



ANALYTICAL REVIEW

«A DANGEROUS NEIGHBOUR – THE INHULSKA MINE»

**A STUDY OF THE MINE'S IMPACT ON THE RESIDENTS WHO RECEIVE AN
UNFAIR SHARE OF ENVIRONMENTAL BURDEN AND ON THE
ENVIRONMENT OF NEARBY SETTLEMENTS**

The purpose of this study was to investigate the likely impact of the Inhulska mine on residents who receive an unfair share of the environmental burden, and the environment of nearby settlements and to identify optimal ways to solve problems related to the negative impact of the uranium mining facility.

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Its content is the sole responsibility of the **Non-governmental organization "Flora"** and does not necessarily reflect the position of the European Union, the National Endowment for Democracy or the Coalition of NGOs "Stop Poisoning Kryvyi Rih".

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INTRODUCTION

Where an average thermal power plant would need 60 wagons of coal or 40 tanks of fuel oil, an average nuclear reactor would need 30 kilograms of uranium. The property of nuclear fuel that allows to obtain a larger amount of energy from a smaller amount of fuel, leads to an increase in demand of such production, which must be satisfied.

The nuclear fuel cycle is the entire sequence of repetitive production processes, starting from fuel extraction and ending with the removal of radioactive waste. The nuclear fuel cycle begins with the extraction of uranium - a very heavy silver-white metal - the basis of nuclear fuel. The bulk of the world's uranium reserves are located in 10 countries, and Ukraine is one of them.

Today, the uranium mining industry of Ukraine is concentrated in the Kirovohradska oblast and is represented by three operating mines of the SE "SkhidGZK" ("Inhul'ska", "Smolinska" and "Novokostyantynivska"), because the region is located on the Ukrainian crystalline shield, which throughout the massif is saturated with natural radionuclides of uranium-radium and thorium series.

The uranium mining industry is dangerous. It begins with dust in uranium mines, continues with possible and actual exposure during normal operation, accidents at mines and their effects on workers and the population living nearby, and ends with possible contamination of water and soil from buried radioactive waste or man-made accidents. That is why the extraction of uranium, which has a negative impact on the environment and people, should not remain outside the attention of public activists and the public.

METHODOLOGICAL NOTES

Purpose: To investigate the impact of the Inhul'ska mine on residents who receive an unfair share of the environmental burden, and the environment of nearby settlements and to identify optimal ways to solve problems related to the negative impact of the uranium mining facility.

Subject: the economic aspect of the functioning of the Inhul'ska mine.

Task:

1. Analyze the regulatory framework for the operation and environmental safety of nuclear fuel cycle facilities.
2. Analysis of the context of mine activity.
3. To analyze the cases of violation of the requirements of environmental protection and ecological safety of the population, conditions and mode of use of natural resources, damage to the surrounding natural environment by the Inhul'ska mine.
4. Analysis of budget costs for the support of mine operation.
5. Analysis of revenues received for the local budget based on the results of mine operations (including in the form of taxes).
6. Analysis of the impact of the mine on the socio-economic life of the community (attraction of investment loans to the region, support of socially significant projects and initiatives, employment of the local population).

Selection: years 2021-2022.

Territorial coverage: Kropyvnytskyi, village Soniachne, village Zorya, village Berezhyinka, village Klyntsi, village Popivka.

The methodological basis of the research consists of a set of both general scientific and special methods, among which the method of laboratory measurements, the method of normative analysis, the method of budget analysis, the method of structural and functional analysis, as well as content analysis and media monitoring can be distinguished.

Sources:

- Normative and legal acts of national legislation and international acts;
- official information of state authorities, provided upon request;
- state statistical reporting;
- results of laboratory tests;
- open data on the financial state of the enterprise, data from state registers;
- local mass media and online editions of communities, districts, regions.
- etc.

Study period: September - December 2022.

Limitations: The research was conducted in conditions of lack of information due to limitations related to the state of war currently in force in Ukraine. It was not possible to gain access to the state statistical reporting containing information on the subject of the study. Inspection portal data is also unavailable.

The target audience of the study: residents who live in the specified settlements and receive an unfair share of the environmental burden.

Analytical review consists of four parts, contains 60 pages of text. The list of sources includes 16 titles.

PART 1: NUCLEAR AND RADIATION SAFETY OF NUCLEAR FUEL CYCLE FACILITIES

Nuclear safety

A key aspect of the activities of nuclear fuel cycle facilities is their nuclear safety, which means compliance with norms, rules, standards and conditions for the use of nuclear materials that ensure radiation safety.

In turn, radiation safety is compliance with the permissible limits of radiation exposure to personnel, the population, and the surrounding natural environment, established by norms, rules, and safety standards. Radiation safety of the population is ensured by limiting exposure to various sources of ionizing radiation.

The main principle of radiation safety involves obtaining as low radiation doses as possible, now known as ALARA (English ALARA - As Low As Reasonably Achievable).

For example, radiation quotas of 0.25 mSv/year of the average dose of people from the population have been established for NPPs (for new NPPs – 0.1 mSv/year). These limits are established taking into account all discharges into the environment during normal operation of the nuclear facility.

The entire radiation safety system is built on three main principles:

- the principle of justification determines that any decision related to exposure must be justified, that is, bring more benefit than harm;
- the optimization principle requires that human exposure is always kept as low as reasonably achievable;
- the principle of rationing is that with any planned exposure of a person (except for medical) the limit values of the dose set by the law must be observed.

The most important of these is the principle of optimization, which in the publications of the International Commission on Radiological

Protection (ICRC) is called the soul and heart of the radiation safety system.

According to the Law of Ukraine "On the Protection of the Natural Environment" [14], the protection of the natural environment, the rational use of natural resources, and ensuring the ecological safety of human activities are an integral condition for the sustainable economic and social development of Ukraine. Therefore, the subject of economic activity is obliged not to harm the environment and the health of people, and bears property and other legal responsibility for the damage and losses caused.

The fulfillment of this obligation involves reducing the man-made impact of the enterprise on the environment, waste disposal, planning for the rational use of limited and non-renewable resources and the reproduction of renewable ones, as well as other factors.

Nuclear legislation of Ukraine

Any industrial activity is based on a system of regulatory documents, which allows coordinating the activities of many enterprises, organizations and individuals in time and space.

In accordance with the requirements of the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management and the Convention on Nuclear Safety, a state regulatory system for nuclear and radiation safety has been created and maintained in Ukraine.

Nuclear and radiation safety norms in Ukraine are enshrined in the national nuclear legislation, where the central normative legal act is the Law of Ukraine "On the Use of Nuclear Energy and Radiation Safety" [9].

In accordance with this law, all types of activities in the field of nuclear energy use are carried out, the management system in the field of nuclear energy use and the safety regulation system during the use of nuclear energy are functioning. The law also defines the basic principles of radiation protection of people and the natural environment.

The system of nuclear regulation (see Appendix 1) provides for the presence of such basic components as the legislative framework that

regulates activities in the field of nuclear energy use and the infrastructure of state regulation of the safety of nuclear energy use.

In Ukraine, the infrastructure of the state regulation of the safety of the use of nuclear energy is represented by the main authorized central body of the executive power for the regulation of the safety of the use of nuclear energy and radiation safety, which is the State Inspection of Nuclear Regulation of Ukraine (State Nuclear Regulation).

State nuclear regulation as a regulatory body is independent from bodies and organizations that carry out activities in the field of nuclear energy use. According to international requirements, the State Atomic Energy Regulatory Authority as a regulatory body is responsible for issuing official permits, carrying out regulatory actions, reviews and assessments, conducting inspections and applying sanctions, as well as introducing principles, criteria, regulations and guidelines in the field of safety.

What concerns the somewhat narrower sphere of uranium mining is regulated by the law "On Mining and Processing of Uranium Ores" [8].

In 2021, a new normative legal act on the safety of uranium ore mining and processing activities was approved and put into effect - General provisions on radiation safety during uranium ore mining and processing activities [12].

These General Provisions establish the main principles, criteria and requirements of radiation safety during mining, processing of uranium ores and its termination by means of liquidation, repurposing, temporary stoppage (conservation) of the mining and/or processing uranium facility, as well as organizational and technical measures aimed at their implementation.

Regulations on radiation safety

Art. 3 of the Law of Ukraine "On the Protection of Humans from the Impact of Ionizing Radiation" [13] guarantees every person who lives or temporarily resides in the territory of Ukraine the right to protection from the impact of ionizing radiation.

In radiation safety, the quantitative assessment of the impact of radiation on humans is of greatest interest. Art. 5 of the Law of Ukraine "On the Protection of Humans from the Effects of Ionizing Radiation" [13] specifies that the main dose limit of individual population exposure should not exceed 1 (one) millisievert (mSv) (114 milliroentgen (mR), or 0.114 P) of the effective dose of exposure for year, while the average annual effective radiation doses of a person classified as a critical group should not exceed the established basic radiation dose limits, regardless of the conditions and ways of formation of these doses.

To determine the dose received by a person, taking into account the above-mentioned factors, a special value - the effective dose - has been introduced. It takes into account both the type of radiation and the radiosensitivity of organs through the use of radiation weighting factors and tissue weighting factors.

The main document that establishes a system of radiation hygiene regulations to ensure the accepted levels of exposure both for an individual and for Ukrainian society in general is the Radiation Safety Norms of Ukraine (hereinafter - NRB-97) [7], approved by Order of the Ministry of Health N 208 from 14.07.97.

NRB-97 includes four groups of radiation hygiene values that must be observed:

The first group - regulations for control and maintenance of exposure of personnel of nuclear fuel cycle facilities and the population at a level acceptable for people and society.

The second group is regulations aimed at limiting human exposure from medical sources.

The third group is the regulations that determine the amount of radiation dose to the population, which is averted as a result of intervention in the conditions of a radiation accident.

The fourth group is regulations that determine the amount of radiation dose to the population from man-made and enhanced sources of natural origin, which is averted as a result of intervention [7].

NRBU-97 establishes numerical values of radiation dose limits for a number of categories of exposed persons:

Category A (personnel) - persons who permanently or temporarily work directly with sources of ionizing radiation.

Category B (personnel) - persons who are not directly engaged in work with sources of ionizing radiation, but in connection with the location of workplaces in the premises and industrial sites of objects with radiation and nuclear technologies may receive additional exposure.

Category C - the entire population [7].

The numerical values of the dose limits are set at levels that exclude the possibility of the occurrence of objectively determined effects of exposure and, at the same time, guarantee such a low probability of the occurrence of accidental effects of exposure that it is acceptable both for individuals and for society as a whole [7].

For persons of categories A and B, dose limits are established in terms of individual annual effective dose of external and internal radiation and equivalent doses of external radiation (limit of annual effective dose and limits of equivalent dose of external radiation) [7].

The measurement of the equivalent dose of radiation is performed to assess the radiation hazard and harmful effects of the biological action of ionizing radiation during chronic human exposure, as well as to assess the field of free ionizing radiation. The unit of measurement of equivalent dose in the SI system is the sievert (Zv). The equivalent dose rate is the rate of dose accumulation per unit time. The dosimeter measures the equivalent radiation dose in units of $\mu\text{Sv/h}$.

Limiting the exposure of persons of category B (population) is carried out by introducing limits of annual effective and equivalent doses in the critical group of persons of category B. The latter means that the value of the annual radiation dose of persons included in the critical group should not exceed the dose limit established for category B [7].

Radiation dose limits are set at:

20 millisieverts per year - for category A (personnel working directly with sources of ionizing radiation);

2 millisieverts per year – for category B (personnel, but not working directly with sources of ionizing radiation);

1 millisievert per year – for the entire population [7].

In addition to the limit of the annual effective dose, the limits of the annual equivalent dose of external irradiation of individual organs and tissues are established: the lens of the eye, skin, hands and feet (see Appendix 2).

At the same time, the distribution of the radiation dose during the calendar year is not regulated. There are separate restrictions only for women of childbearing age (up to 45 years) and for pregnant women.

The sum of effective radiation doses from all industrial radiation sources is compared with the dose limit. However, this amount does not include:

- dose received during medical examination or treatment;
- radiation dose from natural radiation sources;
- the dose associated with emergency exposure of the population;
- radiation dose from man-made and enhanced sources of natural origin [7].

The given numerical values of permissible levels of entry through respiratory organs and permissible concentration in air are calculated based on the conditions of entry into the body only with air that is inhaled or drinking water directly. At the same time, the accumulation of the radionuclide and its decay products in the area, their transfer in the environment, migration through biological chains, and intake through the diet were not taken into account.

For the corresponding radiation-nuclear objects, a quota of the dose limit of exposure to persons of category B is established. For uranium mines, hydrometallurgical plants for the processing of uranium ores, the total quota of the effective dose limit due to air and water ways of formation is 200 microsieverts [7].

Regulation and control of population exposure is carried out on the basis of calculations of annual effective and equivalent doses of exposure

to critical groups. Calculations are performed according to methods approved by the Ministry of Health of Ukraine.

Unfortunately, residents of the territories affected by the Chernobyl accident receive large effective doses in Ukraine: Zhytomyr region - 5 mSv/year and Kyiv region - 4.6 mSv/year.

For critical population groups, the maximum values of effective doses are typical for Zhytomyr (5.6 mSv/year), Cherkasy (5.5), Ternopil (7.4), Mykolaiv (6.3), and Ivano-Frankivsk (6.2) regions [2].

Increased radiation dose values are observed in the following cities: Kherson (7.6 mSv/year), Ternopil (7.4), Cherkasy (7), Vinnytsia (5.4), Odesa (5.1), Donetsk (4.3), Zhovti Vody (4.8), Vilnohorsk (4.6) and Kamianske (3.8) [2].

Measures to limit population exposure

Limitation of exposure to the population is carried out by means of regulation and control:

- gas-aerosol emissions and liquid discharges during the operation of radiation-nuclear facilities;
- the content of radionuclides in certain environmental objects (water, food, air, etc.).

In addition, a sanitary and protective zone can be established for the relevant objects with radiation-nuclear technologies, where a special mode of use of its territory and special requirements for radiation control are regulated.

Permissible discharges and permissible emissions are established on the basis of the dose limit quota for each individual facility. When setting the values of discharges and emissions, the migration of radionuclides in the environment and along food chains, the structure of land use and the actual use of water bodies (recreation, fish farming, fishing, irrigated agriculture, livestock watering, presence of flooded meadows, etc.) must be taken into account.

Exceeding the permissible discharges and emissions under the conditions of normal operation of the source is not allowed.

In order to record the achieved level of radiation safety at the radiation-nuclear facility, in the settlement and the surrounding environment based on information about the radiation situation at a specific radiation-nuclear facility for its individual premises, sanitary protection zone, surveillance zone and other control levels are set for objects. The values of the control levels should be below the corresponding permissible levels.

They should meet:

- when the population is exposed - the dose of a critical group of the population is less than the corresponding quota of the dose limit;
- when personnel are exposed - individual doses lower than the corresponding dose limits.

It is allowed to set control levels for a separate radionuclide and (or) the route of its arrival. Control levels of the content of a radionuclide in an individual food product or in an individual area may be introduced. The control levels are established by the administration of the radiation-nuclear facility in mandatory coordination with state regulatory bodies.

