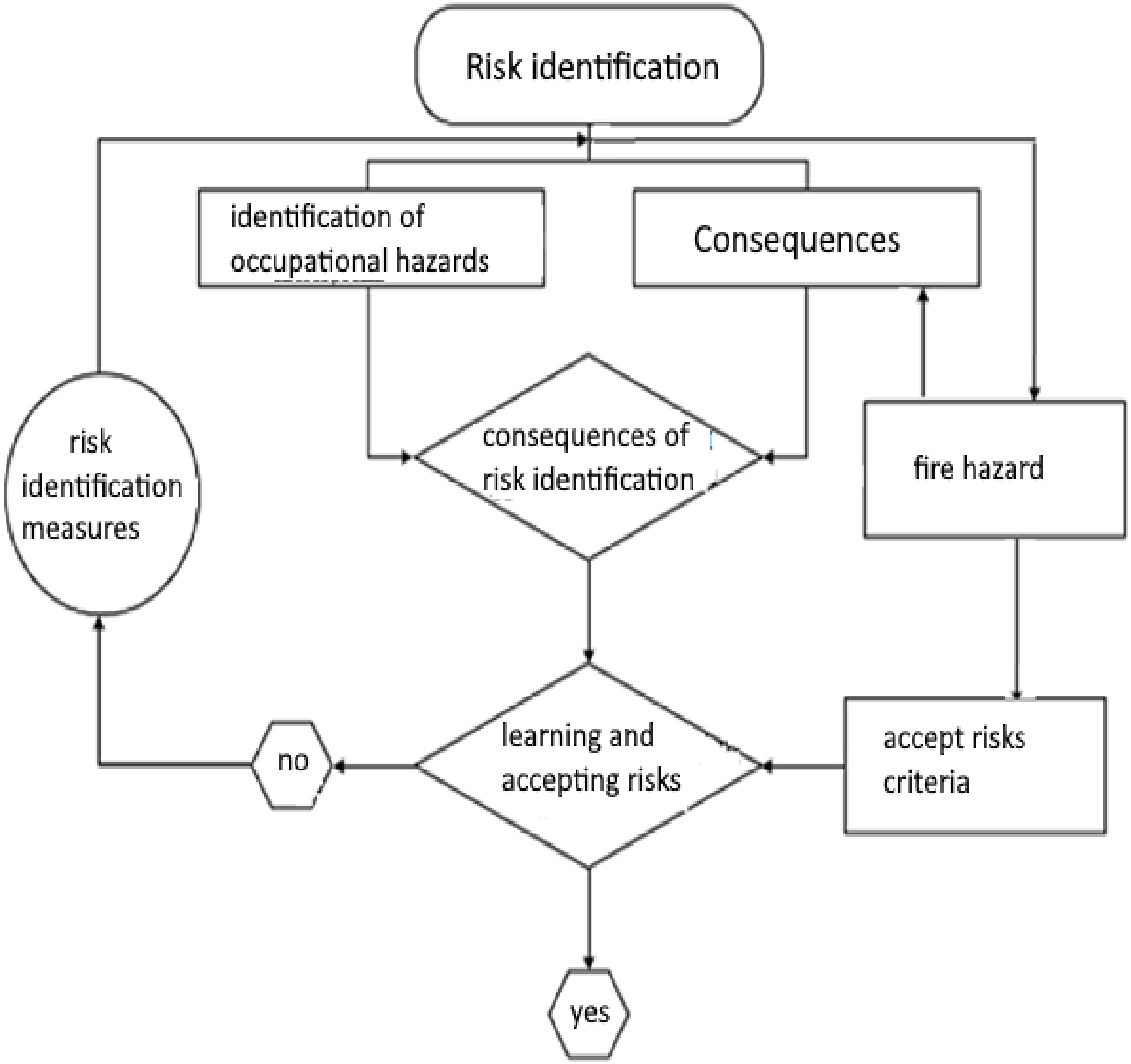


Figure 3.4. Algorithm for assessing risks affecting workers' health.

In Uzbekistan, existing methods dedicated to determining and substantiating the relationship between the long-term effects of dangerous and harmful production factors of working conditions, which are occupational risk factors, and the possibility of harming the life and health of an employee, are designed to identify a number of correlations. The most important of them are the following [87; pp. 1112–1119].

- professional risk factors, causality of types of loss of health and work capacity - work in certain sectors of the economy, production sectors and work for a long time in certain professions, causing the risk of labor and professional illness, industrial injuries, the consequences of which are temporary and (or) permanent disability and in case of death;

- the probability of manifestation of professional risks and the level (severity) of their consequences - in certain professional groups and at the individual level, it is assessed when analyzing situations that lead to temporary or permanent loss of work ability, including disability [87; pp. 1112–1119].

- the age of those injured at work (due to adverse psychophysiological factors of the labor process), the average age of disability due to an accident at work or the average age of those killed at work;

- risk factors, the probability of their manifestation and the level (severity) of their consequences, on the one hand, the types of compensation payments provided, on the other hand, such as the period of benefit or pension were determined [87; pp. 1112–1119].

Research Institute of Sanitary, Hygiene and Occupational Diseases of the Ministry of Health of the Republic of Uzbekistan has developments in the field of classification of working conditions in the workplace, describing the consequences of working in optimal, permissible or harmful working conditions.

Uzbekistan has ratified the ILO Convention on the Basics of Labor Protection and Safety Promotion (Convention No. 187). According to Article 3 of this Convention, “Each Member State shall support the following basic principles: assessment of occupational hazards or risks; professional

to deal with risks or their occurrence; development of a national culture of health care and prevention, including information, counseling and training" [65; 1-pp].

Clause 6 of the Convention's recommendations states that ILO member states should promote a systematic approach to OSH management as outlined in the

Occupational Safety and Health Management System Manual (ILO-OSH 2001 standard).

In accordance with the requirements of international standards, it is necessary to create a system of labor protection and, accordingly, a system of professional risks in NMMC. The system of occupational risk management is part of the employer's labor protection system management system and includes the following main elements:

• professional risk management policy, goals and programs to achieve them;

• planning work on professional risk management;

• professional risk management system procedures;

• monitoring the operation of the professional risk management system;

• analysis of the effectiveness of the professional risk management system by the employer and his representatives.

3.4. The effect of man-made values on the environment of exposure to radiation factors to employees.

Management of occupational risks of radiation factors affecting employees in research work, assessment of their values requires experimentation. In the uranium mining industry, it is important to evaluate the impact of radiation factors on the environment, the magnitude of the dose of exposure to gamma radiation, long-lived alpha nuclides in atmospheric air, the equivalent volume of radon activity in atmospheric air and the air of the working area.

Along with the Big Bang, ionizing radiation appeared around 20 billion years BC. Since then, radiation has filled space, including our earth, with rays of radiation. Ever since the earth was formed, it has been composed of radioactive materials that emit various types of radiation. In turn, the person himself is also radioactive. Radiation is a general concept. Basically, it consists of different types of radiation found in nature and radiation obtained artificially. An important aspect of radiation is ionizing radiation, which is ionizing radiation that interacts with the environment, with various signs of ionizing radiation. This type of radiation changes the physical state of atoms and atomic nuclei into electrically charged ions, or products of nuclear reactions. They have physical and chemical properties. The main property of ionizing radiation is the ionization of the environment, that is, the formation of ions [38; pp. 262–266, 39; pp. 39–43].

The second important feature is the feature of absorption into the object. Therefore, it is often called absorbed ionizing radiation. The greatest or strongest radiation is characterized by absorption, first gamma radiation, then beta radiation, and then beta radiation alpha radiation is placed.

The demand for energy resources around the world is increasing every day. The radioactive element uranium, which has a large underground energy reserve, is of strategic importance for nuclear fuel.

Naturally, in the process of uranium mining, the environment interacts with radiation, that is, ionizing radiation. It is carried out in accordance with the sanitary rules and norms (Sanitary rules and norms 0193-06) for checking the impact of ionizing rays on the environment, soil, water, air in the ecosystem.

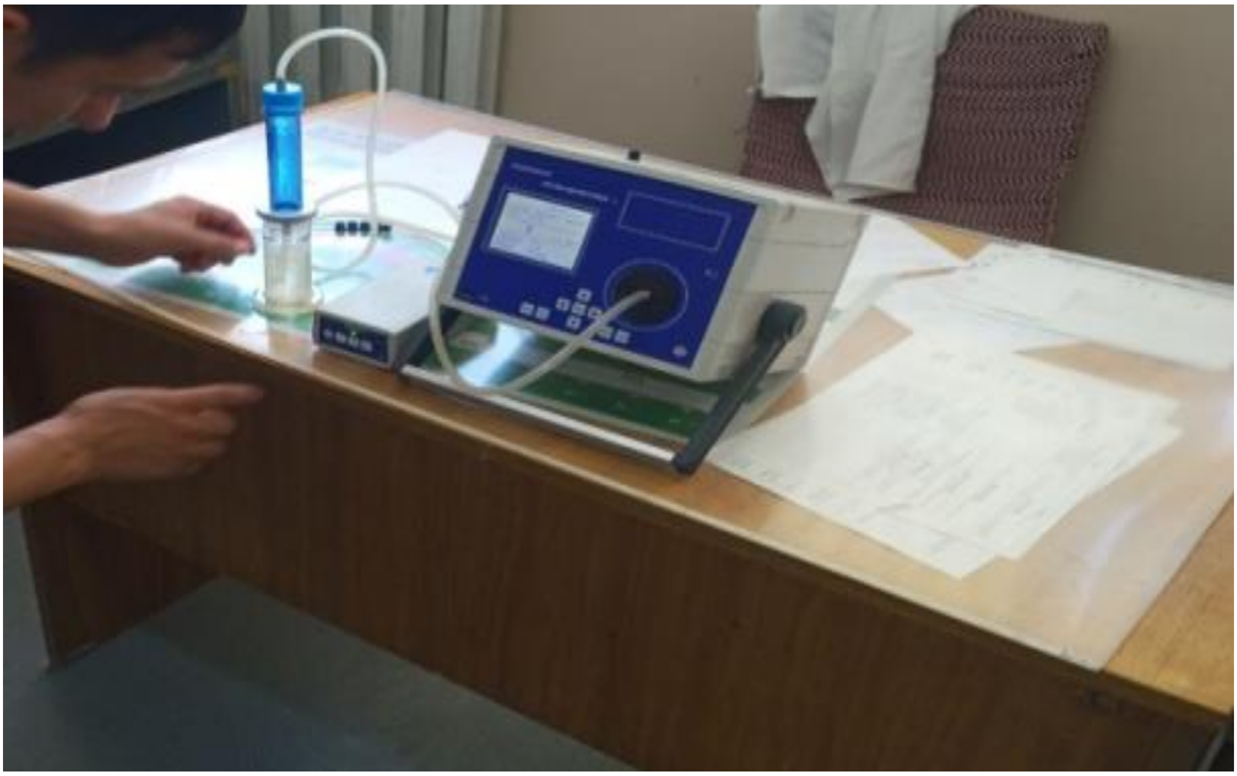
In addition to the above properties of ionizing radiation, it does not have a specific smell, color and taste. By its nature, the human body does not have sensory organs that perceive the effects of ionizing radiation. Therefore, various devices have been developed that determine the effects of ionizing radiation on humans and the environment. These are devices such as dosimeters, radiometers, spectrometers.

Knowing the dose of ionizing radiation and its interaction with substances is very important for students, workers, especially those with large industrial enterprises. Currently, the magnitude of radiation hazard factors in the vicinity of uranium mining enterprises and production areas in the world, the magnitude of environmental pollution of uranium production enterprises' wastes, warehouses, hydrometallurgical complexes, the impact of radiation-polluted production factors on the ecological state of the area, production wastewater, the possibility of contamination of underground water with radionuclides of chemical elements, selective melting of uranium underground, pollution of land areas with radionuclides, low-cost methods of restoration (recultivation) of these land areas, and violation of the coefficient of radioactivity balance of radionuclides in the decay chain of uranium in underground water -research works have been carried out little, and the sources on the object we are studying are almost not given. Contaminated technical facilities, industrial wastewater, samples of uranium-containing drinks of the enterprise, technological solutions, out-of-ppalance minerals, ecosystems (soil, water, air) and erosion water samples from monitoring wells [38; pp. 262–266].

The following improved methods of analysis were developed:

- radiometric, X-ray, α, β, γ and mass spectrometric and dosimetric data were used to assess the extent of radiation-contaminated production factors and their impact on the ecosystem;
- ionizing radiation affects the soil, water, air composition of the ecosystem. In the air - it affects the air of working areas, constructions, buildings of production enterprises. Affects aquatic, underground, surface, drinking and industrial wastewater. Areas contaminated with radioactive substances in the soil are affected by various radioactive factors [38; pp. 262–266].

The exposure dose rate (EDG) of radiation factors in the air was measured using the DKS-96 measuring device, the value of the total volumetric activity (LLAP) of long-lived alpha nuclides in production buildings where uranium products are stored - using the RAA-20 "POISK" measuring device, the sum of long-lived radionuclides in the air volume activity was measured using a ZnS(Fg) type scintillation detector alpha-radiometer "Progress-AR" (see Fig. 2.10-a and b).



a)

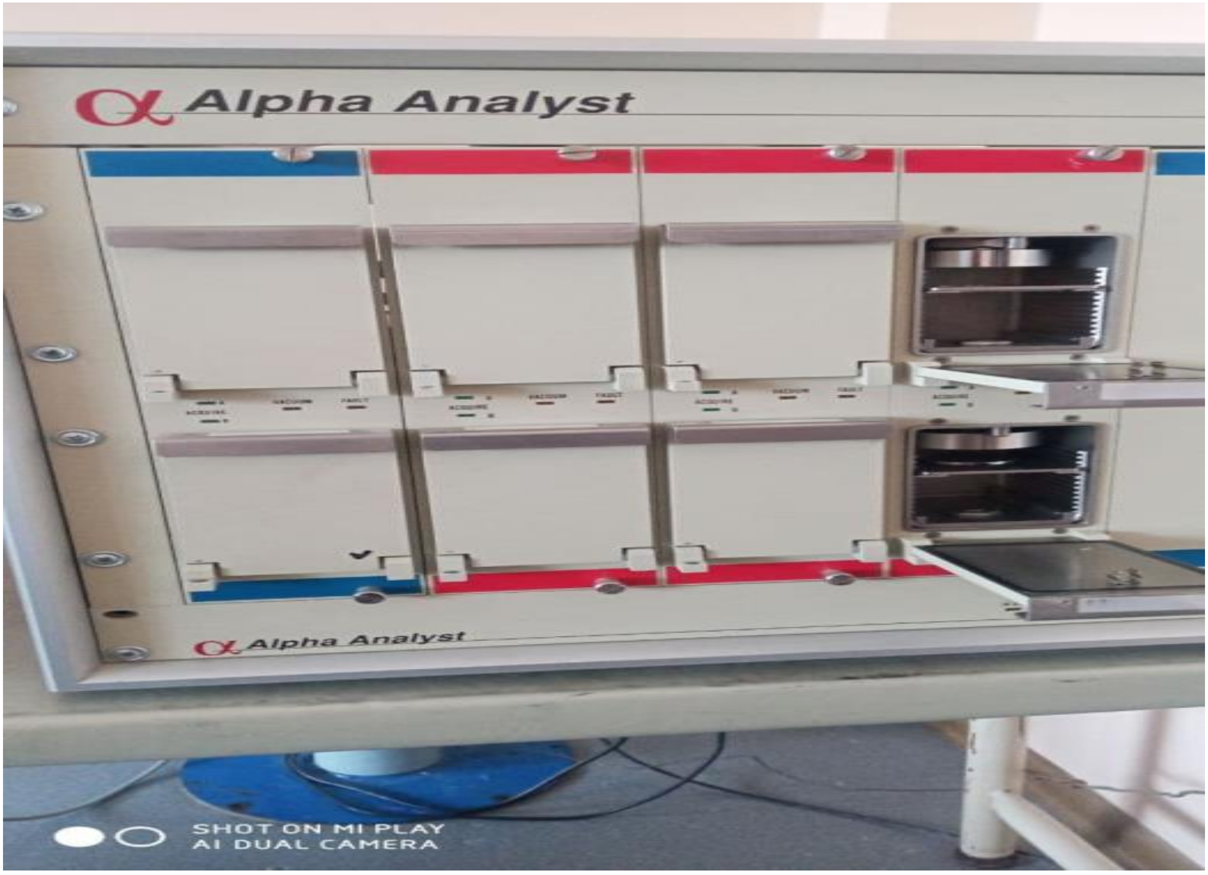
b)

Fig. 3.5 –a-b. The process of measuring the exposure dose rate of radiation radiation factors in the air with the DKS-96 measuring device.

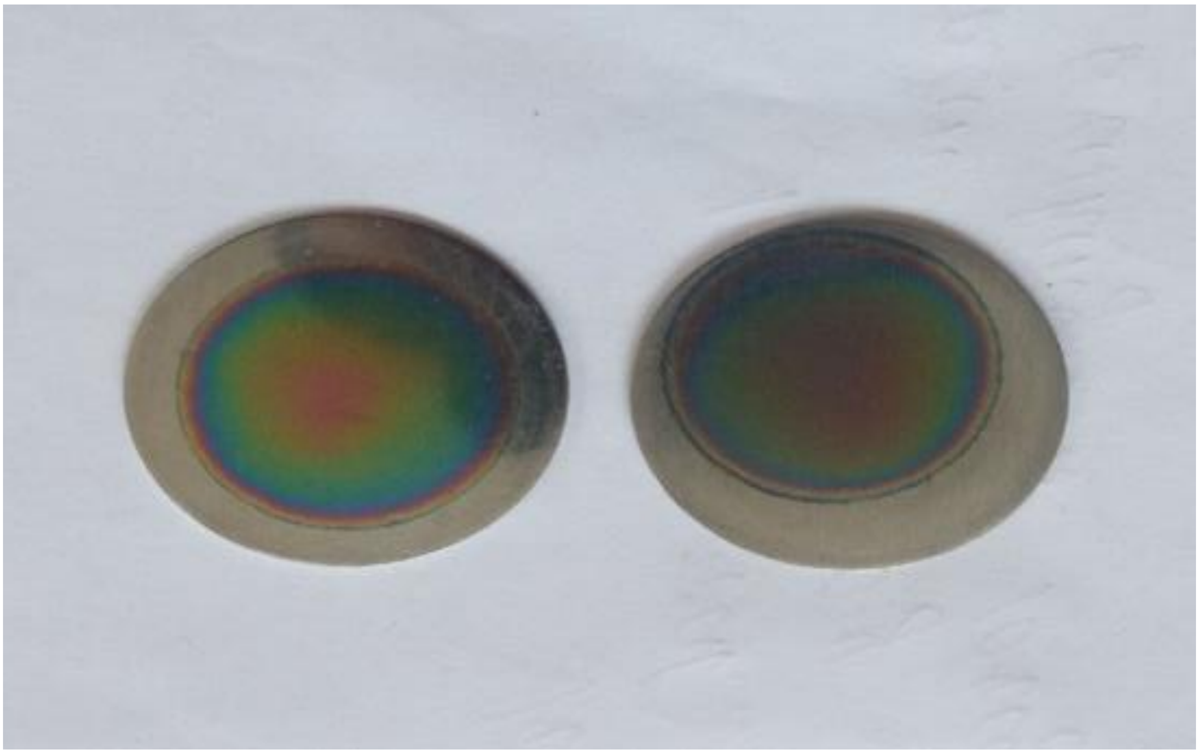
The diameter of the measuring filter is 6-6.5 cm. Measurements of aerosols in the air are carried out on the AFA VP-20 aspiration filter through the PVP-04 A aspirator. After a certain time, the decay of short-lived radionuclides is determined.

Equivalent value of radon volume activity at equilibrium (EVRVAEQ) in the working areas was studied on the measuring device "Alfarad plus" (see figure 3.6).

If total alpha, beta activity, isotope analysis is determined in water, EDG, relative alpha activity, beta activity are determined in soil, and the annual effective dose is calculated based on these values. According to Sanitary norms and rules 0193-06 (Sanitary norms and rules 0193-06), the maximum annual effective dose is 1.0 *mZv*/year for the population, 5.0 *mZv/year* and 20.0 *mZv/yea*r for workers in categories B and A. set at the limit of the year.



a)



б)

Fig. 3.6-a and b. The process of measuring the equivalent value of the volume activity of radon in the working areas in the "Alfarad plus" measuring device.

The annual effective dose of all radioactive factors consists of the following components.

$$\sum E = E_1 + E_2 + E_3 + E_4 + E_5 \qquad (3.4)$$

This E_1 is the annual effective dose of gamma radiation

$$E_1 = 6{,}18 \cdot 10^{-6} (R_\gamma - R_f) \cdot T, mSv / year \qquad (3.5)$$

R_γ - the annual average value of the effective dose power of gamma radiation at a height of 1m above ground level and floor in workplaces in buildings;

R_f - the background value of the effective dosage power at a height of 1 m above the ground in the buildings of enterprises or open spaces where workers of categories A and B work;

E_2 - effective dose of internal radiation due to equivalent equilibrium volumetric activity (EMHF) [38; pp. 262–266].

$$E_2 = 2{,}29 \cdot 10^{-10}(S_r - S_{rf}) \cdot T, mSV / year \quad (3.6)$$

taking into account the effective dose of internal radiation;

S_r - average annual costs or acceptable limit of EMHF at the workplace;

S_{rf} - collecting the relative activity and background value of long-lived alpha nuclei;

E_3 - activity of long-term alpha nuclei, aerosol fractions in the air

$$E_3 = 3{,}18 \cdot 10^{-2} T((S_1 - R_1 \cdot S_2) - (1 - R_1) \cdot S_3), mSv / year \quad (3.7)$$

S_1 - average annual total alpha activity of long-lived alpha-nuclides in atmospheric air in the enterprise building;

S_2 , S_3 - specific alpha-activity and cumulative value of long-term alpha-nuclides in the enterprise building;

R_1 - probability of wind speed up to 3 m/s in the inspected facility;

T - radiation time during the year;

E_4 -the effective dose of internal radiation received due to the activity of drinking water. In the Navoi region, the value of the annual effective dose does not exceed 20 per year.

$$E_4 = m \cdot A_{sol} \quad (3.8)$$

E_5 - effective comparative activity of natural radionuclides in soil samples in the working area $A_{sam.sol.active}$ (Bq/kg).

$$A_{sam.sol.faol} = 0{,}09 \cdot A_{K40} + A_{Ra226} + 1{,}31 A_{Th232} (Bq / kg) \quad (3.9)$$

In order to determine the annual effective dose, the monitoring of experts of industrial enterprises contaminated with radiation in the following years made it possible to choose methods to minimize the annual effective dose of workers and to replace workers in time, and as a result, the most dangerous production radiation factors affecting workers have an effect of 8-10% of the annual effective dose power. allowed to reduce to As a result of repeated observations over the years, the value of the exposure dose rate was determined at more than 30 observation points and at different distances from the radiation source. The annual effective dose was calculated based on the measurement of the exposure dose rate at different observation points, the equilibrium value of the volumetric activity of radon over 100 values of long-lived alpha-nuclides [38; pp. 262–266, 45.].

