Monitoring and Modeling of the Chernobyl Cooling Pond as a Case Study

Projects supported by:

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Chernobyl Cooling Pond

Sources of Contamination
- Dispersed fuel particles, and “hot” particles
- Heavily contaminated water from the reactor basement and soils.
- Total radioactivity >200 TBq, including $^{137}\text{Cs}$-80%, $^{90}\text{Sr}$-10%, $^{239,240,241}\text{Pu}$-10%
- Routine releases of contaminated water

Decommissioning:
Will expose highly contaminated bottom sediments:
Normal climate – 58%  Dry climate – 80 %

Monitoring
- 40 cross sections and aerosol sampling stations;
- 138 groundwater monitoring wells;
- 4 stations for sampling surface water and bottom sediments
Monitoring Systems

- Monitoring atmospheric deposition
  - Post-accident monitoring of aerosol distribution along with modeling studies
  - Resuspension of radionuclides

- Monitoring contamination of surface water and bottom sediments
  - Monitoring of contamination of surface water and bottom sediments since mid-1986.
  - Research sites

- Monitoring saturated and unsaturated zone
  - Post-accident network of groundwater wells, surface water sampling stations
  - Unsaturated (vadose) zone research sites

- Specific monitoring data and analyses used to test the conceptual models
  - Surface water and groundwater monitoring,
  - tracer and pumping tests,
  - radiochemical, geochemical, meteorological measurements,
  - pilot cooling pond drawdown,
  - resuspension monitoring,
  - monthly sampling and radioactive analysis of water from the input and output canals,
  - radio-ecological studies.

New monitoring methods and tools to monitor pond decommissioning and remediation are needed.
Testing Conceptual Site Models

- Processes affecting hydrological and radionuclide transport in the pond and bottom sediments
- Atmospheric deposition and resuspension processes:
  - estimation of a source term;
  - evaluation of the consequences of hypothetical emergency scenarios.

Modified after M. Zheleznyak

Bugai et al., 1997
Modeling of Water Level Drawdown, Radionuclide Behavior, and Vulnerabilities of Environmental Resources

Modeling of the dam break (left) and $^{90}$Sr concentration (right) in the Dnieper River reservoirs

M. Zheleznyak et al., 2006

V. Kashparov, et al. 2001

M. Zheleznyak et al., 2006

Modeling of additional $^{137}$Cs contamination of soil due to sediment resuspension after a hypothetical fire

D. Bugai et al., 1999

A. Konoplev, 2009

D. Bugai et al., 1999

A. Konoplev, 2009
Potential Use of Chernobyl Cooling Pond as a Case Study for Testing Monitoring, Modeling and Remediation Techniques

Savannah River PAR Pond

- Constructed in 1958 as a Cooling Pond for the Savannah River Site's P and R Reactors
- Experimental water-level drawdown in 1991 and monitored radionuclide concentrations in water and bottom sediments.

Testing of Remotely Operated Field Monitoring Techniques:
- Savannah River ADCON Telemetry-a real-time soil moisture monitoring system.
- FDTAS-tritium analysis system in surface and groundwater in near real time.
- Sol-Gel Indicators for Process and Environmental Measurements
- INL Soil and Surface Assay Systems for Gamma, Beta, and Alpha Radiation Sources