Conclusions

As a member of the IAEA, Ukraine has adopted relevant national legislation in the field of uranium mining, its processing, nuclear and radiation safety. International conventions are also supported and the provisions of EU directives are being harmonized in this area.

The main principle of radiation safety involves obtaining as low radiation doses as possible, now known as ALARA (English ALARA - As Low As Reasonably Achievable).

In Ukraine, the infrastructure of the state regulation of the safety of the use of nuclear energy is represented by the main authorized central body of the executive power for the regulation of the safety of the use of nuclear energy and radiation safety, which is the State Inspection of Nuclear Regulation of Ukraine (State Nuclear Regulation).

PART 2: THE INHUL'SKA MINE AND ITS IMPACT ON THE ENVIRONMENT

Currently, Ukraine occupies one of the first places in Europe in terms of uranium reserves.

Work on mining (underground) and processing of uranium ores in Ukraine is carried out by one enterprise - SE "SkhidGZK". It includes the Smolinska mine (operating since 1973), which develops the Vatutinske deposit, and the Inhul'ska mine (operating since 1969), which develops the Michurinske and Tsentralne deposits. In terms of uranium reserves, the Novokostiantynivske deposit is 93,626 tons (uranium content in the ore is 0.14%), one of the ten largest deposits in the world.

Characteristics of the Inhul'ska mine

The Inhul'ska mine was created in 1967 on the basis of the Michurinske deposit of uranium ores. It is located in the village of Neopalymivka, 8 km southeast of Kropyvnytskyy. The mine employs 1,400 people.



Mining is carried out at a depth of 420 meters, shafts have been drilled up to 1000 m.

Currently, the mine produces 470,000 tons of uranium ore per year, and during the mine's heyday (1984-1990), it produced 1,000,800 tons per year.

In 2011, a processing and sorting complex that processes ore waste was created on the territory of the Inhul'ska mine. In the course of secondary processing of ore, rich ore is sifted out, not in significant quantities, and what remains is used as material for roads [1].

Every year, ore production decreased. This is due to the fact that the ores are "poor" in terms of uranium, and the production cost is quite high.

During all these years, eight dumps were formed on the territory of the mine, of which six dumps were empty rock and two were "poor" rock. About 7 million tons of waste rock have been accumulated on the site of the Inhul'ska ore management. The total area occupied by waste and off-balance rock dumps is more than 260,000 m² (26 ha).

The industrial site of the Inhul'ska mine is located 4 km from the regional center of the city of Kropyvnytskyi in the southeast direction, that is, on the outskirts of the city. A sanitary protection zone has been set aside around the industrial site. Beyond its borders are: in the north - the village Zavadivka, in the east - agricultural land, in the south - a village. Neopalymivka, in the southwestern part - the village. Pervozvanivka, in the west - the village of Kiselhur, and in the north-western direction - the village Soniachne.

Currently, uranium ore is mined by the mine method.

A railway track is connected to the territory of the mine, along which the mined uranium ore is transported in wagons for further processing to the hydrometallurgical plant in the town of Zhovti Vody. Highways run through the mine, along which road transport is carried out for the economic needs of the mine service.

Cleaning works are carried out in the 280-210 m floor. The ore is extracted by cage lifting of the "Northern" shaft. The Central deposit was opened by two shafts "Exploration and exploitation Nos. 4 and 5", which were drilled to a depth of 1,048 and 336 m, respectively, and a pit shaft - 160 m [1].

The deposit is opened by horizontal workings at horizons of 160, 230 and 300 m. The height of the working floor is 70 m. Cleaning works are carried out at floors 410, 500–590 and 590–680 m, and mining and capital work – at floors 680–770 and 770–950 m. Such a scheme for the opening of the Central deposit made it possible to transport ore underground to the shaft of the "Northern" mine of the Michurinske deposit, without using the surface complex of mines "Exploration and exploitation Nos. 4 and 5" for the construction of an ore sorting plant, placement of empty rock dumps and off-balance ore warehouses [1].

The impact of the Inhul'ska mine on the environment.

Environmental pollution occurs as a result of the emission of radioactive gases through the ventilation system of the mine, discharge of mine water into the hydrological network, as well as radiation and spraying of radionuclides from the ore yard, where work is carried out with ore and related materials. The ore lifted from the mine is loaded into vehicles and sent to the hydrometallurgical plant. Associated materials - out-of-balance ore and empty rock are piled up.

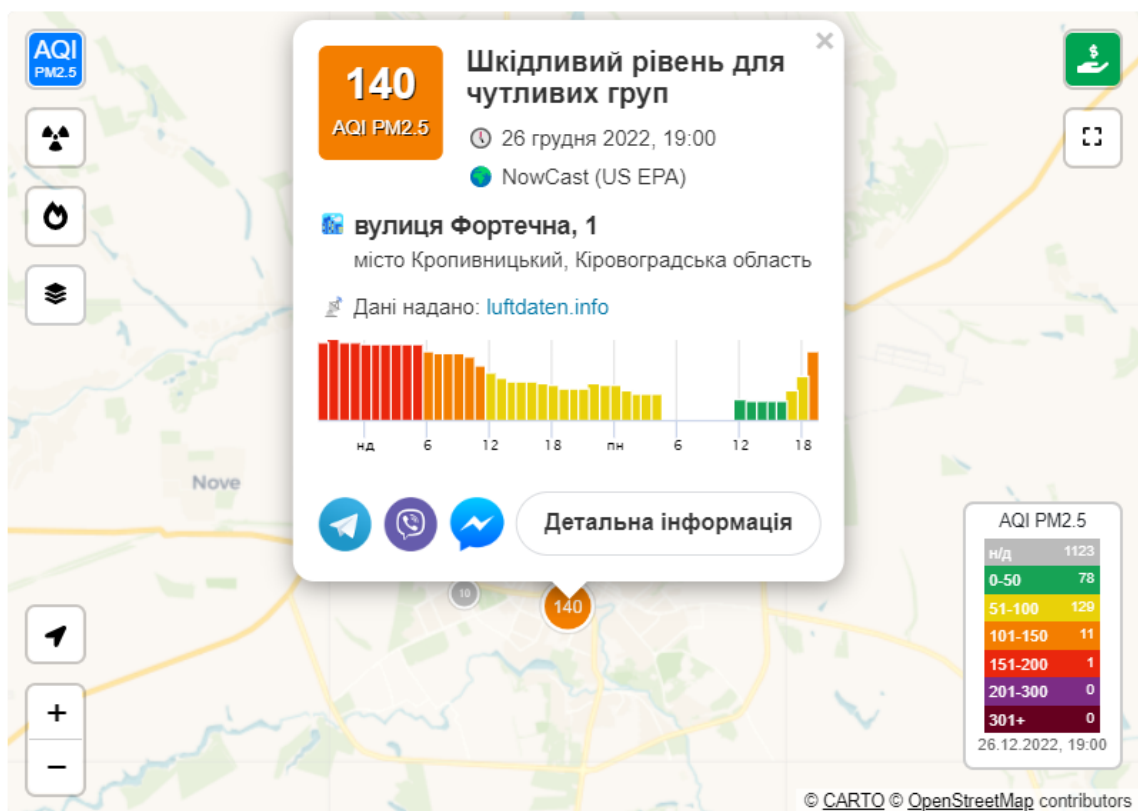
Atmospheric air

Ore dust, which contains uranium radionuclides, is formed directly during ore extraction. Significant radiation pollution of the territory occurs during ventilation of mines after blasting, when dust containing radioactive substances enters the atmospheric air. An exaggeration of the average monthly concentrations in the city of Kropyvnytsky in August 2022 was observed for dust by 1.7 times.

The concentration of ore dust, depending on the time, place and humidity of the ore, especially within the boundaries of the tericons and near the mine itself, varies within very wide limits from almost zero in the absence of mining operations to very high values when numerous blasting operations are carried out. Ore dust significantly affects the radiation

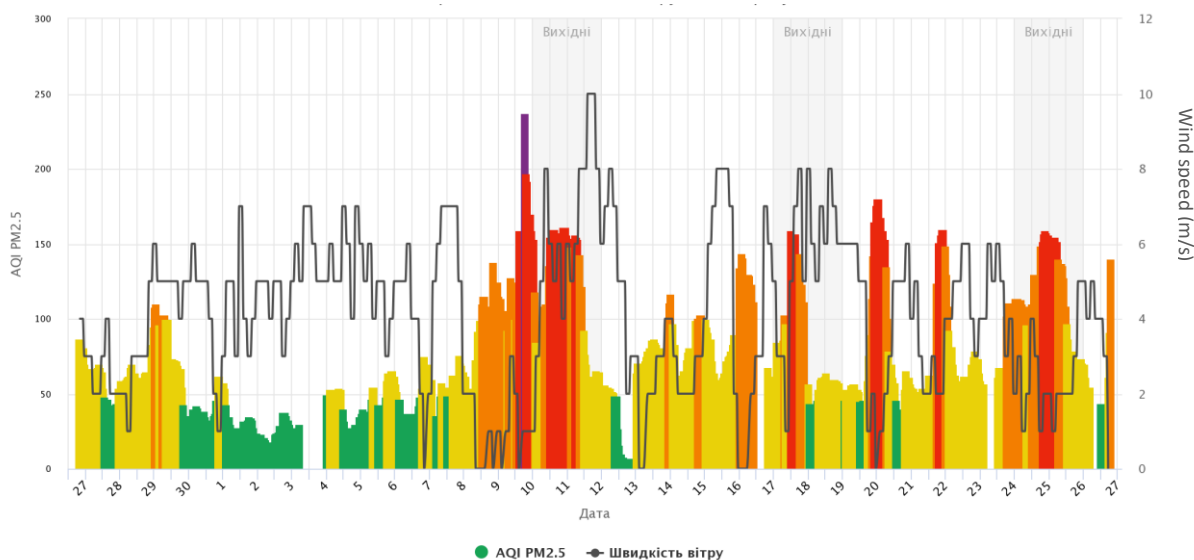
situation of the environment. In addition, the emission of radioactive substances is carried out at a height of 9 meters vertically upwards, which significantly increases their radius of distribution.

The level of atmospheric air pollution in the city of Kropyvnytsky during the II quarter of 2021 was characterized by an increase in nitrogen dioxide, formaldehyde, dust and a decrease in sulfur dioxide, soot in comparison with the I quarter of 2021. Exaggerations of average monthly concentrations were observed for dust by 1.5 times and for formaldehyde by 1.1 times.



Unhealthy for sensitive groups, December 26th, 2022, 19:00, 1 Fortechna street, Kropyvnytsky, Kirovohradska oblast, data provided: luftdaten.info

Average air quality index in Kropyvnytsky
For the period from November 26th till December 26th 2022



Average arithmetic value of the atmospheric air quality index according to the formula for fine dust fraction PM2.5
Wind speed data: Ukrainian hydrometeorological center

According to the data of the Main Department of Statistics, formed on the basis of the report on emissions of pollutants and greenhouse gases into atmospheric air from stationary sources of emissions for 2021 (form 2-TP (air) (annual), the Inhul'ska mine of the Eastern Mining and Processing Plant (the SE "SkhidGZK") made total emissions in the following quantities:

| Names of pollutants and greenhouse gases | The amount of pollutants and greenhouse gases released into the atmosphere (tons) | Threshold emission values (tons per year)** |
|--|---|---|
| Metals and their compounds (01000)* | 16,241 t | - |
| Vanadium and its compounds (01002) | 0,332 t | 0,02 |
| Iron and its compounds (01003) | 0,020 t | 0,1 |
| Manganese and its compounds (01104) | 0,004 t | 0,005 |

| | | |
|---|----------|------|
| Substances in the form of suspended solid particles (microparticles and fibers) (03000) | 5,006 t | 3,0 |
| Soot (03004) | 1, 461 t | 0,3 |
| Nitrogen compounds (04000) | 4,238 t | - |
| Nitrogen dioxide (04001) | 4,224 t | 1,0 |
| Nitrous oxide N ₂ O (04002) | 0,014 t | 0,1 |
| Dioxide and other sulfur compounds (05000) | 2,505 t | 2,0 |
| Carbon monoxide (06000) | 4,008 t | 1,5 |
| Methane (12000) | 0,068 t | 10,0 |
| Carbon dioxide (07000) | 1728,379 | 500 |
| Total for the enterprise (excluding carbon dioxide) 1728,379 tons | | |

*The code of pollutants and greenhouse gases is indicated

**According to Appendix 1 to the Instructions on the procedure and criteria for taking into account state objects that have or may have a harmful effect on human health and the state of the atmospheric air, types and volumes of pollutants emitted into the atmospheric air.

The indicators characterize the amount of emissions of pollutants and greenhouse gases that entered the atmosphere from stationary emission sources of the Inhulska mine for the reporting year. All volumes of emissions of pollutants and greenhouse gases that entered the atmosphere from stationary sources of emissions by all production and technological processes, technological equipment (installations) are displayed, taking into account the pollutants specified in the Instructions on the procedure and criteria for taking objects into the state register, which have or can have a harmful effect on health and the state of the atmospheric air, types and volumes of pollutants emitted into the atmospheric air. Thus, there is an excess of emissions of polluting substances according to seven indicators.

Distribution of pollutant emissions into atmospheric air by categories of emission sources:

| The name of the category of emission sources | Amount of discharged pollutants | | | |
|--|---------------------------------|------------------|-----------------|-----------------|
| | Sulfur dioxide | Nitrogen dioxide | Carbon monoxide | Solid particles |
| Combustion processes in small installations | 2,505 | 2,171 | 0,239 | 1,461 |
| Quarry development and extraction of minerals, except for coal | | 2,046 | 3,758 | 3,161 |
| Storage, processing and transportation of metal products | | 0,007 | 0,011 | 0,111 |
| Other stationary sources of emissions | | | | 0,333 |

The table provides data on the number of individual pollutants released into the atmosphere, for which international reporting obligations have been approved within the framework of the Convention on Long-Range Transboundary Air Pollution, for 60 categories of emission sources, the names of which are brought into compliance with the Methodological Guidelines of the European economic commission of the United Nations.

The problem of sanitary and protective zones of the Inhul'ska mine

In accordance with Article 24 of the Law of Ukraine "On the Protection of Atmospheric Air", in order to ensure optimal conditions for human activity in areas of residential development, mass recreation and health improvement of the population when determining the locations of new, reconstruction of existing enterprises and other objects that affect or may affect on the state of atmospheric air, sanitary protection zones are established.

Article 45 of the Law of Ukraine "On the Use of Nuclear Energy and Radiation Safety" and Article 15 of the Law of Ukraine "On Mining and

"Processing of Uranium Ores" establish special provisions on sanitary protection zones.

In accordance with Article 114 of the Land Code of Ukraine, sanitary and protective zones are created around objects that are sources of the release of harmful substances, odors, increased levels of noise, vibration, ultrasonic and electromagnetic waves, electronic fields, ionizing radiation, etc., in order to isolate such objects from the territories of residential development.

The dimensions and regime of sanitary protection zones are also determined by regulatory documents in the field of construction: DBN B.2.2-12:2019 "Planning and development of territories", etc.

