UA0601051

MODELLING OF THE RADIONUCLIDE FLUXES FROM THE CHEROBYL SHELTER AND COOLING POND INTO PRIPYAT RIVER AND GROUNDWATER

Zheleznyak M [1], Kivva S [1], Dzjuba N [1], Dvorzhak A [1], Onishi Y [2]

[1]Institute of Mathematical Machine and System Problems-IMMSP, Kiev, Ukraine
[2]Environmental Technology Directorate, Pacific Northwest National Laboratory, Richland, Washington, USA

The destroyed Chernobyl Unit 4 under the constructed «Shelter» and the Chernobyl Cooling Pond are potentially most hazardous object in the Chernobyl zone The model based assessment of the consequences of the Shelter collapse on surface water contamination was provided in the frame of the Environmental Impact Assessment of New Safe Confinement (NSC) on Chernobyl NPP, which principal design was developed by the consortium including Bechtel Inc - Electricitй de France – Battelle, PNL with the involvement IMMSP, Ukraine environmental modeling team

The water level in the CPP is at 6 m higher than in the Pripyat River The scenario of a collapse of the dam has been considered, which hypothetical cause can be earthquake, dam score during high flood, terrorist attacks

The environmental risk assessments in both case studies was provided on the basis of the set of IMMSP mathematical models, most of which are incorporated into the Hydrological Dispersion Module of EC real-time on-line decision support system RODOS

The propagation of contaminated water and sediments from the CPP dam breach through the Pripyat River floodplain was modelled by meanof a 2-D model COASTOX of RODOS –HDM The modellling results show that the flooding will be largely limited to Pripyat floodplain The flux of the contaminated water from the CPP and its interaction with the contaminated soil in the inundating area were taken into consideration

The impact of the radionuclide flux from the Pripyat River on the Dnieper reservoir cascade was simulated using the 1-D model RIVTOX the input boundary condition for which was derived by the crossectional integration of COASTOX output

The results show that the worst scenario will increase concentration of ^{90}Sr in Kiev reservoir till 0 4 Bq/l and to 0 2 Bq/l in downstream reservoirs During the flood 1999 the maximum concentrations were at two times more in Kiev reservoir (at 0 8 Bq/l) and at 0 3 Bq/l in lower reservoir

It was concluded that the radiological consequences of the CPP dam break are low and could not be taken into consideration within definition of CPP remediation strategies

As a potential pathway of the radionuclide transport from the Chernobyl zone it was considered fallout on the Pripyat River Floodplain in a case of the Collapse of the Chernobyl Unit 4 Shelter and following transport of radionuclide through and Dneiper reservoirs For the conservative - «worst hydrological scenario» the direction of the wind during the Shelter collapse and thus the fallout was taken to deposit the maximum amount of radionuclides directly on the Pripyat River surface upstream the Chernobyl NPP The contamination of the floodplain and surrounding coastal areas also was taken into consideration by the assessment of the radionuclide wash-off processes The simulation was provided for following scenarios – 1- Shelter collapses without the NSC, 2 - NSC collapses over the Shelter Object during the NSC emplacement over the Shelter, 3 - Shelter collapses inside the NSC and the NSC's air ventilation rate is one NSC volume per day, 4 - Shelter collapses inside the NSC and the NSC's air ventilation rate is 10% of the NSC volume per day On the basis of Battelle scenario of the atmospheric release of 8 kg of reactor fuel due to the Shelter collapse, it was assessed that 2 4 TBq of ^{137}Cs and 1 1 TBq of ^{90}Sr will be released into the Pripyat River within 3 days for Scenario 1

The 1-D model RIVTOX was used to simulate the propagation of releases radionuclides through Dniper reservoir cascade It was shown that the concentrations of ^{137}Cs and ^{90}Sr in Dnieper reservoirs after the Shelter fallout are not higher than during last high spring flood 1999

Since the Ukrainian drinking water limit for ^{90}Sr is 2,000 Bq/m^3 (DU-97), thus even at the Kiev HPP, the peak concentration of 685 Bq/m^3 under Scenario 1, 2 is at 34% of the drinking water limit Under Scenario 4 this peak =230 Bq/m^3 is only 11 5% of the regulatory limit Downstream of the Kremenchug HPP, there is no effect of the radionuclide releases from the accident considered under Scenario 4 on the ^{90}Sr concentrations in the Dnieper River There is no significant impact on annual average ^{90}Sr and ^{137}Cs concentrations in the Dnieper River, as a result of the shelter collapse inside the NSC

The force driving radionuclides from the Chernobyl Shelter to the subsurface is the water inside the Shelter The amount of water from precipitation, condensation, and spraying for dust control now exceeds evaporation, resulting in a 1 4-m-deep pool in Room 001/3 of the Shelter The pool contains 1 0x10^6, 5 2 x 10^6, and 0 36 Bq/L of ^{90}Sr, ^{137}Cs, and ^{239}Pu, respectively The water filters through the 1-m-thick concrete floor to the vadose zone beneath and eventually reaches groundwater that carries radionuclides toward the Pripyat River One of the main benefits of the NSC is elimination of this excess water, thereby removing the driving force for transporting the radionuclides from the Shelter to the subsurface environment

We used the two-dimensional SUSTOX code (Kivva 1997) to simulate the migration of ^{90}Sr, ^{137}Cs, and ^{239}Pu in the subsurface water (vadose zone and groundwater) from the Shelter (through the concrete floor and walls) toward the Pripyat River, 2 5 km away The modeling is conservative (predicts higher radionuclide concentrations) because it does not account for lateral dispersion and dilution

