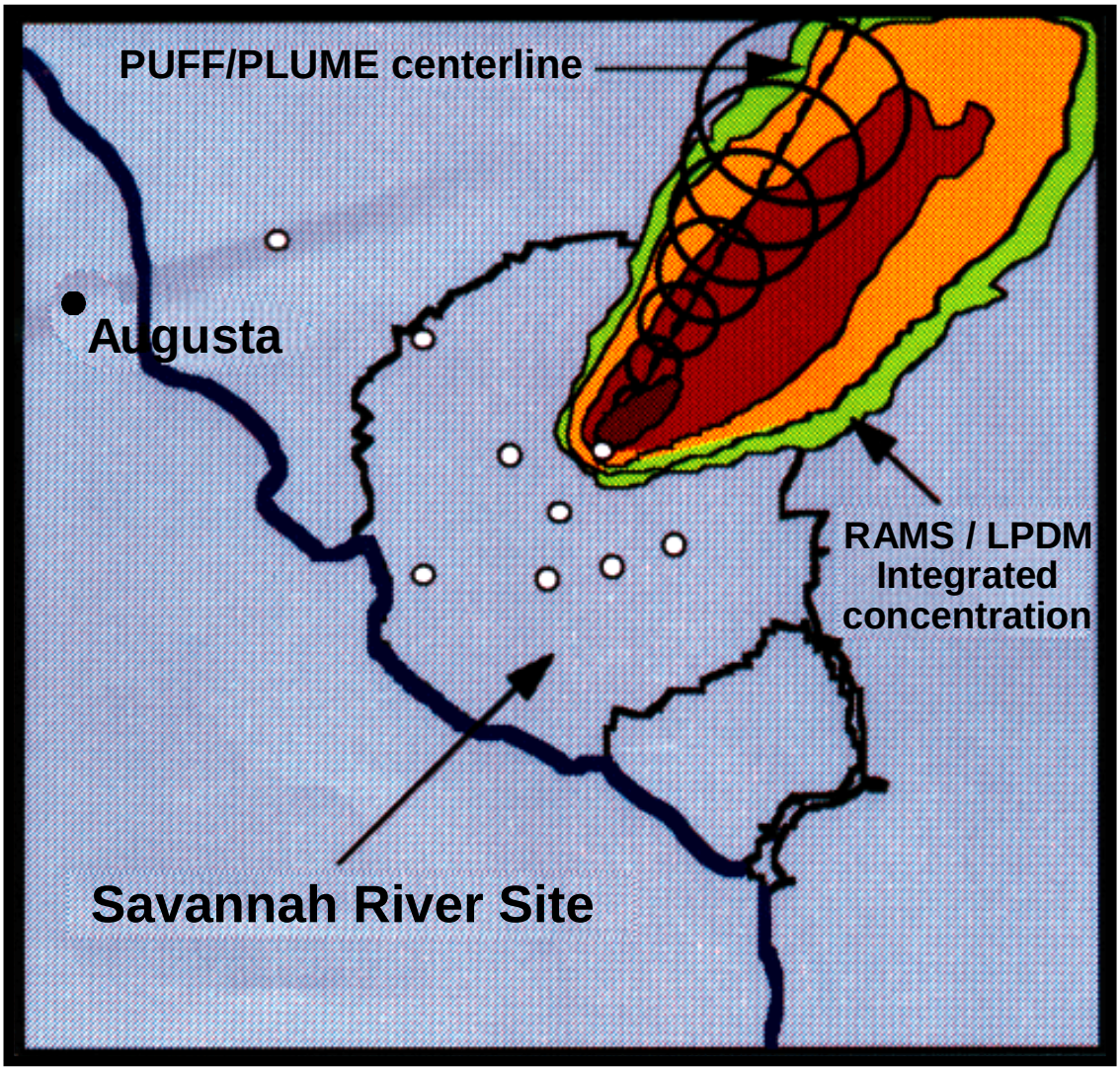
ATMOSPHERIC DISPERSION MODELING RESOURCES



Second Edition

March 1995

Atmospheric Dispersion Modeling Resources©

Second Edition

Prepared for

United States Department of Energy
Emergency Management Advisory Committee
Subcommittee on Consequence Assessment and Protective Actions

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ACKNOWLEDGEMENTS

Finally, the authors wish to thank all the modelers who took time out of their busy schedules to respond to the questionnaire. Without their input, this resource book could not have been produced.

COVERS

The front cover depicts a comparison of the dispersion of a release from the Savannah River Site (SRS) predicted by two different models, PUFF/PLUME and RMS/LPDM. The PUFF/PLUME model is part of the Savannah River Technology Center (SRTC) Weather Information and Display (WIND) System used for operational emergency response while the Colorado State University RAMS mesoscale prognostic model and LPDM Lagrangian particle dispersion model are research tools incorporated into an advanced emergency response system by SRTC.

