Zvonkova Galina Leonidovna,
cand. is Sciences, senior research fellow GA
"IRSTPHS name of G.M. Dobrova National Academy
of Sciences of Ukraine"
E-mail: zvonkova@ukr.net

CHERNOBYL NUCLEAR POWER PLANT: FRAGMENTS OF HISTORY (1977–2000)

Abstract. The article deals with the nuclear energy manufacture in Ukrainian. The background and the consequences of the greatest nuclear disaster of the 20th century are pointed out. The article shows how the NAS of Ukraine participated in dealing with the aftermath of Chernobyl's disaster. The article describes how a state plan for deploying several new nuclear power plants in Ukraine was rejected.

Keywords: nuclear energy, reactor, nuclear pollution, academic science, scientific program.

At the beginning of 1986, the Chernobyl nuclear power plant (ChNPP) was the most powerful atomic power station in the Soviet Union. Its construction with a capacity of 4 million kW. started in 1970, in accordance with the Resolution of the Central Committee of the CPSU and the Council of Ministers of the USSR of February 2, 1967. The first power unit of the AES was launched on September 26, 1977. The next three blocks – in 1978, 1981 and 1983 respectively. Due to violation of the rules of service and operation of the reactor on April 26, 1986 during the design tests there was an explosion that completely destroyed the fourth reactor of the station and caused significant pollution of the surrounding area by radioactive substances. This man-made disaster has become the largest in the world's history of nuclear energy, in the number of dead and injured people, in economic loss. About 200,000 people were evacuated from the pollutants from the reactor. Radioactive particles have been polluted by the territory of Ukraine, Belarus, Russia, Sweden, Norway, Finland, Lithuania, Germany, Poland, Czech Republic, Switzerland, Austria, Hungary, Romania, Greece, and Bulgaria. Here radioactive particles with an atom diameter of more than 20 microns fell from a height of 2000 m. In the next 10 days, the radioactive clouds climbed over a 700-meter high reactor collapse. A few days after the Chernobyl accident, the concentration of cesium-137 in the Finnish coastal waters increased from 100 to 500 times compared to the highest figures observed here in 1974 [1, P. 11].

In order to neutralize the emissions of a destroyed reactor, the potential of academic science was involved. 42 institutions of the Academy of Sciences of the USSR and about 1200 of their employees participated in the liquidation of the accident (of which about 550 – scientists). The main tasks of scientists, researchers and employees have been the salvation of public health; liquidation of the consequences of the accident directly on the ChNPP and in the 30-kilometer zone [2, P. 279]. Work in the ChNPP zone has become a test not only for scientists but also for persuasion regarding the prospects of nuclear power development in Ukraine, expediency of further placement of atomic objects and their exploitation on the territory of Ukraine. By the mid-1980s, nuclear power accounted for over 40% of total electricity production in eight countries around the world, including France, Belgium, Sweden and some Eastern European countries. Nuclear power is characterized by large capital investments and low fuel costs. For controlled nuclear power plants with low cost, the cost of electricity generation is competitive with other sources. The nominal lifetime of most nuclear reactors is 40 years [3, P. 3].

In the mid-1980s, almost 40% of all Soviet nuclear power reactors (14 out of 35) worked on the territory of Ukraine, Chornobyl, Khmelnytsky, Rivne, Zaporizhzhya, South-Ukrainian NPPs acted. In total capacity of power units the republic occupied the 8th place in the world, 14th – for the production of electricity on them. Most of the stations are built in the basins of the Dnieper and Southern Bug, therefore, in the republic there was a shortage of water resources up to 6 km^3 annually. Since the beginning of the 1980s, construction of the Crimean, Odessa, Chigirinskaya NPPs was carried out on its lands. There were problems with ensuring the strength of buildings already in the existing Rivne NPP. At the atomic objects of Ukraine in the late 1980's, annually produced up to 3 million m3 of liquid radioactive waste. IAEA recognized that from the point of view of environmental safety, Ukraine's nuclear energy occupied one of the last places in the world [4, P. 393].