Table 2.8 presents the results of dosimetric measurements performed at observation points and industrial enterprises.

Table 3.7

Results of dosimetric measurements conducted at observation points and settlements of industrial enterprises.

Sample	**Number of measurements**	**EDG, *μZv/h***		**LLAN, mBq/m^3**		**EEVP, Bq/m^3**		**Annual effective dose, *mZv/year***
		The specified value						
		min	**max**	**min**	**max**	**min**	**max**	
1.	15	0,19	0,67	2.2	3.8	5	24	1.21-8.43
2.	23	0,18	0,64	2.1	2.8	2.1	18	2.10-7.17
3.	17	0,16	0,36	1,2	2.4	4.0	14	0,53-5,36
4.	21	0,18	0,63	3.2	4.4	4.0	23	1.43-6.34
5.	18	0,16	0,56	2.2	3.7	5.0	23	1.42-6.31
6.	14	0,18	0,63	1,8	2,3	7	30	1,14-7,3
7.	12	0,16	0,64	2,1	2,4	3,4	24	1,22-8,4
8.	20	0,17	0,36	1,6	2,1	8	32	1,51-9,4

Note:- observation points of industrial enterprises,

3.5. Radiometric analysis of industrial wastewater and aquatic plants.

Cyanides, like radiation agents, are among the most potent occupational hazards. Cyanides are usually thought of as highly toxic compounds in the environment, commonly known as cyanogenic microbes (bacteria, plants, fungi). The mining industry has been using cyanide to extract gold and silver for over a century (since 1887). By increasing the volume of processing of ores from local mines, by the method of selective melting of heaps, a steady growth trend of cyanide consumption is observed in the world, including in Uzbekistan, 3 million tons of cyanide are used annually in the industry [107; pp. 1–6].

The maximum permissible concentration of CN- and their complexes in the world is 0.05 mg/l, in Uzbekistan - 0.1 mg/l.

Cyanides are widespread in the plant world and perform a protective function in plant-fungi and animal interactions, which is an example of chemical regulation of interspecies interactions. More than 2,000 plant species have been found to have the ability to synthesize cyanogenesis - glycosides. The source of hydrocyanic acid synthesis in plants is from sugars or amino acids cyanohydrins formed from their derivatives, in particular, phenylalanine, tyrosine [107; 1-6 p., 114; 1-6 p., 116; p. 192].

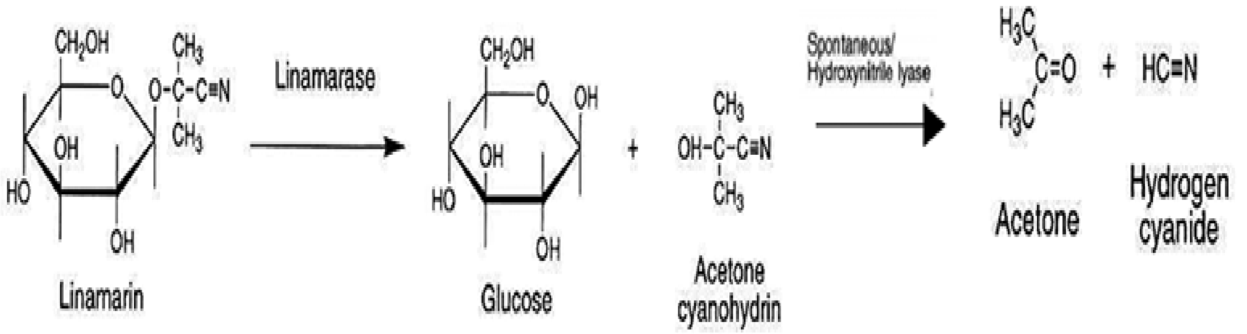
The main biological function of cyanogenic glucosides is the protection of plants from the effects of certain animals (attacks of insects or herbivores). The release of cyanides occurs when the plant is affected by phytopathogenic fungi and when the plant is destroyed by predators.

Poisoning of animals and humans caused by the consumption of cyanogenic plants or food products can cause rapid and acute disruption of the mitochondrial respiratory system, resulting in death. Chronic consumption of plants with low levels of cyanogenic glycosides may cause damage mainly to the nervous system [107; pp. 1–6].

The ecological role of cyanogenic glycosides is that they provide partial, if not complete, protection against attack by many animals. It was found that sheep and other animals prefer to eat the non-cyanogenic form of plants, rodents avoid eating seeds of plants with cyanoglycosides, and ants do not settle on trees rich in these substances.

Normally, hydrogen cyanide from cyanogenic glycosides present in food is released during chewing and digestion. About 25 cyanogenic glycosides are known, and they are usually found in the chewy parts of plants such as apples, apricots, cherries, peaches, plums, and quinces, especially in the seeds of such fruits. The chemical is also found in almonds, seeds, bamboo shoots, flax seeds, beans, peas, etc. Maximum amounts of cyanogenic glycosides were found in plant families such as Fabaceae, Rosaceae, Leguminosae, Linaceae and Compositae. Cyanogenic glycoside itself is not toxic. However, when plant cell structures are destroyed, cyanogenic glycoside undergoes hydrolysis under the action of β-glucosidases.

During hydrolysis, sugar and cyanohydrin are formed, which spontaneously decompose into NCN and a ketone or aldehyde.



The toxicity of cyanogenic glycosides depends on the concentration of cyanide produced and can cause acute or chronic poisoning, so the consumption of canned and other improperly processed foods can cause tropical atoxic neuropathy, including optic atrophy, neurosensory deafness. Sensory gait ataxia, growth retardation, goiter, clinical symptoms of cyanide toxicity include vomiting, nausea, dizziness, abdominal pain, weakness, headache, diarrhea, and sometimes death [107; pp. 1–6].

Through the formation of NSN, it was observed that protection is not limited to vegetables. It is a defense mechanism in millipedes to repel ant attacks, and some brightly colored butterflies also produce NSN at all stages of their life cycle to protect themselves from predators. Many studies have shown that some species of farm animals and molluscs are adapted to NSN and are able to detoxify cyanides with the presence of the enzyme rhodanase (thiosulfate serotransferase), which catalyzes the cyanide detoxification cycle.

The source of sulfur is β-mercaptopurine acid HCH2COCOOH, which in turn turns into pyruvate. A similar reaction occurs in the treatment of cyanide poisoning, where sodium thiosulfate is used as an antidote.

(3.10)

Rhodanase (thiosulfate serotransferase) has been widely studied in animal organisms and microorganisms [16; pp. 65–70] but little studied in plants.
There is also a method of enzymatic hydrolysis of cyanides in living organisms, catalyzed by cyanide hydratase (formamide hydrolysis).

$$HCN + H_2O \rightarrow HCONH_2 \quad (3.11)$$

Cyanide hydratase was first discovered by St. derived from Latin. (Lutus corniculatu phytopathogenic fungi). This enzyme has also been found in some other fungi, including: F. solani, Gl. Sorghi and others. It is characteristic of fungi, and fungi serve as a basis for microbial wastewater treatment of cyanides [57; pp. 63–75, 107; pp. 1–6].

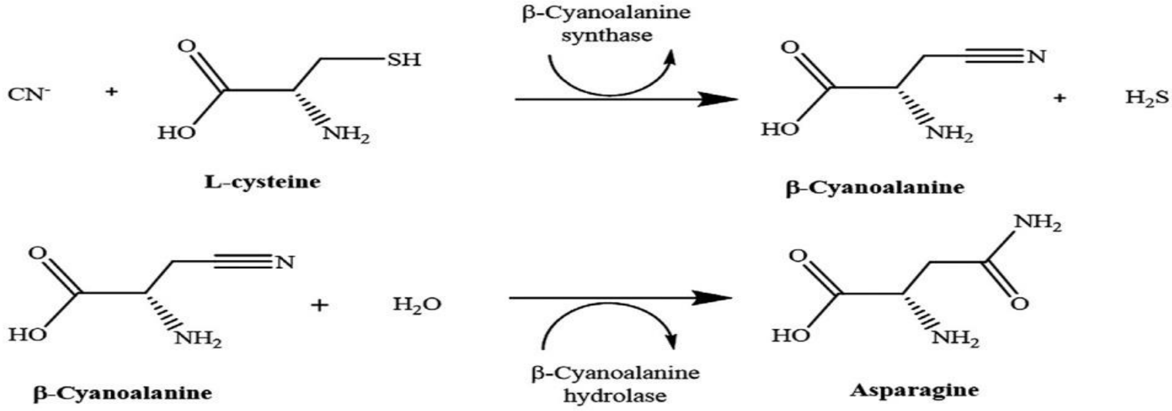
Formamide produced by the radioisotope method was found to be hydrolyzed to formic acid and ammonia, which is then dehydrated to CO2.

$$HCNHCONH_2 \rightarrow HCOOH + NH_3 \rightarrow CO_2 \quad (2.12)$$

A number of authors have found that in higher plants, mainly legumes, as well as in some fungi, the cyanide carbon is incorporated into the carboxyl group of asparagine. B - cyanoalanine is an intermediate product in the process of assimilation of cyanide in plants. An enzyme that catalyzes the synthesis of β-cyanoalanine (non-proteinogenic amino acids) from L-cysteine and cyanide

It is called β-cyanoalanine synthase.

β-cyanoalanine synthase (β-SAS) is a pridoxalga (vitamin B6)-dependent lens (enzymes) that catalyzes the β-substitution of electrophilic groups in the β-state according to the equation.



Currently, the scientifically known β-cyanoalanine synthase is intensively studied in Uzbekistan and abroad [107; pp. 1–6].

The enzyme was isolated from plants belonging to many families, its properties and properties were studied. β - cyanoalanine synthase is a highly toxic compound, and undergoes further transformation in plants under the catalysis of β - cyanoalanine hydratase (β -SAG) with the formation of an important amino acid - asparagine.

With the task of selecting the most useful plants for the purification facilities of the gold mining enterprises of the Republic of Uzbekistan, the possibilities of photorefining of various types of aquatic plants were studied, in particular, in the lower reaches, shores and streams of the Zarafshon River. Aquatic Plants Reed Phragmitesaustraliss Cav Trin. ex Steud, cattails Tyypha latifolia L., T. angustifolia L, umbelliferae Butoomus umbellatus L, lake reed Sccirpus lacustris L, spicata Myriophylilum spicatum L, hornwort dark green and semi-submerged Ceratouphyllummeris, P. L., P., P. natans L. , P. perfoliatous L., charovaceae Chara vulgariss L., Ch. fragilis Desv., Ch. dominii Vilh algae have received special attention because they form extensive thickets on the bottom of shallow and still water bodies. Hydrophytes (Charophyta) significantly influence the dynamics of environmental conditions for many types of aquatic organisms. In the process of growth, water is checked during photosynthesis, lime is deposited in their thallus. In most cases, a combination of microorganisms, including the smallest periphyton of plants and algae, bacteria, simple animals and fungi develop in the outer part of plant thalli [20; pp. 4159–4176, 46; 107; pp. 1–6].

Plants were collected in growing areas, sorted by species, thoroughly washed, and an average sample was taken. In the buffer solution, the level of activity of β-cyanoalanine synthase and β-cyanohydratase was determined according to the method presented in the work [93; pp. 41–43].

When studying the properties of β-SAS in aquatic plants, it was found that its properties are fundamentally different from the properties of the enzyme in terrestrial plants. β-SAS is a cytoplasmic enzyme rather than a mitochondrial enzyme in aquatic plants. This allows aquatic plants to instantly use exogenous cyanide from outside. It was found that β-SAS of aquatic plants depends on the pH and the nature of the buffer, the greatest activity of the reaction with NSN is observed in 0.2 M pyrophosphate buffer at a pH of 8.8.

In order to select the most effective cyanidating species of aquatic plants, screening studies were conducted to evaluate the enzymatic activity of aquatic plants found in the water bodies of Uzbekistan.

It was found that the level of activity of pyridoxal-dependent lenses does not depend on the age and season of the year, it is higher in the leaves of flowering plants than in the stem. There is a significant difference in enzyme activity in plants of the same species but grown in different environmental conditions. Plants growing in water bodies with increased insolation show high activity, in particular, a comparison of three types of algae was made in the Zarafshan River [46; 108; pp. 1–6].

β -SAS activity is related to β -SAG activity. With high activity of β-SAS, a high level of β-SAG activity is determined (Table 3.7). The process of detoxification of cyanides ends with the formation of non-toxic metabolites of asparagine, so the high toxic resistance of aquatic plants to cyanides was determined.

A concentration of 100 mg/l of sodium cyanide was found to have no effect on plant growth responses. At concentrations of 1-50 mg/l, on the contrary, rapid growth of plants and increase in protein content, as well as the level of enzymatic activity of the studied enzymes are observed.

Table 3.7

Results of evaluation of activity level of two related enzymes β -SAS and β -SAG neutralizing cyanide.

The name of the plant	β -SAS activity, nMol H2S min-1 mg-1 protein	β -SAG activity, nMol min-1 mg-1 protein
Fully submerged - hydatophytes		
Nitella hyaline (DC.) Ag	4.5	1.8
Chara aculeolata Kütz	6.8	2.8
Chara tomentosa L	8.1	1.9
Myriophyllum spicatum L	1,2	0,9
Hornwort yashil	1,2	0,6
Potamogeton filiformis Pers	0,8	0.2
Potamogeton pectinatus L.	0,8	0,6
Floating leaves		
Butomus umbellatus L	5.6	1.5
Southern cane	2.4	1.9
Broad-leaved cattail	3.2	7.0
Typha angustifolia L.	3.6	3.2

Experimentally, using mathematical planning of experiments, it was found that the induction of β-SAS in algae is described by the regression equation.

$$Y = 2{,}01 + 0{,}07X_1 + 0{,}09X_2 - 0{,}13X_3 - 0{,}05X_{12} - 0{,}1X_{22} - 0{,}15X_{33} \quad (3.13)$$

In this, X_1 - cyanide dose, X_2 - pH, X_3 - temperature.

By knowing the level of β-SAS activity, the environmental conditions (pH and temperature) in the water reservoir, the dose of metabolized cyanide can be calculated assimilation capacity of phytoremediation treatment plants.

In order to activate the processes of purification of wastewater from cyanides, it is recommended to plant seaweed directly in the landfill, reeds and sedges along the coast. To determine the absorption capacity of structures, it is necessary to calculate using the proposed equation.

3.6. Promising technologies for wastewater treatment of gold mining tailings dumps in Uzbekistan

Currently, Uzbekistan firmly occupies a leading position in the production and sale of gold on the world market. In the Navoi region in the Kyzylkum desert is the world's largest Murutau mine, which ranks second in the world in annual gold production, more than 60 tons, and the Navoi MMC. NMMC units are located in regions with high (40-80%), extremely high (more than 80%) water scarcity and in arid, low-water areas. The company carries out water intake from the Amu Darya, Zerafshan, Tusunsai reservoir and water intake artesian wells.

The analysis of the long-term water management situation in the Zarafshan river basin shows that with the existing level of agricultural production, machinery, technology and organization of water management, the water resources of the river are completely exhausted. It was found that in the formation below Navoi, there are significant exceedances of MPC for total mineralization, copper, phenols and petroleum products, as well as nitrogen salts (nitrates, nitrites, ammonium). The sources of pollution of the Zarafshan River are the constantly increasing anthropogenic load caused by the increase in population in the territory due to the growth of industrial production, an increase in water intake for agricultural, industrial, municipal and other needs of the region; inefficient operation of hydro-reclamation systems and discharge of highly mineralized, polluted collector-drainage waters of irrigated territories of the Samarkand and Navoi regions, poor-quality treatment of industrial and wastewater waters.

In an arid climate, the total water consumption of NMMC is approximately 121.3 million m^3, and wastewater discharge is 12.3 m^3. In general, wastewater disposal is dominated by normatively purified by biological treatment - 60%, the rest is water discharged to the relief and irrigation, conditionally clean or insufficiently purified water. Suspended substances, nitrogen salts, sulfates, chlorides, phosphates, petroleum products, heavy metals, BOD are allocated to the list of priority potentially hazardous substances in wastewater. The system of reuse of industrial and treated municipal wastewater for technological needs works effectively at NMMC. As part of the gold production technology, up to 7 million m3 is used annually.

The company is extremely interested in improving the closed water circulation system with the use of modern biotechnological solutions and allocates funds for research in this direction with the involvement of both well-known specialists in this area and young scientists from universities in Navoi

Recently, traditional methods of wastewater treatment and post-treatment have been supplemented with new promising bioremediation technologies based on the use of aquatic plants. These technologies are also used for ecological reconstruction of water bodies.

Water treatment systems built on the principles of bioremediation belong to the class of new water protection structures, which are swamp-like systems similar to the natural landscape. In such facilities, purification occurs due to the accumulation and metabolic transformations of pollutants both directly in the biomass of plants and microbial communities developing in the root zone and other substrates in the aquatic environment.

Similar treatment systems in the world today are called constructed wetlands, bioplato, PSS (phyto-cleaning systems or structures), BIS (bioengineering structures). They may differ structurally, but when polluted water passes through plant thickets, the root layer and the filter loading, it is cleaned during natural processes to an environmentally acceptable state and can be safely dumped into reservoirs.

Such purification technologies are quite effectively used in the treatment of domestic wastewater, surface water, agricultural and food production wastewater. The first artificial wastewater treatment facilities based on natural mechanisms were created in Australia at the beginning of the XX century. Research in this area began in Europe in the 1950 s, and in the USA in the 1970s. After that, phytotechnologies for wastewater treatment began to develop massively in many countries due to the availability and relatively high efficiency of wastewater treatment and low cost. Currently, this technology is becoming extremely popular and similar structures are being built in different natural climatic zones from Norway to Australia. The number of scientific research and publications is growing exponentially, these technologies are very popular in China and other countries of Southeast Asia and Oceania, North America, Europe. The possibilities of using this technology are evaluated for industrial wastewater from various industries.

The purpose of this work is to summarize modern data on the use of wastewater bioremediation technologies at mining enterprises and to assess the prospects for using such technology at NMMC.

Objects and methods of research

The paper summarizes the literature data on the implementation of bioremediation technology at mining enterprises in Russia and other countries, as well as experimental studies to assess the purification functions of plants growing in Uzbekistan in laboratory modeling using real wastewater from the ponds of the GMZ-2 and GMZ-3 NMMC tailings ponds.

The experiments used aquatic plants listed in the PHYTOREM database created by the Department for the Use of Environmental Biotechnologies in Hal (Quebec, Canada), This database contains information on terrestrial and aquatic plants of the world that have phytoremediation potential for heavy metals such as aluminum, beryllium, cadmium, cobalt, manganese, copper, molybdenum, arsenic, nickel, palladium, platinum, radium, mercury, lead, strontium, uranium, chromium, caesium and zinc.

This database was created using a wide computer search of published scientific research and refereed commercial services using keyword search and cross-references with 19 of the above-mentioned elements. The database contains 775 registered plant species belonging to 76 families, 39 orders and 9 subclasses. It contains not only vascular plants, further subdivided into flowering plants, conifers, ferns and related species, but also other organisms such as bacteria, algae, lichens, fungi and bryophytes (mosses and liverworts). Currently, this database is constantly being updated, as research is conducted mainly on the local flora.

Botanical studies have established that the flora of the Zarafshan River in the middle reaches is represented by 331 species of algae belonging to 5 departments (Cyanophyta, Bacillariophyta, Dinophyta, Euglenophyta, Chlorophyta). Of these, 29.3% belong to indicator-saprobic types, which can be used to judge the level of water pollution.

The higher aquatic and wetland plants of the Zaravshan River are represented by 22 species of hygrophytes from the genera: Imperata, Erianthus, Cetaria, Digraphis, Juncus, Epipactis, Poligonum, Potentilla, Trifolium, Epilobium, Calystegia, Mentha, Plantago, Bidens, Taraxacum; 12 species of hydrophytes of the genera Salvinia, Typha, Sparganium, Alisma, Sagittaria, Butomus, Phragmites, Cyperus, Papyrus, Batrachium, Nasturtium; and 16 species of hydatophytes from the genus Chara. In coastal zones grow: southern reed (Phragmites australis (Cav.) Trin. ex Steud.), holly (Typha angustifolia L., T.latifolia L.), umbrella sedge (Butomus umbellatus L.), lake fold (Scirpus lacustris L.), prickly yurt (Myriophyllum spicatum L.), hornwort dark green (Ceratophyllum demersum L.), algae (Potamogeton pectinatus L., P. natans L., P. perfoliatus L.), creeping clover (Trifolium L.) and algae (Chara vulgaris L., Ch. fragilis Desv., Ch. dominii Vilh.), etc.In the work, the cleansing functions of the plants presented in Fig. 1 were studied.

Fig. 3.8 Studied plants 1- eichornia (water hyacinth) 2- azolla karolinska; 3- pistia; 4- duckweed small.

Fig. 3.9 Cultivation of eichornia and pistia in the open air

Eichhornia (Eichhornia crassipes (Solms.), Pontederiaceae) grows on the surface of water, its spoon-shaped smooth glossy greenish leaves are oval in shape, the edges are smooth, with clearly distinguished venation. The aerenchyma located at the base of the leaf ensures the suspended state of the plant on the surface of the water.

The hairs of the fibrous root have a dichotomous branching. Lateral roots of the first order develop from the base of the stem, fused with 15-20 leaf sheaths. The lateral roots of the second order with a length of 2.5 cm are located horizontally on the surface of the water.