The basis for the establishment of sanitary protection zones is the sanitary classification of enterprises, productions and objects, which is given in Appendix No. 4 to the State Sanitary Rules for Planning and Development of Settlements, approved by Order No. 173 of the Ministry of Health of Ukraine dated June 19, 1996. Enterprises are divided into 5 classes according to their harmfulness, according to which sanitary protection zones from 50 to 3000 m are established.

The mine has a sanitary protection zone from 250 m to 1000 m.



All sanitary and protective strips around uranium production facilities are lightly wooded in order to protect the population from the dust transfer of radionuclides. First of all, around the Inhul'ska mine, where the sanitary protection strip has now been turned into arable land, which increases the amount of radioactive dust that flies to the city of Kropyvnytskyi, where the concentration of dust exceeds the maximum permissible concentration. Dust transport of radionuclides falls on streets and sidewalks in populated areas.

The sanitary and protective zone should be arranged with green plantings: trees of such species as tall ailant, white acacia, and Turkestan poplar. Trees are planted at a distance of 0.3 meters from each other and 3 meters between rows. Shrubs are additionally planted. From the entire list, we can unfortunately only see shrubs near the Inhul'ska mine dumps.

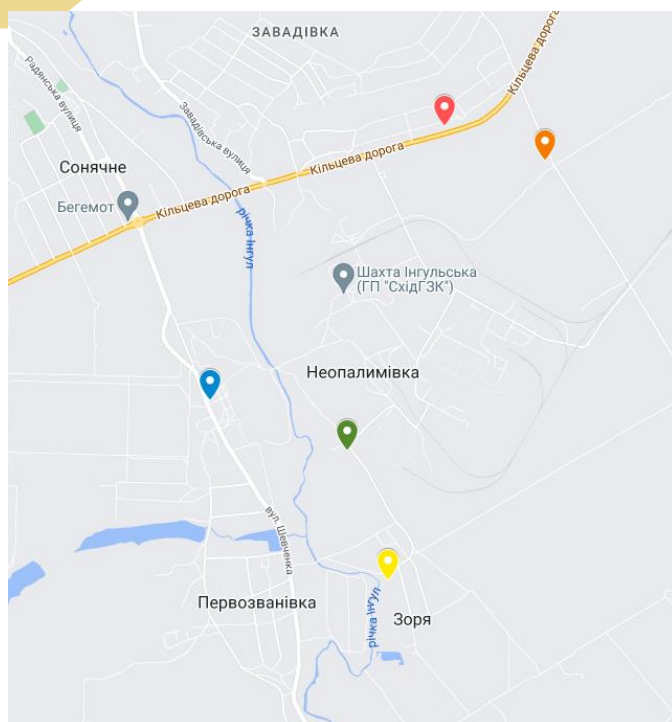
Soils

During the mining of uranium ores, there is a significant impact on the soil cover of the territory. A huge area of land is under tericones. They contain various elements, including harmful ones. It is here that the greatest dust pollution of the soil is observed. A significant part of the dust is transported over long distances, which significantly increases the radius of spread of pollutants. Water from atmospheric precipitation, flowing from the surface of the dumps, is filtered through the layer of rocks, becomes polluted and clogs and, in turn, pollutes and clogs the soils. Such pollution significantly worsens the quality of soils.

Since a railway track passes through the agricultural land located close to the territory of the mining concession of the Inhul'ska mine, along which uranium ore is transported from the mine territory to Zhovti Vody for further processing, as well as wind dispersion of radioactive dust from the surfaces of empty and uranium-balanced rock dumps, which is one of the main sources of radionuclides entering the environment, including the soil, the lack of protection of the fields by a forest strip on the side of the territory of the Inhul'ska mine may serve as a contributing factor.

The content of radionuclides in soils located close to the territory of the mining concession of the Inhul'ska mine.

| Indicator, unit measurement | Normative value of the indicator | Test results | | | | |
|---|--|--------------|---------|---------|---------|---------|
| | | Point 1 | Point 2 | Point 3 | Point 4 | Point 5 |
| Physico-chemical parameters | | | | | | |
| Chloride ion in aqueous extract, mmol per 100 g | Not normalized | 0,26 | 0,29 | 0,26 | 0,30 | 0,25 |
| Sanitary and toxicological indicators | | | | | | |
| Sulfate ion in aqueous extract, mmol per 100 g | Not normalized | | | | | |
| Toxic elements | | | | | | |
| Lead, mg/kg | ≤ 6,0 | <1,0 | < 1,0 | 1,43 | 1,23 | 1,2 |
| Cadmium, mg/kg | ≤ 0,7 | < 0,5 | < 0,5 | < 0,5 | < 0,5 | < 0,5 |
| Copper, mg/kg | ≤ 3,0 | < 0,5 | < 0,5 | < 0,5 | < 0,5 | < 0,5 |
| Zinc, mg/kg | ≤ 23,0 | 0,58 | 0,7 | 16,0 | 2,4 | 3,08 |
| Manganese, mg/kg | ≤ 140,0 | 37,5 | 34,5 | 35,8 | 26,0 | 24,3 |
| Cobalt, mg/kg | ≤ 5,0 | < 0,5 | < 0,5 | < 0,5 | < 0,5 | < 0,5 |
| Nickel, mg/kg | ≤ 4,0 | < 0,5 | < 0,5 | < 0,5 | < 0,5 | < 0,5 |
| Radionuclides | | | | | | |
| Specific activity of Cesium-137, Bq/kg | Not normalized | 5,5 | 3,1 | 3,0 | 6,3 | 10,3 |
| Specific activity of Radium-226, Bq/kg | Not normalized | 11,1 | 15,1 | 29,5 | 13,8 | 17,4 |
| Specific activity of Thorium-232, Bq/kg | Not normalized | 27,8 | 25,3 | 20,5 | 21,3 | 21,0 |
| Specific activity of Potassium-40, Bq/kg | Not normalized | 342,9 | 439 | 299,3 | 353 | 335,8 |



The map shows the locations of soil sampling.

Point 1 is red
48.469629, 32.321708

Point 2 is orange
(48.467756, 32.329931)

Point 3 is yellow.
48.444929, 32.317063

Point 4 is green.
48.451983, 32.313697

Point 5 is blue.
48.454735, 32.302508

Impact on surface and underground water resources

Discharges of contaminated mine water and leaching of radioactive substances by rainwater from contaminated sites into the environment have a significant impact.

In accordance with the content of the Special Water Use Permit issued by the State Enterprise "SkhidGZK" (the Inhul'ska mine of the State Enterprise "SkhidGZK"), which carries out the intake and discharge of mine water into the Inhul river, water intake limits equal to 4,380 thousand cubic meters per year have been established.

Limits for the discharge of polluting substances (maximum allowable discharges) and actual discharges of substances with return (wastewater) waters into surface water bodies have also been approved.

The permissible discharge volume is 500.00 m³/h, 4167.191 thousand m³/year, and the actual discharge volume of return (wastewater) water is 293.22 m³/h (according to the developed norms of maximum permissible discharges).

| Polluting substances, the discharge of which is regulated | Actual concentration (mg/dm ³) | Maximum permissible concentrations (mg/dm ³) |
|---|--|--|
| Ammonium nitrogen | 1.95 | 1.95 |

| | | |
|----------------------|-------|-------|
| BOD5 | 3,49 | 3,49 |
| COD | 33,00 | 33,00 |
| Suspended substances | 19,75 | 19,75 |
| Oil products | 0,09 | 0,09 |
| Nitrates | 35,57 | 35,57 |
| Nitrite | 0,55 | 0,55 |
| Sulfates | 655,0 | 600,0 |
| Phosphates | 0,25 | 0,25 |
| Chlorides | 570,0 | 570,0 |
| Iron is common | 0,12 | 0,12 |
| Anionic surfactants | 0,045 | 0,045 |
| Calcium | 298,0 | 298,0 |

Other indicators and characteristics of return (waste) water:

1. Dissolved oxygen: should not be less than 4 mg/dm³ in any period of the year in a sample taken before 12 noon;
2. Hydrogen concentration (pH): should not exceed 6.5 - 8.5;
3. Temperature: the natural water temperature should not rise more than 3°C in summer;
4. Lactose-positive Escherichia coli (LCC): no more than 10,000 CFU/1 dm³, coliphages (in plaque-forming units): no more than 100 CFU/1 dm³, viable eggs of helminths: absence;
5. Water toxicity level (based on biotesting): return water should not have acute lethal toxicity to aquatic organisms;
6. Radioactivity of water (total radioactivity): should not exceed the natural background of the water body receiving return water.

Samples were taken at the waste water discharge point of the Inhulska mine outside the village. Neopalymivka (coordinates - 48.4565844, 32.3077527) for conducting laboratory tests.



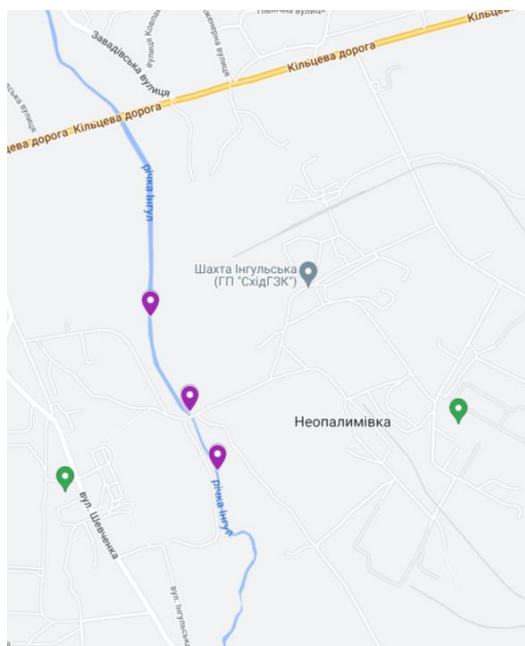
The actual results are as follows:

| Indicator, unit of measurement | Test result |
|--|-------------|
| Toxic elements | |
| Cadmium, mg/dm ³ | < 0,001 |
| Lead, mg/dm ³ | 0,006 |
| Copper, mg/dm ³ | 0,0588 |
| Zinc, mg/dm ³ | 0,0225 |
| Mercury, mg/dm ³ | 0,0016 |
| Sanitary and chemical indicators | |
| Hydrogen indicator, units. pH | 8,43 |
| Suspended substances, mg/dm ³ | 160,5 |
| Total iron, mg/dm ³ | 0,84 |
| Nitrates, mg/dm ³ | 9,7 |
| Nitrites, mg/dm ³ | 0,081 |
| Sulfates, mg/dm ³ | 804,1 |
| Dry residue, mg/dm ³ | 1892,0 |
| Chlorides, mg/dm ³ | 308,9 |
| Phosphates (PO ₄) ₃₋ , mg/dm ³ | 32,67 |
| COD, mg O/dm ³ | 52 |
| BOD, mg O ₂ /dm ³ | 0,5 |
| Radionuclides | |
| Specific activity of Uranium-238, Bq/kg | 1,36 |

| | |
|--|------|
| Specific activity of Radium-225, Bq/kg | 1,16 |
|--|------|

Instead, the state of the surface water above, below and at the discharge point is as follows:

| Name of the indicator, unit of measurement | Test result | | |
|--|--------------------------|---------------------------------|--------------------------|
| | Point 1, above discharge | Point 2, at the discharge point | Point 3, below discharge |
| Toxic elements | | | |
| Cadmium, mg/dm ³ | ≤ 0,001 | < 0,001 | < 0,001 |
| Lead, mg/dm ³ | 0,0074 | < 0,001 | 0,001 |
| Copper, mg/dm ³ | 0,0613 | 0,0613 | 0,0537 |
| Zinc, mg/dm ³ | 0,0295 | 0,0145 | 0,0233 |
| Mercury, mg/dm ³ | 0,00048 | 0,0006 | 0,00022 |
| Sanitary and chemical indicators | | | |
| Hydrogen indicator, units. pH | 8,37 | 8,42 | 8,48 |
| Suspended substances, mg/dm ³ | 209,75 | 178 | 203,0 |
| Total iron, mg/dm ³ | 0,26 | 0,63 | 0,4 |
| Nitrates, mg/dm ³ | 12,9 | 12,2 | 14,7 |
| Nitrites, mg/dm ³ | 0,21 | 0,21 | 0,185 |
| Sulfates, mg/dm ³ | 354 | 354 | 350,2 |
| Dry residue, mg/dm ³ | 931,0 | 939 | 982,0 |
| Chlorides, mg/dm ³ | 76,52 | 77,22 | 87,05 |
| Phosphates (PO ₄) ₃₋ , mg/dm ³ | 24,32 | 28,98 | 29,23 |
| COD, mg O/dm ³ | 60,0 | 28 | 36 |
| BOD, mg O ₂ /dm ³ | 0,7 | 0,9 | 1,9 |
| Radionuclides | | | |
| Specific activity of Uranium-238, Bq/kg | 0,34 | 0,52 | 0,81 |
| Specific activity of Radium-225, Bq/kg | 0,05 | 0,91 | 0,55 |



The map shows the locations of surface water sampling:

Point 1 (highest) - 48.4596097,
32.3058672

Point 2 (middle) - 48.4565884,
32.3077527

Point 3 (lowest) - 48.4546993,
32.3090885

Laboratory tests of water from underground sources (wells) near the Inhul'ska mine were also conducted.

