

RESRAD Program

The EVS staff developed the RESRAD family of computer codes to provide a scientifically based answer to the question "how clean is clean," and to evaluate human health and ecological risks resulting from residual radioactive and chemical contamination. The RESRAD code and some of its sibling codes have been widely used in the United States and abroad, and approved by federal and state agencies for use in demonstrating compliance with regulatory requirements and for evaluating contaminated sites. The extensive applications of the RESRAD family codes have proved their usefulness in environmental regulation, evaluation, and remediation, and have resulted in significant savings in both human effort and financial cost in cleaning up contaminated sites.

PROBLEM/OPPORTUNITY

The potential risk to human health and the environment is a primary concern when state and federal agencies make environmental policies and decisions. Specific questions such as "how clean is clean?" cannot be answered without adequate consideration of the potential risk on a solid scientific basis. The evaluation of potential risks to human health and ecological systems from exposure to radioactive and chemical contaminants often requires the modeling of contaminant transport in different environmental media, and of the subsequent intake and uptake of contaminants by human and ecological receptors.

APPROACH

Some of the RESRAD family codes incorporate transport models that consider various mechanisms affecting the concentration and distribution of contaminants in the environment and capture the characteristics of the concentration profile over time at the receptor location. The transport models were benchmarked with other multiple pathway models and were used to participate in international programs to validate computer models with actual sampling data collected after the Chernobyl accident.

Contaminant intake and uptake are considered in the RESRAD family codes using widely accepted human and ecological exposure models. These models estimate contaminant exposures as functions of environmental media concentrations, receptor occupancy fractions, and receptor inhalation/ingestion rates. For most of the family codes, time integrated doses/risks are calculated to provide more realistic estimates without excessive conservatism.

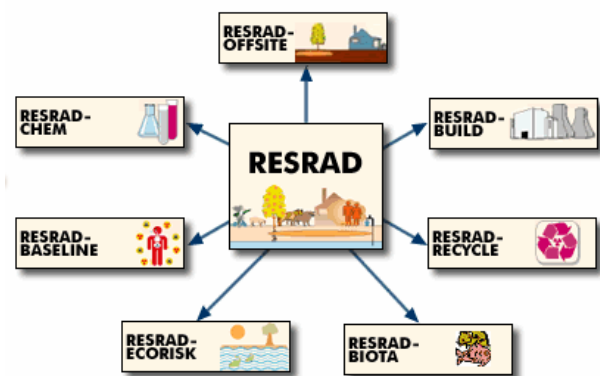
To quantify uncertainties involved in dose/risk estimates, deterministic and probabilistic sensitivity analysis

methods were incorporated in the RESRAD family of codes. The deterministic method studies the influence of one parameter at a time while keeping the others at fixed values. The probabilistic method employs distribution functions of input parameters and analyzes the distribution of the resulting doses/risks. Both sensitivity analysis methods can be applied to set priority in collecting additional data for the important parameters and to quantify safety margins when setting remediation goals.

To assist the users in selecting proper input parameter values, extensive literature search was conducted to collect data and to develop default deterministic values and distribution functions for input parameters. The compiled data collection handbooks can be consulted for conducting a site-specific risk assessment.

RESULTS

Eight RESRAD family codes have been developed over the years.



Comparison of RESRAD Family of Codes

Computer Code	Source of Contamination	Type of Contamination	Transport Model	Receptors	Operating System	Development Status	Uncertainty Analysis
RESRAD	Soil	Radionuclides	Yes	Human	Windows	Distributed	Deterministic/ Probabilistic
RESRAD-BUILD	Buildings	Radionuclides	Yes	Human	Windows	Distributed	Deterministic/ Probabilistic
RESRAD-CHEM	Soil	Chemicals	Yes	Human	DOS	Test/evaluation	Deterministic
RESRAD-BASELINE	All media	Radionuclides and chemicals	No	Human	Windows	Test/evaluation	Deterministic
RESRAD-RECYCLE	Scrap metals/equipment	Radionuclides	No	Human	Windows	Distributed	Deterministic
RESRAD-ECORISK	Soil	Chemicals	Yes	Biota	DOS	Test/evaluation	Deterministic
RESRAD-OFFSITE	Soil	Radionuclides	Yes	Human	Windows	Test/evaluation	Deterministic/ Probabilistic
RESRAD-BIOTA	Soil, water, sediment	Radionuclides	No	Biota	Windows	Distributed	Deterministic

The RESRAD code has been applied for remediation and risk evaluation at more than 300 sites in the United States and in other countries. Comparing with other multiple exposure pathway models for risk assessment and site remediation, RESRAD is the most extensively tested, verified, and validated code. Over the years, it has obtained numerous achievements, including but not limited to the followings:

- (1) It is the only computer code designated in DOE Order 5400.5 for use in evaluating radiologically contaminated sites;
- (2) It is approved by the U.S. Nuclear Regulatory Commission for use in dose calculations related to site decommissioning and waste disposal at licensed nuclear facilities;
- (3) The EPA used RESRAD in its rulemaking for evaluating remediation of sites contaminated with radioactive materials;
- (4) The Interagency Steering Committee on Radiation Standards (ISCORS) sewage sludge subcommittee used RESRAD and RESRAD-OFFSITE in evaluating radioactivity in sewage sludge and in forging its recommendations to publicly owned treatment works (POTWs) regarding potential worker exposures;
- (5) Several state agencies have approved the use of RESRAD for evaluating site cleanup activities;
- (6) The RESRAD family of codes has been used at many universities as teaching and research tools, resulting in numerous publications on the basis of discussions on various aspects and applications of the codes; and

- (7) More than 100 training workshops have been conducted on the use of RESRAD, RESRAD-BUILD, RESRAD-OFFSITE, RESRAD-RECYCLE, and RESRAD-BIOTA.

FUTURE

EVS established the RESRAD program more than 15 years ago. DOE is the primary sponsor; others include EPA and NRC. EVS will continue to improve and update the current models, develop new tools for risk assessment, conduct training workshops, and provide assistance in applying these models to actual sites.

The RESRAD codes have also been used by many foreign countries, and EVS will seek additional opportunities for international collaboration and for application of the RESRAD codes to solve international and global environmental problems.

COMMUNICATION OF RESULTS

A web site <http://www.evs.anl.gov/resrad> provides information about the RESRAD codes, recent updates, and upcoming workshops; permits downloading of the codes; and accepts questions on the codes. A user database is maintained and used for distributing news and code update information. Many reports and papers have been published to support the use of the RESRAD family of codes and are also available for downloading at the RESRAD web site.