Azolla caroliniana (Azolla caroliniana (Willd.), Azolla Seae) is a small (1-5 cm) surface-floating aquatic fern, growing on the surface of the water, the length reaches 0.7-1.8 cm. The upper part of the sporophyte is covered with two rows of small (0.5 - 1 mm) leaves like scales, and roots 2.0-2.5 cm long are formed in the lower part. In the structure of the leaf, they have reached a high development, that is, each leaf consists of two segments: the upper segment of green color is located on the surface of the water, the lower segment is located under water and serves to absorb substances dissolved in water. Sometimes in overripe plants, spore sacs are located in this part. The optimal period for reproduction of Azolla Karolinska is considered to be July – September, since in these months the plant forms 250-300 g/m2 of biomass per day

Pistia (Pistia stratiotes (L.), Araceae) in the conditions of introduction has a length of 20-40 cm, with a shortened stem (5-8 cm), leaves (15-22 cm long) are flat-shaped. The leaves growing from the rosette of the root form a thick bundle, the upper part is green, in the longitudinal section they have linear deep traces. The entire surface of the leaf blade is covered with thick multicellular transparent hairs. The lower part of the leaves have a light green color, from which 9-12 thin filamentous fibers originate. The aerenchyma of the leaves of the plant is well developed, which ensures that the plant is suspended on the surface of the water. The roots of the pistia are spongy, 30-60 cm long, covered with many transparent ciliated hairs

Duckweed small (Lemna minor (L.), Lemnaceae) is an aquatic plant of small size, its leaf–like stems are 2-4.5 mm long and 2-3 mm wide. Under each leaf there is a thin spine, the length of which reaches 5-7 cm. The upper part of the leaves of the duckweed is slightly convex, green in color, the lower part of the leaves is lighter in color. The body of the plant consists of 3-6 foxlets, floating in bundles on the surface of the water.

Under laboratory modeling conditions, 15 liters of the studied wastewater and aquatic plants were introduced into aquariums at a rate of 1 to 10 g/l, exposed to light and at certain intervals water samples were taken and the residual content of the studied wastewater components was analyzed. The physiological state of aquatic plants was assessed by the movement of chloroplasts, the appearance of plants and the content of chlorophyll, the activity of enzymes from the class of oxidoreductases and

The initial wastewater was taken from the ponds of the GMZ-2 and GMZ-3 tailings ponds (Fig.3).

Fig. 3.10 Place of sampling wastewater tailings GMZ-3

The analysis of the chemical composition of wastewater was performed by an accredited laboratory of water problems at the NMMC Central Research Institute. Table 3.8 shows the average chemical composition of wastewater

Table 3.8

Chemical composition of wastewater GMZ-3

№	Samples	pH	NaCN	SiO_2	Ca	Mg	Na	K	Fe_{um}	Cu	Zn	Pb	Mn	Ni
			mg/dm^3											
1	KEMIKS GMZ-3 tail Filtrate	9,4	<10,0	38,3	801,6	<10,0	1465	72,0	24,4	14,0	1,65	0,14	0,08	1,6
2	Water of the GMZ-3 tail farm	7,3	<10,0	5,0	531,0	534,7	1133	209,0	0,06	2,8	<0,1	0,16	0,03	8,4

№	Samples	Co	Cr	Al	Cl	CO3	HCO3	NO2	NO3	SCN	As	Weighing A substance	SO4
		mg/dm3										g/dm3	
1	KEMIKS GMZ-3 tail Filtrate	0,26	0,05	<10,0	1276,2	364,7	<5,0	0,38	6,7	1299,4	<2,0	1,5	3,1
2	Water of the GMZ-3 tail farm	2,1	0,06	<10,0	779,9	<5,0	210,1	0,24	6,6	340,0	<2,0	<0,05	5,2

Natural processes of self-healing and self-purification that have existed for millions of years have supported and ensured the viability of the natural environment, but now they can no longer cope with the enormous load and it is necessary to create conditions for their implementation. A complex of methods for water and soil purification based on the use of the biochemical potential of microorganisms (bacteria, fungi), algae and higher aquatic plants, called bioremediation, has been studied in recent years for use in the mining industry.

Bioremediation technology has been developed for the conditions of the northern territories of Russia - the Murmansk region for the Olenegorsky Mining and Processing Plant (JSC "Olkon"), which develops deposits of the Zaimandrovsky iron ore district. Mining of rock mass is carried out in an open and combined way using a wide range of explosives based on nitrogenous compounds, the content of which can reach more than 1% in the discharged mine and quarry waters. Designs of floating phytomodules with the used local species of aquatic plants have been proposed and implemented for wastewater treatment. Designs for devices for fixing aquatic plants in phyto-purification plants, such as phytomats, garden phytomodules, and phytotubuses, as well as combinations of plant phytocenoses for wastewater treatment of mining enterprises, are proposed.

Phyto-treatment facilities are also applicable for the treatment of waste water from tailings dumps. In particular, tested technologies for phytoremediation of wastewater from gold recovery factories (Buryatzoloto, Baleizoloto. Eastern Siberia, Angrenskaya ZIF, Uzbekistan), enterprises for the extraction and processing of copper ores (Karabash industrial complex, Southern Urals). At the same time, the mechanisms of detoxification of the most dangerous components of tailings wastewater have been studied in detail.

Unlike the gold mining facilities studied earlier, the tailing dumps of the Novaiysky MMC are located in arid climate zones and the qualitative composition of their wastewater significantly differs in total salinity, heavy metals, cyanides and rhodanides. The total salinity (dry residue) of the studied wastewater was 8.1 – 8.7 g/l.

To assess the prospects and feasibility of introducing biotechnologies for wastewater disposal, the ZIF studied the ability of local vegetation species found in the Zarafshan River valley to extract wastewater components in a laboratory experiment.

Table 3.9 shows the results of evaluating the effectiveness of purification from the main components of wastewater in a laboratory experiment in plastic containers with a volume of 10 liters and introduced plant biomass at the rate of 500 g/m2 (Fig.3,4) at an exposure of 10 days

Fig. 3.11 Laboratory tests of the purification potential of aquatic plants in the laboratory of

water problems of CSRL NMMC

Fig. 3.12 The condition of the studied plants after 1 day and 10 days

Table 2. Efficiency of wastewater treatment from the GMZ-3 tailings dump, % (experimental conditions 10 liters of wastewater, 500 g/m2 of plants, initial pH 8.5 , illumination during the day ranged from 2000 to 5000 lux, air temperature from 25 to 350C, water from 21 to 260C, exposure -10 days, the initial content of anions and cations (mg/l): cyanide -10; rhodanide 300; chloride -780; carbonate-5; nitrite and nitrate- 6.8; sulfates- 5.2; calcium-531; magnesium-534; sodium- 1133; potassium-209; iron-0.06; copper -2.8; zinc-0.1; lead-16; nickel-8.4; cobalt-2.1; chromium-0.06; aluminum-10)/

Table 3.9

The plant	cyanide	rodanide	chloride	carbonate	nitrate	sulfate	Cr	Al
eichornia	93,4	78,7	95,1	100,0	56,5	71,2	4,2	86,1
pistia	68,4	68,6	87,5	100,0	53,8	73,2	2,3	67,3
duckweed	65,4	65.7	56,7	98,0	45,5	65,7	1,3	56,3
azola	36,8	68,9	76,5	96,9	43,9	69,3	0,7	64,4

The plant	Ca	Mg	Na	K	Fe	Cu	Zn	Mn	Pb	Ni	Co
eichornia	9,2	31,9	75,5	85,1	83,4	72,1	70,2	15,3	25,4	77,6	12,3
pistia	11,3	31,4	74,4	84,3	73,4	65,3	67,5	12,3	14,4	65,6	3,6
duckweed	13,2	29,6	65,5	36,6	71,3	56,6	81,3	6,7	5,5	30,6	4,5
azola	8,6	28,3	5,3	47,4	48,5	38,5	65,4	0,9	3,4	4,5	0,6

As follows from the above data, the highest purification potential is characteristic of eichornia, it accumulates metals and metabolizes cyanides. We have previously proved that this particular plant is characterized by the presence of beta-cyanalaningiratase. Pistium and azole proved to be unstable to a high level of salinity, and they need to be adapted by additional application of organic substances, in particular sheep manure tested by us.

Based on the results of the research, it can be concluded that, among the tested plants, the highest indicators of phytoremediation were shown by eichornia (E. crassipes Solms.) and duckweed (L. minor L.), other plant species can be used in complex cleaning as auxiliary.

The next stage of the study will be semi-industrial tests in the conditions of a tailings dump and an assessment of the localization of macro- and microelements in plant tissues, the development of technical regulations for the technology.

SUMMARY OF CHAPTER III

1. Fire and explosion safety in underground mines of the mining industry was assessed and studied.

2. An assessment of the actual working conditions and environmental impact of workers involved in the exploration of gold and uranium mines was developed.

3. A mathematical model of professional and environmental risk monitoring in gold and uranium production processes in industrial conditions was developed.

4. Improved methods of analysis based on radiometric, X-ray, α, β, γ and mass spectrometric and dosimetric data were developed and used to estimate the value of radiation-contaminated production factors and their impact on the ecosystem.

5. Industrial wastewater was analyzed by radiometric analysis of aquatic plants. It was found that the activity level of pyridoxal-dependent lenses does not depend on the age and season of the year, it is higher in the leaves of flowering plants than in the stem.

CHAPTER IV. EXPERIMENTAL AND PRACTICAL RESULTS OF ECOLOGICAL MONITORING OF MINING INDUSTRY AREAS

4.1. Evaluation of the risk of explosion in the mining industry by "critical" ratios of various gas flows

After sampling and analyzing radiation and gas from gold and mining mines, the point of danger can be indicated on an explosion diagram. The direction of point movement depends on the flow rate of radiation, methane, fresh air and inert gas. In other words, the gas point moves as a result of the flow rate. At the same time, it is also clear that the "resultant direction" of the gas point can be towards or away from the explosive triangle. Therefore, there must be a "critical" ratio of various gases to the mine atmosphere, which in turn keeps the mine atmosphere in a minimally "non-explosive" condition. Thus, this coefficient can serve as an indicator for evaluating the explosive condition of the mine atmosphere. For this case, the "critical" ratio for the areas shown in Figure 3.1 was analyzed.

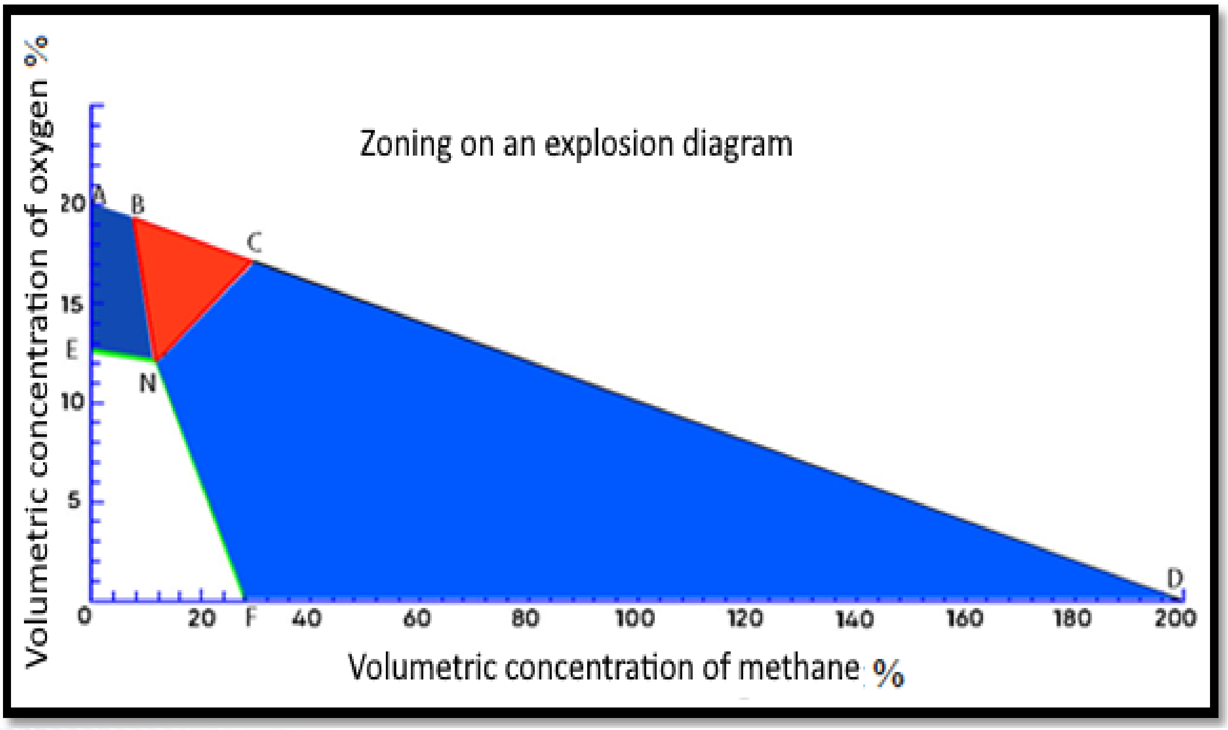


Figure 4.1. Exploded view zoning diagram.

Figure 3.2 (a) shows a sample of a gas that is not hazardous, but where the state point in this region is located in a region with a specific characteristic.

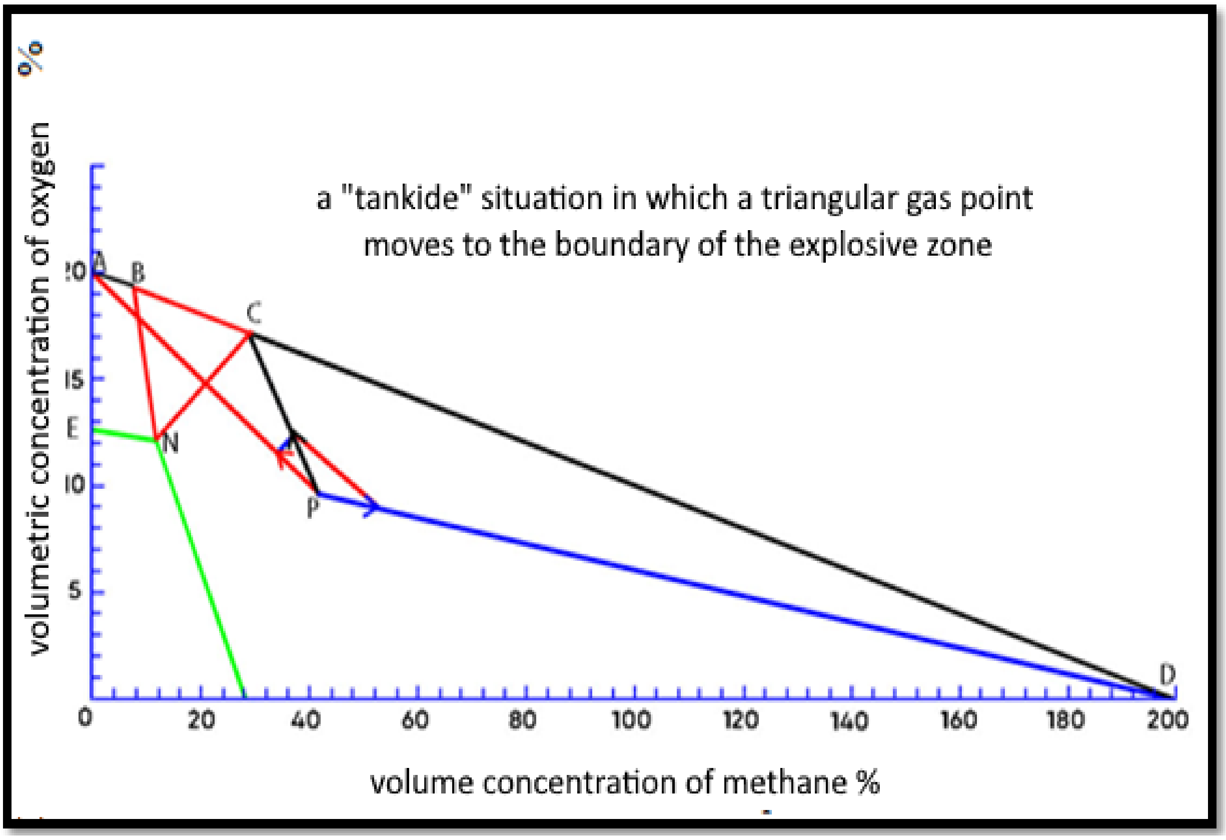


Figure 4.2. a) Scientifically based analysis of the "critical" situation in which the triangular gas point moves to the border of the explosive zone.

As can be seen in the figure, the direction of movement of the gas point depends on the speed of the flow of methane and fresh air to completely cover the explosion area and moves in the "effective direction", and as a result, the point can enter the explosive triangle, and vice versa, more methane can force the gas point out of the triangle. Therefore, there must be a "critical" situation where the gas sample can pass into the boundary of the explosive triangle, as shown at point "C" in this figure. We express this situation by the following formula (3.1).

$$\begin{cases} \cos(\angle CPD) = \dfrac{CP^2 + PD^2 - CD^2}{2 \cdot CP \cdot PD} \\ \cos(\angle CPA) = \dfrac{CP^2 + PA^2 - AC^2}{2 \cdot CP \cdot PD} \\ \dfrac{V_{air}}{\sin(\angle CPD)} = \dfrac{V_{CH_4}}{\sin(\angle CPA)} \end{cases} \quad (4.1)$$

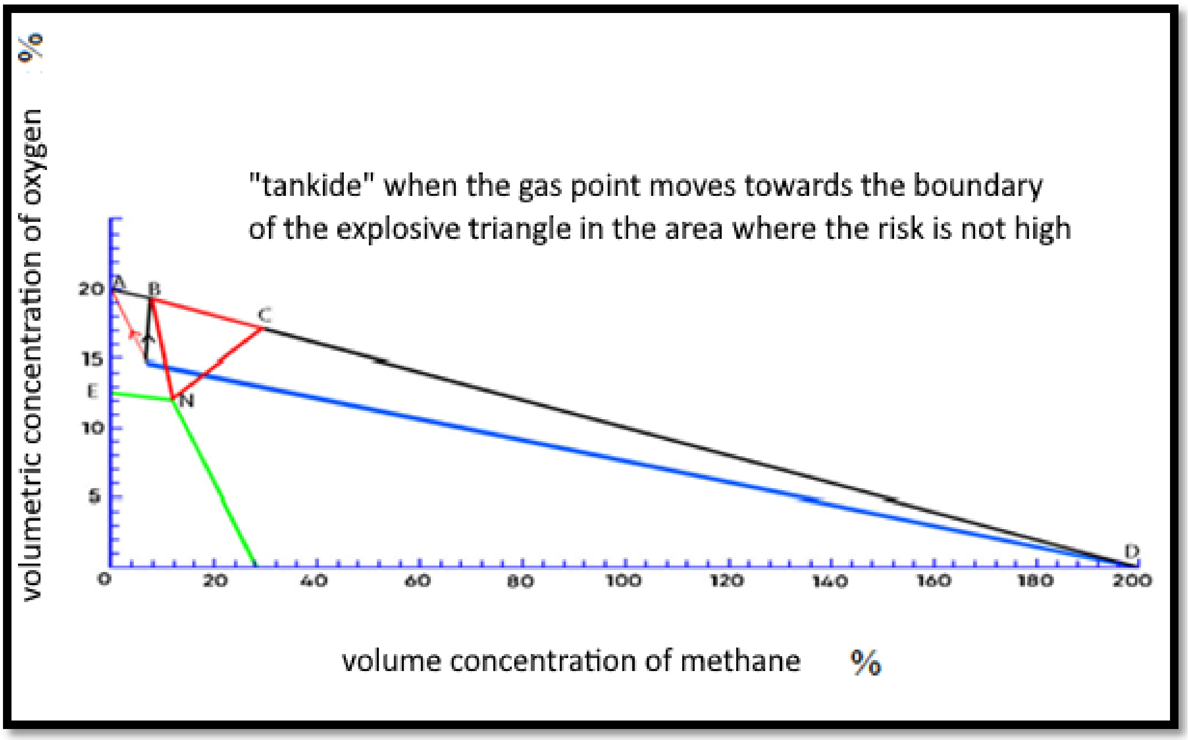


Figure 4.3. b) Diagram of the "critical" situation when the gas point moves towards the boundary of the explosive triangle in a non-high-risk area.

Therefore, the "critical" ratio in this region is equal to the methane flow rate of the fresh air flow. When this ratio is greater than "critical", it indicates that the gas point may move towards the triangle, and control measures for such a mine atmosphere will be ineffective. [33; p. 157–163; 77; 85; pp. 176–183, 112.].

Note that VAir and VCH4 are the volumetric flow rates of fresh air and methane mixed with the closed mine atmosphere. Therefore, the V_{Air} /V_{CH4} ratio can be obtained using the above system of equations. As more air is added or the methane content decreases, as the gas point moves toward the explosive triangle, there is a risk of an atmospheric explosion. Figure 3.2 (b) shows a gas sample located in a non-hazardous area. The direction of movement of the gas point is also completely dependent on the flow rate of methane and clean air and moves in the "resultant direction". If more methane is added, the gas point may move into the explosive triangle, whereas more fresh air may cause the gas point to move away from the triangle. Therefore, a "critical" situation may occur when the gas sample passes to the boundary of the explosive triangle, which is indicated by point "V" in the figure. Therefore, the "critical" ratio in this area is the consumption of methane for fresh air consumption. If the ratio is greater than critical, this indicates that the gas point is moving towards the "explosion" triangle. [33; p. 157–163;.]. We determine the ratio using the following formula (3.2)

$$\begin{cases} \cos(\angle \mathrm{BPD}) = \dfrac{\mathrm{BP}^2 + PD^2 - BD^2}{2 \cdot BP \cdot PD} \\ \cos(\angle \mathrm{APB}) = \dfrac{\mathrm{AP}^2 + PB^2 - AB^2}{2 \cdot AP \cdot PB} \\ \dfrac{V_{xaвo}}{\sin(\angle BPD)} = \dfrac{V_{CH_4}}{\sin(\angle APB)} \end{cases} \qquad (4.2)$$

The "critical" relationship can be expressed mathematically. The ratio V_{Air}/V_{CH4} can be obtained using the above system of equations. By adding more methane or reducing the amount of air, the atmosphere becomes more explosive as the gas point moves toward the explosive triangle.