The results of laboratory tests of water from a well located in the city of Kropyvnytsky, 45 Motokrosna street (Zavadiivka microdistrict) near the mine area. Test data allow to illustrate the dynamics of the accumulation of pollutants in the water of underground sources.

| The name of the indicator, units of measurement | Normative value of the indicator | Test result | | |
|---|----------------------------------|-------------|--------|--------|
| | | 2014 | 2021 | 2022 |
| Physico-chemical parameters | | | | |
| Hydrogen indicator, units. pH | 6,5 – 8,5 | 8,05 | 8,06 | 8,35 |
| Total hardness, mol/m ³ | ≤ 10,0 | 18,0 | 16,34 | 17,14 |
| Dry residue, mg/dm ³ | ≤ 1500 | 1788,0 | 2128 | 1940,0 |
| Chlorides, mg/dm ³ | ≤ 350 | 131,31 | 133,34 | 124,4 |
| Sulfates, mg/dm ³ | ≤ 500 | - | 999,7 | 868,4 |
| Total iron, mg/dm ³ | ≤ 1,0 | - | 0,1 | 0,16 |
| Sanitary and toxicological indicators | | | | |
| Permanganate oxidizability, mg/dm ³ | ≤ 5,0 | 2,88 | 1,54 | 2,05 |
| Ammonium, mg/dm ³ | ≤ 2,6 | 0,11 | 0,14 | 0,15 |
| Nitrites, mg/dm ³ | ≤ 3,3 | 0,003 | 0,004 | 0,003 |
| Nitrates, mg/dm ³ | ≤ 50,0 | 124,2 | 187,7 | 134,4 |
| Fluorides, mg/dm ³ | ≤ 1,5 | - | 0,67 | 0,75 |

| | | | | |
|---|-------|-------|-------|------|
| Manganese, mg/dm ³ | ≤ 0,5 | - | 0,011 | 0,01 |
| Radionuclides | | | | |
| Specific activity of Radon-222, Bq/kg | ≤ 100 | 196,9 | 1,35 | - |
| Specific activity of Uranium-238, Bq/kg | ≤ 1 | 1,17 | 1,06 | - |

An analysis of water from underground sources of other settlements near the mine was also carried out: Kropyvnytsky, village Pervozvanivka, village Popivka, village Klyntsi

| The name of the indicator, units of measurement | Normative value of the indicator | Test result | | | | | |
|---|----------------------------------|--------------------------------------|-------------------------------------|-------------------------------------|---|-----------------------------|-----------------------------|
| | | Kropyvnytskyi, 12a Inzhenerna street | Pervozvanivka, 71 Shevchenka street | Pervozvanivka, 35 Shevchenka street | Pervozvanivka, 21 Pershotravneva street | Popivka, 13 Chekhova street | Klyntsi, 20 Kolhosna street |
| Physico-chemical parameters | | | | | | | |
| Hydrogen indicator, units. pH | 6,5 – 8,5 | 7,88 | 7,98 | 7,86 | 7,40 | 7,85 | 6,74 |
| Total hardness, mol/m ³ | ≤ 10,0 | 20,61 | 14,3 | 15,71 | 14,58 | 10,82 | 4,38 |
| Dry residue, mg/dm ³ | ≤ 1500 | 2336,0 | 1296,0 | 1420,0 | 1208,0 | 1260,0 | 404,0 |
| Chlorides, mg/dm ³ | ≤ 350 | 86,8 | 117,2 | 86,8 | 151,88 | 96,91 | 92,32 |
| Sulfates, mg/dm ³ | ≤ 500 | 1191,7 | 345,7 | 436,3 | 271,70 | 310,1 | 41,35 |
| Total iron, mg/dm ³ | ≤ 1,0 | < 1 | 0,01 | < 0,1 | 0,23 | 0,01 | 2,64 |
| Sanitary and toxicological indicators | | | | | | | |
| Permanganate oxidizability, mg/dm ³ | ≤ 5,0 | 1,79 | 2,3 | 2,3 | 3,97 | 2,05 | 6,08 |
| Ammonium, mg/dm ³ | ≤ 2,6 | 0,10 | 0,11 | 0,12 | 0,20 | 0,10 | 0,31 |
| Nitrites, mg/dm ³ | ≤ 3,3 | < 0,003 | 0,004 | < 0,003 | 0,019 | 0,003 | 0,012 |
| Nitrates, mg/dm ³ | ≤ 50,0 | 50,34 | 68,9 | 83,3 | 77,97 | 1,06 | 3,92 |
| Fluorides, mg/dm ³ | ≤ 1,5 | 0,47 | 0,71 | 0,58 | 0,67 | 0,12 | 4,89 |
| Manganese, mg/dm ³ | ≤ 0,5 | 0,02 | 0,01 | 0,02 | 0,01 | 0,01 | 0,017 |

Radiation contamination of territories

According to the data of the Department of Civil Protection of the Kirovohrad Regional State Administration, the radiation condition in the territory of the sanitary protection zone and the monitoring zone of the Inhulska and Tsentralna mines is characterized by the following power levels of the equivalent radiation zone:

- The background value of the power of the equivalent dose of the studied territory according to the "Report on the results of radiation control of objects of the surrounding natural environment in the territory of Kirovohrad district (background), 2014" is equal to 0.14-0.24 $\mu\text{Sv/h}$.

At the border of the sanitary protection zone, the power of the equivalent dose of gamma radiation varies in the range: 0.12-0.22 $\mu\text{Sv/h}$.



On the territory of the monitoring zone of the Inhulska and Tsentralna mines, the value of the power of the equivalent dose is 0.12-0.23 $\mu\text{Sv/hour}$, which corresponds to the fluctuations of the natural radiation background of the territory of the Kropyvnytsky district.

The power of the dose of gamma radiation in the territory of populated areas of the monitoring zone is:

Neopalymivka village - from 0.15 to 0.22 $\mu\text{Sv}/\text{hour}$;

Pervozvanivka village - from 0.13 to 0.17 $\mu\text{Sv}/\text{hour}$;

Kropyvnytsky, Velyka Balka district - from 0.12 to 0.18 $\mu\text{Sv}/\text{hour}$;

Kropyvnytsky, Zavadivka district - from 0.15 to 0.23 $\mu\text{Sv}/\text{h}$.

The dosimetric survey near the dumps of empty and poor rocks was carried out along the perimeter of each dump on the day surface near its base at a distance of 2-3 m from the dump. All the minimum values of the equivalent radiation dose exceed the permissible level, which indicates radioactive contamination of the territory at the foot of the dumps and the impossibility of using this territory for any economic purposes. In addition, there is a danger of dispersion of radioactive dust from the dumps by natural (wind, rain and meltwater) and man-made (motor vehicles) factors.

When conducting research in the village of Neopalimivka near the yards, the values of the equivalent radiation dose ranged from 0.07 to 0.24 $\mu\text{Sv}/\text{h}$. and averaged 0.14 $\mu\text{Sv}/\text{h}$. During the research, an anomalous area with a large gamma-emitting background was discovered near the garden plots. The values reached values of 390.4 $\mu\text{Sv}/\text{h}$, which is 3000 times higher than the permissible level, the minimum value is 1.94 $\mu\text{Sv}/\text{h}$, on average this area emits 43.4 $\mu\text{Sv}/\text{h}$, which is 360 times higher than the permissible level.

This plot is located 40 m from the nearest house and 10 m from the nearest vegetable garden. When studying other areas near the gardens of the village. Neopalymivka values of the equivalent radiation dose ranged from 0.12 to 0.4 $\mu\text{Sv}/\text{h}$. and averaged 0.19 $\mu\text{Sv}/\text{h}$.

For comparative analysis, a control measurement of the equivalent radiation dose was performed, which was determined at a distance of 20 km in the southwest direction from the uranium mining region, in the absence of sources of radioactivity, in a natural area. The average value is 0.07-0.16 $\mu\text{Sv}/\text{hour}$, which is slightly higher than the permissible level.

Conclusions

A characteristic feature of uranium mining is that almost all waste - mine rock dumps, mine water, gaseous emissions - are sources of radiation pollution of the environment.

The storage of ore and other materials that are formed during the extraction of uranium is also accompanied by radioactive pollution of the atmosphere. In particular, the remains of uranium-bearing rocks after the separation of minerals from the empty rocks of uranium-enriched fractions are a rather powerful source of radionuclides that disperse in the environment. It is important to note that only uranium is extracted from the ore at the hydrometallurgical plant, and the accompanying radium and polonium are almost completely transferred to the tailings. Radon, polonium-210 and lead-210 belong to the most dangerous nuclides that enter the environment during these technological processes.

The ionizing capacity and relative biological activity of these particles is quite significant and all of it is consumed upon contact with the first cells of the environment, causing their destruction. Therefore, their distance in tissues does not exceed a few millimeters, which is not enough to pass through the dead layer of the skin, and in the air their distance does not exceed 8 cm. In view of this, there is no radiation risk with external exposure to alpha particles. Danger is created only by internal exposure, when radioactive material enters the human body with food, water or air. This is possible with dust transfer of radionuclides. To prevent this, it is necessary to "hide" all uranium production facilities in the forests, namely to afforest sanitary and protective strips.

Since many radionuclides of potassium, calcium, phosphorus and other radioactive elements are brought into settlements from fields, all fields and roads should be lined with forest strips, and streets and sidewalks in settlements should be lined with trees, turning them into shady alleys.

PART 3: THE PRACTICE OF VIOLATION OF ENVIRONMENTAL PROTECTION LEGISLATION BY THE MINE

According to the Law "On Protection of the Natural Environment" [14], the protection of the natural environment, rational use of natural resources and ensuring the environmental safety of human activities are an integral condition for the sustainable economic and social development of Ukraine. Therefore, the subject of economic activity is obliged not to harm the environment and the health of people, and bears property and other legal responsibility for the damage and losses caused. Fulfilling this obligation involves reducing the man-made impact of the enterprise on the environment, waste disposal, planning the rational use of limited and non-renewable resources and the reproduction of renewable ones, as well as other factors.

The Inhulska mine has a long-standing practice of violating the norms of environmental protection legislation, which were recorded by the units of the State Environmental Inspection for many years.

In order to establish the real facts of illegal operation of the mine, the non-governmental organization "Flora" analyzed the materials of scheduled and unscheduled inspections carried out by the State Environmental Inspection for three years (2019, 2020, 2021).

2019

In 2019, according to the results of scheduled inspections of compliance with the requirements of environmental protection legislation of the Inhulska mine of SE "SkhidGZK", it was established that the requirements of environmental protection legislation were violated, namely:

- violation of waste management requirements;
- violation of the emission procedure;
- exceeding the approved concentrations of pollutants upon discharge into a water body;

It was also established that on the territory of the Inhulska mine, the technological regulation of mine water purification is violated, in terms of the use of lime, as well as dehydration, storage and removal of cake,

which leads to environmental pollution with natural radionuclides of the uranium series.

The company was given a binding order to eliminate violations of the requirements of environmental protection legislation. For the detected violations, the responsible persons were brought to administrative responsibility and an administrative penalty was imposed in the form of fines in the amount of UAH 5,338. Charges have been paid in full.

As a result of inefficient operation of treatment facilities, discharges of insufficiently purified return water were carried out in the Inhul River. Taking into account the above, the State Enterprise "Eastern Mining and Processing Plant" ("SkhidGZK") the Inhul'ska mine presented a claim for compensation for damages caused to the state as a result of the pollution of the Inhul river by the discharge of insufficiently purified return water in the amount of UAH 91,824 thousand.

According to the results of the inspections, a number of violations were detected in the period from January 1, 2019 to July 1, 2020:

- violation of waste management requirements;
- violation of the emission procedure;
- non-compliance with the water protection regime during the operation of water intake wells;
- irrational use of water resources;
- exceeding the approved concentrations of pollutants upon discharge into a water body;
- failure to take measures to combat weeds;
- violation of the rules of technical operation of gas purification plants.

The Inhul'ska mine was given a mandatory order to eliminate violations of the requirements of environmental protection legislation.

For the detected violations, the responsible persons were held administratively liable and an administrative penalty was imposed in the form of fines in the amount of UAH 7,480 under the following articles of the Code of Ukraine on Administrative Offenses:

Article 52 - Spoilage and pollution of agricultural and other lands;

Part 1 of Article 59 - Pollution and clogging of waters, violation of the water protection regime in watersheds, which causes their pollution, water erosion of soils and other harmful phenomena;

Article 60 - Violation of water use rules;

Part 1 of Article 78 - Release of polluting substances into the atmospheric air without the permission of a specially authorized body of the executive power or failure to comply with the requirements stipulated by the granted permit, other violations of the procedure for the release of polluting substances into the atmospheric air or exceeding the technological norms of permissible pollutant emissions and norms of maximum permissible pollutant emissions substances of stationary sources during the operation of technological equipment, buildings and objects;

Article 82 - Violation of the requirements for handling waste during its collection, transportation, storage, processing, utilization, neutralization, removal or burial.;

Article 91-4 - Refusal to provide or untimely provision upon request of complete and reliable environmental information provided for by legislation;

Article 188-5 - Failure to comply with legal orders or prescriptions of officials of bodies that exercise state control in the field of environmental protection, use of natural resources, radiation safety, or protection of natural resources [5].

It was also established that as a result of inefficient operation of treatment facilities, discharges of insufficiently purified return water were carried out in the Inhul river. Taking into account the above, SP "SkhidGZK" the Inhul'ska mine presented a claim for compensation for damages caused to the state as a result of the pollution of the Inhul river by the discharge of insufficiently purified return water for the total amount of UAH 221,933.88.

2020

In the period from June 15 to June 26, 2020, an unscheduled inspection of the Inhul'ska mine was carried out by SE "SkhidGZK" on the instructions of the Prime Minister of Ukraine. For the detected violations, the responsible persons were brought to administrative responsibility and

imposed penalties in the form of fines in the total amount of UAH 1,802. (paid). A binding order has been issued.

A claim has been submitted for compensation for damages caused to the state as a result of the discharge of insufficiently purified return (house) waters in the Inhul river in the amount of UAH 102,506 thousand.

2021

In the course of a routine inspection of the Inhulska mine of SE "SkhidGZK" from July 15 to 22, 2021, a violation of the technological regulation of mine water purification regarding the reduction of pollutant concentrations according to the mine water purification project by the mine water purification plant was found, namely the need to use lime when necessary 1335.36 t (discharged water volume 2568.6 thousand m³) actually used 684.749 t, i.e. actually with insufficient use of lime for removal of radionuclides.

In accordance with the Protocols for measuring the quality of waste water composition of the Inhulska mine of SE "SkhidGZK" and accounting reports on water use in the form of 2-TP water farm (annual), the company discharged into the Inhul river exceeding the maximum allowable discharges for the following periods:

- from 22.09.2020 to 31.12.2020, 734,982 m³ of waste (mine) water (ZR sulfates and nitrites) was discharged in excess of the GDS;
- from 01.01.2021 to 01.06.2021, 1,128,084 m³ of wastewater (mine) water (ZR sulfates and nitrites) was discharged in excess of the GDS.

At the time of the inspection of the territories (objects) of the Inhulska mine of SE "SkhidGZK", stationary sources were found that were not included in the permits for emissions of pollutants into the atmosphere.

The Inhulska mine of SE "SkhidGZK" has not carried out the work for the state registration of the object I and II of the second group, which has or may have a harmful effect on human health and the state of the atmospheric air.

When inspecting the territory of the dump near the site of the mine water treatment plant of the Inhulska mine, the fact of cake storage near

the dump was established, which, according to the working project, should be stored in a specially designated place near the radiometric enrichment section of the Inhulska mine.

Clause 8 of the Special Conditions for the Use of Subsoil to Special Permit No. 1880 dated 05/19/1999 stipulates "compliance with the requirements of the Law of Ukraine "On Environmental Impact Assessment". On December 11, 2018, changes were made to the specified permit in connection with the discovery of new types of minerals (Resolution of the Cabinet of Ministers of Ukraine dated May 30, 2011 No. 615). The need to carry out an environmental impact assessment of SE "SkhidGZK" Inhulska mine was not considered.

For the above-mentioned violations, the responsible persons were brought to administrative responsibility under the following articles of the Code of Ukraine on Administrative Offenses:

Part 1 of Article 59 - Violation of requirements for protection of territorial and internal sea waters from pollution and clogging;

Part 2 of Article 61 - Damage to water management structures and devices, violation of the rules of their operation;

Part 1 of Article 78 - Violation of the procedure for carrying out activities aimed at artificial changes in the state of the atmosphere and atmospheric phenomena;

Part 2 of Article 79 - Violation of operating rules, as well as non-use of installed facilities, equipment, apparatus for cleaning and controlling emissions into the atmosphere;

Article 82 - violation of the requirements for handling waste during its collection, transportation, storage, processing, utilization, neutralization, removal or burial;

Article 82-1 - Violation of the rules of primary accounting and control over waste management operations or failure to submit or report on the generation, use, disposal and removal of waste

Article 52 - Spoilage and pollution of agricultural and other lands [5].

2 claims for compensation for damages caused to the state as a result of the discharge of insufficiently purified return (settlement) water in the Inhul river in the amount of UAH 152,920,000 have been submitted. Claims were not voluntarily paid, copies of inspection materials of SE

"SkhidGZK" the Inhulska mine were sent to the Prosecutor's Office of the Kirovohradska oblast for the purpose of representative powers.