At that time there was a system of monopoly law of the party-state leadership of the Soviet Union on the decision to build nuclear power plants. The scientific potential of the Academy of Sciences of the Ukrainian SSR, the ministries and departments of the republic, were not involved in the development of projects for the construction of nuclear facilities on the territory of the republic. Scientific and design developments were carried out and approved outside of Ukraine. The Academy of Sciences possessed only information on the availability of a program for the construction of nuclear facilities, begun in 1966 on the territory of the republic. In order to develop scientific proposals and security capabilities for the development of nuclear energy, scientists of the institutes of the Academy, on their own initiative, conducted intelligence on its lands, but the structures of the USSR in every way tried to prevent Ukrainian scientists from participating in this work [5, P. 388].

The first power unit of the Chernobyl Nuclear Power Plant was put into operation in September 1977. The Academy of Sciences of Ukraine denied the expediency of continuing work on the expansion of the Chernobyl power plant located in the upper reaches of the Dnieper (project Chernobyl NPP-2). At that time, at a time of 250–500 km from the nuclear power plant, at that time, nine nuclear power facilities (territories of Ukraine, Russia, Lithuania and Byelorussia). The main attention in the message of the Presidium of the Academy of Sciences of the USSR to the party leadership and the Government of the USSR focused on the hydrobiological, environmental and social aspects of the problem. At the end of 1979, the USSR Ministry of Energy proposed a plan for the continuation of the construction of nuclear facilities on the territory of the republic in 1981–1985. The Academy of Sciences proposed specific measures that were envisaged, that only after the previous implementation of a wide range of scientific research with the participation of Ukrainian scientists, the development of their prognostic estimates of the consequences of the construction and operation of nuclear facilities, careful consideration of all "for" and "against" one can develop a scheme for the placement of nuclear facilities for the next 20–30 years. Support for the position of the Academy by the party-state leadership of Ukraine forced the union authorities to stop the construction of the Odessa and Kharkov APEC, the Crimean NPP and similar in the Donetsk region, on the coast of the Azov Sea, an increase in the number of units in the Khmelnitsky, Rivne and South-Ukrainian nuclear power plants. In November 1981, the Academy of Sciences of Ukraine had clearly identified the negative consequences in the event of extreme situations at nuclear power facilities, in particular the Chernobyl Nuclear Power Plant [5, p. 388–393].

In March 1986, a group of employees consisting of academicians E. V. Sobotovich, VM Shestopalov and other scholars at a meeting of the Earth Sciences Division on the topic "Estimation of the probability of disaster at Ukrainian NPPs" predicted an accident in Chernobyl. But the statement was left out of sight. The accident at the Chernobyl Nuclear Power Plant has become the largest of the 296 accidents that occurred in the world at nuclear facilities and facilities. The accident at the Chernobyl Nuclear Power Plant has become the largest of the 296 accidents that occurred in the world at nuclear facilities and facilities. The explosion in Chornobyl on April 26, 1986 was estimated as an explosion of more than 500 atomic bombs, similar to those dropped on Hiroshima. The destroyed power unit contaminated the territory over 50 thousand km^2 in 74 districts of 12 oblasts of Ukraine. They have 2294 settlements. The victims of the Chornobyl catastrophe – 3.2 million people (out of 10 million victims in Russia, Belarus and Ukraine), among them about 1 million children. The magnitude of the spread of the consequences of the accident is significantly reduced [5, P. 4; 8; 12, 375–376, 445].

