

## How Clean Is Clean?



### Need

Potential risk to human health and the environment is a primary consideration in formulating key environmental decisions and policies. Specific questions such as "How clean is clean?" cannot be answered without a scientific basis. Studying the possible impacts resulting from exposure to radioactive and chemical contaminants often requires the modeling of contaminant transport in the environment.

### Argonne's Answer

Sponsored by the U.S. Department of Energy (DOE), Argonne began tackling this question in the early 1980s. As a result of this initiative, researchers developed a family of computer codes called RESRAD to:

- Calculate radiation doses and lifetime cancer risks to a chronically exposed individual or population group and
- Derive cleanup criteria for radiologically contaminated soils and building material (Figure 1).

RESRAD is the only code designated in DOE Order 5400.5 for the evaluation of radioactively contaminated sites. RESRAD is

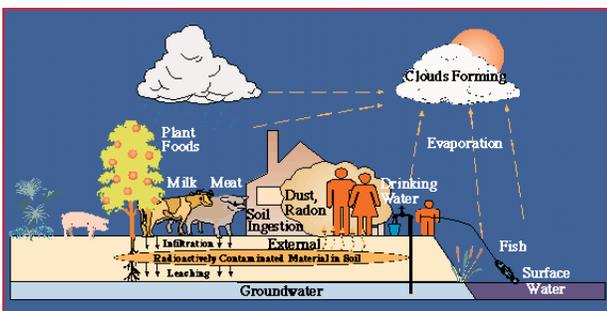


Figure 2. Exposure pathways considered in RESRAD

also cited in the U.S. Nuclear Regulatory Commission (NRC) Standard Review Plan for license termination applications. It is downloadable at no cost from the RESRAD web site (<http://web.ead.anl.gov/resrad>).

### Approach

RESRAD uses a pathway analysis method in which the relationship between radionuclide concentrations in soil and the dose to



Figure 1. Applications of RESRAD family of computer codes to sites contaminated with radioactive residues

a member of the critical population group is expressed as a pathway sum — the sum of "pathway factor" products. Nine environmental pathways are considered: direct exposure, inhalation of particulates and radon, and ingestion of plant foods, meat, milk, aquatic foods, water, and soil (Figure 2).

The RESRAD family of codes (Figure 3) includes:

- RESRAD, which evaluates doses and related risks to human health and the environment resulting from exposure to radiologically contaminated soils;
- RESRAD-CHEM, which assesses chemical risk from soil contamination;
- RESRAD-ECORISK, which estimates the risk from chemical contaminants to ecological receptors;
- RESRAD-BUILD, which evaluates potential health impacts in buildings contaminated with radioactive materials;
- RESRAD-RECYCLE, which estimates radiation doses to various receptors resulting from the recycling and/or reuse of radioactively contaminated materials and equipment;
- RESRAD-BASELINE, which performs baseline risk assessments following the U.S. Environmental Protection Agency's (EPA's) human health risk assessment guidelines;
- RESRAD-BIOTA, which uses a graded approach in assessing biota dose for radionuclides.

All of the RESRAD codes are easy to install, have user-friendly interfaces, and provide on-line help messages. They can be used

for different applications and are maintained and updated regularly; comprehensive documents are available to support their operation and application.

### ***Accomplishments***

RESRAD is the most extensively tested, benchmarked, verified, and validated code in the environmental risk assessment and site cleanup field. It has been widely applied to more than 300 sites in the United States and other countries. RESRAD significantly reduces cleanup costs — saving millions.

NRC has approved the use of RESRAD for dose evaluation by licensees involved in decommissioning and waste disposal. Many universities use RESRAD as a teaching and research tool. Over 60 training workshops have been sponsored by DOE, NRC, EPA, DOD, and state agencies.

Version 6.1 of RESRAD and version 3.1 of RESRAD-BUILD were released this summer.

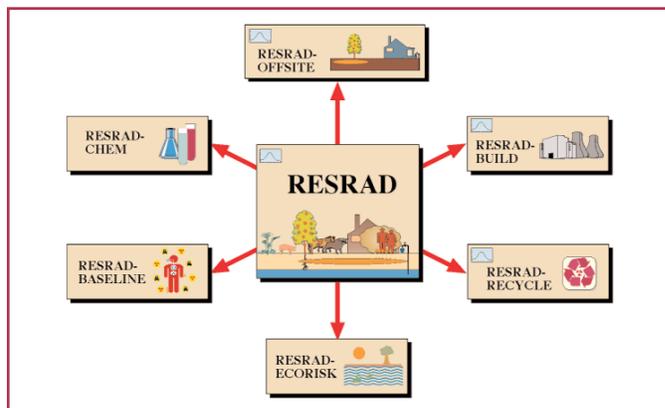


Figure 3. RESRAD family of codes

### ***Collaborators***

U.S. Department of Energy (sponsor)  
U.S. Nuclear Regulatory Commission (sponsor)  
U.S. Environmental Protection Agency

### ***RESRAD Training Workshop Sponsors***

U.S. Department of Energy  
U.S. Nuclear Regulatory Commission  
U.S. Environmental Protection Agency  
U.S. Army Corps of Engineers  
State of California Department of Health Services  
GPU Nuclear  
Bechtel Hanford, Inc.  
Conference of Radiation Control Program Directors

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