In calculating the time required to convert a non-explosive atmosphere into an explosive atmosphere, the "resultant direction" of the gas point indicates the movement of the mine atmosphere on the explosion diagram. During additional research, the points of intersection of the mine atmosphere with the explosive triangle were obtained by extending the "direction of movement" line. This may indicate to us that the composition of the mine atmosphere can be known when it is "explosive". In this case, based on the consumption of methane or fresh air, the time required to convert a non-explosive atmosphere into an explosive atmosphere can be calculated.

In the non-hazardous or above non-hazardous area. Figure 3.3 shows a gas sample in (a) and (b). We used the following methods to calculate time:

Gas “point displacement”: Since the gas point moves in a “point direction” that depends on the methane and fresh air flow rates, gas point trajectories can be planned primarily considering only methane and fresh air effects.

After these results, the "direction in the result" can be determined. Let's assume that the coordinate "R" is (C, O), indicating that the concentration of methane is "C" and that of oxygen is "O". Equations (3.3) and (3.4) give methane concentration "CA" and oxygen concentration "CV" for which methane or fresh air is added per unit of time.

It should be remembered that the unit of time (T) used in the equations when performing calculations can be a random number. If "CA" and "CV" are known, the points "RA" and "RV" can be plotted and the "resulting direction of motion of the gas point" can be shown in the following formula.

$$C_A \frac{V_{CH_4} \cdot t + V_{total} \cdot C}{V_{CH_4} \cdot t + V_{total}} \tag{4.3}$$

$$C_B \frac{0.21 \cdot V_{air} \cdot t + V_{total} \cdot O}{0.21 \cdot V_{air} \cdot t + V_{total}} \tag{4.4}$$

When determining the point of intersection, we can expand the line "Direction of movement" and get the point of intersection of the mine-mine atmosphere with the explosive triangle, accordingly, we will be able to read the coordinate of "Explosives" (explosive).

The estimated time at which the output method used above can be used again is given by the following equation:

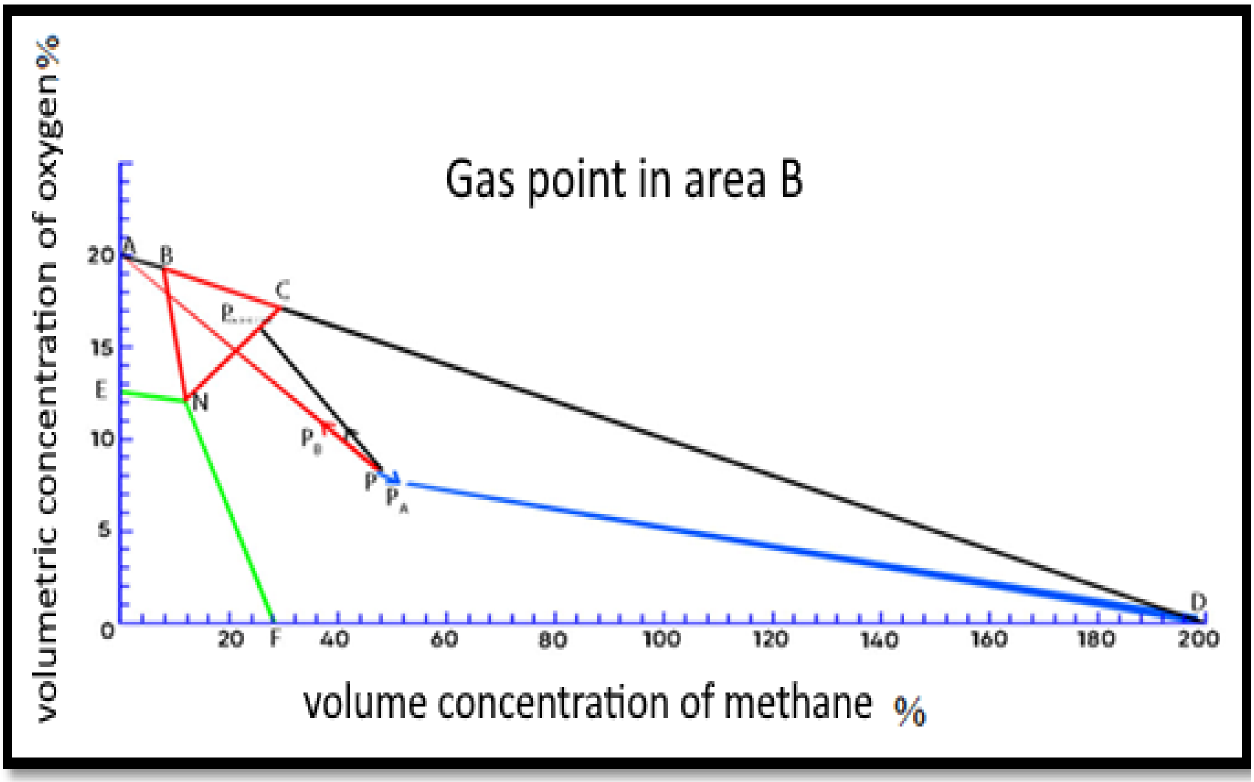
For non-hazardous area

$$C_{explosive} \frac{V_{CH_4} \cdot t_{must} + V_{total} \cdot C}{V_{CH_4} \cdot t_{must} \cdot V_{total} + V_{air} + t_{must}} \tag{4.5}$$

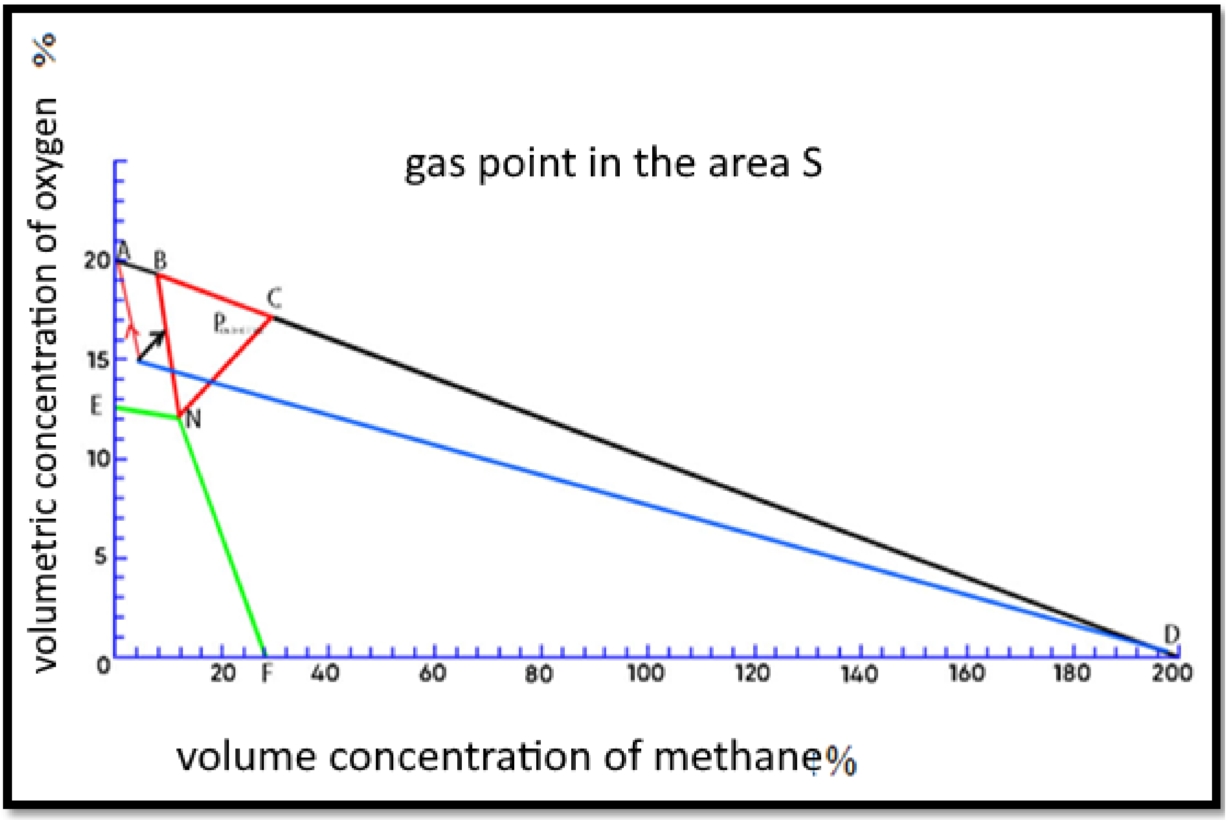
$$t_{must} \frac{V_{total} \cdot C_{explosive} - V_{total} \cdot C}{V_{CH_4} - V_{CH_4} \cdot C_{explosive} - V_{air} \cdot C_{explosive}} \tag{4.6}$$

$$O_{explosive} \frac{0.21 \cdot V_{air} \cdot t_{must} + V_{total} \cdot O}{0.21 \cdot V_{air} \cdot t_{must} \cdot V_{total} + V_{CPH_4} + t_{must}} \tag{4.7}$$

$$t_{must} \frac{V_{total} \cdot O_{explosive} - V_{total} \cdot O}{0.21 \cdot V_{air} - 0.21 \cdot V_{air} + O_{explosive} - V_{CH_4} \cdot O_{explosive}}$$



a)



b)

Figure 4.3 Diagram of movement of gas points towards the boundary of the explosive triangle: (a) gas point in area B and (b) gas point in area C.

4.2. Evaluation of explosion hazard reduction for explosive atmospheres.

It takes time for the explosive atmosphere to leave the explosive area. If an explosive atmosphere is inside an explosive triangle, how long would it take miners in the mining industry for such an environment to become self-explosive. Figure 3.4 shows a gas point inside a triangle. In gold mines, mine operators often inject inert gas into the atmosphere to reduce the risk of explosion. In addition, methane released from underground layers also changes the composition of the atmosphere. [33; pp. 157–163].

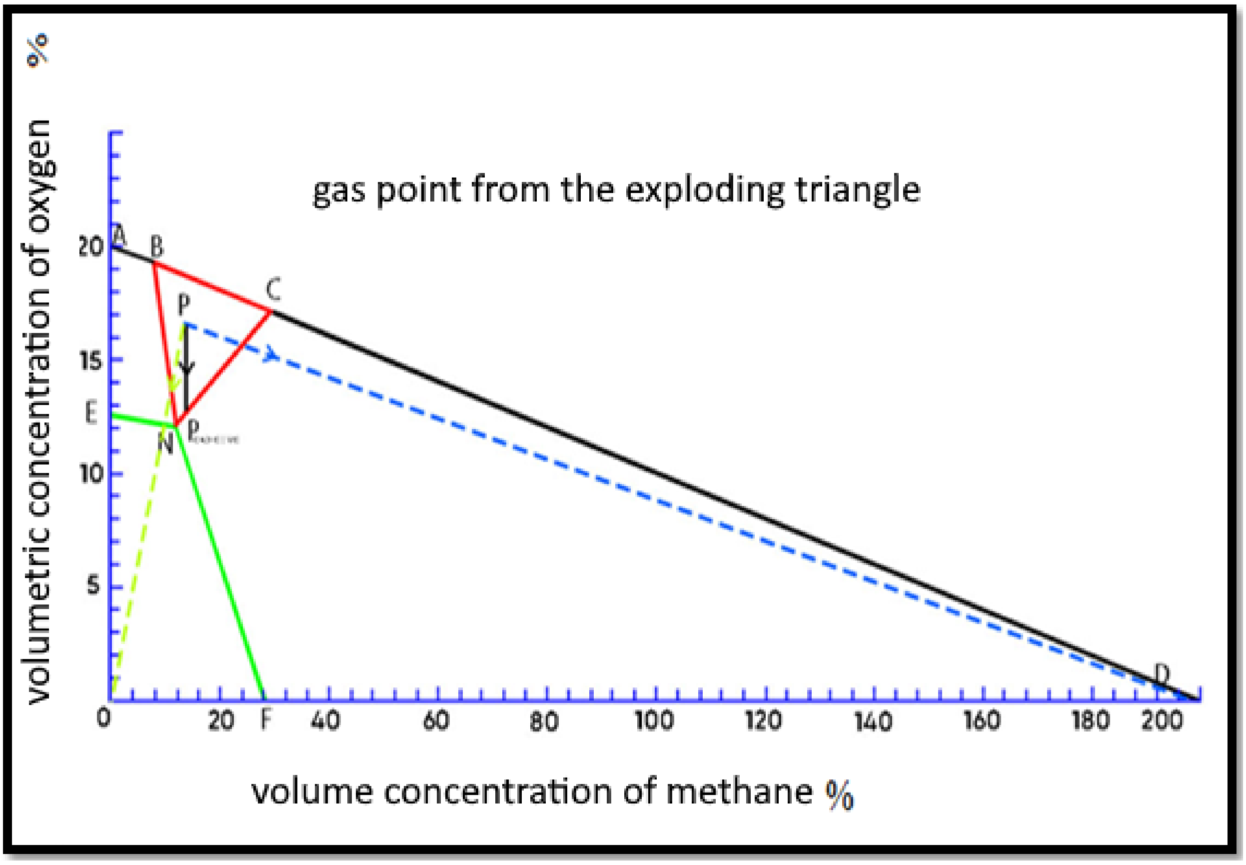


Figure 4.4. Gas Point Explosive Triangle Exit Situation Diagram.

Therefore, as shown in Figure 3.4, the "resultant direction" of the gas point can move towards the boundary of the explosive triangle. During the evaluation, the coordinates of the "explosive" were calculated using the following equations, based on the method described in the previous section, Figure 4.4:

$$N_{\text{explosive}} \frac{V_{N_2} \cdot t_{must} + V_{\text{total}} \cdot N}{V_{N_2} \cdot t_{must} \cdot V_{total} + V_{N_{CH4}} + t_{must}} \quad (4.9)$$

$$N_{explosive} = 100 - C_{explosive} - O_{explosive} \quad \text{and} \quad N = 100 - C - O \tag{4.10}$$

$$T_{must} = \frac{V_{total} \cdot N_{explosive} - V_{total} \cdot N}{V_{N_4} - V_{N_2} \cdot N_{explosive} + V_{CH_4} + N_{explosive}} \tag{4.11}$$

Table 4.1

Table of categories for fire hazard of external devices.

A	If there are flammable gases inside the device; slightly flammable liquids with a flash point of up to 28oC; in case of interaction with water, oxygen in the air and/or combustible substances and/or materials (if stored, processed, transported); if the condition that the individual risk value of the above-mentioned substances is more than 10-6 per year at a distance of 30 m from the external device, when there is a possibility of burning by creating pressure waves, the device belongs to category An.
B	If the device contains flammable dust and/or fibers; slightly flammable liquids with a flash point above 28oC; in case of flammable liquids (storage, processing, transportation); If the condition that the individual risk is more than 10-6 per year at a distance of 30 m from the external device, the device belongs to the Bn category.
V	If there are flammable and/or flammable liquids inside the device; highly flammable and/or difficult to burn substances and/or materials (including dust and/or fibers); in case of interaction with water, oxygen in the air and/or combustible substances and/or materials (if stored, processed, transported); if the criteria for inclusion of the device in categories An or Bn are not fulfilled; if the condition that the individual risk of burning of the above-mentioned substances is greater than 10-6 per year at a distance of 30 m from the external device, the device belongs to category Vn.
G	If non-flammable substances and/or materials are hot, heated or melted inside the device (stored, processed, transported), the process of handling them is observed by the release of radiant heat, sparks and/or flames, and

	flammable gases, liquids and/or or devices in which solid substances are burned or used as fuel belong to category Gn.
D	If the device mainly contains non-combustible substances and/or materials in a cold state (stored, processed, transported) and does not belong to categories An, Bn, Vn, Gn according to the above criteria, then the device belongs to category Dn.

Therefore, the best balance between the different gas flows is maintained to reduce the risk of explosion. Once a gas point mine is located within the explosive triangle, it is important to artificially protect the explosive atmosphere of the mine from explosion so that it does not explode. By analyzing the explosive diagram, it can be determined that if the gas point can move along a line perpendicular to the boundary of the explosive triangle, it shows the minimum time required to exit the explosive triangle and the maximum opportunity to reduce the risk of explosion. For mining workers, the rate of methane flow cannot be controlled artificially because it depends on the geological conditions of the mine. Therefore, to protect the explosive atmosphere from an effective explosion, careful control of the nitrogen flow rate to adjust the formed special movement direction proved to be one of the wise methods.

The recovery method described in the last sections can also be used again, but for this it is necessary to perform the following actions:

1. Starting from the gas point, a line was drawn to determine the coordinates of the $P_{explosive}$ boundary ($C_{explosive}$, $O_{explosive}$) using the "Result direction".

2. Expanding the methane addition line to get the intersection point with the explosive triangle, the coordinate was expressed as "P_{metan}" (C_{metan}, O_{metan}).

3.”P”, “$P_{explosive}$” and “P_{metan}” the triangle defined by the points is a right triangle, and the best ratio of the nitrogen input rate to the methane input rate can be expressed as the tangent of

"θ" shown in Fig. 3.5 and calculated mathematically (4.11).

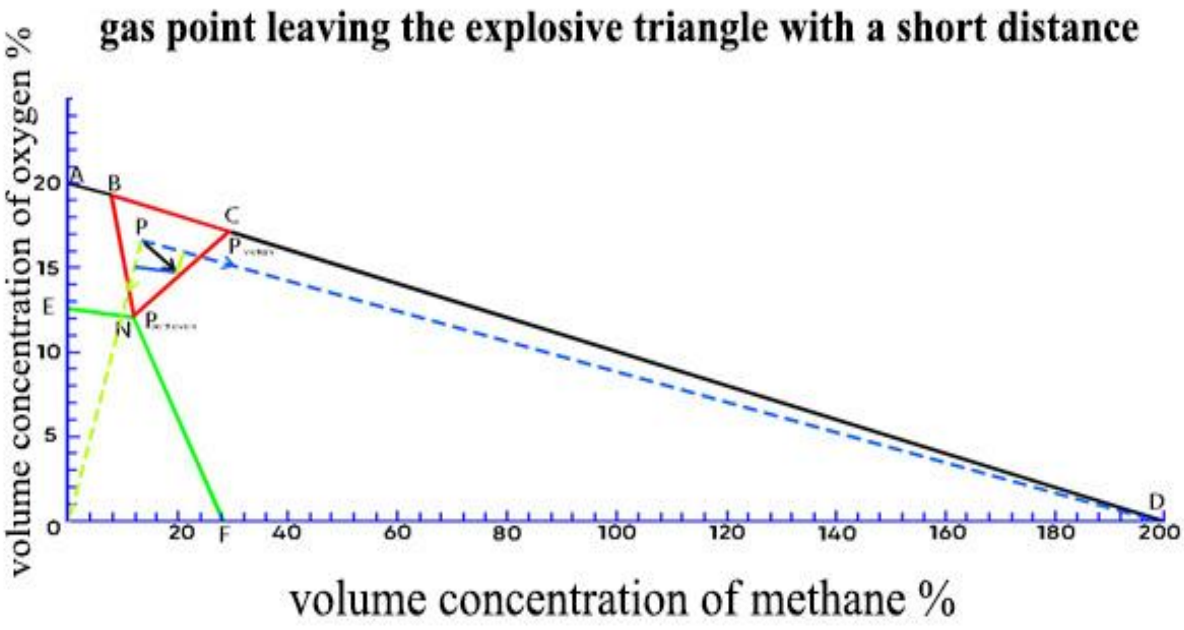


Figure 3.5. Diagram of the case of the gas point leaving the explosive triangle with a short path.

$$tan(\theta)\frac{V_{N_2}}{V_{N_{CH4}}} = \frac{P_{CH_4}P_{explosive}}{PP_{explosive}} \qquad (4.11)$$

If this ratio is maintained, using the shortest time, it can be sure that the gas point can exit the explosive triangle in this way. [33; pp. 157–163].

We can find answers to several important questions from our experiments, namely;

1.According to the equation, the maximum "critical" ratio of the fresh air flow rate to the methane flow rate is V_{air}/ V_{CH4} = 1:83, that is, when the fresh air inlet rate exceeds 0.73 m3/s, the gas point moves forward in the explosive triangle, and equations (2) using (4.3) and (4.4) the resulting direction of gas point movement is determined. Thus, it was possible to read the coordinates of "Explosives". Then, using equation (4.6), this "non-explosive" atmosphere becomes explosive in about 11442 s (3.18 h) under clean air flow conditions of 4 m^3/s.

Typically, after sealing, methane is continuously pumped into the mine hole, causing the methane to accumulate to the point of explosion. However, due to the large size of the pit and problems with air leakage, etc., measures to mitigate the addition of methane can take a very long time. On the other hand, two other approaches are often chosen for rescue operations in underground mines: to introduce more inert gas into the mine atmosphere or to ventilate the atmosphere with fresh air to dilute the explosive gas mixture, fresh air ventilation is not desirable in most situations because it is dangerous and can lead to a secondary explosion will come

In most cases, methane emission rates can be obtained from field measurements. However, since it is not possible to collect the emission factor in some special cases, it is recommended to estimate the factor value by category of the mine. It should be noted that methane emission rates in mines should be measured in open air. The mathematical model estimated these values reliably and accurately.

2. (4.1) According to equation (4.2), the minimum "critical" ratio of fresh air flow to methane flow is V_{AIR}/ V_{CH4} =0:82, that is, if the fresh air flow is less. 2.05 m^3/s, the gas point moves forward in the explosive triangle, and using equations (4.2) (4.3) and (4.4) determine the resulting direction of motion of the gas point. Thus, it will be possible to read the coordinates of "Explosives". Then, using equation (4.8), this non-explosive atmosphere can become explosive in about 9840 s (2.73 h) under clean air flow conditions of 1 m^3/s.

3. Determination of the resulting direction of the movement of the gas point using equations (4.1) (4.3) and (4.4). Thus, it was possible to read the coordinates of "Explosives". This "explosive" atmosphere may become non-explosive in about 12500 s (3.47 h) assuming a nitrogen flow of 0.4 m^3/s. (4.2) Using the equation (4.11), it is calculated that V_{AIR}/ V_{CH4} =1.67, that is, it is proved that the gas point used the shortest time to leave the explosive triangle.

