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RESRAD — A Computer Code for Evaluating Radioactively Contaminated Sites[*]

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RESRAD is a computer code developed at Argonne National Laboratory (ANL) for the U.S. Department of Energy (DOE) to calculate site-specific residual radioactive material guidelines and radiation dose/risk to an on-site individual (worker or resident) at a radioactively contaminated site.

The RESRAD code has been adopted by the DOE in Order 5400.5 for the derivation of soil cleanup criteria and dose calculations, and it has been used widely by DOE, other federal agencies, and their contractors. The original models used by ANL to develop RESRAD were initially developed as part of a DOE effort that began in the early 1980s and involved most of the national laboratories and DOE program offices. The RESRAD code is continuously improved and updated to incorporate comments from users and new features that ease the interaction with users and increase the code's capability and flexibility. The DOE Offices of Environmental Guidance and Environmental Restoration also provide periodic guidance regarding any significant changes to the code.

RESRAD uses a pathway analysis method in which the relation between radionuclide concentrations in soil and the dose to a member of a critical population group is expressed

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as a pathway sum, which is the sum of products of "pathway factors." Pathway factors correspond to pathway segments, which connect compartments in the environment. Radionuclides can be transported, or radiation transmitted, between these compartments. Nine potential exposure pathways are analyzed: direct exposure to external radiation from contaminated soil material; internal radiation from inhalation of contaminated dust; internal radiation from inhalation of radon; internal radiation from ingestion of plant foods grown on-site and irrigated with water drawn from an on-site well or pond; internal radiation from ingestion of meat from livestock fed with fodder grown on-site and water drawn from an on-site well or pond; internal radiation from ingestion of milk from livestock fed with fodder grown on-site and water drawn from an on-site well or pond; internal radiation from direct ingestion of contaminated soil; internal radiation from ingestion of aquatic foods (fish) from a nearby pond; and internal radiation from drinking water from an on-site well or pond. Figure 1 illustrates the nine pathways considered in the RESRAD code.

The RESRAD code runs on an IBM or IBM-compatible personal computer, or Personal System/2, with a DOS 3.1 or equivalent operating system, a hard disk drive of 4 megabytes storage space, and at least 500 kilobytes of memory. Use of a math coprocessor or a mouse is optional, but highly recommended. The program is designed with various user friendly features, including internal help files for information on input and output data. A mouse can be used to show default values. A user-friendly menu system simplifies management of the RESRAD operations and files. Users can access the data input screens, run the RESRAD calculations, and view the output from the menu system. The menu system also provides options for suppressing one or more of the nine exposure pathways calculated by RESRAD.

RESRAD provides both tabular and graphic output. The tabular output presents detailed calculational results, including doses and risk from various pathways, concentration
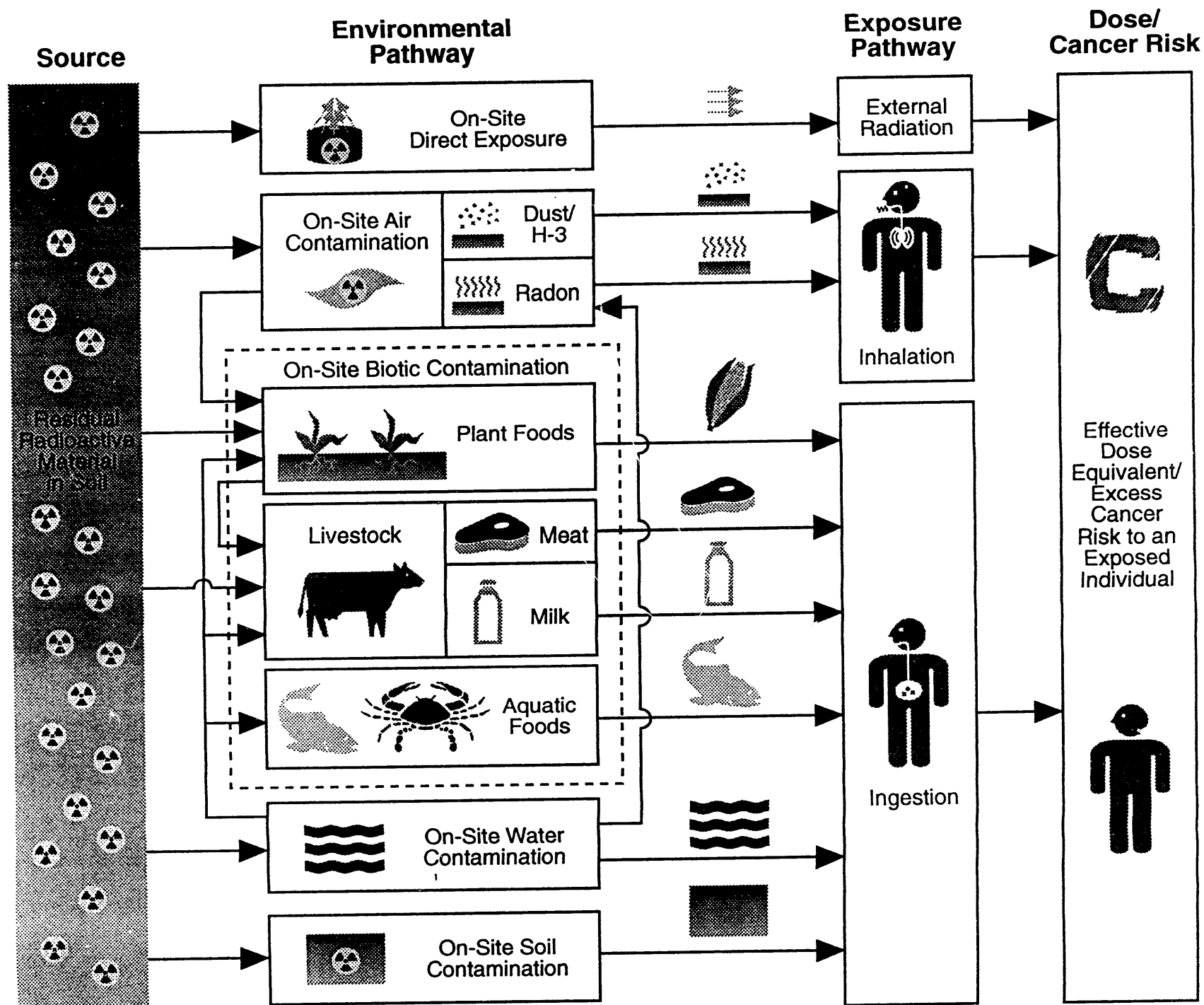
FIGURE 1 Pathways Considered in RESRAD Code.

