Memorandum on the assessment of the possible negative consequences of the spring flood in the Chernobyl zone

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Secret

On assessing the potential negative consequences of spring flooding in the Chernobyl Nuclear Power Plant zone

In connection with the upcoming spring flooding in the Chernobyl Nuclear Power Plant zone, the KGB Directorate of the Ukrainian SSR for Kiev and Kiev Region, using operational and official sources from hydrologists and meteorologists, studied the potential negative consequences for water sources due to the washout of radioactive substances and assessed the reliability of the measures taken.

The analysis revealed the following.

The hydrological situation within the 5-kilometer zone, which is the most contaminated with radionuclides, is characterized by the following data. The area of all water sources, including part of the cooling pond, is 14.9 square kilometres (approximately 23%). The main rivers flowing within the zone (the Pripyat, Uzh, Ilya, Sakhan, Rodvino, Borshchi, Glinnitsa, and Benevka) are fed by mixed rain and snow. The spring flood period accounts for 43 to 64 percent of the annual runoff. Maximum recorded water level fluctuations range from 140 cm for small rivers to 600 cm for large rivers. The average annual precipitation in March is 35 mm, and in April, 30 mm.

According to experts from the Leningrad Hydrological Institute, the development of this year's flood will be determined by the following hydrometeorological conditions.
Snow cover depth in the zone and adjacent areas, as well as water reserves, are 150 mm and 27 mm in the field, and 120 mm and 24 mm in the forest, respectively. The depth of soil freezing ranges from 0.5 to 0.7 m in the field and 0.1 to 0.4 m in the forest. Moisture content of the upper meter of soil is estimated as moderate. Thaws and precipitation caused minor surface runoff in small water intakes, but this has had virtually no effect on the average river flows, which are in the deep winter phase.

The Pripyat River's water flow at the Chernobyl site is 130-140 m^3 per second, close to the absolute minimum value for a century.
Due to the impossibility of a reliable long-term weather forecast, the hydrological situation was assessed under two scenarios: a spring without rain and a spring with above-normal precipitation. However, even in the latter scenario, the maximum water flow in the Pripyat River will not exceed last year's levels. The forecast is currently being updated.

Given the increased contamination of soil and bottom sediments in water sources with radioactive substances, 131 filter dams were constructed in the zone in 1986 to prevent their erosion and subsequent migration into the Kiev Reservoir via the Dnieper River. To ensure partial absorption of radionuclides dissolved in the water, a porous mineral, zeolite, was embedded in the filter dams. A total of 26,000 tons of zeolite were used.

However, studies have shown that the effectiveness of using this material in this manner was low, primarily due to the loss of its filtering properties due to rapid contamination, including by biological substances. As a result, the filter became a source of secondary contamination.

The construction of a significant number of dams in an area with a complex hydrological regime led to a disruption of the water balance, primarily because a significant portion of the irrigation and drainage structures were put out of service.
All this led to a rise in groundwater levels in the area of the plant and the disposal sites for radioactive waste collected during the clean-up of the accident. According to some experts, this was one of the reasons for the subsidence of the foundation of turbine No. 6 by 6 mm.
The negative impacts of this phenomenon require further study.

This circumstance led to the decision to lower the groundwater level of most dams and drainage systems.
Currently, 13 dams (8 filter dams and 5 closed dams) are in operation in the zone. Units of the USSR Ministry of Defence and the Ministry of Water Resources of the Ukrainian SSR are carrying out reconstruction and strengthening work on them.
Emergency supplies of gravel and other construction materials have been delivered to 8 dams, and delivery is being completed for the remaining 5.

Based on the experience of handling last year's flood, a decision has been made to install containers of zeolite on the spillways of the dams this year, which will allow for their replacement as they become contaminated. The required amount of mineral has been delivered, and work is underway to load the containers.

These and other measures are aimed at minimizing the loss of radioactive materials from the ground surface into the Kiev Reservoir through runoff.

According to leading specialists at the Complex Joint Venture, the majority of radioactive substances in the zone are concentrated in the surface soil layer (up to 5 cm) in the form of microparticles from 200 to 10 microns (approximately 80%) and less than 10 microns (approximately 20%). Within the dirtiest zone (5 km), the gamma radiation is generated primarily by these so-called "hot particles," while in the remaining zone, it is generated by aerosols and microparticles.

The contamination status of water sources, bottom sediments, and sediments is characterised by the following indicators.

The total activity of surface waters within a 5-kilometer zone ranges from 25.9 to 40.7 Bq/L.
The concentration of cesium-137 and strontium-90 in the Uzh and Ilya rivers is 0.48–0.96 Bq/L and 1.11–1.48 Bq/L, respectively.
The specific activity of suspended sediments in the Pripyat River ranges from 2,960 to 5,550 Bq/kg. The suspended matter consists of finely dispersed material.
The bottom sediments of the Pripyat River consist primarily of washed sand.

Average cesium-137 contamination ranges from 18,500,000,000 to 370,000,000,000 Bq/km^2 [18.5-370.0 GBq/km^2]. Sections of the river with active silt accumulation are characterised by cesium-137 concentrations of 740,000,000,000 to 3,700,000,000,000 Bq/km^2 [0.74-3.7 TBq/km^2]. Radionuclides are mostly concentrated in the 3–6-meter layer of bottom sediments.

Experts estimate the activity of radionuclides concentrated in the cooling pond to be approximately 55,500,000,000,000 Bq [55.5 TBq].

Based on current hydrometeorological conditions and forecasts of expected water levels and radiation conditions, according to estimates by specialists at the Leningrad Hydrological Institute, the removal of cesium-137 from the zone with the Pripyat River will not exceed 1987 levels and will amount to approximately 3,700,000,000,000 Bq [3.7 TBq] in dissolved form and approximately 4,440,000,000,000 Bq [4.44 TBq] in suspended matter.

The runoff rate, which was 1% last year, is expected to be lower this year. The threat of a breakthrough of the main channel of the Pripyat River into the backwater, “Semikhodovsky”, and the cooling pond is unlikely, given the condition of the dams.
At the same time, the condition of the river's water surface and the presence of thawed patches indicate water seepage from the pond into the riverbed. Some experts believe that, since the pond was created on the site of an old riverbed, it is possible that the water flows through an underground channel beneath the old riverbed.

Although the activity level of the water in the pond does not exceed 0.37 Bq/L, activity may be removed by microparticles in bottom sediments. Rough estimates place this level at 74,000,000,000 to 111,000,000,000 Bq [74-11 GBq] per year.
The problem of the Glinnitsa River, which carries water from the most contaminated areas to the Pripyat River, has not been fully resolved. The question of constructing a dam has not been fully studied, as it would lead to additional swamping in the area around the plant, which is clearly undesirable.

Considering the above, the condition of the cooling pond, the existing radionuclide amounts, and the potential for contamination of the Dnieper River basin, particularly the Kiev Reservoir, require serious research and engineering considerations in the future. A more in-depth study of the erosion of rivers’ banks, the movement of bottom sediments due to waves and currents, and the potential for nuclide migration through the water surface and groundwater is necessary. The issue of preventing biological matter from entering the station's underwater channel in the event of a mass fish kill in the pond also requires consideration.

At the same time, according to a number of station managers, in order to reduce the level of material costs for cargo transportation, it is necessary to analyse the possibility of allocating part of the backwater where the cargo berths are located for shipping.
With our existing capabilities, we have taken additional measures to strengthen control over the development of the situation.

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