It should be noted that this calculation assumes that the inert gas introduced into the sealed volume is instantly mixed with the contents of the sealed atmosphere. As a general rule, the sealed area often reflects the size of a rectangle. In the event of a fire or related accident, the entrance and exit points on both sides of the entrance will be closed. The degree of mixing of the released inert gas with the surrounding atmosphere in the direction of flow mainly depends on the type of flow - laminar or turbulent. However, the inert gas usually enters the enclosed area as a turbulent flow. Due to such turbulence, turbulent flow also occurs in the closed region. For rectangular records, the length is much greater than the transverse width. Therefore, in a turbulent flow, transverse mixing (perpendicular to the flow direction) occurs over a very short distance, in this case, in the direction of the flow.

In most cases, an inert gas generator can produce inert gas with a volumetric flow rate of 500 m^3/h (8.3 m^3/min) to 1200 m^3/h (20 m^3/s). In general, it is customary to use several generators to simultaneously supply closed areas of the mine with inert gas. Given that the inert gas usually enters a closed region, as in a turbulent jet, it is large enough to satisfy the above assumption that transverse mixing (perpendicular to the flow direction) occurs over a very short distance to form an instantaneous mixing process.

Another important point about the feasibility of using the models proposed in our work is that mining engineers need to accurately and quickly monitor the changes in composition inside the mine. In some critical situations, the atmosphere can become explosive in a matter of seconds. Currently, in the mining industry, a pipeline system that can monitor the underground atmosphere, combining various gas sensors, as well as gas analysis equipment, is common. With the help of such a system, it was recommended that mining engineers better understand the evolution of explosiveness and implement any measures more rationally.

Any results of theoretical calculations obtained using the recommended models should be considered as minimum requirements for complex engineering problems and safety considerations. For example, after evaluating the non-explosive time interval of an explosive atmosphere, it was proved that to achieve an absolute safety condition, two or three times the amount of inert gas, as well as the injection time, must be used continuously.

4.3. Mathematical model and monitoring of the surface layer of the atmosphere of the mining industry.

Monitoring and forecasting the environmental situation in mining areas remains one of the important scientific and practical tasks. Prediction, monitoring and assessment of pollution of the atmosphere and its subsurface with passive and active compounds, as well as placement of mining enterprises and territories in accordance with sanitary standards for pollution are one of the urgent problems of environmental protection [98; pp. 3–9].

All factors affecting the quality of atmospheric air polluted by chemical and physical processes can be modeled using mathematical and numerical methods. To develop any models related to the properties of the air, general mathematical and cumulative methods are used to simulate in one way or another the physical and chemical processes that affect the distribution of substances into the ecosystem. After receiving meteorological data and information on the sources of atmospheric emissions, these samples are characterized as primary pollutants that enter the atmosphere directly and secondary pollutants that cause complex chemical reactions in the atmosphere. With the help of these models, it is possible to develop the best methods of monitoring air quality, controlling air emissions, predicting their generalization and reducing harmful substances in the atmosphere. Based on meteorological data and data on sources of atmospheric emissions, these models describe both primary pollutants entering the atmosphere directly and secondary pollutants formed by complex chemical reactions in the atmosphere [98; pp. 3–9, 123; pp. 329–335].

These models are very important for the air quality management system because they help to develop effective strategies for controlling atmospheric emissions, predicting their distribution and reducing harmful substances in the atmosphere [98; 3rd p., 123; pp. 329–335].

In mining areas, the sources of harmful waste can reach several hundred thousand. These dangerous and harmful substances are found in air, soil, water, living organisms and people. Models based on analytical and numerical calculations of the general diffusion equation can be used to estimate or predict the time-spatial distribution of pollutants and are also called atmospheric dispersion models. It is the most essential atmospheric dispersion model for an air quality management system because it tracks air emissions, predicts their dispersion, and develops better models.

The need to develop models allows for the analysis of environmental quality. There are many models, such as Euler, Langraje, Berland models, but they have little dynamic performance, that is, they do not take into account changes in direction and wind speed, as well as the characteristics of the terrain.

The complexity and variety of processes, as well as subjective factors, show that today there is no alternative, well-defined model of the distribution of pollutants in the atmosphere. That's why there are so many different models.

The type and number of models can be determined, first of all, by the range of tasks, (these are the tasks set before the services dealing with the environment) and secondly, according to the conditions of accuracy of the tasks. The conditions for the application of certain methods are different, depending on the criteria of pollution assessment and the specific nature of the expansion of polluting wastes in different meteorological conditions.

To create a model, information is needed to consider the toxicity of the facility exposed to the waste cloud. The object can be characterized by its qualities, concentration of harmful substances and duration of its exposure. An industrial enterprise or employees can serve as an object. The model is defined using the necessary criteria. Samples for the models were taken quarterly [98; pp. 3–9].

Advanced analytics and statistical models are also used to automatically predict adverse weather conditions and estimate air pollution levels, and make short- and long-term decisions about safety measures. In order to obtain a high-quality forecasting method, it is necessary to diagnose meteorological processes at the synoptic scale, implement this model, and create a taxonomy of synoptic processes based on these studies. The development of computational models is based on multivariate statistical tools. The construction of predicted correlations is based on the theory of solving incommensurate problems, so a stable solution is obtained in the presence of correlated parameters.

The method and software make instantaneous predictions of the concentration of hazardous substances in the atmosphere in given meteorological data. In addition, the mathematical modeling method can extend the prediction to the place related to the enterprise. Assists in data technical support for rapid development and widespread use of technology, vegetation change studies and environmental monitoring. Among them, remote sensing images are usually used in regional ecological monitoring of land. The research paper examines the land use classification system in the study area based on remote sensing data from the sources through quarterly data collection. A suitable support vector machine-guided classification method is used to obtain data on land cover changes in different periods and evaluate the accuracy of land classification. (See Table 4.2).

The classification results of remote sensing images can provide basic information about changes in the ecological environment in the study area, using Figure 3.6 as a data source for land use processing and analysis of the study area.

4.2-table

Quarterly survey data collection.

QUARTER	EDG *μZv/x*	EBVA *Bk/m³*	LLAN *мBk/m³*	DUST *μg/m³*
1-quarter	0,13	4	7.5	1,25
2-quarter	0,14	2	6.9	1,32
3-quarter	0,15	3	6.5	1,35
4-quarter	0,12	5	4.2	1,5

The main requirements for measuring the necessary factors have been met:

The place where the gas analyzer can be placed on the windward side should record all the data of the gas analyzer, including the various sources of pollution, so that the wind falls on the gas analyzer from the industrial area.

P - pressure;

Tts - Dry bulb temperature in Celsius

Tv is the wet bulb temperature in Celsius Humidity %;

Wind speed m/s

Wind direction

Cloudiness

Samples - provide information on the concentration and maximum permissible concentration of atmospheric substances.

The laws of distribution and migration of dust particles in the atmosphere near the surface of the earth can be obtained by creating, calculating and solving a mathematical model of air flow associated with dust.

To solve the problem, we can find the distance from the coordinates y_1, y_2 ... up of point *i* in the phase space to a number of ready-made standard solutions from equation (3.2)

$$p_i^2 = \sum_{i=1}^{N} \left(\frac{y_i - x_i^{(1)}}{\sigma_i^{(1)}} \right)^2 \qquad (4.12)$$

In addition, spaces are set up to other groups and groups with u status and very small space groups.

The average concentration of each substance characteristic of a certain cluster is obtained from the following equation:

$$x_i = \frac{\sum_j^n x_j}{n} \qquad (4.13)$$

Here n - the number of elements in the cluster; x_j - the concentration of the substance.

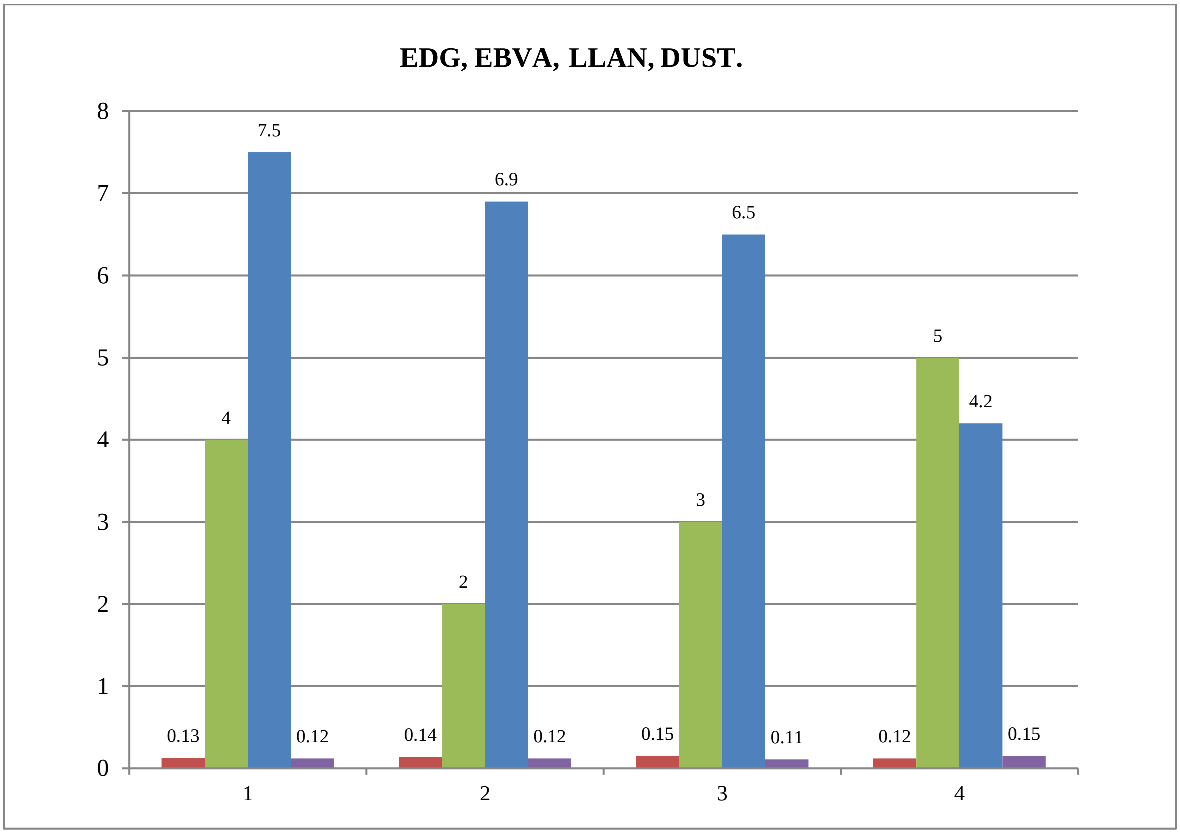


Figure 4.6. The dynamics of environmental changes during each sampling (the sampling process was carried out quarterly).

A mathematical description of air and dust-related flows was developed, taking into account local desertification and dust emissions from mining, to study the laws of distribution and migration of sand particles in the near-surface atmosphere. Three-dimensional stationary Navier-Stokes equations for an incompressible fluid are adopted to describe air flow in an open atmosphere. Based on the modeling results and the scattering model, the optical scattering and dust attenuation characteristics can be obtained. The discrete ordinate method was used to solve the equations to study the conduction characteristics of the surface atmosphere polluted with mixed dust.

$$\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+\vartheta\frac{\partial u}{\partial y}+w\frac{\partial u}{\partial z}=-\frac{1}{\rho}\frac{\partial p}{\partial x}+\frac{\eta_h}{\rho}\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}\right)+\frac{1}{\rho}\frac{\partial}{\partial z}\left(\eta_\vartheta\frac{\partial u}{\partial z}\right) \quad (4.14)$$

$$\frac{\partial \vartheta}{\partial t}+u\frac{\partial \vartheta}{\partial x}+\vartheta\frac{\partial \vartheta}{\partial y}+w\frac{\partial \vartheta}{\partial z}=-\frac{1}{\rho}\frac{\partial p}{\partial y}+\frac{\eta_h}{\rho}\left(\frac{\partial^2 \vartheta}{\partial x^2}+\frac{\partial^2 \vartheta}{\partial y^2}\right)+\frac{1}{\rho}\frac{\partial}{\partial z}\left(\eta_\vartheta\frac{\partial \vartheta}{\partial z}\right) \quad (4.15)$$

$$\frac{\partial w}{\partial t}+u\frac{\partial w}{\partial x}+\vartheta\frac{\partial w}{\partial y}+w\frac{\partial w}{\partial z}=-\frac{1}{\rho}\frac{\partial p}{\partial z}+\frac{\eta_h}{\rho}\left(\frac{\partial^2 w}{\partial x^2}+w\right)+\frac{1}{\rho}\frac{\partial}{\partial z}\left(\eta_\vartheta\frac{\partial u}{\partial z}\right) \quad (4.16)$$

$$\frac{\partial p}{\partial t}+p\frac{\partial u}{\partial x}+p\frac{\partial u}{\partial y}+p\frac{\partial z}{\partial y}=0 \quad (4.17)$$

$$\rho=\frac{p}{R_C T_\vartheta} \quad (4.18)$$

$$\frac{\partial T}{\partial t}+u\frac{\partial T}{\partial x}+\vartheta\frac{\partial T}{\partial y}+w\frac{\partial T}{\partial z}=\eta_h\left(\frac{\partial^2 T}{\partial x^2}+\frac{\partial^2 T}{\partial y^2}\right)+\frac{\partial}{\partial z}\left(\eta_\vartheta\frac{\partial T}{\partial z}\right)+f \quad (4.19)$$

$$\frac{\partial s}{\partial t}+u\frac{\partial s}{\partial x}+\vartheta\frac{\partial s}{\partial y}+w\frac{\partial s}{\partial z}=\eta_h\left(\frac{\partial^2 s}{\partial x^2}+\frac{\partial^2 s}{\partial y^2}\right)+\frac{\partial}{\partial z}\left(\eta_\vartheta\frac{\partial s}{\partial z}\right) \quad (4.20)$$

Hazardous mixture processes include three-dimensional nonstationary equilibrium, turbulent exchange, and constant disturbance exponents.

$$\frac{\partial \xi}{\partial t}+u\frac{\partial \xi}{\partial x}+\vartheta\frac{\partial \xi}{\partial y}+w\frac{\partial \xi}{\partial z}=\frac{\partial}{\partial x}\left(\eta_h\frac{\partial \xi}{\partial x}\right)+\frac{\partial}{\partial y}\left(\eta_h\frac{\partial \xi}{\partial y}\right)+\frac{\partial}{\partial z}\left(\eta_h\frac{\partial \xi}{\partial z}\right)+\mu_{\varphi.\varphi} \quad (4.21)$$

The increase of harmful substances to the environment can be compared with a surface linear source, whose contours correspond to the trajectory of movement, and the expression of this moving source can be seen in the following equation:

$$\mu_\varphi=\sum_{i=1}^{N} A_\kappa^i\delta(\bar{r}-\bar{r}_i) \quad (4.22)$$

Due to the methods of accounting for static information and calculation of enterprise waste, E_n^i can be determined. According to the specified model, together with the method, a three-dimensional model of dust particle distribution was implemented. The distribution laws of atmospheric wind field flow and dust concentration in two-dimensional vertical direction are derived. When the wind blows in the open atmosphere, the dust particles are gradually blown out. The dust particles are not completely dispersed to the dust source, but when the wind turbulence increases and gradually reaches a maximum, the dust particles gradually disperse completely. When the dust dispersion distance reaches a certain point, the dust particles gradually settle under the influence of gravity. The distribution of dust particles in the vertical direction near the dust source is relatively small [98; pp. 3–9, 113; pp. 1038–1042].

The essence of this program, created on the basis of a mathematical model, is to establish a connection between the program and nature in general. The task of normalization of information was set, meteorological conditions were taken into account during the moment. C++ web applications were used to implement pollution monitoring [47]. The created program provides a prediction of the concentration of harmful substances in the environment and industrial climate for organizations. The goal of these organizations is to normalize the ecological situation of the region.

4.4. Radioecological factors and methods of their detection in man-made uranium objects.

Along with the determination of the concentration of harmful substances (dust) present in the environment and near the industry, the determination of radon in the radiation environment is the most urgent problem in man-made uranium facilities.

The natural radiation environment of the area is evaluated by determining the amount of natural radionuclides in them. The value of radiation quantities - exposure dose rate, specific activity of each radionuclide, relative effective activity of natural radionuclides - A_{eff}, radon emanation and radon flow density from the surface indicate the level of contamination of this object. Radioecological factors and radiation indicators in ecosystem objects are regulated by IAEA, UN, WHO and other international normative documents of the Republic of Uzbekistan (UzDst, GOSTs).

Estimating the values of the above-mentioned radiation factors in the soils of man-made uranium facilities allows to determine the ecological risk and radiation values released from these soils for human health and the environment in general. In addition, the obtained value of radiation factors allows for a detailed development of environmental and professional risks in a given facility, as well as the development of various measures for environmental protection [78; pp. 330–336].

The man-made object of Uranus has an additional man-made effect on the radiation environment. The soil contains natural radionuclides and radionuclides of the uranium fission chain, which are sources of ionizing radiation. The concentration of uranium on the soil surface is about 50 g/t. Radon formed from this uranium passes through the pores of the earth and accumulates in the atmospheric air of various objects. It is of practical interest to conduct extensive scientific research, taking into account the evidence for determining the amount of natural radionuclides and radionuclides of the uranium decay chain in soils selected from various man-made uranium objects [7; pp. 203–211, 78; pp. 330–336].

To achieve the set goal, the following actions are performed:

- determining the speed of exposure dose;
- determination of relative activity of each -^{238}U, ^{226}Ra, ^{232}Th and ^{40}K radionuclides;
- Determination of the relative effective activity of natural radionuclides A_{eff};
- determination of natural radionuclides - ^{238}U, ^{226}Ra, ^{232}Th and ^{40}K in the samples from radon emanation and radon molasses density.

The rate of the exposure dose was determined experimentally by directly measuring the DKS-96 device, the radon emanation and the radon flux density from the ground surface directly by measuring the Progress devices, and the relative gamma activity of ^{226}Ra, ^{232}Th and ^{40}K was measured by the gamma devices such as CANBERRA and Progress-gamma. method was carried out by spectrometry. The dry ground sample is placed in a Marinelli container and placed in the detector. In the "Marinelli" geometry, the spectrum set is launched in the mode of measuring the activity of ^{137}Cs, ^{40}K, ^{226}Ra and ^{232}Th radionuclides. After 30 minutes of active measurement, the program automatically displays on the screen the activity of these radionuclides and completely static errors in the activity value [44; 78; pp. 330–336].

The obtained results were analyzed from various man-made uranium objects - soils from radioactive waste residues, from selective underground uranium smelting, from uranium waste and from the areas where the uranium enterprise operates. Table 4.3 shows the results of determining the activity of each radionuclide and the specific effective activity of A_{eff} in soil samples.

It is known that the general, specific activity of alpha-radiation from the soil is characterized by its natural background, that is, the amount of radionuclides in them. A systematic analysis of the total relative activity of alpha-radiation in the soil allows to determine the extent of the man-made impact of the uranium mining enterprise on the environment. As shown in Table 3.2, values for ^{40}K are 740-1412 Bk/kg, values for ^{232}Th are 19-39 Bk/kg, and values for ^{226}Ra are 42-543 Bk/kg. Relative efficiency is A_{eff} -194 - 638 Bk/kg of soil samples. The value of the total specific activity of alpha radiation is 598-1189 Bk/kg [78; pp. 330–336].

4.3-table

Results of determination of total specific activity and specific effective activity in soil samples.

№ t/p	Specific activity in soil, Bk/kg				Specific total alpha activity of soils,Bk/kg
	^{40}K	^{226}Ra	^{232}Th	A_{eff}	
1	1143	298	43	457	1283
3	1008	447	19	563	888
4	943	336	38	471	983
5	892	321	21	429	922
6	786	543	20	640	877
7	881	302	29	3146	956
8	889	301	11	395	917
9	801	329	19	426	954
10	807	373	17	468	909

11	902	410	28	528	977
12	865	325	18	426	953
13	998	216	21	333	805
14	1234	386	19	522	1008
15	1138	103	23	236	908
16	1265	101	28	252	872

The study of the distribution of natural radionuclides from the point of view of the sampling depth is of scientific and methodological interest, and consists in determining the factor associated with the change of the amount of natural radionuclides and the Clark value of natural radionuclides over many years.

Determination of the total relative activity of alpha radiation from the soil by sampling depth characterizes the specific anthropogenic impact of the man-made uranium object on a certain local area of the earth.

The obtained results show that there is no obvious anthropogenic impact factor, that is, natural processes occur in these soils. This evidence means that the man-made object is reliably isolated and does not have a negative impact on the environment beyond the normalized values [78; pp. 330–336].

As can be seen from the constructed histogram, the total relative activity of natural radionuclides and alpha radiation does not differ much from each other and is at the background level for the region. The values of natural radionuclides in these samples are typical for uranium regions, that is, they are much higher than in settlements located far from industrial facilities, and the distribution of natural radionuclides in these samples does not differ in both cases. The distribution of total specific activity of alpha-radiation from soils by sampling depth is shown in Figure 4.7.