Pursuant to the order of the Prime Minister of Ukraine dated September 7, 2021 No. 39200/1/41-21 regarding the implementation of unscheduled measures of state supervision (control) regarding compliance with the requirements of environmental legislation by enterprises polluting water resources, in the period from December 8, 2021 to On December 17, 2021, an unscheduled inspection of the Inhulska mine of SE "SkhidGZK" was conducted and the following violations were found.

The enterprise does not comply with the conditions of the permit and rules for special water use dated September 24, 2021 No. 111/KR/49d-21 issued by the State Water Resources Agency of Ukraine.

According to the results of departmental instrumental control and monthly reports of laboratory measurements of mine water discharge in the Inhul river (after installation of mine water treatment), monitoring of the Inhul river and wastewater of the Inhulska mine for June - November 2021, exceeding the norms of maximum permissible concentrations of pollutants in return (mine) waters discharged from the mine water treatment plant of the Inhulska mine into the Inhul river. The norms of maximum allowable concentrations of pollutants for the following substances were exceeded: sulfates, chlorides, iron and nitrites.

According to the results of the instrumental inspection control, the exceeding of the standards of maximum permissible concentrations for the content of suspended substances, chlorides and sulfates was recorded.

At the time of the inspection of the Inhulska mine of the SE "SkhidGZK", a violation of the technological regulations for mine water treatment during June - December 2021 regarding the reduction of uranium and natural radionuclides concentrations according to the mine water treatment project by the mine water treatment plant was found, namely with insufficient use of chemical reagents and materials for the removal of radionuclides (in particular construction quicklime and sulfuric acid).

The Inhul'ska mine of SE "SkhidGZK" does not take measures to prevent the pollution of water bodies by sewage (rain, snow) water discharged from the territory.

At the time of the inspection, it was established that the sanitary protection zone of the Severynivska water intake is maintained in an improper sanitary condition and the fence of the 1st belt of the sanitary protection zone of underground water sources is partially missing, the passport for the water intake well No. 21-12 RE has not been developed.

Violation of the requirements of the legislation in the field of environmental impact assessment was found in the activities of the Inhul'ska mine of the SE "SkhidGZK", namely, the violation of the requirements established by the law regarding the implementation of the environmental impact assessment during the construction (drilling) of the water intake well No. 21-12 RE on the territory of the Severynivska water intake (which located northeast of the village of Velyka Severynka, Kropyvnytskyi raion, Kirovohradska oblast) at the time of the Law of Ukraine "On Environmental Impact Assessment" [16].

For the specified violations, the responsible persons were brought to administrative responsibility under the following articles:

Part 1 of Article 59 – Water pollution and clogging, violation of the water protection regime at water intakes, which causes their pollution, water erosion of soils and other harmful phenomena;

Part 2 of Article 59 - Commissioning of enterprises, communal and other facilities without structures and devices that prevent water pollution and clogging or their harmful effects.

Part 2 of Article 61 – Violation of the rules of operation of water management structures and devices.

Article 91-5 - Violation of the requirements for the protection of territorial and inland sea waters from pollution and clogging [5].

The company has been presented with 2 claims for compensation for damages caused to the state by SE "SkhidGZK" the Inhul'ska mine as a result of the pollution of the Inhul river by the discharge of insufficiently treated return water in the period from 02.06.2021 to 10.12.2021 for a total amount of UAH 95,497 thousand. Claims were not voluntarily paid, copies of inspection materials of the Inhul'ska mine of SE "SkhidGZK" were sent

to the prosecutor's office of the Kirovohradska oblast for the purpose of representative powers.

Thus, on the basis of the obtained data, it can be confidently asserted that the Inhulska mine systematically commits violations, does not comply with instructions regarding the elimination of violations, because the problems discovered during inspections are systematic and multi-year in nature.

PART 4: ANALYSIS OF THE ECONOMIC COMPONENT FUNCTIONING OF THE INHUL'SKA MINE

Uranium reserves.

Uranium is the basis for creating nuclear fuel, so this raw material is necessary for the functioning of any nuclear power plant in the world. Ukraine is among the top 10 countries in terms of the mass of uranium mined annually:

Table 1. Uranium production in the world, tons. Source: [World Nuclear Association](#)

| # | Country | 2019 | 2020 | 2021 |
|---|--------------------|------------|------------|------------|
| | Kazakhstan | 22 808 | 19 477 | 21 819 |
| | Australia | 6 613 | 6 203 | 4 192 |
| | Namibia | 5 476 | 5 413 | 5 753 |
| | Canada | 6 938 | 3 885 | 4 693 |
| | Uzbekistan | 3 500 | 3 500 | 3 500 |
| | Niger | 2 983 | 2 991 | 2 248 |
| | russian federation | 2 911 | 2 846 | 2 635 |
| | China | 1 885 | 1 885 | 1 885 |
| | Ukraine | 800 | 744 | 455 |
| | India | 308 | 400 | 615 |

In addition, as of 2019, Ukraine had about [108,700](#) tons of raw uranium in its underground (2% of the total world reserves).

Principles of formation of uranium prices on the world market.

Since the subject of purchase and sale is quite specific, the global uranium market is characterized by a number of conditions under which it functions.

First, uranium is sold only to those countries that have signed the [Treaty on the Non-Proliferation of Nuclear Weapons \(NPT\)](#), which was put into effect on July 1, 1968 and is aimed at limiting the spread of nuclear weapons. Signatories to the NPT are subject to international inspection to ensure that they only use uranium for peaceful purposes.

Second, uranium has a limited scope of use and is most often required for the production of electricity in nuclear reactors and the formation of isotopes used in medicine, industry and defense.

Thirdly, several specific factors affect the supply and demand of these raw materials, such as:

- sentiments of investors;
- increase/decrease of nuclear power plants in the world;
- opening of new/closing of existing uranium deposits;
- priorities of countries in the method of obtaining energy (nuclear power plants, thermal power plants, wind or solar plants, etc.);
- the political and security situation in the uranium exporting/importing countries.

For example: there are 440 nuclear reactors in the world operating in 32 countries with a total output of 390,000 megawatts (MW). According to data from the [World Nuclear Association](#) at the end of 2021, 55 more reactors are currently under construction out of a planned 100.

In contrast to the growing demand for nuclear fuel, the supply of uranium could fall by 15% by 2025 due to a lack of investment in new mines ([Financial Times, 2021](#)).

In order to understand whether the field of uranium extraction and sale is economically profitable, we suggest considering the trends in the formation of international prices for uranium and finding out the place of Ukraine in the export-import of raw materials.

Review of uranium prices. The influence of Russia's invasion of Ukraine on the formation of the value of uranium.

Uranium in the form of uranium oxide concentrate is not a publicly traded material like other commodities.

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According to the Law of Ukraine "[On Extraction and Processing of Uranium Ores](#)", the export and import of uranium ores and their concentrates is carried out only by legal entities with special permits.

Such permission can be granted only in the presence of official commitments of the importing country that the received materials, as well as nuclear materials produced on their basis or as a result of their use:

- will not be used for the production of nuclear weapons or other nuclear explosive devices;
- will be provided with means of physical protection at levels not lower than those recommended by the IAEA;
- will be re-exported or transferred from the jurisdiction of the importing country to any other country only under the conditions specified in this article.

A special permit for the export (import) of uranium ores or their concentrates can be granted once (for a batch of goods) or for export to one country (import from one country) of a certain amount of goods for a certain period for a period of no more than three years.

Buyers and sellers deliver uranium materials on the basis of spot and long-term (futures) contracts. The structure of buying and selling uranium is dominated by futures contracts — 85% of all contracts annually.

Graph 1. Dynamics of the price of uranium futures in the world in US dollars per pound¹



Source: [Trading Economics, 2022](#)

Historically, the price of uranium reached a ceiling in May-June 2007, when the mineral traded at a price of more than \$140 per pound. Later, the market stabilized and reached average annual values in the

¹ The value of uranium is calculated using financial instruments such as over-the-counter (OTC) and contracts for difference (CFD).

range of \$60-20 per pound. The exception was 2011, when an accident occurred at the Fukushima-1 nuclear power plant.

However, uranium prices started to rise in the last quarter of 2021, hitting a nine-year high of \$48 a pound in September. The rally continued in 2022 due to supply issues, rising to \$65 a pound in April, a level not seen since March 2011.

The limited supply of uranium on the world market in 2022 was mostly due to the January unrest in Kazakhstan, the world's largest uranium producer.

Russia's full-scale invasion of Ukraine in February also [added to commodity prices](#). However, here, fears on the world market are caused by the significant role of enterprises located on the territory of the Russian Federation and engaged in uranium enrichment. Although the share of uranium concentrate (U₃O₈) from Russia is low — 5% of world production, 2/5 of the world's uranium enrichment capacity is located in Russia.

Instead, Kazakhstan enterprises, reacting to potential market challenges, increase the target indicators of uranium production, so that it is possible to replace Russian capacities and prevent a surge in prices.

Market drivers for the near future will be such factors as: the reorientation of the EU energy structure to other energy sources, Poland's plans [to build two nuclear power plants](#), a possible decrease in uranium supply due to the Russian-Ukrainian war.

Ukraine's place in the world trade in uranium.

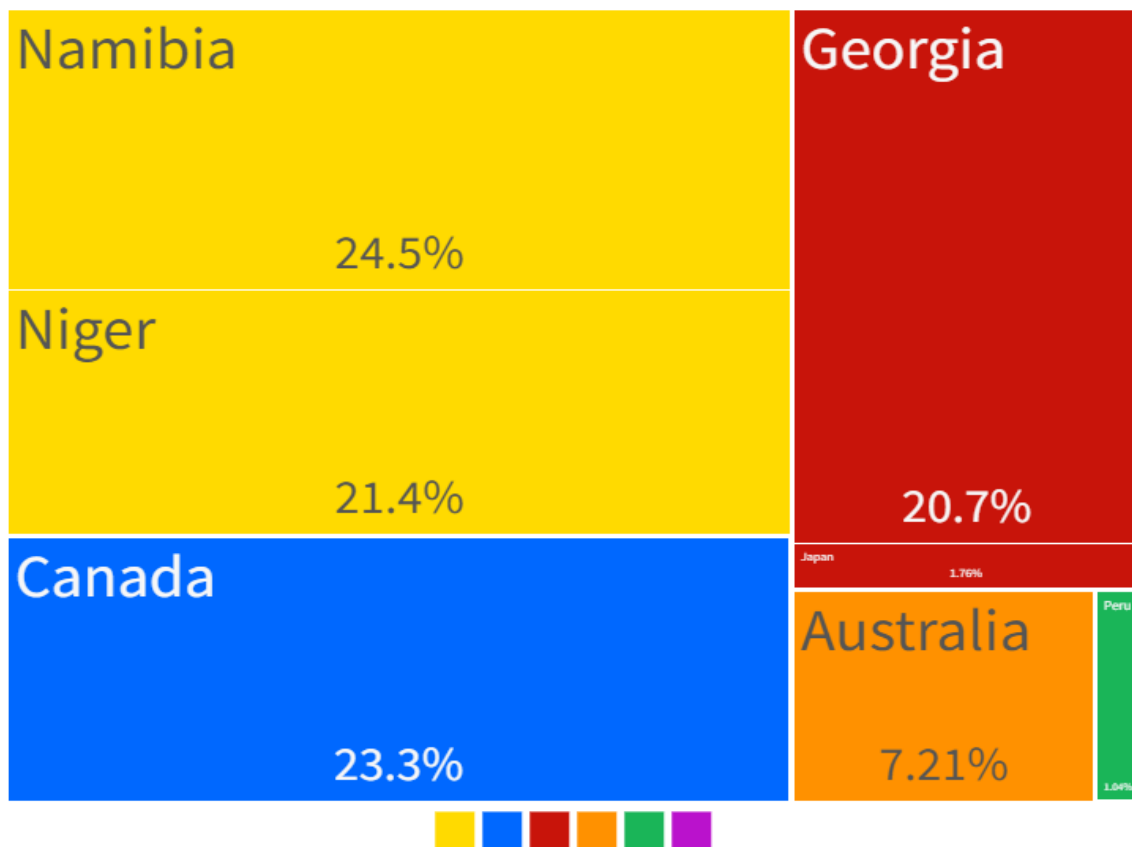
In 2020, the world traded uranium ores and their concentrates for a total amount of about [\\$360 million](#).

Namibia (\$88.3 million), Canada (\$84 million), Niger (\$76.9 million), Georgia (\$74.6 million) and Australia (\$25.9 million) received the largest funds for the **export** of uranium ores and concentrates).

In 2020, the largest **importers** of uranium ores and concentrates were India (\$159 million), Canada (\$128 million), the United States (\$32.3 million), France (\$14.7 million) and Spain (\$11.8 million).

Diagram 1. Exporters of uranium ores and concentrates, 2020.

Total: \$360M



ec.world/en/profile/hs/uranium_ores_and_concentrates

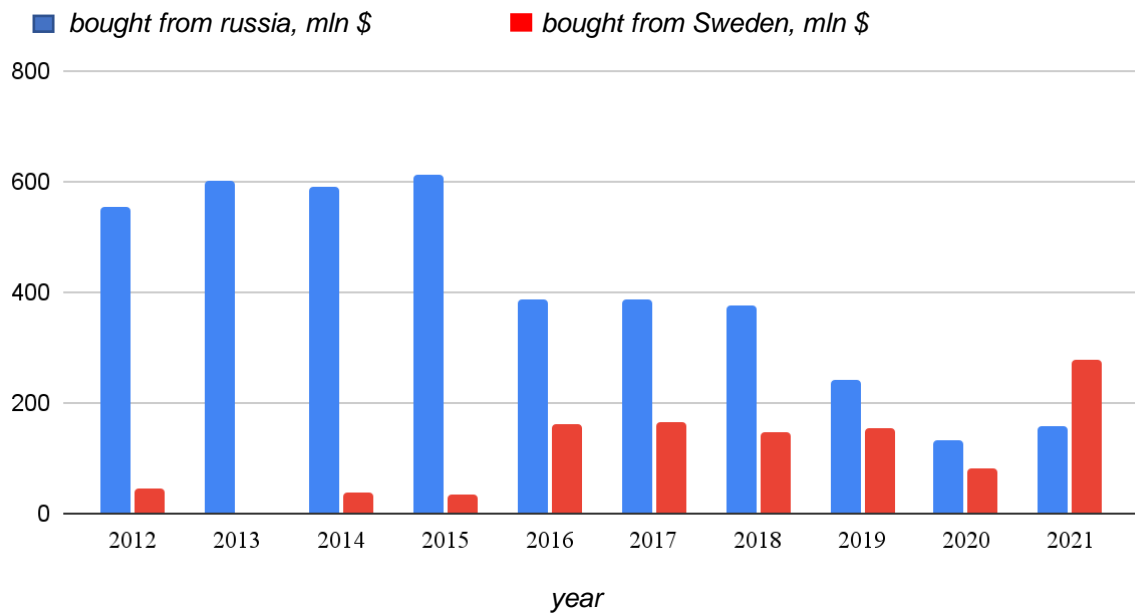
Instead, Ukraine has not sold uranium ores and their concentrates to other countries for more than 20 years.