in various media, maximum doses and minimum soil guidelines, and many intermediate calculational results. The graphic output displays calculational results for doses and concentrations and any sensitivity analyses that have been requested.

The RESRAD code has been expanded to include chemical contaminants. Currently, 151 chemicals are included in RESRAD-CHEM code. Another version, RESRAD-BUILD, is designed to evaluate building contamination. A Monte Carlo preprocessor has been incorporated into the RESRAD code. This preprocessor allows the RESRAD code to conduct uncertainty analyses and extends RESRAD from a deterministic code to a stochastic (probabilistic) code.

RESRAD has undergone several benchmarking analyses and has been included in the International Atomic Energy Agency's VAMP and BIOMOVS II projects (international efforts to compare environmental transport models). The benchmarking results have been complied as a draft report, and the VAMP and BIOMOVS II results are being complied and will be published in 1994.

Many supplemental documents have been prepared for the RESRAD code. These include *Manual for Implementing Residual Radioactive Material Guidelines,*[1,2] *Data Collection Handbook for Establishing Residual Radioactive Material Guidelines,*[3] *A Compilation of Radionuclide Transfer Factors for the Plant, Meat, Milk, and Aquatic Food Pathways and the Suggested Default Values for the RESRAD Code,*[4] and *RESRAD Parameter Sensitivity Analysis.*[5] These documents serve to clarify the RESRAD code so that it can be properly applied to solve real problems.

Copies of the RESRAD code are distributed with appropriate restrictions by the Energy Science and Technology Software Center, P.O. Box 1020, Oak Ridge, TN 37831-1020 (615-576-2606).

References

1. Gilbert, T.L., C. Yu, Y.C. Yuan, A.J. Zielen, M.J. Jusko, and A. Wallo, *A Manual for Implementing Residual Radioactive Material Guidelines,* ANL/ES-160, DOE/CH/8901, prepared by Energy and Environmental Systems Division, Argonne National Laboratory, Argonne, Ill., for the U.S. Department of Energy, Office of Remedial Action and Waste Technology (June 1989).

2. Yu, C., A.J. Zielen, J.-J. Cheng, Y.C. Yuan, L.G. Jones, D.J. LePoire, Y.Y. Wang, C.O. Loureiro, E. Gnanapragasam, E. Faillace, A. Wallo III, W.A. Williams, and H. Peterson, Jr., *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0,* Final Draft, Argonne National Laboratory, Argonne, Ill. (Sept. 1993).

3. Yu, C., C.O. Loureiro, J.-J. Cheng, L.G. Jones, Y.Y. Wang, Y.P. Chia, and E. Faillace, *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil,* ANL/EAIS-8 Environmental Assessment and Information Sciences Division, Argonne National Laboratory, Argonne, Ill. (April 1993).

4. Wang, Y.Y., B.M. Biwer, and C. Yu, *A Compilation of Radionuclide Transfer Factors for the Plant, Meat, Milk, and Aquatic Food Pathways and the Suggested Default Values for the RESRAD Code,* ANL/EAIS/TM-103, Environmental Assessment and Information Sciences Division, Argonne National Laboratory, Argonne, Ill. (Aug. 1993).

5. Cheng, J.-J., C. Yu, and A.J. Zielen, *RESRAD Sensitivity Analysis,* ANL/EAIS-3, Environmental Assessment and Information Sciences Division, Argonne National Laboratory, Argonne, Ill. (Aug. 1991).

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