The main driving force of groundwater in the area is the 6-m hydraulic head difference between the cooling pond at the Chernobyl Plant and the Pripyat River The water level in the cooling pond will be reduced to the river level because water is no long being pumped into the pond from the Chernobyl Plant This slows the groundwater flow toward the river significantly Our analysis conservatively used the current water level in the Chernobyl cooling pond

We evaluated the Shelter with and without the NSC The main source of the seepage of the radionuclides to the ground water through the basement of the Shelter is Room 001/3 collecting water penetrating into the Shelter with rains and condensed in the premises of the Shelter (SIP, 2000) Without the NSC, the water in Room 001/3 was fixed at a depth of 1 4 m After NSC construction, the precipitation influx to the Shelter would stop and the water level in Room 001/3 would decrease to zero in 1 5 years The seepage rate through the concrete floor was simulated as a part of the subsurface water and radionuclide transport modeling The NSC was assumed to last 100 years, by then all radionuclides would have been removed from the Shelter

Simulation of ^{90}Sr without the NSC reveals the slow movement of this radionuclide ^{90}Sr with a concentration above 4x106 Bq/L has moved less than 100 m from the Shelter due to adsorption (assigning the distribution coefficient of 1 L/kg) The 0 1 Bq/L level is reached only 600 m from the Shelter, a fraction of the 2 5-km distance to the Pripyat River

The predicted arrival time of ^{90}Sr at the Pripyat River is about 800 years With a half-life of 29 12 years, the ^{90}Sr level would be reduced to 5 7x10^{9} of the original concentration due to radionuclide decay This is reflected in the very small ^{90}Sr influx (about 0 0002 Bq/s) to the Pripyat River at that time When this ^{90}Sr influx is fully mixed with the average Pripyat River discharge of 404 m^3/s, the resulting ^{90}Sr concentration is $1x10^{-9}$ Bq/L This concentration is very small compared with the current level of 0 1 Bq/L and the drinking water limit of 2 Bq/L. Moreover, the simulation results are conservative because the 2-D model (as opposed to actual 3-D phenomena) and the current water level of the Chernobyl cooling pond were used Thus, infiltration of ^{90}Sr from the Shelter will have no harmful effects on the Pripyat River, even without the NSC

Construction of the NSC will stop precipitation into the Shelter, and the water in Room 001/3 will dry out in 1S years Thus the NSC will decrease ^{90}Sr concentrations because fewer radionuclides will filter through the Shelter floor with little or no water migrating out of Room 001/3 Construction of the NSC would significantly reduce the radionuclide flux to subsurface and river environments Thus the NSC would reduce radionuclide flux to subsurface and river environments

Predicted ^{137}Cs concentration distributions indicate that it moves slower than ^{90}Sr because its larger distribution coefficient, 2 L/kg, produces a larger retardation After 2,000 years, its plume would still be within 200 m of the Shelter without the NSC With the NSC, it would move even slower With a half-life of 30 years, radionuclide decay over 2,000 years would reduce ^{137}Cs concentrations by a factor of 1x020 Thus, ^{137}Cs would not harm the Pripyat River or humans through the aquatic pathway with or without the NSC

Unlike ^{90}Sr and ^{137}Cs, ^{239}Pu has a long half-life of 24,065 years Thus radionuclide decay would not solve the environmental problem caused by plutonium Because of its high adsorption to the soil matrix (the distribution coefficient of 30 L/kg), 239Pu barely migrates from the Chernobyl Shelter Even without the NSC, it would take approximately 25,000 years to reach the river At that time, the resulting increase in ^{239}Pu concentration in the river would be 2x10-6 Bq/L, compared with the current level of 2 $5x10^{-4}$ Bq/L Both current and predicted ^{239}Pu levels are much less than the Ukrainian regulatory limit of 1 Bq/L Thus, infiltration of ^{239}Pu from the Shelter, even without the NSC, will cause no harm to the Pripyat River The NSC would further reduce ^{239}Pu concentrations in the groundwater, and thus plutonium influx to the Pripyat River from levels already too small to be of any concern

UA0601052

МОНІТОРИНГОВА ОЦІНКА СЕЗОННОЇ ПРИРОДНОЇ ПІРОЛОГІЧНОЇ СИТУАЦІЇ ТЕРИТОРІЇ ЗОНИ ВІДЧУЖЕННЯ АЕРОКОСМІЧНИМИ МЕТОДАМИ

О Т Азімов[1], М Д Кучма[2], В І Лялько[1]

[1]Центр аерокосмічних досліджень Землі ІГН НАН України, м. Київ
[2]Всеукраїнський науково-дослідний інститут цивільного захисту населення і територій від надзвичайних ситуацій техногенного та природного характеру МНС України, Київ

Лісові пожежі є головною причиною пошкодження і загибелі лісів Вони суттєво знижують стійкість лісових насаджень внаслідок даних пошкоджень і всихання окремих дерев, ділянок або цілих масивів лісу Крім того, актуальність лісопожежної проблеми в Україні обумовлена наявністю великої площі лісів зі значною щільністю забруднення радіонуклідами, більша частина якої (98%) розташована в межах Київської і Житомирської областей За останні роки в даному регіоні лісопожежна проблема загострилася внаслідок зміни режиму ведення лісового господарства та соціально-економічних умов

Відомо, що лісові пожежі в зонах радіоактивного забруднення прискорюють вертикальну міграцію радіонуклідів за межі первинного випадіння Як у грунті (після верхової пожежі в мінеральну частину грунту переходить 60–80% радіоцезію, в той час як у нор-