The last sales were recorded in 1999. Then it was possible to sell raw materials abroad in the amount of [\\$12.4 million](#). In relation to the total volume of exports at that time, deals for uranium ores amounted to 0.097%.

However, according to some Ukrainian media reports, the suspension of uranium sales abroad took place much later, in [2007](#), a year of crisis for this type of industry.

Our own mined uranium is enough to cover about [30-40%](#) of the needs of Ukrainian nuclear power plants. The shortage has to be bought abroad.

Chart 2. Nuclear fuel purchases by Ukraine, 2012-2021. Source: State Statistics Service



The operator of all four operating nuclear power plants of Ukraine is the state-owned enterprise NAEK ENERGOATOM, which purchases nuclear fuel from abroad under contracts with the companies TVEL (russia) and Westinghouse Electric Sweden (Sweden).

As we can see from the graph, the dependence of Ukrainian nuclear power plants on Russian supplies has been observed from year to year, although it is significant that for the first time since independence last year, Ukraine purchased more nuclear power from another country than from russia.

An even greater achievement is that since the beginning of the full-scale invasion of russia, [Ukraine has refused to buy russian fuel at all](#), which does not affect the country's energy security - the state has fuel reserves at its disposal for the next 5-6 years. During this period, it is expected that all NPPs will be fully converted to fuel from Westinghouse and its own production.

However, in the context of the economic justification of the activity of the Inhul'ska mine of the state-owned enterprise "Eastern Mining and Enrichment Combine" (hereinafter referred to as "SkhidGZK"), it is important to note that Ukraine does not have its own technology for enriching mined uranium due to the agreements under [the Budapest Memorandum](#). As a result, uranium oxide concentrate (UOC, U3O8 according to the text) is obtained at the production site, which should be enriched in another country for the further production of uranium tablets.

Who mines uranium ores in Ukraine?

Domestic production of uranium ore is concentrated around several Ukrainian deposits, which are mainly located in the Kirovohradska oblast. In order to carry out economic activity on the extraction of uranium ores, the enterprise must, among other things, have the main class of the type of economic activity (KVED) ["07.21 Extraction of uranium and thorium ores"](#).

This class provides the possibility of the following types of activities:

- extraction of ores that mainly contain uranium and thorium: uranite, etc.;
- concentration of uranium and thorium ores;
- production of "yellow coke" (uranium concentrate).

According to the YouControl registry, during the period of independence, there were only 5 legal entities in Ukraine with the main KVED 07.21:

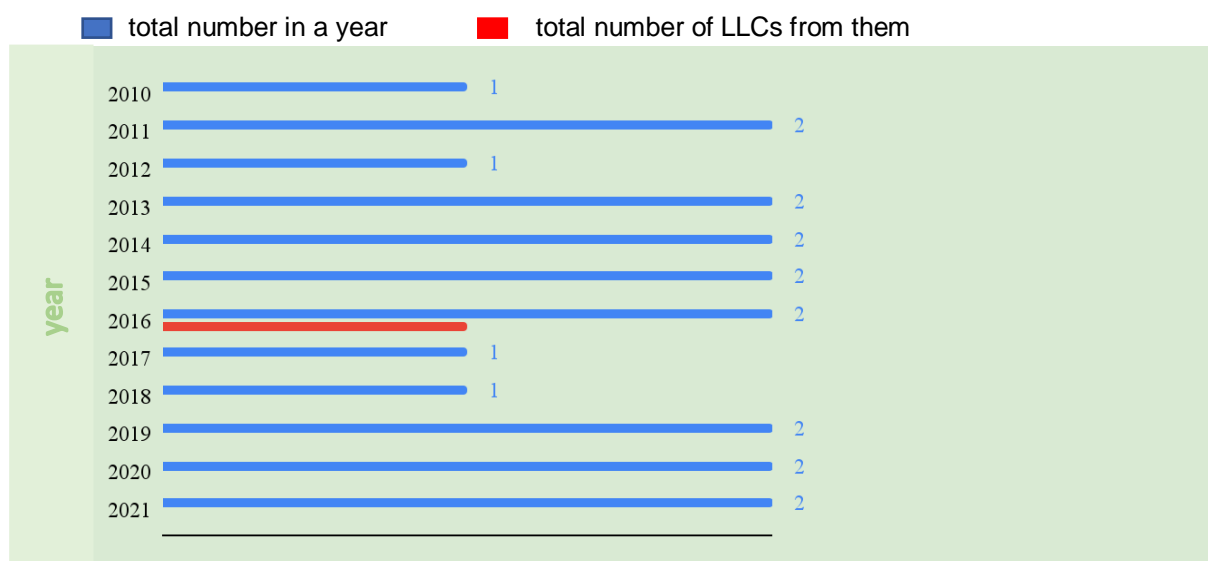
Table 2. Legal entities and FOP with the main KVED 07.21

| Name of the legal entity | Separate subdivisions of the legal entity | Unified State Register of Enterprises and Organizations of Ukraine (EDRPOU) code | Status |
|---|---|--|-----------------------------------|
| "TFT Group" LLC | - | 37949912 | Not in the process of termination |
| LIMITED LIABILITY COMPANY PRODUCTION MANAGEMENT SAFONIVSKE (PM | - | 38462799 | In the process of termination |

| | | | |
|---|--|----------|-----------------------------------|
| SAFONIVSKE LLC | | | |
| NUCLEAR ENERGY SYSTEMS UKRAINE LIMITED LIABILITY COMPANY (NUCLEAR ENERGY SYSTEMS UKRAINE LLC) | - | 39926373 | Not in the process of termination |
| Tarnahorodska Ruta Leonidivna LLC | - | - | Discontinued |
| STATE ENTERPRISE EASTERN ORE DRESSING COMPLEX (SE VOSTGOK) | + | 14309787 | Not in the process of termination |
| | INHULSKA MINE OF STATE ENTERPRISE "EASTERN MINING AND CONCENTRATION COMBINATION" | 14314239 | Not in the process of termination |
| | SMOLINSKA MINE OF STATE ENTERPRISE "EASTERN MINING AND CONCENTRATION COMBINATION" | 14314222 | Not in the process of termination |
| | NOVOKOSTIANTYNIIVSKA MINE OF STATE ENTERPRISE "EASTERN MINING AND CONCENTRATION COMBINATION" | 37262160 | Not in the process of termination |

If we look at the dynamics of changes in the number of active legal entities with the main KVED "07.21 Extraction of uranium and thorium ores", we can see that their number has not undergone significant changes in the direction of decrease or increase from year to year - 1-2 active economic entities functioned annually.

Chart 3. Dynamics of changes in the number of economic entities according to KVED 07.21, 2010-2021. Source: State Statistics Service.



Given the specificity of entrepreneurial activity, we can assume that this is why similar enterprises are not opened.

As can be seen from the table and according to the [State Statistics Service](#), in 2021, only 2 economic entities operated under the "07.21" class in Ukraine - SE "SkhidGZK" and LLC "Nuclear Energy Systems of Ukraine". However, the existence of registered enterprises does not mean that they operate and extract natural minerals. It is impossible to extract uranium ore without a special permit for the use of subsoil (extraction) and an existing mining right-of-way.

According to the information of the State Inspection of Nuclear Regulation of Ukraine, in 2021, the license to carry out uranium ore mining activities at all three mines, including on the Inhulska. However, the State Service of Geology and Subsoil of Ukraine refused² LLC "Atomic Energy Systems of Ukraine" to grant a special permit for the extraction of uranium ores in the Safonivska site, which is located in the Mykolaiv oblast.

Therefore, today the SE "SkhidGZK" is actually the only enterprise in Ukraine that produces uranium ore, processes it and obtains uranium concentrate (U3O8).

² Order of the State Geology and Subsoil Service of Ukraine dated October 22, 2022, No. 773 "On refusal to grant a special permit for the use of subsoil." URL: <https://www.geo.gov.ua/diyalnist/nakazy/arhiv-nakaziv/>

SE "SkhidGZK" is engaged in the development of several deposits:

Table 3. Development of uranium deposits of the SE "SkhidGZK". Source: [State Nuclear Regulation Inspection of Ukraine, 2021](#)

| Mine | Smolinska | Inhul'ska | Novokostiantyniv'ska |
|------------------------------|-----------------|----------------------------|----------------------|
| Deposits | Vatutinske | Mitchurinske Tsentralne | Novokostiantyniv'ske |
| Indicator of production cost | up to 130 \$/kg | up to 260 \$/kg | up to 80 \$/kg |

As we can see from the table, the Inhul'ska mine develops two uranium deposits at once. However, the extraction of uranium ore is complicated, given the depleted developed deposits and especially strong, granite rocks, for the development of which special high-cost equipment and technologies are required.

Formation of prices for Ukrainian uranium oxide concentrate

The Inhul'ska mine produces uranium ore. Next, the ore has to go through the process of transformation, which takes place at other facilities of the SE "SkhidGZK". After processing, a finished product is obtained - uranium oxide concentrate, which is a product on the world market. However, in the case of the process of obtaining nuclear fuel, it is necessary that UOC can be turned into so-called uranium pellets. For this, the technology of conversion and enrichment of UOK to certain values is used.

As already mentioned earlier, the procurement of nuclear power for all NPPs is carried out by SE "NAEK "ENERGOATOM", including purchasing UOC from SE "SkhidGZK". However, as noted in the reports of the President of NAEK "ENERGOATOM", the cost of purchasing UOC from SE "SkhidGZK" is much higher than on the world market — [about \\$120 per kilogram last year](#).

At the same time, as can be seen from [the financial statements of SE "SkhidGZK" for 2020](#), the company sold UOC for an amount less than the cost of its production.

The report notes that the reason for this is the unreasonably determined price for UOC by the National Commission for State Regulation of Energy and Utilities (NKREKP).

In addition, the increase in the cost of UOC sales occurred as a result of a change in the structure of uranium raw materials for the production of UOC, namely, a decrease in the specific weight of raw materials from the Novokostiantyniv'ska mine with a low cost and an increase in the specific weight of raw materials from the Smolinska and Inhul'ska mines with a higher cost.

According to the law of Ukraine "[On mining and processing of uranium ores](#)", uranium ores and products of their processing are purchased by state order at contractual prices **that ensure a level of profitability not lower than the minimum.**

Until 2018, the price of UOK in Ukraine was formed by the Ministry of Energy of Ukraine through the issuance of a corresponding order based on a formula that would justify the cost price and minimum profitability.

In 2017, the NCRECP sets the price for uranium-containing raw materials (U3O8), its conversion and enrichment in the structure of the production cost of electricity and heat energy produced at the NPP³. In addition, the price of UOC since that time has been determined according to world **spot prices**, which at that time were significantly lower, and remain so, than the cost price of UOC from Ukraine.

The lack of a tool for adjusting the market index of the UOC spot value to the cost of mining and production leads to the fact that in 2018 the Ministry of Energy and Coal Industry approved a price for uranium concentrate of [\\$112/kg](#) for SE "SkhidGZK" (a price with minimum profitability), and the NCRECP method allows SE "NAEK "ENERGOATOM" to buy concentrate at a price of only \$71/kg (the spot price indicator for UOK for 2018). In 2019, the spot price indicator for U3O8 did not become much higher — only \$75/kg, which also did not

³ We are talking about Resolution of the NCRECP dated August 1, 2017 No. 990 "On approval of the Methodology for the formation, calculation and setting of tariffs for electric and thermal energy produced at nuclear power plants". URL: <https://zakon.rada.gov.ua/laws/show/v0990874-17#Text>

correspond to the cost of obtaining uranium concentrate at SkhidGZK with minimal profitability.

Currently, the cost price of uranium produced in Ukraine is [\\$110-115/kg](#). There are assumptions that putting into operation the production capacities of the Novokostiantyniv'ska mine will allow reducing the cost of uranium oxide concentrate to [\\$90/kg](#).

The difference between the spot price and the contract price with minimum profitability was supposed to be covered by the state budget, but it does not provide for these expenses. Thus, the State Enterprise "SkhidGZK" is forced to sell UOC at a price lower than the cost price, and the State Enterprise "NAEK "ENERGOATOM" - to contract this UOC.

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Therefore, SE "SkhidGZK" receives losses under contracts for the supply of UOC, and SE "NAEK "ENERGOATOM" cannot actually receive the volume of contracted products.

Payment of taxes by the mine.

The Inhul'ska Mine is a branch of the state enterprise "Eastern Mining and Processing Plant". The activity is carried out under KVED 07.21 "Extraction of uranium and thorium ores" and KVED 36.00 "Absorption, purification and supply of water".

As a taxpayer, the mine pays personal income tax, military service, rent, environmental tax and local taxes and fees.

As of October 1, 2022, the tax debt for the payment of taxes and fees by the Inhul'ska mine of the SE "SkhidGZK" to the budgets of all levels amounted to UAH 27,644.9 thousand, incl. rent payment for the special use of water - 194.5 thousand UAH, rent payment for the use of subsoil for the extraction of minerals - 23698.3 thousand UAH, environmental tax - 369.1 thousand UAH, payment for land - 2709.9 thousand UAH, tax on immovable property other than land - 673.1 thousand UAH.

Table 4. Amounts of taxes and fees paid by the Inhulska mine over the past two years. Source: State Tax Service of Ukraine

| The name of taxes, fees, payments to the budget | Budget income classification code | Name of the consolidated community | Paid, hryvnias | |
|---|-----------------------------------|------------------------------------|-----------------|-----------------------|
| | | | 2021 | 2022 as of 10/27/2022 |
| Personal income tax paid by tax agents from the taxpayer's income in the form of wages * | 11010100 | Pervozvanivska | 32977182,7 2 | 13301802,88 |
| Rent for the special use of water (except rent for the special use of water of local water bodies) * | 13020100 | Velykoseveryni vska | 435301,13 | 0 |
| Rent for the special use of water (except rent for the special use of water of local water bodies) * | 13020100 | Pervozvanivska | 7018,77 | 0 |
| Rent for the use of subsoil for the extraction of other minerals of national importance * | 13030100 | Velykoseveryni vska | 128560,41 | 0 |
| Rent for the use of subsoil for the extraction of other minerals of national importance * | 13030100 | Pervozvanivska | 11913204,7 5 | 133000 |
| Land tax on legal entities | 18010500 | Kropyvnytska | 149302,87 | 0 |
| Land tax on legal entities | 18010500 | Velykoseveryni vska | 1959,78 | 0 |
| Land tax on legal entities | 18010500 | Pervozvanivska | 57169,79 | 0 |
| Environmental tax, which is paid for emissions of pollutants into the atmosphere by stationary sources of pollution (with the exception of emissions of carbon dioxide into the atmosphere) * | 19010100 | Pervozvanivska | 2011,66 | 0 |
| Inflow from discharges of polluting substances directly into water bodies * | 19010200 | Pervozvanivska | 45946,77 | 0 |
| Proceeds from the disposal of waste in specially designated places or facilities, except for the disposal of certain TYPES OF WASTE as secondary raw materials * | 19010300 | Pervozvanivska | 27800,64 | 0 |

*funds subject to distribution between the state and local budgets in accordance with the Law of Ukraine "On the State Budget of Ukraine"

As we can see from the table, the mine has paid the most taxes and fees to the Pervozvanivska rural territorial community over the past 2 years. Starting from 2022, the mine paid UAH 13.4 million in taxes.