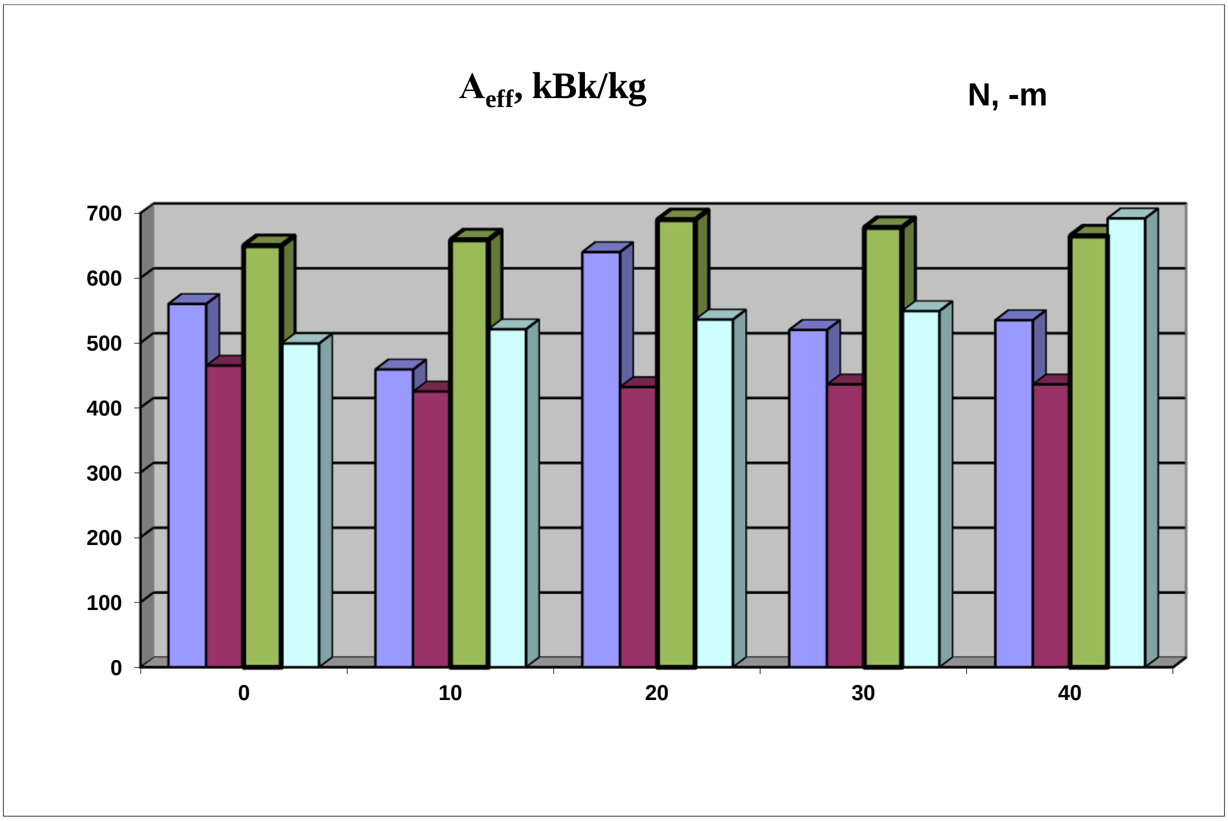


Figure 4.7. Plot of test results distribution of total specific activity of alpha-radiation from soils by sampling depth.

The emanation coefficient of radon in samples is determined by the following formula:

$$\eta = \frac{A_6}{A_1} \qquad (4.23)$$

Here η - the coefficient of radon emanation in the samples, A_1 and A_6 - (in measurements 1 and 6) activity values of $A_{Ra\text{-}226}$.

The release of radon from the surface of the local area is directly proportional to the concentration of natural radionuclides in it. It can be assumed that when receiving the recoil energy of the radon atom, the release of radon will move to a distance of 0.02-0.07 microns with respect to different soil sizes.

The relative effective activity A_{eff} value of natural radionuclides (TRN) in test samples is determined by the following formula:

$$A_{eff} = A_{Ra} + 1{,}31A_{Th} + 0{,}09A_K \qquad (4.24)$$

The value of the absolute error in the measurement of the specific activity - A_{eff} u- radionuclide and the absolute error of detection (Δ_{eff})is calculated according to the following formula:

$$\Delta_{eff} = \sqrt{\Delta_{Ra}^2 + (1{,}31 \times \Delta_{Th})^2 + (0{,}09 \times \Delta_K)^2} \qquad (4.25)$$

Relative effective activity in soil - A_{eff} TRH value is calculated according to the following formula:

$$A_{eff} = \eta \cdot A_{Ra} + 1{,}31 A_{Th} + 0{,}09 A_K \qquad (4.26)$$

In this case, it is recommended to take R -coefficient R= 1.3, taking into account the lack of radioactive balance in the radium series.

The value of the absolute error in measuring the specific activity of A_{eff} - j -th radionuclide and the absolute detection error (Δ_{eff}) in the calculation of samples that have not passed the influence of time can be calculated by the following formula:

$$\Delta_{eff} = \sqrt{(\eta \times \Delta_{Ra})^2 + (1{,}31 \times \Delta_{Th})^2 + (0{,}09 \times \Delta_K)^2} \qquad (4.27)$$

Soils are crushed, passed through a sieve (hole diameter 5 mm), placed in a Marinelli container (volume 1 liter), sealed and measured by gamma-spectrometric method on the "Progress-gamma" device, see Figure 4.8.

Figure 4.8. The process of measuring crushed soils by the gamma-spectrometric method on the "Progress-gamma" device.

Determined η - emanation coefficient - ^{222}Rn (the ratio of the activity of the last measurements of radium to the initial activity of radium). For the equilibrium of radon with maternal radium, a time equal to 10 half-lives of radon (half-life of radon is 3.83 days), that is, 38-40 days, should pass [78; pp. 330–336].

Table 3.4 shows the results of measuring the relative activity of natural radionuclides and the relative effective activity of the soil A_{eff}. Radon emanation coefficient can be used to determine the value of radium activity in the first measurement. Otherwise, the samples should be sealed and measured after 40 days. This method of radium detection significantly speeds up experimental work.

4.4-table

Results of specific activity of natural radionuclides and specific effective activity of soils - A_{eff}.

Sample number	Special activity, Bk/kg				η coefficient
	$A_{Ra\text{-}226} \pm \Delta_{Ra\text{-}226}$	$A_{Th\text{-}232} \pm \Delta_{Th\text{-}232}$	$A_{K\text{-}40} \pm \Delta_{K\text{-}40}$	$A_{eff} \pm \Delta_{eff}$	
1.	32,9 ± 6,5	38,1 ± 4,2	830,3 ± 81,7	158,0 ± 11,0	0,89
2.	32,7 ± 5,1	39,2 ± 4,0	852,5 ± 83,0	160,5 ± 10,6	0,88
3.	31,9 ± 5,2	29,5 ± 3,4	594,9 ± 57,6	123,7 ± 8,6	0,85
4.	39,3 ± 7,7	32,2 ± 4,3	601,5 ± 61,2	133,8 ± 11,1	0,98
5.	943,9 ± 177,4	336,7 ± 42,7	38,8 ± 5,4	421,1 ± 33,7	0,93
6.	892,2 ± 162,3	321,3 ± 38,6	21,8 ± 4,2	363,7 ± 27,4	0,90
7.	786,8 ± 165,1	543,7 ± 57,3	20,9 ± 4,7	583,4 ± 47,1	0,96
8.	881,5 ± 161,6	439,9 ± 47,8	29,5 ± 6,1	411,7 ± 32,8	0,92

Based on the research conducted in this way, the distribution of natural radionuclides and radionuclides of the decay chain of uranium obtained from the soil of various man-made objects was determined. The value of the total specific activity of alpha-activity was determined in them, which showed that the average specific activity in the samples was in the range of 500 Bk/kg to 1200 Bk/kg.

The dynamics of changes in the natural distribution of these radioecological factors show that the man-made object has a moderate impact on the environment and their value is below the standard values [78; pp. 330–336].

4.5. Methods of reducing radioecological impact on the environment.

When assessing workplace conditions, it is necessary to assess the potential impact on employees and the environment in a mining enterprise. Therefore, it is necessary to clearly distinguish the monitoring carried out to assess the protection of workers from radiation exposure and to determine the potential impact of these factors on the environment [2; pp. 212–225, 3.].

The purpose of professional radiation monitoring is to protect employees and the environment from the harmful effects of ionizing radiation and to establish a standard annual limit for the effective dose. This is usually achieved through continuous monitoring or surveys of production sites. Radiation monitoring of the environment consists in evaluating the values of radiation factors and protecting the environment from the harmful effects of ionizing radiation, which is achieved by monitoring the area, taking soil, water and air samples.

Regarding the monitoring program, the scope of the considered elements of the program depends on the specific production factors of the local area or site for mineral processing. When creating a mathematical model of the processes, the concentration of radionuclides, factors involved in various stages of mineral processing, and the number of employees are taken into account.

Regulatory documents such as No. 0193-06, valid in the territory of the Republic of Uzbekistan, are drawn up in accordance with international standards, and hard samples are divided into IV class for use for various purposes for certain effective activities.

I class. If $A_{eff} < 370$ (Bk/kg), then it is allowed to use these building materials for the construction of housing and social facilities;

II class. If $A_{eff} \leq 740$ (Bk/kg), then it is allowed to use these building materials for the construction of housing, roads and industrial facilities;

III class. If $A_{eff} \leq 1350$ (Bk/kg), then it is allowed to use these construction materials for the construction of roads outside settlements;

IV class. If $A_{eff} \leq 4000$ (Bk/kg), it is necessary to obtain permission from the sanitary-epidemiological service to use these building materials.

A detailed assessment of the situation of radionuclides is necessary to determine the permissible routes of exposure of mining workers and the environment, as well as to evaluate any changes in these routes. In cases where only physical ore processing (for example, gravimetric or electrostatic separation, crushing, etc.) is carried out, the behavior of radionuclides is unlikely to change. Therefore, it can only be determined by looking at it and increasing the concentration of radionuclides in the processed material or dust in the workplace. The radon level in the air also increases in places where minerals are burned, and the possibility of inhaling dust increases significantly. In the case where minerals are difficult to process or their enrichment (including chemical or heat treatment or both) is carried out, changes in the behavior of radionuclides require detailed studies to determine changes in the age balance of uranium and thorium [43; pp. 43–45, 111; pp. 44–45].

For example: Polonium and lead from some minerals can volatilize at relatively low temperatures (above 250-300°C) and are attached to dust particles. At some stages of chemical processing, radium atoms are mobile and can then pass through various process streams through the processing unit. Then, at a later stage, for example, after treatment with sulfuric acid, the radium can be measured in tubes or precipitated into purification vessels.

Accumulation of radon and taron in buildings is the foundation of walls (soil, gravel, sand, plaster, tiles, granite, brick) at the construction site. The activity of radon and radioactive radiation emitted from building materials depends on the amount of natural radionuclides (^{238}U, ^{232}Th, ^{226}Ra and ^{40}K) in them.

Building materials from various natural minerals and bodies are used for the construction of houses and industrial buildings. These are natural minerals and bodies that contain a certain amount of natural radionuclides, which are sources of ionizing radiation. The Clark content of uranium in the soil surface is approximately ≤50 g/t. Radon, formed from uranium, passes through the pores of the earth and accumulates in the air inside the room.

The relative effective activity value of natural radionuclides - A_{eff} - (TRN) (Fig. 3.9) is calculated according to the following formula:

$$A_{eff} = A_{Ra} + 1{,}31A_{Th} + 0{,}09A_K \qquad (4.28)$$

Using the radon emanation coefficient, it is possible to determine the value of radium activity during the first measurement rather than sealing it, and it is measured after 40 days. This method of determining radium significantly speeds up experimental work (Table 4.5).

4.5-table

Results of effective activity of natural radionuclides and effective activity in soils of industrial areas.

Samples (soil)	**Weight, gramm**	**$A_{Ra-226} \pm \Delta_{Ra-226}$ Bk/kg**	**$A_{Th-232} \pm \Delta_{Th-232}$ Bk/kg**	**$A_{K-40} \pm \Delta_{K-40}$ Bk/kg**	**$A_{eff} \pm \Delta_{eff}$ Bk/kg**
1	1108.5	37,4 ± 6,8	40,2 ± 4,3	818,8 ± 77	163 ± 11,2
		32,3 ± 4,7	34,5 ± 3,9	808,7 ± 81	156 ± 10
		27,2 ± 8,6	40,8 ± 5,2	865,2 ± 85	158 ± 3,3
		35,5 ± 7,5	36,5 ± 3,6	795,1 ± 80	154 ± 9,9
		31,8 ± 5,9	37,9 ± 4	844,9 ± 82	157 ± 10,8
		33,4 ± 5,4	38,8 ± 3,9	849,1 ± 85	160 ± 0,7
2	1132.5	37,7 ± 5,9	35,5 ± 3,7	842,6 ± 84	160 ± 10,8
		30,7 ± 5,9	40,4 ± 4,4	876,1 ± 83	162 ± 11,1
		26,6 ± 4,7	43,4 ± 4,4	839 ± 81	159 ± 10,9
		40,2 ± 4	35 ± 3,5	818,5 ± 82	159 ± 9,6

		28,1 ± 5,6	39,9 ± 4,3	887,5 ± 83	160 ± 10,9
		33,2 ± 4,3	40,8 ± 3,9	851,5 ± 85	163 ± 10,2
3	1081.4	33,7 ± 7,6	23,9 ± 3,9	625,8 ± 63	121 ± 10,8
		25,6 ± 3,4	33,2 ± 3,2	595,5 ± 60	122 ± 7,6
		33,1 ± 5,5	26,9 ± 3	606,9 ± 57	123 ± 8,5
		33,6 ± 4,6	31,6 ± 3,2	548,9 ± 53	124 ± 7,8
		36,6 ± 5,9	28,1 ± 3,2	602,9 ± 57	127 ± 8,8
		28,8 ± 4,4	33,3 ± 3,6	589,8 ± 56	125 ± 8,1
4	1026.5	39,3 ± 3,7	32 ± 3,2	602,4 ± 60	135 ± 7,8
		44,3 ± 7	32,9 ± 3,7	542,1 ± 53	136 ± 9,8
		33,7 ± 7	26,9 ± 3,9	659,3 ± 65	128 ± 10,5
		45,2 ± 8,6	23,9 ± 4,3	573,8 ± 60	128 ± 11,6
		26,3 ± 13	38,1 ± 6,2	617,9 ± 69	131 ± 16,2
		38,7 ± 6,8	39,2 ± 4,2	613,3 ± 60	145 ± 10,2

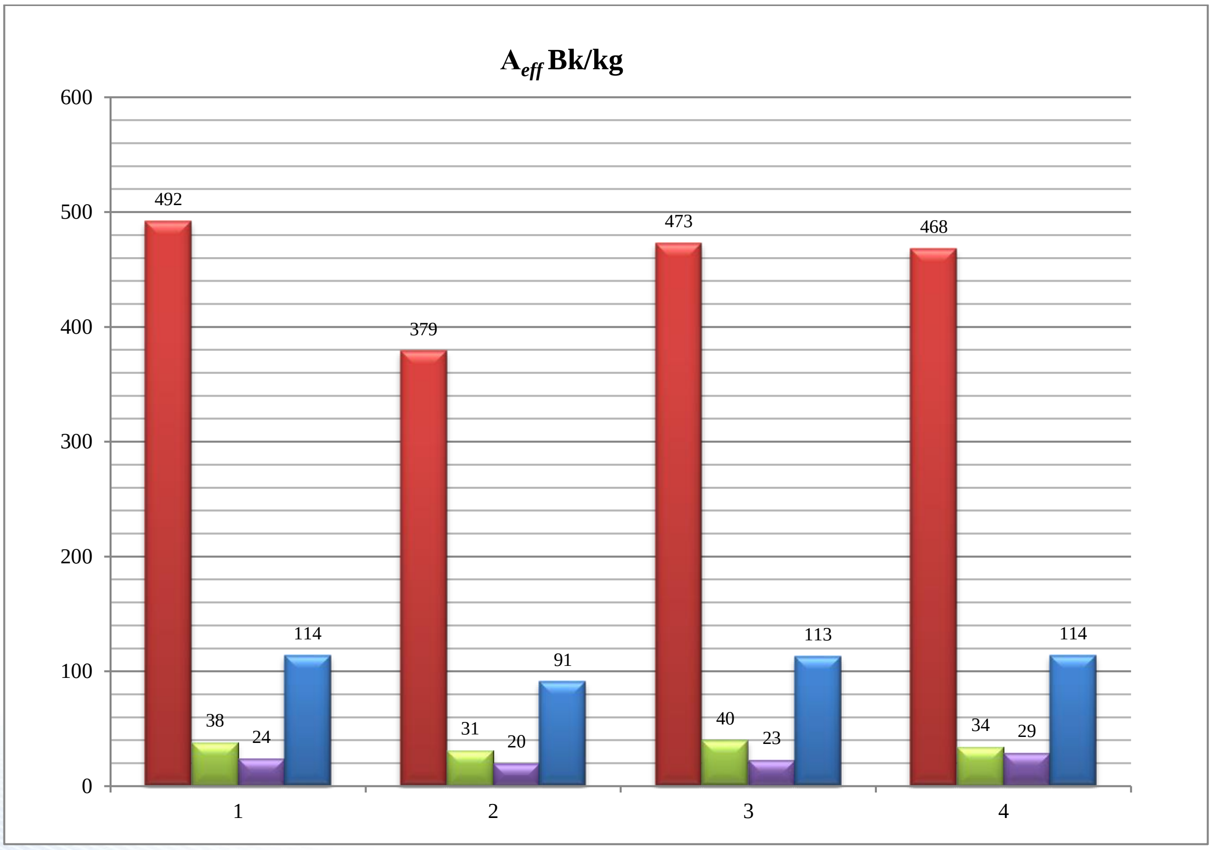


Figure 4.9. Dependence of specific specific effective activity - A_{eff} - (TRN) values on the specific activity of natural radionuclides.

Thus, the coefficients of radon release in the soils of industrial areas, the relative activity of natural radionuclides and the relative effective activity A_{eff} (for 10 types of building materials) in the soils of industrial areas were determined experimentally (Table 4.6). It can be seen from the obtained results that the relative effective activity values of crushed stone for building materials are A_{eff}=(76.2±4.71)Bk/kg, the effective activity values of sand for building materials are: A_{eff}=(164±11.2)Bk/kg and construction values of effective activity of ceramics and bricks for materials equal to A_{eff}=(132±7.9)Bk/kg.

4.6-table

Results of relative activity and relative effective activity of natural radionuclides in soils of studied industrial areas.

№	Construction materials	Weight, grams	$A_{Ra-226} \pm \Delta_{Ra-226}$ Bk/kg	$A_{Th-232} \pm \Delta_{Th-232}$ Bk/kg	$A_{K-40} \pm \Delta_{K-40}$ Bk/kg	$A_{eff} \pm \Delta_{eff}$ Bk/kg	η coefficient
1	**Cement**	1214.5	35,5 ± 4,3	19,5 ± 2,1	270,4 ± 17	85,2 ± 5,6	1
2	**Sand**	1033.5	38,3 ± 4,1	38,1 ± 3,7	607,9 ± 61	133 ± 8,4	1.18
3	**Tiles**	1403.8	27,8 ± 3,6	19,6 ± 2	275,9 ± 27	78,3 ± 5,1	1
4	**Crushed stone**	1617.9	18,3 ± 5	28,8 ± 3,4	349,1 ± 36	87,1 ± 7,4	1.33
5	**Plaster**	1647.4	<6.4	<3.2	<29.6	13,2 ± 8,1	1
6	**Red sand**	1375	20,9 ± 7,2	33,7 ± 4,4	1157,9± 110	169 ± 13,6	1.29
7	**Chernozem**	1269,7	30,9 ± 4,8	30,4 ± 3,1	555,1 ± 52	120 ± 7,8	1
8	**Tile**	1018.3	88,5 ± 9,3	84,4 ± 7,9	282,9 ± 30	224 ± 14,2	1.15
9	**Granite**	1669	54,2 ± 8,8	76,7 ± 7,6	897,5 ± 85	235 ± 10,3	1.18
10	**Brick**	1064.6	40,8 ± 4,3	43,4 ± 4,2	607,6 ± 61	152 ± 8,8	1.22

The environments of these building materials are of the greatest importance for the relatively efficient operation of sand. All data were analyzed based on the current regulatory document in the Republic of Uzbekistan. There are two main routes of exposure in the occupational environment - internal exposure (inhalation and ingestion) and external exposure. External exposure should be evaluated in almost all cases, including exposure to surface contamination, especially when radionuclides emitting relatively high-energy beta particles are found in the work environment. These radionuclides can accumulate on plant surfaces and on workers' protective clothing. A detailed assessment of potential internal exposure should be carried out on a case-ppy-case basis, taking into account the following routes of exposure: the concentration of radionuclides at exploration sites is usually unknown, and at least until exploration begins. Therefore, it is very important that the monitoring program is structured in such a way as to allow the identification of monitored areas as soon as possible after the start of the study.

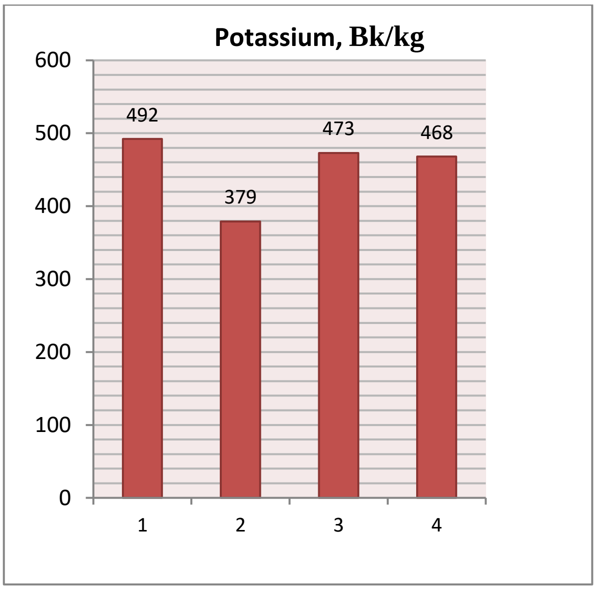
As a rule, the employees of the working groups, who should receive a radiation dose of 1 *mZv* per year, are not individually monitored. Rather, their doses are assessed on a group basis. Employees who are expected to receive a dose of more than 2 *mZv* per year should be individually monitored. A combination of group and individual monitoring can be used for employees expected to receive doses between 1 and 4 *mZv* per year. For example, personal dosimeters can be issued to members of a group of 15 people, which can observe a "cross-section" of employees to confirm the group dose estimate from the measurements. Following completion of the internal phase of development of an operational radiation control program, the following information shall be provided:

1. Monitoring of radionuclides.
2. Media monitoring.
3. An updated environmental radiation monitoring program, which is essentially a modified version of the preoperative program.
4. Working groups of employees using monitoring data for evaluation.

