Note on ways to transform the Shelter facility into an environmentally safe system

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On some issues related to the aftermath of the Chernobyl Nuclear Power Plant accident.

Leading scientists and specialists in the country continue to discuss options for converting the Shelter into an environmentally safe system. The solution to this problem boils down to the key question: whether to leave the nuclear fuel in the destroyed reactor or remove it for disposal in accordance with international norms and regulations.

The most acceptable option proposed by specialists from the USSR Ministry of Atomic Energy is the concrete lining of the facility's process rooms, delaying the complete removal of fuel from the former reactor for 100 years or more. The scientific justification for this project is the conclusion of the Kurchatov Institute of Atomic Energy's Integrated Expedition, which states that the Shelter is currently nuclear safe.

At the same time, a number of scientists at the Academy of Sciences of the Ukrainian SSR express concern over the fact that a scientific forecast of the long-term behaviour of concrete under the influence of radiation and the temperatures generated in fuel-containing materials when additionally insulated with a concrete "coat" is currently lacking. Modern science has not yet encountered a solution to this problem.

Moreover, in their opinion, the volume of experimental research being conducted does not allow for the substantiation of the nuclear safety of all accumulations of fuel-containing masses over a long period, and therefore, the adoption of a concept for ways to render the "Shelter" harmless before the above issues is premature.

Despite these unresolved issues, specialists from the USSR Ministry of Atomic Energy, citing the need to secure the reactor's upper lid due to the possibility of its collapse, still strongly suggest implementing the initial option of concrete lining the reactor shaft and sub-reactor spaces of the destroyed power unit.

In turn, scientists from the Institute of Nuclear Research of the Academy of Sciences of the Ukrainian SSR believe it is necessary to develop an alternative method for reliably isolating the "Shelter," which would involve the removal of fuel-containing materials and their subsequent disposal.

To implement this plan, it is proposed to conduct additional research aimed at substantiating the safety of all accumulations of fuel-containing materials. Particular attention should be paid to the study of accumulations of graphite, fuel, and other elements of the former core in the south-western and north-eastern parts of the central hall of the destroyed unit. An important area of research, in their opinion, is determining the radiation resistance of concrete, taking into account changes in its properties and condition.

In this regard, a number of scientists and specialists believe it would be appropriate to hold a discussion about the likely consequences of concreting the reactor shaft and sub-reactor spaces at the Second East-West Symposium on Materials and Processes, which opens May 26–30 in Finland.

Suggestions have also been made regarding the need to focus efforts on creating specialised facilities for processing, packaging, containerisation, and disposal of high-level waste, since, according to expert assessments, the effectiveness of the work carried out in this area by NPO Pripyat and PO Spetsatom remains insignificant.

Given the differing approaches of the Scientific and Technical Council of the USSR Ministry of Atomic Energy and scientists of the Ukrainian Academy of Sciences, it is proposed to establish an expanded inter-republican expert council on the Shelter issues, with the participation of scientists from the RSFSR, BSSR, and the Ukrainian SSR, as well as union ministries and agencies. This council will discuss the safety status of the facility in the near future and develop an alternative option for transforming it into an environmentally safe system.

In addition to the above, one of the main challenges in eliminating the consequences of the accident remains the protection of water resources from radionuclide contamination.
According to experts, the large-scale organisational and engineering measures carried out between 1986 and 1991 made it possible to reduce to a certain extent the likelihood of radioactive substances being washed into waterways, the migration of nuclides in groundwater, and their wind-driven dust transfer to the water surface.

However, the conditions under which these measures were implemented and their complexity made it impossible to foresee all possible negative consequences.

Among them, experts noted serious disruptions to the hydrological regime within a 30-kilometer zone and adjacent territories as a result of the destruction of drainage systems and the construction of dams, which led to rising groundwater levels. They also noted the transformation of filter dams into secondary sources of contamination due to the accumulation of significant quantities of radioactive substances in the dam body and in bottom sediments in adjacent river sections.

These negative consequences are exacerbated by the fact that the previously held belief that the fuel released into the environment is insoluble or only slightly soluble has been refuted by the results of recent studies by scientists from the All-Union Research Institute of Geological Minerals (Kazan) and the Pripyat Scientific Production Association.

Currently, according to experts, the greatest danger may come from the runoff of radioactive substances from the surface of the Pripyat and Dnieper rivers' floodplains, especially during periods of high flooding, followed by their removal into the Dnieper reservoir cascade. Therefore, the construction of a protective dam on the left bank of the Pripyat River near the Chernobyl Nuclear Power Plant is a top priority.

Some experts express concerns that its construction without sufficient scientific study could lead to negative consequences. Their main argument is based on calculations indicating that

reducing the collective radiation dose to the population, primarily in Kiev, which consumes Dnieper water, by 0.8-1.6 person-Sv per year would result in doses of 25-30 person-Sv for personnel working on the dam's construction. Experts estimate that the construction will generate up to 200,000 m^3 of radioactive waste, the way of the management of which has not been determined.

Furthermore, construction could lead to significant changes in the hydrological conditions of adjacent territories, requiring further scientific study of this project.

Along with the problems outlined, experts note that, due to the burial of radioactive substances in the soil and the deterioration of temporary radioactive waste containment facilities (TRWCFs), which are equipped with deviations from sanitary regulations for their handling, the task of preventing the migration of nuclides via groundwater is becoming increasingly important.
Of particular concern are data obtained by VNIIgeolne-Rud, indicating the possible removal of radioactive substances from the Shelter via groundwater.

Under these conditions, reliable and effective groundwater monitoring is required by increasing the number of monitoring wells, a shortage of which is felt in the areas of the PVLRO and the Chernobyl Nuclear Power Plant.

It is also necessary to expedite the development of technical means for rapid analysis of strontium-90, plutonium-239, and other radionuclides. The Khlopin Radium Institute (Leningrad) and the Vernadsky Institute of Geochemistry and Analytical Chemistry (Moscow) are considered as potential developers.

Along with this, it is proposed to survey and, where necessary, restore the drainage system, which will improve the hydrological regime and lower groundwater levels in the areas of the waste disposal site, the "Red Forest" burial site, and river floodplains.

Overall, the goal of preventing the further spread of radionuclides is planned to be achieved through the implementation of the Vector program, which provides for the reburial of radioactive waste in permanently equipped repositories that meet sanitary requirements. Its implementation will require significant capital investment, estimated at 120–160 million roubles.

Among the key issues requiring urgent attention, specialists highlight the problem of collecting and disposing of bottom sediments from the Chernobyl Nuclear Power Plant cooling pond, the Pripyat backwater, and other bodies of water that can be tentatively classified as solid and liquid waste storage facilities, as the radioactivity of the sludge in some of them reaches 3,700,000 Bq/kg. The severity of the problem lies in the fact that the volume of bottom sediments to be collected and disposed of is estimated at several million cubic meters, and over time, this volume may accumulate to a level that would be physically impossible to process. The lack of appropriate equipment and technology hinders the resolution of this problem.

In this regard, experts propose, along with conducting scientific and technical studies on the possibility of decontaminating reservoirs, predicting the contribution of bottom sediments to the pollution of the Dnieper reservoir cascade and ensuring reliable monitoring of the situation.

The State Security Committee of Ukraine continues to assist government agencies, ministries, and departments in eliminating the consequences of the Chernobyl nuclear power plant accident and identifying the causes and conditions that reduce the effectiveness of the measures taken.

Committee Chairman N. Golushko