Traditionally, for a mining enterprise, the largest amounts of taxes are personal income tax on the wages of Inhul'ska mine workers and rent for the use of subsoil. It is worth noting that many taxes for 2022 have not been paid at all.

Table 5. Debts of the Inhul'ska mine for the payment of taxes and fees to the budgets of various levels in 2021-2022. Source: State Tax Service of Ukraine

| The name of taxes, fees, payments to the budget | Budget income classification code | Name of the consolidated community | Debt (100%), hryvnias | |
|---|-----------------------------------|------------------------------------|-----------------------|------------------|
| | | | 2021 | as of 27.10.2022 |
| Rent for the special use of water (except rent for the special use of water bodies of local importance) * | 13020100 | Velykoseverynivska | 0 | 188707,50 |
| Rent for the special use of water (except rent for the special use of water of local water bodies) * | 13020100 | Pervozvanivska | 0 | 5768,23 |
| Rent for the use of subsoil for the extraction of other minerals of national importance * | 13030100 | Velykoseverynivska | 187873,08 | 242972,63 |
| Rent for the use of subsoil for the extraction of other minerals of national importance * | 13030100 | Pervozvanivska | 17365662,60 | 23455344,35 |
| Tax on immovable property, other than land, paid by legal entities that are owners of non-residential real estate objects | 18010400 | Kropyvnytska | 21187,54 | 26169,31 |
| Tax on immovable property, other than land, paid by legal entities that are owners of non-residential real estate objects | 18010400 | Pervozvanivska | 511770,55 | 646904,77 |
| Land tax on legal entities | 18010500 | Kropyvnytska | 1791633,29 | 1940936,18 |
| Land tax on legal entities | 18010500 | Velykoseverynivska | 23512,50 | 25472,32 |
| Land tax on legal entities | 18010500 | Pervozvanivska | 686335,38 | 743505,16 |

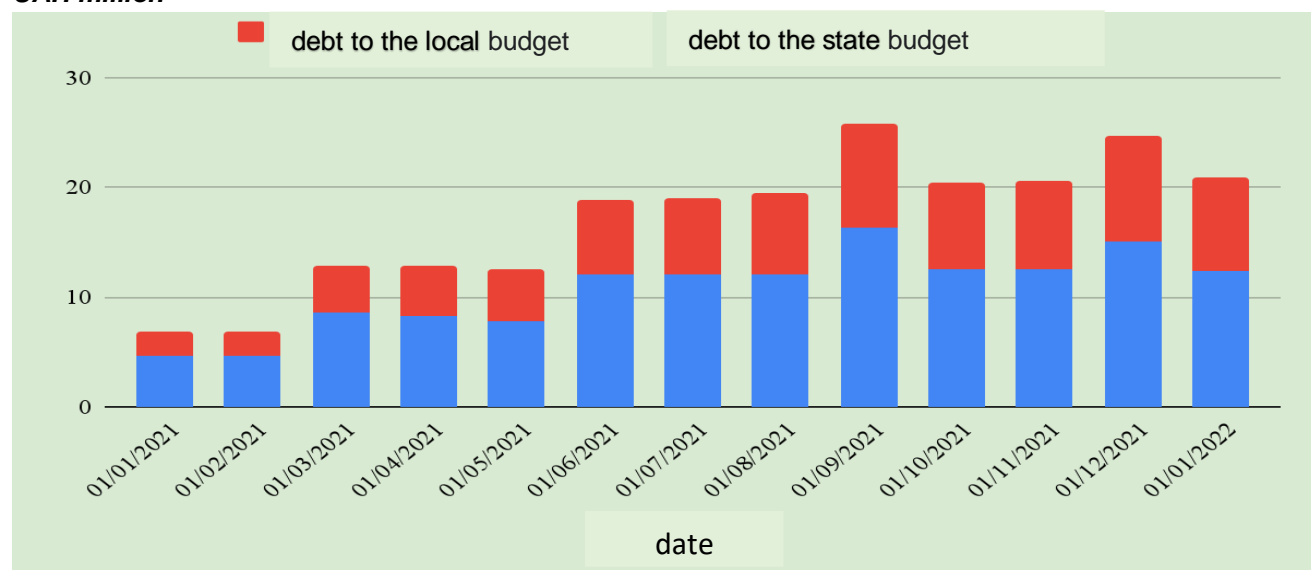
| | | | | |
|---|----------|--------------------|-----------|-----------|
| Environmental tax, which is paid for emissions of pollutants into the atmosphere by stationary sources of pollution (with the exception of emissions of carbon dioxide into the atmosphere) * | 19010100 | Pervozvanivsk a | 20444,51 | 21819,36 |
| Inflow from discharges of polluting substances directly into water bodies * | 19010200 | Pervozvanivsk a | 183675,45 | 228650,88 |
| Income from the placement of waste in specially designated places OR at facilities, except for the placement of certain types of waste as secondary raw materials * | 19010300 | Pervozvanivsk a | 85505,49 | 101319,75 |

*funds subject to distribution between the state and local budgets in accordance with the Law of Ukraine "On the State Budget of Ukraine"

As for debts due to taxes and fees, the Pervozvanivska rural territorial community also lacks the most funds. As of the beginning of 2022, the total amount of taxes owed by the Inhul'ska mine to the Pervozvanivska rural territorial community amounted to over UAH 25 million, i.e. twice as much as the mine paid to the community during the same period. However, the situation may change by the end of 2022.

If we look at the amounts of the tax debt of the mine to the budgets of different levels during the last year, we can conclude that the amount of unpaid tax liabilities has been growing dynamically:

Chart 4. The structure of the tax debt of the Inhul'ska mine of the State Enterprise "SkhidGZK", UAH million



From the structure of the tax debt, we can see that over the last year, the amount of unpaid taxes by the branch increased by more than 2 times. In particular, the amount of taxes to be paid to the State Budget of Ukraine tripled during the year, while the amount of taxes to be paid to the local budget almost quadrupled.

In 2021, a new problem arose at the SE "SkhidGZK" - the state executive service began to block invoices and payments from the enterprise. To eliminate this problem, in June 2022, people's deputies took the initiative to adopt [a draft law](#) that would allow restoring the solvency of the uranium mining company and impose a moratorium on execution of executive actions, seizure within the framework of executive proceedings of funds on accounts and such companies under martial law. Currently, [the draft law](#) is included in the agenda, but a mostly negative scientific and expert opinion has been received.

Employment, work, payment of wages

According to media reports, from February 7, 2022, the Inhul'ska mine once again [went out of business](#).

Due to financial troubles, the number of employees at the SE "SkhidGZK" is decreasing. [According to the results of the 3rd quarter of 2020](#), the average number of employed persons at the SE "SkhidGZK" amounted to 4,931 persons, which is 358 persons less than in the same period of 2019.

The average monthly expenses for wages of employees amounted to UAH 16.5 thousand, for administrative and management personnel – UAH 30.9 thousand.

Despite the reduction in personnel, administrative costs at the enterprise have, on the contrary, increased. And for the third quarter, they amounted to UAH 22.3 million, which is 2.9 million more than planned.

As of November 2022, [the Inhul'ska mine needs to fill 246 vacant positions of employees](#) of various categories, the absolute majority of vacancies involve underground work in difficult, harmful or particularly harmful conditions.

Also worthy of attention are the numerous reports on the condition of the Inhul'ska mine of the State-owned Enterprise "SkhidGZK" from the Primary Trade Union Organization of the Nuclear Trade Union of Ukraine. So, this year, the head of the trade union registered an electronic petition on the website of the President of Ukraine ["Let's save the State Enterprise "SkhidGZK"](#) and the uranium mining industry of Ukraine and preserve the energy independence of Ukraine." In the appeal, among other things, it is reported about the salary arrears to the employees for 3 months and the dismissal of the staff.

In addition, there were [several cases of protest actions](#) organized by mine workers of the State Enterprise "SkhidGZK".

Asset management

In accordance with the legislation of Ukraine⁴, financial statements are submitted by respondents who are legal entities.

According to the data of EDRPOU, as of the time of conducting the research, the legal status of the Inhul'ska mine of the SE "SkhidGZK" is a branch (separate subdivision) without the right of a legal entity.

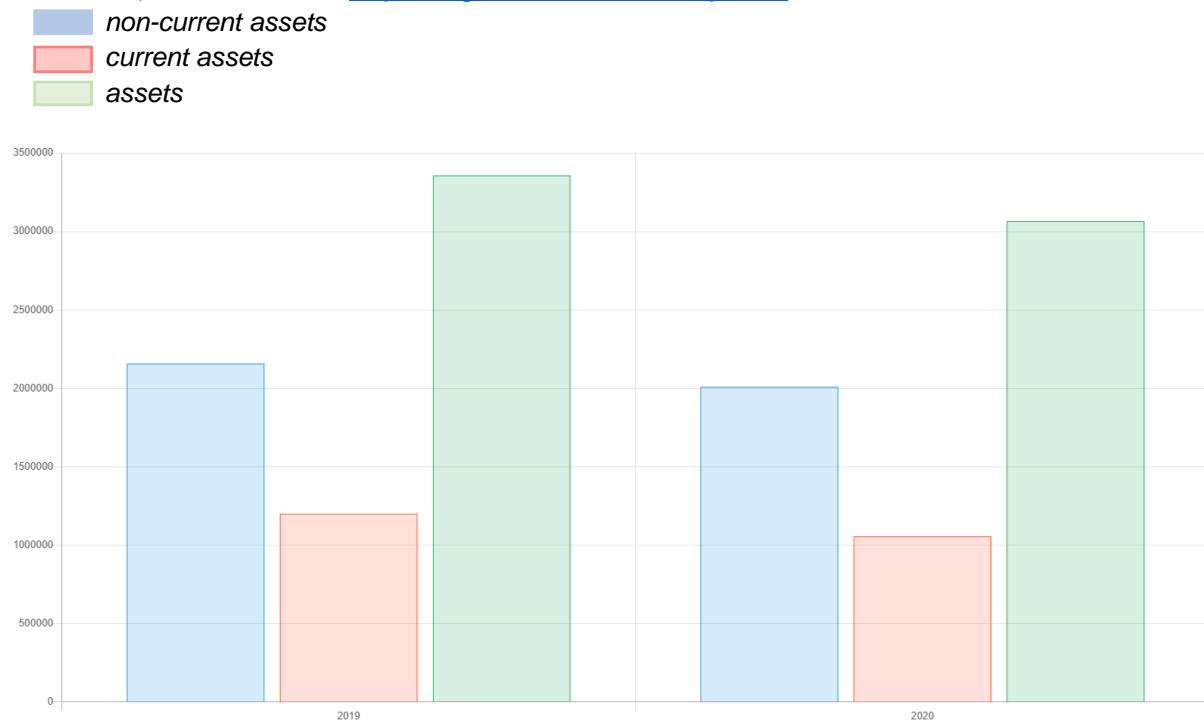
Therefore, we will consider the changes that have taken place in the management of the assets of the SE "SkhidGZK" recently.

After the implementation of the [new methodology](#) of the NCRECP for the procurement of UOC in 2018, the company reported a profit of UAH 49.2 million. With the deepening of the UOK price crisis, the company ended 2019 with a loss of UAH 680.2 million. In 2020, the unprofitable trend continued, and in just 9 months the company reported financial losses of UAH 356.9 million.

Let's consider how the company carried out general asset management

⁴ We are talking about the Law of Ukraine "On Accounting and Financial Reporting in Ukraine" and Resolution of the Cabinet of Ministers of Ukraine dated February 28, 2000 No. 419 "On Approval of the Procedure for Submitting Financial Reporting".

Chart 5. Dynamics of the assets of the SE "SkhidGZK" in 2019-2020. Source: State Tax Service of Ukraine, calculations — [Reporting of Ukrainian enterprises](#)



Weakening of the economic potential is observed, which is indicated by a decrease in the amount of assets by 8.7%. That is, the amount of property at the disposal of the enterprise is reduced.

In response to systemic challenges and threats to the activities of the state-owned enterprise, in May 2021, the Kropyvnytskyi City Council addressed the President of Ukraine, the Chairman of the Verkhovna Rada of Ukraine, the Prime Minister of Ukraine, the Minister of Energy of Ukraine [regarding the activities](#) of the Inhul'ska mine of SE "SkhidGZK".

In the appeal, it was noted that the situation at the Inhul'ska mine is critical, given the insufficient funding of the mine's activities, the unreasonable tariff for uranium oxide concentrate, which excludes the mine from earning a profit.

There are also measures that would improve the situation at the Inhul'ska mine, in particular:

- return of powers to the Ministry of Energy to set the price of UOC with the establishment of a minimum profitability of 8%;
- setting the price of UOC based on its cost price;

- adoption of a decision on the merger of the State-owned Enterprise "SkhidGZK" and the state-owned enterprise "NAEK "ENERGOATOM";
- introducing amendments to the Law of Ukraine "On the State Budget of Ukraine for 2021" regarding the increase in expenditures to the Ministry of Energy of Ukraine for financing the new budget program "State support of a uranium mining enterprise to increase the authorized capital in order to replenish its own working capital of the SE "SkhidGZK" in the amount of 2.2 UAH billion (author's note - in fact, this is the amount owed to SE "NAEK "ENERGOATOM").

Discussions regarding the merger of the companies of the State-Owned State Enterprise "SkhidGZK" and the state-owned enterprise "NAEK "ENERGOATOM" have been going on for a long time, there are two different views on such a merger:

1. [Full integration](#) of the State Enterprise "SkhidGZK" into the structure of NAEC "Energoatom", so that the latter already includes the development of the uranium plant in its investment programs, because it is easier for "Energoatom" to attract investment funds;
2. Accession of [only liquid assets from SE "SkhidGZK" to the structure of NAEC "Energoatom". The illiquid assets are planned to be transferred to the custody of Barrier State Enterprise.](#)

In the second case, the "illiquid" assets, namely the Inhul'ska and Smolinska mines, will most likely remain without state support and proper care after the termination of their activities. This, in turn, threatens environmental hazards and the loss of jobs for almost half of the employees of the State Enterprise "SkhidGZK".

The contribution of the Inhul'ska mine to the development of the community.

The Inhul'ska mine of SE "SkhidGZK" is actually located on the territory of the Pervozvanivka consolidated community of the Kirovohradska oblast. The branch is registered in the village of Neopalymivka of the same community.

Based on the information provided in the [Strategic Development Plan of the Pervozvanivska Consolidated Community for 2020-2024](#), the Inhul'ska mine is the largest taxpayer in the community. The same

document positions the presence of the mine as one of the strengths of the community.

Along with this, as already mentioned above, the mine is a debtor for the payment of taxes, including for the Pervozvanivska consolidated community — the amount of unpaid taxes is twice as much as the tax contributions to the community.

However, as it follows from the previously conducted expert survey⁵, there is no consolidated opinion in the community regarding the relationship between the payment of taxes by the mine and the environmental situation on the territory of the community.

We decided to separately investigate the opinion of experts who live in the villages where the Inhulska mine exerts its influence regarding the economic aspect of its activity.

