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## GENII Version 2.10: An Essential Decision-Making Tool in Worldwide Radiation Protection

Regulatory decision-makers worldwide rely on a variety of conceptual and computational models to inform decisions on protecting human health and safeguarding the environment. The GENII Version 2.10 Environmental Dosimetry System, developed at Pacific Northwest National Laboratory (PNNL), provides regulators and industry with a tool for ensuring compliance with environmental regulations.

GENII Version 2.10 is a set of computer programs that can be used to estimate radionuclide concentrations in the environment and dose/risk to humans and biota from:

- ▶ Acute or chronic exposures
- ▶ Releases to surface water or atmosphere
- ▶ Initial contamination conditions.

Available Models in GENII Version 2.10 include:

- ▶ Atmospheric transport
- ▶ Surface water transport
- ▶ Waste/soil redistribution
- ▶ Terrestrial uptake
- ▶ Human Exposure
- ▶ Dose/Risk
- ▶ Uncertainty/Sensitivity.



### DEVELOPMENT AND CURRENT USERS

Under U.S. Environmental Protection Agency sponsorship, PNNL scientists developed GENII Version 2.10 specifically to assist in estimating radiological risks at sites across the country. It is one of a set of quality-assured and configuration-controlled safety analysis codes managed and maintained for U.S. Department of Energy's Safety Software Central Registry. Regulators and decision-makers in other federal agencies, and in countries from Italy to South Africa, use this state-of-the art, technically peer-reviewed system.

### SYSTEM CAPABILITIES AND TECHNICAL SUPPORT

The GENII Version 2.10 system calculates radiation doses following chronic and acute releases to the environment during normal operations, and estimates potential health risks to humans and biota using specific release scenarios created for individual sites. It identifies target populations by direction and distance using radial or square grids. The system can monitor radionuclide transport via air, water, and the soil surface. For air transport, GENII Version 2.10 relies on

puff and plume models that are capable of incorporating effective stack height and/or calculating plume rise from buoyant and/or momentum effects. The system also can incorporate building wake effects in acute atmospheric release scenarios. GENII Version 2.10 uses U.S. Nuclear Regulatory Commission models included in LADTAP to calculate surface water doses.

## COMPONENT PROGRAMS

GENII Version 2.10 is an integrated package of computer programs that includes:

- ▶ Seven independent atmospheric models (puff and plume)
- ▶ One biota dose module
- ▶ One surface water model
- ▶ Three independent environmental accumulation models
- ▶ One exposure module
- ▶ One dose/risk module.

GENII Version 2.10 incorporates improved transport models, exposure options, dose and risk estimation, and user interfaces. It also incorporates user interfaces with internal and external dose factor libraries and environmental dosimetry programs. For maximum flexibility the system is divided into several interrelated, but separate, exposure and dose calculations. The system also generates reports for atmospheric and surface water doses to humans and biota.

## SCENARIOS AND PATHWAYS

GENII Version 2.10 provides release scenarios for chronic and acute radionuclide releases to water, air (ground-level or elevated sources), and initial contamination of soil surfaces. Exposure pathways include direct exposure via water (swimming, boating, and fishing), soil (surface and buried sources), air (semi-infinite cloud and finite cloud geometries), inhalation, and ingestion.

The GENII Version 2.10 system's interactive, menu-driven interfaces provide users the flexibility to enter parameters for a variety of generic sites. Although default exposure and consumption parameters are provided for the average (population) and maximum individual, the user may modify them. Users can enter source term information as radionuclide release quantities for transport scenarios or as basic radionuclide concentrations in air, water, or soil. The system also allows for input of parent radionuclide decay and ingrowth of radioactive decay products before a scenario is run for basic or derived concentrations. Because GENII 2 works sequentially on individual decay chains, it can process at

one time unlimited numbers of radionuclides, including the decay of parent radionuclides and the source term.

### GENII V.2 ATMOSPHERIC DEPOSITION MODELS

- ▶ One of a set of quality-assured and configuration-controlled safety analysis codes managed and maintained for the Department of Energy's Safety Software Central Registry
- ▶ All models have plume depletion/mass balance capabilities
- ▶ Dry deposition
  - "Resistance model"
  - Includes gravitational settling of larger particles
- ▶ Wet deposition
  - Washout dependent on precipitation rate
  - Rain and snow considered.

### TECHNICAL SUPPORT AND HANDS-ON TRAINING

GENII system developer, PNNL, has conducted workshops and provided training to users in government and industry around the world. To schedule a training session or for technical assistance in running the system, please contact us.

### QUALITY ASSURANCE

PNNL developed GENII under quality assurance plans based on the American National Standards Institute standard NQA-1 as implemented in the PNNL's Quality Assurance Manual. All code development steps have been documented and tested, and hand calculations have verified the code's implementation of major transport and exposure pathways for a subset of the radionuclide library. A collection of hand calculations and other verification activities is available.