So, after the accident at the Chornobyl NPP, scientists at the Marine Hydrophysical Institute (MHI) began research on the topic "Investigation of the influence of hydrometeorological, hydrodynamic and geochemical processes on the distribution and migration of radioactive contaminants in water and the driving atmosphere of the northwest part of the Black Sea and the Dnipro water system". Work was begun on complex measurements of spatial and temporal characteristics of different fields (concentration of radionuclides in seawater, waters of the Dnipro River and the driving atmosphere, water temperature, salinity, velocity of flows, wind speed in the driving atmosphere); estimation of various physical and chemical parameters of the environment on the basis of observation data; modeling of mechanisms for formation of radionuclide concentration fields. At the same time, the development of new and improved existing techniques and equipment was carried out. The first work on the study of radioactive contamination of the black sea atmosphere after the Chernobyl accident occurred during the expedition of the research vessel "Academician Vernadsky" during the period from May 15 to June 3, 1986. Following a route following the ship from the Gibraltar Strait to Sevastopol, 15 samples of aerosols were selected. Later it was organized to observe the content of radioisotopes of cesium in the surface layer of the atmosphere in the settlements of certain regions of the Crimea: in the cities of Alushta, Evpatoria, Kerch, Sevastopol and the villages of Katsiveli, Laspi, Nikolaevka, Frunzenskaya. In Katsiveli, such observations were conducted continuously for three years (1987–1989 years) [6, P. 194].

After the Chernobyl accident, the efforts of scientists at the Institute of Biology of the Southern Seas focused on: the role of living and conservative (sluggish) Black Sea biogeocenoses and the migration of fragmented products; the effects of ionizing radiation on the vital functions of mass organisms of the Black Sea; levels of radioactivity of the Black Sea plankton, benthos and nekton; the use of radioactive indicators to study the accumulation of rare and scattered elements from the environment by mass organisms and soils of the Black Sea. Subsequently, these directions became general in the light of the development of marine hydrobiology. For 1986–1987, 6 marine and 3 land expeditions in the Black, Mediterranean and Aegean regions and the Dnieper-Bug estuary, the mouth of the Danube, were erected on topics related to the consequences of the Chernobyl accident; Chernobyl, Novaya Kakhovka and the Caspian Sea to the Black Sea. All research results were published [7, P. 346, 348]. Work of nuclear physicists of the Institute of Atomic Energy named after. IV Kurchatov, Leningrad and Obninsk research institutes of the FTI of the Academy of Sciences of the USSR, the Institute of Nuclear Research of the Academy of Sciences of the USSR, which was aimed at the liquidation of the Chernobyl accident, was headed by Academician of the Academy of Sciences of the Soviet Union V. O. Legashov. The main task of the Governmental Disaster Management Commission was to work directly at the station itself and in the adjacent 30-kilometer zone. Beyond that, many acute problems have arisen in the contaminated territories of Belarus, Ukraine and Russia. The main effects of the blast felt on Ukraine. Radiation contaminated almost a tenth of the territory of a republic with a population of several million people. More than 100 thousand people needed urgent relocation to clean areas. Severe radiation contamination was received by the Kiev reservoir, which became a threat to the inhabitants of Kiev and the entire Dnipro basin. Within a few hours, the Government of Ukraine provided emergency evacuation of 45 thousand inhabitants of the city of Pripyat [2, P. 215].

The first consolidated scientific program of work on the study of radioactive contamination of the natural environment for 1986–1990 was developed by scientists of the Academy of Sciences of the USSR in May 1986 and provided for the improvement of methods and means of monitoring radioactive contamination of the environment; study of changes in the dynamics of radioactive screening and behavior of radionuclides in the natural environment, "hot particles". On this basis, development was made using mathematical modeling of short and long-term forecasts; the study of the patterns of formation of radioactive contamination of the areas after the accident [8, P. 28].

In accordance with this program, in order to reduce the level of radiation and prevent the release of radionuclides into the environment in May-November 1986, a protective Shelter building was erected over the 4th power unit of ChNPP. In some cases, constructive decisions were made without sufficient scientific justification. Therefore, after the building was put into operation, there was constant concern about its destruction and release of a new portion of radioactive substances. In this connection, it was planned to build a new shelter, designed for 100 years, and subsequently dismantle the old "Shelter" and begin to remove the remains of nuclear fuel remaining in the collapse of the 4th power unit [9, P. 9].

In 1987 the state of the "Shelter" object was temporarily safe. But already from next year began to slow down the implementation of the GDR, measures to strengthen the construction of the facility, which increased the potential nuclear threat. In 1988–1990, the pace of work on the "Shelter" fell due to lack of funding and because of the part of civil defense and military builders left the site [10, p. 46–48].