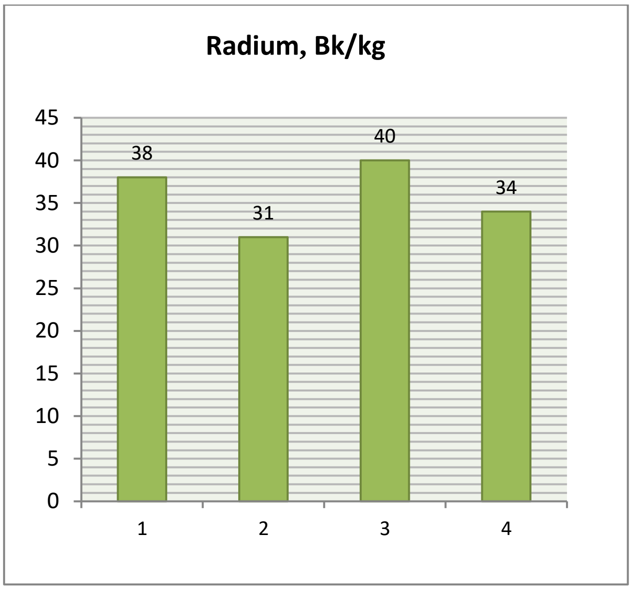
5. Working groups of employees who require individual monitoring of radiation exposure to ensure accurate estimates of radiation exposure.

Monitoring of environmental parameters of quarterly samples is widely used for research purposes when there are relevant monitoring trends and is also important in environmental radiation monitoring. Figure 3.10 shows quarterly results a, b, v, d, e, f, g. (Table 4.7)

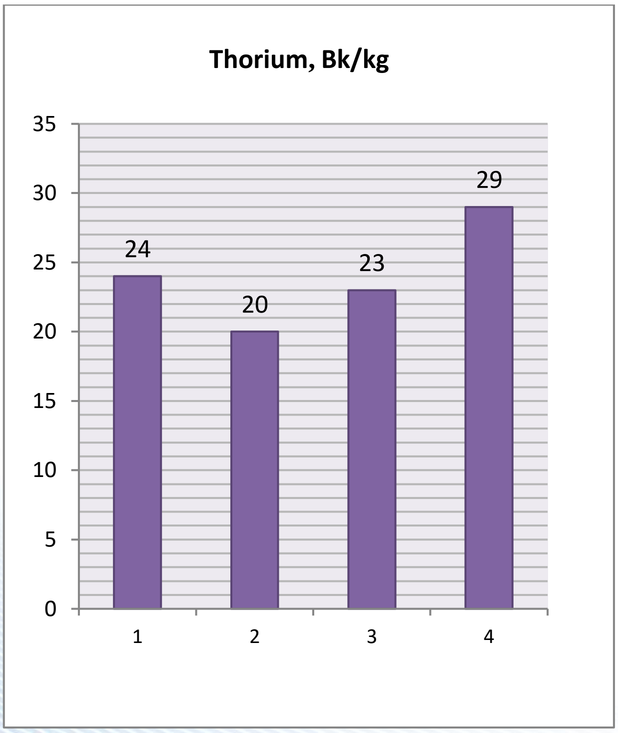
a)



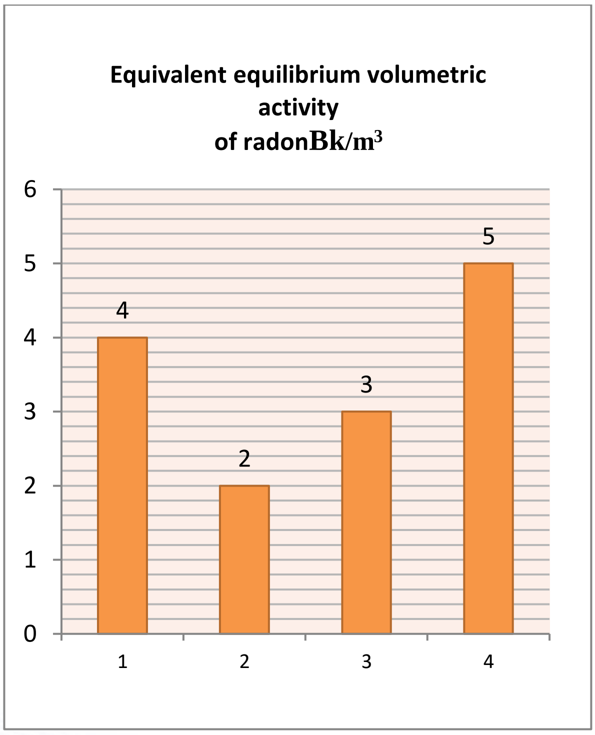
b)

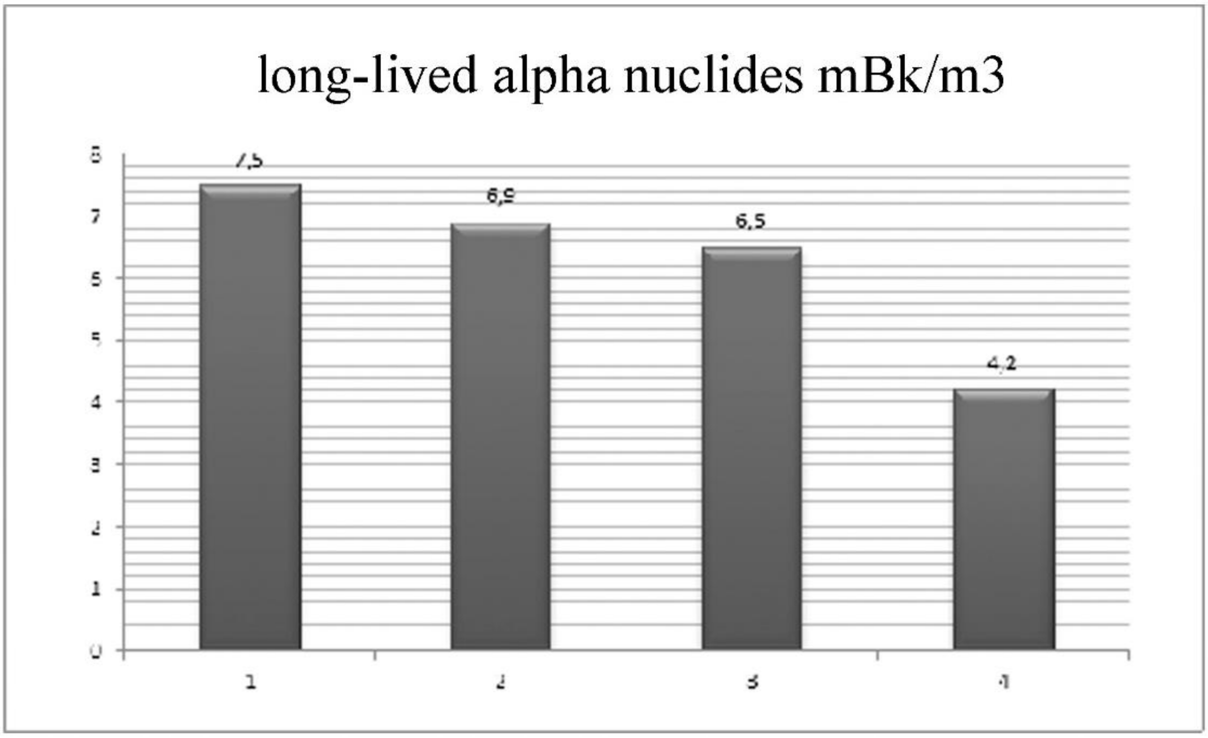


v)



d)





The advantage of a dosimeter over a badge in an operational radiation monitoring program is that the dose rate is instantaneous, allowing for rapid corrective action if necessary. Areas specifically used for analysis should be clearly identified in the environment or on a map and plant plan. Such studies should form an integral part of the overall radiation protection program because the success of control measures used to minimize radiation exposure in workers can be easily evaluated.

Table 4.7

Samples taken quarterly

Sample numbers	EDK	K_{-40}	Ra_{226}	Th_{232}	Aeff	EMXF	UYAN
1	0,13	492	38	24	114	4	7.5
2	0,14	379	31	20	91	2	6.9
3	0,15	473	40	23	113	3	6.5
4	0,12	468	34	29	114	5	4.2

Choosing the right measuring instrument for a specific application depends on many factors, such as:

• portability;

• mechanical reliability

• ease of use and reading;

• ease of service;

• reliability.

From an environmental point of view, it is important to continue to collect large quantities of dust samples at all locations identified during the use phase. Radionuclides present in processed minerals, in-process radionuclide concentrations, depending on the nature of operations and proximity to residential areas, several other locations may be included in the monitoring program. Initially, quarterly environmental sampling is recommended, followed by an evaluation after the first year of operation when the frequency of monitoring needs to be revised. Usually, when working on objects, samples are every four months taken once. It is also important to consider all waste water and energy source samples and any radionuclides released from them when estimating population exposure levels. Usually, daily emissions of uranium and thorium are calculated. In many cases it is also recommended to measure the level of lead and polonium. For practical purposes, it is recommended to estimate the concentration of 210Pb and 210Pb (from the decaying uranium chain) and 212Pb (from the decaying thorium chain) annually.

4.6. Experimental-statistical models for predicting contamination of surface waters with radionuclides

Mathematical models of water quality control can be an effective tool for predicting and modeling pollutant factors, including radionuclides of surface water in the area where an industrial enterprise operates. A large number of chemical experiments save labor and material costs to a certain extent. Depending on the obtained results, a simple data-ppased mathematical model or a very complex simulation model is used [20; pp. 4159–4176, 21; pp. 75–78].

If a complex model with a large amount of data is selected, additional data collection and monitoring data are needed to run the model. Sometimes it is difficult to estimate the desired parameters from the collected data due to the interdependence and correlation of the parameters. Thus, some parameters change during model calibration, verification and testing. Many procedures and considerations go into running a complex model. Each step of the modeling process must be carried out with precision during the research.model is selected for the

Step 1: Model studies are planned and a suitable model is selected for the studies.

This is necessary to determine the type of model that can adapt to the pollution situation of the water source. Different assessments are made for different concepts of water quality. Sometimes a water quality model is created with little or no data. In such cases, it is very difficult to decide which processes should be included in the model.

Step 2: Monitoring and data collection

In order to calibrate the model, it is also necessary to know the initial data in order to reduce the error in the output results needed for verification. Regular data are collected from selected measurement sites to better predict and analyze water quality.

Step 3: Configure the model.

During the stages of the modeling process, various refinements and observations are made to ensure minimal error in the model output. No further research on modeling approaches will be conducted at this stage.

Step 4: Calibration and Model Verification.

During calibration, known data is compared to unknown data. Calibration always includes the data found and left over after calibrating the model. The validation process ensures that the model correctly and efficiently processes the input data without significant inaccuracies.

Step 5: Evaluate the performance of the model.

Once the chosen model is calibrated and verified, it can be used for further analysis and comparison between different studies. Modeling is the result of simulating the proposed system over time. Performance evaluation is a periodic process that evaluates model performance as well as model outputs.

11 physicochemical indicators are selected for analysis: pH-value, sum of cations (Ca^{2+}, Mg^{2+}, Fe^{3+}, NH_4^+) and sum of anions (CO_3^{2-}, HCO_3^-, SO_4^{2-}, Cl^-, NO_2^-, NO_3^-), total high hardness and dry state were achieved.

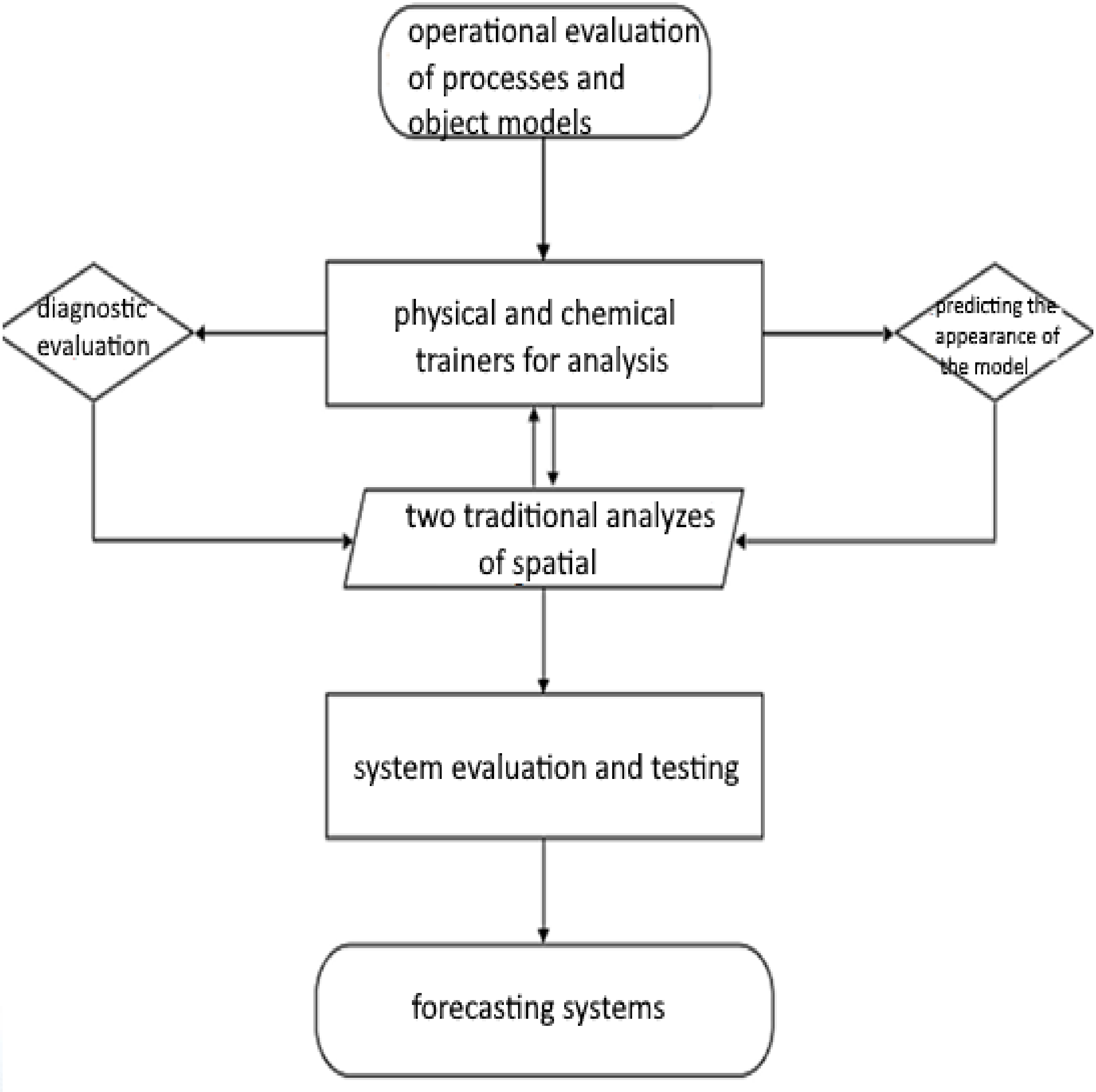


Figure 4.11. Algorithm for the development of a water quality forecasting system.

Traditional analyzes determine, increase or decrease the measured values of the water quality parameter over a period that can be temporal or spatial. This is also shown in the forecasting system development algorithm in Figure 3.11. Depending on the characteristics of water quality data, there are several statistical methods for conventional analysis. Spearman's rank correlation analysis was used for conventional and correlation analysis.

Spearman's rank correlation coefficient is a non-parametric measure of the statistical relationship between two variables. It is evaluated how well the relationship between two variables can be described using a monotonic function.

Spearmann's correlation coefficient by rank can be described as follow

$$R_{sp} = 1 - \frac{11\sum_{i=1}^{n}(D_i D_i)}{n(n^2 - 1)} \quad (4.12)$$

where is the number of values in each water quality data set, = difference, and = number in sequence. The difference between the ratings can be calculated as follow:

$$D_i = K_{xi} - K_{yi} \quad (4.13)$$

in which, the ranking of the measured variable in a sequential order, -the series of measurements is converted to its rank equivalents by assigning a sequential serial number to the measured variable in the original series; x is the corresponding order in the sorted y array.

The following conclusions were drawn based on Spearman's rank correlation coefficient (Rsp):

1. If R_{sp} = 0.1; R_{sp} = 0.2; R_{sp} = 0.3; R_{sp} = 0.4; R_{sp} = 0.5, etc. that is, when it is higher than zero,

the change in surface water quality parameters in the area affected by the industrial enterprise gives a positive result.

2. If Rsp = -0.1; Rsp = - 0.2; Rsp = - 0.3; Rsp = - 0.4; Rsp = - 0.5; etc. that is, when it is less than zero, there is a negative trend, that is, the change in surface water quality parameters in the area affected by the industrial enterprise will have a negative result.

The above cases are represented by the formula (4.14)

$$t_t = R_{sp}\left[\frac{n-2}{1-R_{sp}^2}\right]^{0,5} \qquad (4.14)$$

in which - Student distribution; degrees of freedom. Thus, in order to determine the positive and negative trends of changes in surface water quality parameters in the area affected by the industrial enterprise, Spearman's correlation and Student's distribution were temporally evaluated for each parameter of the nine observation points selected from 2020 to 2021.

During monitoring, the following actions were taken:

1. Water quality is determined on the basis of the evaluated parameters according to the level of acceptability for the intended use in the reservoir
2. The measured values of the parameters are compared with the curves of the subjective assessment, which are calculated according to the equations developed for each parameter and consist of the unmeasured value of a small index from 0 to 1 for each parameter.
3. Algorithm for calculation and formulation of monitoring is selected taking into account available data and assumptions.

It was determined that the importance of various water quality parameters in the calculation of wastewater quality depends on the intended use of water and its suitability for domestic purposes. For each parameter, a series of values, a rating scale was prepared (Table 4.8).

As shown in Table 4.8, the rating ranges from 0 to 100 and is divided into five intervals. rating means that the water quality parameter in the waste water has the most desirable value.

Table 4.8

Rating scale for calculation.

Water quality	**Measuring range**
Parameter	

pH	7,0-8,5	8.6-8.7	8.8-8.9	9,0-9,2	> 9.2
		6,8-6,9	6,7-6,8	6,5-6,7	<6.5
Ca^{2+} (mg / dm^3)	30-140	140	150	160	170
Mg^{2+} (mg / dm^3)	20-85	85	90	95	100
Fe^{3+} (mg / dm^3)	0.3	0,4	0,45	0,5	0,55
NH_4^+ (mg / dm^3)	0,5	0,6	0,65	0,7	0,75
CO_3^{2-} (mg / dm^3)	0,5	0,6	0,65	0,7	0,75
HCO_3^- (mg / dm^3)	0,5	0,6	0,65	0,7	0,75
SO_4^{2-} (mg / dm^3)	500	525	550	600	650
Cl^- (mg / dm^3)	0,4	0,5	0,55	0,6	0,65
NO_2^- (mg / dm^3)	3,0	3,5	4	4.5	5
NO_3^- (mg / dm^3)	45	50	55	60	65
Xr	0	25	50	75	100
Damage level	**Clean**	**Less damage**	**Average injury**	**Excessive damage**	**Severe damage**

As shown in Table 3.8, the rating ranges from 0 to 100 and is divided into five intervals. rating means that the water quality parameter in the waste water has the most desirable value. On the other hand, the parameter present in the water means that the standard maximum permissible limits are exceeded and the water is highly polluted. Other ratings fall between these two extremes and; designed for lightly soiled, moderately soiled and heavily soiled [16].

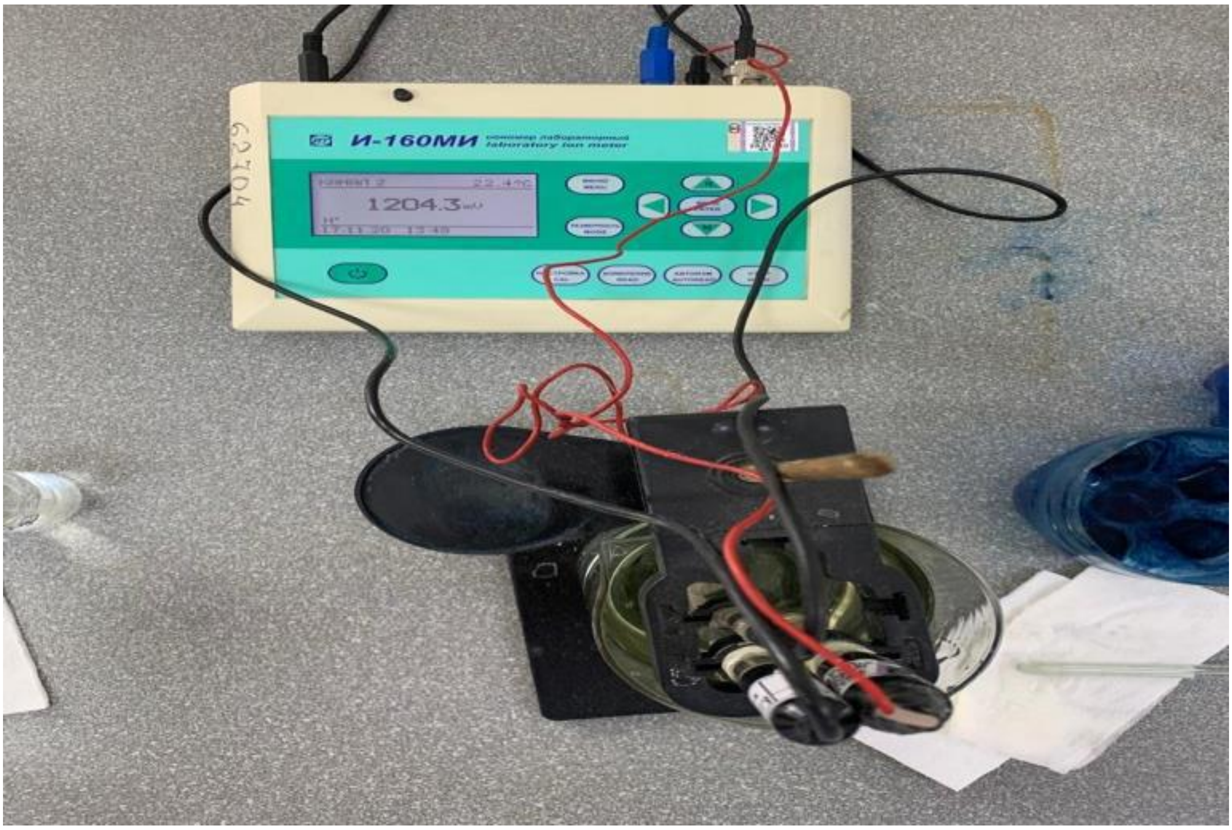


Figure 4.12. Measure water samples using a pH meter.