The most frequent positive factor pointed out by experts is tax revenue for the community budget and the branch's creation of jobs for the population. Two experts out of eight noted that the mine does not bring positive economic factors to the life of the community.

At the same time, 5 out of 8 experts are of the opinion that the most negative factor is the tax arrears of the Inhulska mine.

Regarding the selection of the optimal procedures that could improve the economic activity of the mine, the experts note the following:

- 3 out of 8 people expressed the opinion that the closure and conservation of the mine is necessary;
- 2 out of 8 experts suggest intensifying investment activity and attracting grant funds for its operation;
- the rest of the experts did not directly decide on the possible optimization of the mine's operations.

In addition to paying taxes, the Inhulska mine supplied water to the village of Soniachne of this community and one of the microdistricts of Kropyvnytskyy.

⁵ We are talking about the information specified in the document: "Report on the results of an expert survey: Eco-situation and health status of residents of Pervozvanivska Territorial Community // December 2021 — January 2022."

However, as reported by the [mass media](#), from November 1, 2022, the function of water supply to the village is performed by another supplier. The problem with the mine's water supply turned out to be low-quality water and frequent gusts, which made it impossible to use the network.

Attempts to stimulate the economic activity of the Inhul'ska mine.

In November 2017, the Cabinet of Ministers approved [the Concept of the state target program for the development of the nuclear industrial complex](#) of Ukraine until 2020. This program replaced the previous state targeted economic program "[Nuclear Fuel of Ukraine](#)".

The latter set ambitious goals, one of which was not fully realized given the fact that the actual amount of financing from the state budget amounted to about 3.6% of the amount planned at the beginning of its implementation (financing from the state budget was expected in the amount of UAH 4,335 million, in fact UAH 127.8 million was financed); financing in the amount of UAH 9,215 million was expected from other sources, UAH 623.1 million, or 6.8%, was actually financed.

[The new target program](#) by 2020 envisages increasing the production of uranium concentrate to 2,500 tons. But the program was not implemented, one of the reasons was again chronic underfunding: the government allocated only 10-12% of the required sums.

Currently, there is an approved state investment project - "Novokostyantyniv'ska mine. Development of production capacities". The project is designed for five years (2019-2023). The total amount of investments in 2018 prices is 2.9 billion UAH, of which 1.7 billion UAH should be invested by the company, and another 1.2 billion UAH should be provided by the state.

The investment project was approved in 2018, but due to underfunding in previous years, its implementation was postponed. The project is part of the measures envisaged by the Concept of the [State Targeted Economic Program for the Development of the Nuclear Industrial Complex](#) for the period until 2026. According to the forecast, the implementation of the investment project for the development of the production capacities of the Novokostyantyniv'ska mine will make it

possible to increase the production of uranium to 701 tons (in 2018, the production was 336 tons), thus gradually withdrawing the production of uranium ore at the Smolinska and Inhul'ska mines from the active stage. Financing and implementation of the investment project [is progressing slowly](#).

Instead, according to the Concept of the [State Targeted Economic Program for the Development of the Nuclear Industrial Complex for the period up to 2026](#), approved by the CMU, **the decommissioning of the Inhul'ska mine due to the depletion of uranium reserves is foreseen in 2028.**

In order for this Concept to be developed, it was necessary to convene the National Security and Defense Council of Ukraine, which passed the decision ["On measures to neutralize threats in the field of nuclear energy and industry"](#). However, the state target economic program itself has not yet been approved.

Conclusions

Ukraine is among the top 10 countries in the world in terms of annual uranium production, having about 2% of the explored world reserves of this natural mineral. At the same time, all the extracted uranium is used for internal consumption by the NPP. Not only that, Ukraine's own uranium production is not enough to fully cover the need for nuclear fuel. Yes, annually, thanks to its own technologies, Ukraine covers only 30-40% of its own needs. Ukraine buys the rest of the nuclear fuel abroad. Before the full-scale invasion on February 24, 2022, agreements were made with TVEL (Russia) and Westinghouse Electric Sweden (Sweden). After the invasion, Ukraine refused to contract Russian nuclear fuel and decided to switch to Westinghouse Electric Sweden technology.

Instead, Ukraine exported uranium concentrate (the product from which nuclear fuel is made) more than 20 years ago.

If we consider the economic expediency of Ukraine's trade in uranium oxide concentrate, it should be noted that there is actually no international market for uranium oxide concentrate. Rather, it is a system of bilateral agreements with numerous restrictions. These restrictions include:

- uranium is sold only to those countries that have signed the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), and deliveries are subject to inspection and supervision;
- uranium oxide concentrate has a limited scope of use and is most often used for the needs of nuclear power plants;
- supply and demand for uranium is influenced by several factors, such as: investor sentiment; increase or decrease in the number of nuclear power plants in the world; development of new or closure of old fields; the security situation in uranium exporting and importing countries, etc.

Almost all supplies of uranium between countries are carried out on the basis of futures contracts. Spot contracts make up only about 15% of the entire supply structure.

Russia's full-scale invasion of Ukraine in February added to the value of raw materials. However, here, fears on the world market are caused by the significant role of enterprises located on the territory of the Russian Federation and engaged in uranium enrichment. Although the share of uranium concentrate (U₃O₈) from Russia is low — 5% of world production, $\frac{2}{5}$ of the world's uranium enrichment capacity is located in Russia.

Instead, Kazakhstan enterprises, reacting to potential market challenges, increase the target indicators of uranium production, so that it is possible to replace Russian capacities and prevent a surge in prices.

The State Enterprise "Eastern Mining and Enrichment Combine", which includes the Inhul'ska mine, is currently the only enterprise in Ukraine that has a license to mine uranium ores and was engaged in their extraction and processing at its own production facilities, the production of uranium oxide concentrate.

The Inhul'ska mine was developing two uranium deposits, which are depleting their reserves. However, in order to extract uranium ore, it is necessary to use high-cost technologies, which significantly increase the cost of ore. Currently, it is estimated that the extraction of ore from these deposits is worth \$110-115/kg, which is significantly lower than world prices.

At the same time, as can be seen from the financial statements of SE "SkhidGZK" for 2020, the company sold UOC for an amount less than the cost of its production.

According to the law of Ukraine, uranium ores and their processing products are purchased by state order at contractual prices that ensure a level of profitability not lower than the minimum.

However, in 2017, the National Commission, which carries out state regulation in the fields of energy and communal services, sets the price for uranium-containing raw materials (U₃O₈), its conversion and enrichment in the structure of the production cost of electricity and thermal energy produced at NPPs. Since then, the price of UOC has been determined according to world spot prices, which at that time were significantly lower and remain so (\$70-75/kg) than the cost price of UOC from Ukraine. The lack of a tool for adjusting the market indicator of the spot value of UOC to the cost of mining and production leads to the fact that the main product of the activity of the SE "SkhidGZK" is forced to sell its main product to the state enterprise "NAEK "ENERGOATOM" at a price lower than the cost and bear losses.

The consequence of the unprofitable policy of pricing uranium oxide concentrate was the lack of income and the inability to cover own expenses.

Because of this, the Inhul'ska mine, although it pays large amounts of taxes to the territorial communities within which it operates, does so partially. For example, in 2022, the Inhul'ska mine owed twice as much taxes to the Pervozvanivska Consolidated Community as it received from it.

In addition, the mine does not fulfill its obligations to supply water to the village of Soniachne of this community and one of the microdistricts of the city of Kropyvnytskyi.

At the same time, in the Strategic Development Plan of the Pervozvanivska Consolidated Community for 2020-2024, the presence of the mine is positioned as one of the strengths of the community.

If we look at the company's asset management policy, starting from 2019, the State Enterprise "SkhidGZK" annually bears financial losses,

which led to a debt of more than UAH 2.1 billion only to the state-owned enterprise "NAEK "ENERGOATOM" for the contracted, but not yet delivered, uranium oxide concentrate.

The large debt burden of the State Enterprise "SkhidGZK" in general and of the Inhul'ska mine in particular leads to reductions and dismissals of mine workers, strikes and downtime. Currently, from January 2022, the Inhul'ska mine is in forced idleness.

In addition, according to government plans, the Inhul'ska mine will operate only until 2028 — after that, the reserves of its deposits should be exhausted.

In order to resolve the situation, it is planned to merge the SE "SkhidGZK" and the SE "NAEK "ENERGOATOM" into one structure. However, there is still no general vision of how exactly this should happen. According to one plan, the two enterprises should be subject to the merger procedure in full, according to the other, only liquid assets — Novokostyantyniv'ska uranium ore mine, the construction of which has not yet been completed, and the production assets of Smolinska and Inhul'ska mines, without them — are foreseen to be joined to SE "NAEK "ENERGOATOM". It is proposed to hand over the mines themselves to the custody of Barrier State Enterprise.

APPENDIXES

Appendix 1: System of nuclear legislation of Ukraine

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|---|--|
| International acts: | <p>Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.</p> <p>Convention on nuclear safety.</p> <p>Treaty on the Non-Proliferation of Nuclear Weapons</p> <p>Vienna Convention on Civil Liability for Nuclear Damage</p> <p>Conventions on assistance in the event of a nuclear accident or radiation emergency</p> <p>Conventions on prompt notification of a nuclear accident</p> <p>Conventions on physical protection of nuclear material</p> <p>Agreement between Ukraine and the IAEA on the application of guarantees in connection with the Treaty on the Non-Proliferation of Nuclear Weapons.</p> |
| Laws of Ukraine | <p>Law of Ukraine "On the use of nuclear energy and radiation safety"</p> <p>"On radioactive waste management"</p> <p>"On mining and processing of uranium ores"</p> <p>"On human protection against the effects of ionizing radiation"</p> <p>"On permitting activities in the field of nuclear energy use"</p> <p>"On physical protection of nuclear installations, nuclear materials, radioactive waste, other sources of ionizing radiation"</p> <p>"On civil liability for nuclear damage and its financial support"</p> <p>"On streamlining issues related to ensuring nuclear safety"</p> <p>"On the procedure for making decisions on the location, design, and construction of nuclear installations and facilities intended for the management of radioactive waste that are of national importance," etc.</p> |
| Resolutions of the Cabinet of Ministers of Ukraine | <p>"On approval of the Regulation on the state system of accounting and control of nuclear materials" dated December 18, 1996 No. 1525</p> <p>"On the approval of the Regulation on the basic principles of the organization of the transportation of radioactive materials through the territory of Ukraine" dated November 29, 1997 No. 1332</p> <p>"On approval of the Procedure for public hearings on the use of nuclear energy and radiation safety" dated July 18, 1998 No. 1122</p> <p>Resolution of the Cabinet of Ministers of Ukraine dated 04.26.03 No. 625 "On approval of the procedure for determining the level of physical protection of nuclear installations, nuclear materials, radioactive waste, other sources of ionizing radiation according to their category"</p> |
| Normative documents on | <p>General safety provisions of the nuclear fuel production facility (NP 306.2.163-2010), approved by the order of the State Atomic Energy</p> |

nuclear and radiation safety, physical protection and accounting of nuclear materials

Regulatory Commission No. 112 of 09/06/2010, registered in the Ministry of Justice on 11/10/2010 No. 1082/18377

Requirements for the quality assurance program at all stages of the life cycle of nuclear installations (NP 306.5.02/3.017-99). Approved by the order of the Ministry of Security of Ukraine dated 11.03.99 No. 53, registered in the Ministry of Justice of Ukraine on 07.05.99 under N 294/3587.

Requirements for the periodicity and content of reports provided by licensees in the field of nuclear energy use (NP 306.1.129-2006), approved by the order of the State Nuclear Regulatory Commission No. 162 dated 10.16.2006 (registered by the Ministry of Justice on 12.06.2006 under No. 1268/13142)

Basic rules of nuclear safety during processing, storage and transportation of nuclear hazardous fissile materials (PBYA-06-00-88).

Requirements for the content and structure of the plan for ensuring the physical protection of the nuclear installation and nuclear materials and the plan for ensuring the accounting and control of nuclear materials (NP 306.8.150-2008), approved by the order of the State Nuclear Regulatory Commission No. 196 dated 04.12.2008, registered by the Ministry of Justice on 23.12.2008 under No. 1223/15914

Rules of nuclear and radiation safety during the transportation of radioactive materials (PBPRM-2006) (NP 306.6.124-2006). Approved by the order of the State Atomic Energy Regulatory Commission dated August 30, 2006 No. 132, registered by the Ministry of Justice on September 18, 2006 under No. 1056/12930.

Rules for keeping records and control of nuclear materials (NP 306.7.122-2006), approved by the order of the State Committee for Nuclear Regulation of Ukraine dated June 26, 2006 No. 97, registered in the Ministry of Justice of Ukraine on July 17, 2006 under No. 849/12723.

State Nuclear Regulation Committee Order|Plan, dated 16.07.2010, No. 93 "Response plan of the functional subsystem of the unified state system of prevention and response to emergency situations of man-made and natural nature "Safety of nuclear energy facilities" "Regulations on the state system of accounting and control of nuclear materials" (approved by Resolution of the CMU of December 18, 1996 No. 1525);

"Procedure for development and approval of norms, rules and standards for nuclear and radiation safety" (approved by Resolution of the CMU of February 8, 1997 No. 163);

"The procedure for the interaction of executive authorities and involved legal entities in case of detection of sources of ionizing radiation that are in illegal circulation" (approved by Resolution of the CMU of March 4, 1997 No. 207);

| | |
|--|--|
| | <p>"Regulations on the State Register of Sources of Ionizing Radiation and Payment for Services for Their Registration" and "Program for Creation of the State Register of Sources of Ionizing Radiation" (approved by Resolution of the CMU of August 4, 1997 No. 847);</p> <p>"Regulations on the organization of the transportation of radioactive materials through the territory of Ukraine" (approved by Resolution of the CMU of November 29, 1997 No. 1332);</p> <p>"Procedure of special inspection for granting permission to work at nuclear installations, with nuclear materials" (approved by Resolution of the CMU of December 25, 1997 No. 1472).</p> |
| Documents on radiation protection | <p>Basic sanitary rules for ensuring radiation safety of Ukraine OSPU (DSP 6.177-2005-09-02), approved by the order of the Ministry of Health dated 02.02.2005, registered by the Ministry of Justice on 05.20.2005 under No. 552/10832.</p> <p>Radiation safety standards of Ukraine. Supplement: radiation protection from sources of potential exposure (NRBU-97/D-2000) (DGN 6.6.1.-6.5.061-2000). Approved by the decision of the Chief State Sanitary Doctor of Ukraine dated July 12, 2000. No. 116.</p> <p>Radiation safety norms of Ukraine (NRBU-97) (DGN 6.6.1.-6.5.001-98). Approved by the resolution of the Chief State Sanitary Doctor of Ukraine dated 01.12.1997 No. 62</p> |

*The list is not exhaustive

Appendix 2: Doses of external irradiation of individual organs and tissues of the body.

| | Category of persons exposed to radiation: | | |
|---|--|----------|----------|
| | A | B | C |
| Effective dose limit | 20 mSv | 2 mSv | 1 mSv |
| Limits of the equivalent dose of external radiation: | | | |
| For the lens of the eye | 150 µsv | 15 µsv | 15 µsv |
| For the skin | 500 µsv | 50 µsv | 50 µsv |
| For hands and feet | 50 µsv | 50 µsv | - |

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