The Chernobyl catastrophe forced to start training of personnel, which Ukraine had practically not prepared before. As a result of the joint efforts of the Ministry of Chernobyl, the Ministry of Education and the Academy of Sciences of the USSR, a National Program was prepared, which provided for the preparation of radiobiologists, radioecologists, as well as spectrometers and dosimeters for work in agriculture, processing and food industry. In some higher educational institutions of Ukraine, special courses were organized, created training groups and laboratory complexes for the development of radiochemical and spectrometric detection methods for cesium-234/237, strontium-90 in food, environmental objects [9, P. 28].

After the annual expert analysis of the accident at the Chernobyl Nuclear Power Plant, scientists from the Institute for Problems of Mathematical Machines of the Academy of Sciences of the USSR made estimates for 1987–1995 and changes in the level of pollution of reservoirs in the Dnipro cascade and in the Dnieper-Bug estuary. They are reduced to the following.

First. By 1995, the amount of radionuclides coming from flushing out of contaminated drains in the cascade of the Dnipro reservoirs will decrease on average by 5–10% annually.

The second. In the Kiev reservoir against the backdrop of significant intra-annual variability of pollution concentrations the average annual level of pollution for strontium-90 and cesium-137 is expected to slowly decrease.

Third. Due to the large volume of the Kakhovka reservoir there are practically no intra-annual fluctuations in the concentration of pollution. In the coming years (1987–1988), a monotonous increase in the level of pollution of the Kakhovka reservoir for strontium-90 and for cesium-137 is expected. A significant decrease in the level of these substances by 1995 is not expected.

Fourth. In the year of extreme water content (less than 10% of supply) the concentration of strontium-90 and cesium-137 in the projected period may increase in the Kakhovka and Kakhovka reservoirs.

Fifth. In the Dnieper-Bug estuary, the concentration of strontium-90 and cesium-137 will vary from seasonal changes in water activity in the estuary, associated with changes in the intensity of water exchange with the sea.

These preliminary forecasts by scientists will be clarified depending on the dynamics of pollution in the bottom mules, the impact of biota, as well as in this connection, the mathematical models of long-term migration of radionuclides in reservoirs will be further elaborated [11, p. 30–31].

After the events of April 26, 1986, many countries imposed a moratorium on the expansion of nuclear power plants in Chernobyl. From the work of the institutes of the Academy of Sciences of the UkrSSR on the elimination of the accident, one can conclude: accident-free operation of nuclear power engineering, as one of the most important components of the economy, depends not only on operators, specialists and their qualifications. There is a more difficult task: burial of radioactive slag. But before deciding on the construction of a nuclear power plant, It is necessary to scientifically substantiate their placement, the efficiency of nuclear energy on an international scale, the global nature of its use and ensuring the reliability of precautionary measures[12, p. 434–438].

The situation, associated with the Chernobyl tragedy on April 26, 1986, activated the work of scientists in limiting and negative impact on living and inanimate nature. Since 1987, the institutes of the Academy have concentrated their efforts on scientific support of all works, which were conducted within the framework of the Union programs, and since 1992 – the republican programs of neutralizing the consequences of the Chernobyl disaster. Studies under the control of the Presidium of the National Academy of Sciences of Ukraine are actively conducted in the institutes of nuclear research; problems of oncology and radiobiology; hydrobiology, colloid chemistry and water chemistry, metallophysics, botany, zoology, geochemistry and physics of minerals, physical chemistry, chemistry of surfaces, and others. In 1991, to strengthen these studies, the Department of Environmental Radiochemistry of the Academy of Sciences of the USSR was created, who headed the acad. E.V. Sobotovich, and the Scientific and Engineering Center of Radiohydroecological Polygon Studies of the Academy of Sciences of the USSR, headed by Corr. VM Shestopalovym [2, p. 271–272].

After the start of work in 1977, the Chernobyl nuclear power plant (the first power unit) was decommissioned by the Decree of the Cabinet of Ministers of Ukraine: in December 1997 the unit number 1; in March 1999 the unit number 2. On December 15.2000, the third, last operating power unit of the ChNPP was stopped [13, p. 271–272].

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