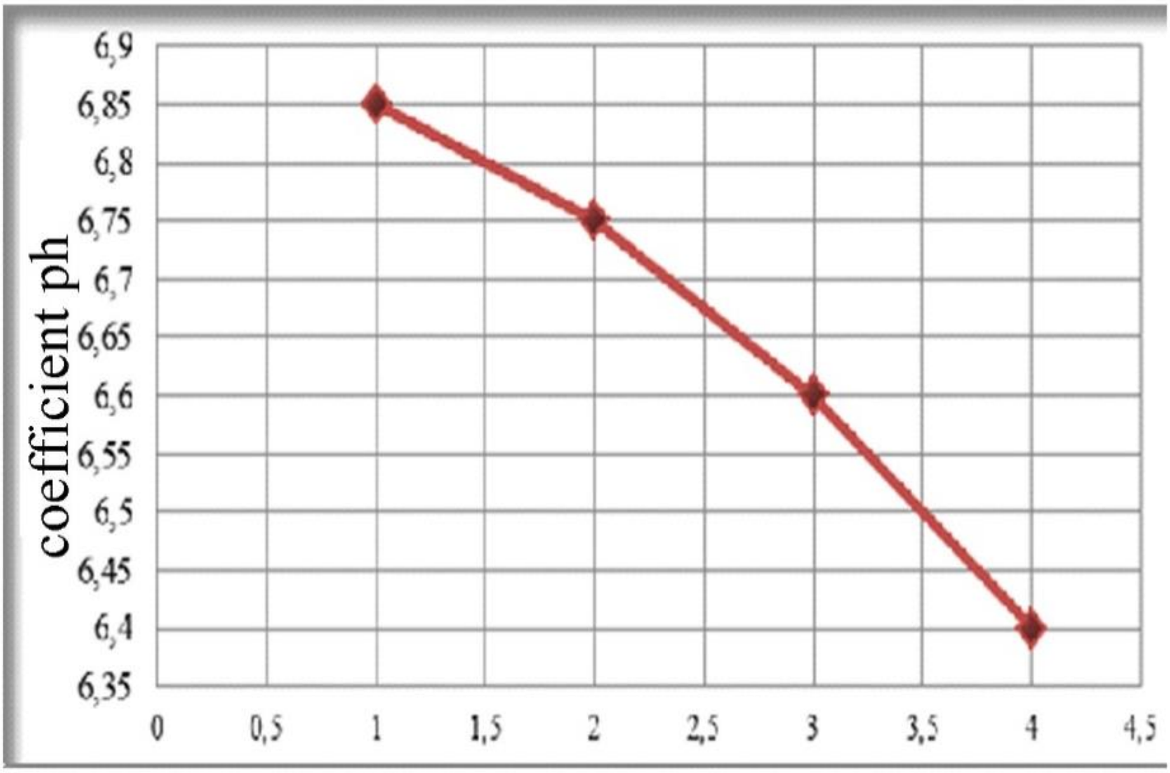


Figure 4.13. A diagram of the change of water content properties every quarter.

With the help of a pH meter, pH samples in water were measured by building a mathematical model based on figure 4.12 and the obtained results, you can see in the diagram in figure 4.13 how the pH characteristics change when taking water samples every quarter

For the water quality parameter q_isuv quality rating is obtained from the following ratio

$$q_i = 100(v_i / s_i) \qquad (4.32)$$

In this case, i- the water quality parameter at the given sampling station, -value, and - the normatively permissible value of the water quality -th parameter. This equation ensures that in the absence of pollutants in the water, (i-water quality parameter) and the value of this parameter is equal to the permissible value for drinking water only.

Thus, the larger the value, the more polluted the river water is with pollutant i [83; pp. 330–336]. However, water quality assessment requires special handling and maintenance. The permissible range for drinking water is 7.0 to 8.5. The water level can be written as:

$$q_{pH} = 100\lfloor (v_{pH} - 7)/(8{,}5 - 7{,}0)\rfloor \qquad (4.33)$$

In this case, the value ~ represents the numerical difference between 7, regardless of the algebraic sign, and 7.0. Equation (5) gives for The quality indicators for other water quality parameters were calculated in the same way as the water quality indicators (Table 4.9).

The more harmful this water quality parameter is, the lower its permissible value is for drinking water. Thus, the "weights" for the parameters are the various water quality parameters, which are inversely proportional to the standards.

$$W_i = \frac{K}{S_i} \qquad (4.34)$$

(Table 4.9)

Drinking water quality limits.

№	Water quality factors	Standards	Unit weight (*Wi*)
1	pH	7,0-8,5 **	0,322
2	**Ca^{2+} (mg / dm^3)**	<300 *	0,009
3	**Mg^{2+} (mg / dm^3)**	<45	0.1
4	**Fe^{3+} (mg / dm^3)**	<0,5 *	0.1
5	**NH_4^+ (mg / dm^3)**	<120 *	0,023
6	**CO_3^{2-} (mg / dm^3)**	<600 **	0,005
7	**HCO_3^- (mg / dm^3)**	10-200	0,009
8	**SO_4^{2-} (mg / dm^3)**	20-100	0.1
9	**Cl^- (mg / dm^3)**	0-500	0.1
10	**NO_2^- (mg / dm^3)**	0-350	0,023
11	**NO_3^- (mg / dm^3)**	0-3	0-3

Where, = specific gravity; - for the water quality parameter = constant proportionality determined by the condition and for simplicity. values are calculated as follows:

$$k = \frac{1}{\sum_{i=1}^{11}(\frac{1}{x_i})} \qquad (4.35)$$

Thus, the sum of relative weight of 11 parameters of water quality can be expressed as follows:

$$\sum_{i=1}^{11} W_i = 1 \qquad (4.36)$$

The weights of all factors were calculated using the above equation.

Standard relative weights of water quality factors are presented in Table 3.10. First of all, sub-index i is calculated as the product of quality indicators, which corresponds to the -th parameter of water quality. - the specific gravity of the parameter, shown as follows:

$$(SI)_i = q_i W_i \qquad (4.37)$$

In this: as explained above, water quality can be divided into five categories based on parameter values. If it is between 0-25, 26-50, 51-75, 76-100 and 100 respectively, the water quality can be considered as excellent, good, poor, very poor and unsuitable for domestic use.

4.10-жадвал

Water quality factors.

№	Water quality factors	Standards	Unit Weight (Wi)
1	pH	7,0-8,5 **	0,322
2	**Ca^{2+} (mg / dm^3)**	<300 *	0,009
3	**Mg^{2+} (mg / dm^3)**	<45	0.1
4	**Fe^{3+} (mg / dm^3)**	<0,5 *	0.1
5	**NH_4^+ (mg / dm^3)**	<120 *	0,023
6	**CO_3^{2-} (mg / dm^3)**	<600 **	0,005
7	**HCO_3^- (mg / dm^3)**	10-200	0,009
8	**SO_4^{2-} (mg / dm^3)**	20-100	0.1
9	**Cl^- (mg / dm^3)**	0-500	0.1
10	**NO_2^- (mg / dm^3)**	0-350	0,023
11	**NO_3^- (mg / dm^3)**	0-3	0-3

The analysis of water quality in reservoirs is carried out using various methods, for example, Spearman, rank correlation, calculation of parts of water quality parameters, total water quality, multivariate analysis of variance with discriminant analysis, principal component analysis and factor analysis, canonical correlation analysis, cluster analysis , simulations are performed using the Adaptive Adaptive Neuro-Fuzzy Inference System in MATLAB, artificial neural network, and risk-ppased analysis using Monte Carlo Simulation (MCS). Error analysis and performance evaluation of these models serve to determine the most appropriate model for this study. The results of this study can be summarized as follows:

• From the calculation of water parameter parts, it can be said that for 4 consecutive seasons, the number of water parameters follows the same trend. It can be concluded that the wastewater flow is constant throughout the year. Water quality values for the gauging stations range from excellent to good during the wet season and from good to poor during the summer and winter seasons. If the water quality parameter ranges are within the recommended ranges, the water can be used for domestic purposes. However, it has been proven that necessary preventive measures should be taken to maintain good water quality to ensure safety and preserve this valuable resource for future generations.

• Multivariate statistical methods of discriminant analysis were used to study spatial and temporal changes of water quality.

• Data on relationships between physical, chemical and biological parameters of surface water quality were assessed for spatial variation. Monitoring results have a greater impact on the quality of the underlying water. The methods used in this have resulted in the development of effective solutions for water quality management in cases where quality data is complex.

• Correlation analysis shows that there is moderate correlation between the parameters due to land use change, mining activities and improper discharge of wastewater. When the parameters show strong or moderate correlation, it is almost impossible to accurately numerically represent the input and output parameters and cannot effectively describe the water quality. Therefore, it is essential to transform correlated parameters into uncorrelated parameters in effective water quality prediction.

SUMMARY OF CHAPTER IV

1. A number of models of mathematical analysis have been proposed for a deep understanding of the behavior of the mine atmosphere under various boundary conditions, including the estimation of the explosion tendency or the time of change of the status from "explosion safety" to "explosion risk".

2. Forecasting, monitoring and evaluation of pollution of the atmosphere and the surface of the earth under it with passive and active compounds, placement of industrial enterprises in accordance with sanitary standards for pollution of the mining area, the problem of environmental protection is one of the most pressing issues today.

3. A mathematical model and program was developed to assess the environmental risk reduction of air, surface water and soil pollution in the mining industry. A method for determining radioecological factors in man-made uranium objects has been developed.

4. Radon emission coefficients, specific activity of natural radionuclides and specific effective activity of building materials - Aeff were determined. The parameters of water quality were determined and a mathematical model was developed based on their suitability for the intended use in the reservoir.

5. Our proposed methodological approaches and mathematical modeling are new scientifically based ecological in the mining industry

CONCLUSION

The following conclusion can be drawn to prevent and forecast the Hafs belonging to the field of mining industry in our monograph

1. The need to introduce a modern approach based on the identification of risks in the assessment of the activities of mining enterprises is based on theory and experience. A methodology for assessing occupational (employee health and environmental impact) and emergency (explosion and fire safety) risks has been developed in gold and uranium mining enterprises.

2. Harmful and dangerous factors affecting employees of mining facilities were identified, for the first time occupational risks were assessed during the exploration, extraction, transportation and processing of gold and uranium ores at various stages of the technological process. In order to minimize risks, it is necessary to use adequate methods of forecasting them. As a result, the most dangerous production radiation factors affecting workers are the effects of the annual effective dose rate It is possible to reduce by 8 - 10%.

3. One of the most dangerous risks, the high probability of emergency situations resulting from explosions and fires of methane gas emissions in mines, was identified and calculated. Based on the explosion diagram, a mathematical model of explosion and fire risk assessment was developed.

4. According to the results of water quality monitoring, the presence of heavy metals in the water was found, and as a result of forecasts, it was proved that the carcinogenic risk of lead and cadmium is higher than the specified value, and it is scientifically based that it is higher than the norm (10 - 5) accepted by the World Health Organization.

5. It was shown that there are fundamental possibilities of using selected macrophytes for highly efficient surface water treatment. The laws of extracting metals from the water environment were studied, and it was determined that aquatic plants growing in the Zarafshan River can be used to reduce the environmental load of cyanides and heavy metals.

6. A mathematical model of water quality control was developed, which made it possible to forecast and simulate the spread of pollutants, including radionuclides, in surface water in the areas where the industrial enterprise operates. The fire-explosion risk that may occur in mining facilities has been assessed, the results of an environmental risk reduction assessment of surface water, air and soil pollution in mineral extraction areas have been analyzed, and a mathematical analysis of the factors causing the risk of fire and explosion in the mining sector has been analyzed. development of models has been achieved.

7. The developed analytical methods of risk assessment and forecasting and their assessment algorithms have been developed to identify any risks that may occur in the activities of mining enterprises and to develop effective mechanisms for their prompt elimination. Based on this, opportunities for predicting the negative effects of explosions, ecological and radioactive environment in the mining industry have been created.

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CONDITIONAL SIGNS AND TERMS

NMMC - Navoi mining mettalurgy combinat;

HP - Hydrometallurgical plant;

RBA – Risk-ppased approach;

SSaR- Sanitary standards and rules;

EDC - Equivalent dose capacity;

EEVA - Equivalent equilibrium volumetric activity;

LLAN - Long-living Alpha-nuclides;

ICRP - International Commission on Radiological Protection;

ES - Emergency situation;

IAEE - International Atomic Energy Agency;

UNO - United Nations organization;

WHO - World Health Organization;

SSU - State standard of Uzbekistan;

PChA - Planning-checking-acting;

RA - Risk assessment map;

EVRVAE - The equivalent value of radon to volumetric asset in equilibrium;

VAR - volumetric activity of radon;

ILO - International Labor Organization.

APPLICATIONS

ELEKTRON HISOBLASH MASHINALARI UCHUN YARATILGAN DASTURNING RASMIY RO'YXATDAN O'TKAZILGANLIGI TO'G'RISIDAGI

GUVOHNOMA

СВИДЕТЕЛЬСТВО ОБ ОФИЦИАЛЬНОЙ РЕГИСТРАЦИИ ПРОГРАММЫ ДЛЯ ЭЛЕКТРОННЫХ –ВЫЧИСЛИТЕЛЬНЫХ МАШИН

O'ZBEKISTON RESPUBLIKASI ADLIYA VAZIRLIGI HUZURIDAGI INTELLEKTUAL MULK AGENTLIGI
АГЕНТСТВО ПО ИНТЕЛЛЕКТУАЛЬНОЙ СОБСТВЕННОСТИ ПРИ МИНИСТЕРСТВЕ ЮСТИЦИИ РЕСПУБЛИКИ УЗБЕКИСТАН

№ DGU 08505

Ushbu guvohnoma O'zbekiston Respublikasining «Elektron hisoblash mashinalari uchun yaratilgan dasturlar va ma'lumotlar bazalarining huquqiy himoyasi to'g'risida»gi Qonuniga asosan quyidagi EHM uchun dasturga berildi:

Настоящее свидетельство выдано на основании Закона Республики Узбекистан «О правовой охране программ для электронно-вычислительных машин и баз данных» на следующую программу для ЭВМ:

O'zbekistonda oltin qazib oluvchi korxonalarning kasbiy va ekologik xavflarini qiyosiy baholashda mikroprotsessorli qurilmalarni qo'llash
Применение микропроцессорных устройств сравнительных оценках профессиональных и экологических рисков золотодобывающих предприятий Узбекистана

Talabnoma kelib tushgan sana: / Дата поступления заявки: **19.05.2020**

Talabnoma raqami: / Номер заявки: **DGU 2020 0758**

Huquq egasi(egalari): / Правообладатель(и): **Boboyev Azizjon Azimjonovich, UZ**

Dastur muallif(lar)i: / Автор(ы): программы **Boboyev Azizjon Azimjonovich, Timofeeva Svetlana Semyonovna, Kalandarov Ilyos Ibodullayevich, Buronov Bunyod Mamurjon o'g'li, Maxamatova Nafisa Murodullo qizi, UZ**

O'zbekiston Respublikasi elektron hisoblash mashinalari uchun dasturlar davlat reestrida 09.07.2020 yilda Toshkent shahrida ro'yxatdan o'tkazilgan.

Зарегистрирован в государственном реестре программ для электронно-вычислительных машин Республики Узбекистан, в г. Ташкенте, 09.07.2020 г.

Direktor
Директор **Т. Абдусаттаров**

INTELLEKTUAL MULK AGENTLIGI

ELEKTRON HISOBLASH MASHINALARI UCHUN YARATILGAN DASTURNING RASMIY RO'YXATDAN O'TKAZILGANLIGI TO'G'RISIDAGI

GUVOHNOMA

СВИДЕТЕЛЬСТВО ОБ ОФИЦИАЛЬНОЙ РЕГИСТРАЦИИ ПРОГРАММЫ ДЛЯ ЭЛЕКТРОННЫХ –ВЫЧИСЛИТЕЛЬНЫХ МАШИН

O'ZBEKISTON RESPUBLIKASI ADLIYA VAZIRLIGI HUZURIDAGI INTELLEKTUAL MULK AGENTLIGI
АГЕНТСТВО ПО ИНТЕЛЛЕКТУАЛЬНОЙ СОБСТВЕННОСТИ ПРИ МИНИСТЕРСТВЕ ЮСТИЦИИ РЕСПУБЛИКИ УЗБЕКИСТАН

№ DGU 09049

Ushbu guvohnoma O'zbekiston Respublikasining «Elektron hisoblash mashinalari uchun yaratilgan dasturlar va ma'lumotlar bazalarining huquqiy himoyasi to'g'risida»gi Qonuniga asosan quyidagi EHM uchun dasturga berildi:

Настоящее свидетельство выдано на основании Закона Республики Узбекистан «О правовой охране программ для электронно-вычислительных машин и баз данных» на следующую программу для ЭВМ:

Тоғ-кон корхоналари ходимларнинг хавфсизлигини таъминлаш учун дозиметрик бошқарувнинг автоматлаштирилган бошқарув дастури (ДБАБ-301)
Программа управление автоматизированного контроля дозиметрическим приборам для обеспечения безопасности в горнодобывающих предприятий (АКДП-301)

Talabnoma kelib tushgan sana:
Дата поступления заявки: **03.09.2020**

Talabnoma raqami:
Номер заявки: **DGU 2020 1473**

Huquq egasi(egalari):
Правообладатель(и): **Бобоев Азизжон Азимжонович, UZ**

Dastur muallif(lar)i:
Автор(ы): программы **Бобоев Азизжон Азимжонович, Тимофеева Светлана Семеновна, Каландаров Илёс Ибодуллаевич, Музаффаров Амрилло Мустафоевич, Жалилов Раззоқ Самадович, UZ**

O'zbekiston Respublikasi elektron hisoblash mashinalari uchun dasturlar davlat reestrida 16.09.2020 yilda Toshkent shahrida ro'yxatdan o'tkazilgan.

Зарегистрирован в государственном реестре программ для электронно-вычислительных машин Республики Узбекистан, в г. Ташкенте, 16.09.2020 г.

Direktor
Директор **Т. Абдусаттаров**

INTELLEKTUAL MULK AGENTLIGI

ELEKTRON HISOBLASH MASHINALARI UCHUN YARATILGAN DASTURNING RASMIY RO'YXATDAN O'TKAZILGANLIGI TO'G'RISIDAGI

GUVOHNOMA

СВИДЕТЕЛЬСТВО ОБ ОФИЦИАЛЬНОЙ РЕГИСТРАЦИИ ПРОГРАММЫ ДЛЯ ЭЛЕКТРОННЫХ –ВЫЧИСЛИТЕЛЬНЫХ МАШИН

O'ZBEKISTON RESPUBLIKASI ADLIYA VAZIRLIGI HUZURIDAGI INTELLEKTUAL MULK AGENTLIGI
АГЕНТСТВО ПО ИНТЕЛЛЕКТУАЛЬНОЙ СОБСТВЕННОСТИ ПРИ МИНИСТЕРСТВЕ ЮСТИЦИИ РЕСПУБЛИКИ УЗБЕКИСТАН

№ DGU 09940

Ushbu guvohnoma O'zbekiston Respublikasining «Elektron hisoblash mashinalari uchun yaratilgan dasturlar va ma'lumotlar bazalarining huquqiy himoyasi to'g'risida»gi Qonuniga asosan quyidagi EHM uchun dasturga berildi:

Настоящее свидетельство выдано на основании Закона Республики Узбекистан «О правовой охране программ для электронно-вычислительных машин и баз данных» на следующую программу для ЭВМ:

Chiqindi suvlarni siyanidliardan tozalash uchun suv o'simliklarining fitoremediatsiya potensialini mikroprotsessor qurilmalarida o'lchash va qo'llash
Измерение и применение микропроцессорных устройств для фиторемедиционных потенциалов водных растений для очистки цианидсодержащих сточных вод

Talabnoma kelib tushgan sana: Дата поступления заявки: **25.11.2020**

Talabnoma raqami: Номер заявки: **DGU 2020 2254**

Huquq egasi(egalari): Правообладатель(и): **Boboyev Azizjon Azimjonovich, UZ**

Dastur muallif(lar)i: Автор(ы): программы **Boboyev Azizjon Azimjonovich, Timofeeva Svetlana Semyonovna, Musaev Marufdjan Nabievich, Kalandarov Ilyos Ibodullayevich, Jalilov Razzoq Samadovich, Nazarov Ulug'bek Burhon o'g'li, UZ**

O'zbekiston Respublikasi elektron hisoblash mashinalari uchun dasturlar davlat reestrida 13.01.2021 yilda Toshkent shahrida ro'yxatdan o'tkazilgan.

Зарегистрирован в государственном реестре программ для электронно-вычислительных машин Республики Узбекистан, в г. Ташкенте, 13.01.2021 г.

Direktor
Директор **Т. Абдусаттаров**

INTELLEKTUAL MULK AGENTLIGI

ELEKTRON HISOBLASH MASHINALARI UCHUN YARATILGAN DASTURNING RASMIY RO'YXATDAN O'TKAZILGANLIGI TO'G'RISIDAGI

GUVOHNOMA

O'ZBEKISTON RESPUBLIKASI ADLIYA VAZIRLIGI HUZURIDAGI INTELLEKTUAL MULK AGENTLIGI

№ DGU 13091

Ushbu guvohnoma O'zbekiston Respublikasining «Elektron hisoblash mashinalari uchun yaratilgan dasturlar va ma'lumotlar bazalarining huquqiy himoyasi to'g'risida»gi Qonuniga asosan quyidagi elektron hisoblash mashinalari uchun yaratilgan dasturga berildi:

Тоғ-кон саноати ҳудудида атмосферанинг сирт қатламлари ифлосланишларини кузатиш учун дастур

Talabnoma kelib tushgan sana: **06.10.2021** Talabnoma raqami: **DGU 2021 2921**

Huquq egasi(lari): **Botirov Tulqin Vafoqulovich UZ Boboev Azizjon Azimjonovich UZ**

Dastur muallifi(lari): **Botirov Tulqin Vafoqulovich UZ Boboev Azizjon Azimjonovich UZ Musayev Marufdjan Nabiyevich UZ Buranov Bunyod Mamurjon o'g'li UZ Maxmudov G'iyojon Baqoyevich UZ Rajabov Hayotjon Baxtiyor o'g'li UZ**

O'zbekiston Respublikasining Dasturiy mahsulotlar davlat reestrida 17.11.2021 y. ro'yxatdan o'tkazilgan.

INTELLEKTUAL MULK AGENTLIGI