The back cover depicts the streamline flows from the Terrain-Responsive Atmospheric Code (TRAC) used for Emergency response consequence assessment at the Rocky Flats Environmental Technology Site.

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1.0 INTRODUCTION

The purpose of this publication is to provide DOE and other federal agency emergency managers with an in-depth compilation and description of atmospheric dispersion models available to DOE and other Federal sites. The Second Edition of the Atmospheric Dispersion Modeling Resources describes 94 computer-generated dispersion models and provides the reader with information (without editorial comment) about each.

Officials in the Office of Emergency Management, within the Office of Nonproliferation and National Security, United States Department of Energy recognized that the DOE site consequence assessment process required more information on atmospheric dispersion modeling of radiological and chemical hazardous material releases than was perceived to be available. The Office of Emergency Management brought the matter to the attention of the DOE Emergency Management Advisory Committee (EMAC). Members of the EMAC, who are DOE representatives from across the DOE Emergency Management System, agreed and tasked the Subcommittee on Consequence Assessment and Protective Actions to gather more information. The Subcommittee established a working group whose mission was to compile a list of models available to emergency managers. The working group was further tasked to describe each of the models so that DOE field elements and site emergency managers could make decisions relative to acquiring consequence assessment tools such as computer-generated dispersion models.

2.0 BACKGROUND

2.1 Overview of EMAC and SCAPA

On April 30, 1991, DOE issued a significant revision to its 5500-Series Orders which identified Emergency Management requirements for all DOE entities. One of these revised orders, DOE 5500.1B, "Emergency Management System," established the Emergency Management Advisory Committee (EMAC). The purpose of the EMAC is to assist the Director of Emergency Management in the identification of problem areas and issues related to the DOE Emergency Management System (EMS) and to provide recommended solutions to those issues. The end products are specific technical recommendations aimed at enhancing the implementation of the DOE EMS.

Within the more narrow areas of consequence assessment, protective actions, and selected health and safety program elements, EMAC established the Subcommittee on Consequence Assessment and Protective Actions (SCAPA) to focus on issues associated with these considerations. SCAPA is chartered to develop technical recommendations in the area of consequence assessment, protective actions, and other emergency preparedness topics related to health and safety of workers and the public, as well as environmental protection resulting from exposure to radiological or non-radiological materials. SCAPA consists of a Steering Group, supported by Working Groups for evaluation of selected topics. The following SCAPA Working Groups are now active:

- Emergency Planning Zone Working Group;
- Consequence Assessment Working Group;
- Chemical Mixtures Working Group;
- Chemical Exposures Working Group;
- Source Term Working Group;
- ERPG Working Group;
- Programmatic Hazards Working Group; and
- Atmospheric Dispersion Modeling Resources Working Group.

The Charter for the Subcommittee on Consequence Assessment and Protective Actions (January 1992), inclusive of the scope of its activities is included as Appendix A. Within its Charter, SCAPA is intended to serve as an information-sharing forum to facilitate consistency throughout the DOE system for emergency preparedness and response aspects of releases of hazardous materials.

2.2 SCAPA 1992 Survey

With respect to the Subcommittee's intent to serve as an information sharing forum, the SCAPA Atmospheric Dispersion Modeling Resources Working Group developed a Survey of DOE Emergency Management Atmospheric Modeling Resources, which was released in April 1992. The purposes of that undertaking were to:

- look at and make recommendations on model evaluations and model performance standards;
- promulgate standards for use in evaluations; and,
- evaluate existing systems and routine operational resources in DOE for responses to emergencies.

Although the April 1992 document represented an excellent starting point, it provided only a limited sampling of atmospheric dispersion modeling resources available to the DOE consequence assessment community.

2.3 SCAPA 1995 Survey

Recognizing that additional resources were available in the DOE community, and within the jurisdiction of other governmental entities and acknowledging that most atmospheric dispersion modeling information is subject to change with time due to model evolution, retirement, and other factors, the SCAPA Atmospheric Dispersion Modeling Working Group in April 1994 determined that a more comprehensive update to this document was merited. In order to maximize the usefulness of this survey, a much larger sample of models was acquired from other Department of Energy field/operations offices, as well as from other United States Government departments (e.g., Department of Defense, Department of Agriculture, Department of Commerce). Models used by the Environmental Protection Agency (EPA) and Nuclear Regulatory Commission (NRC) were also represented. Modeling resource books compiled by the Energy Facility Contractors Group (EFCOG) and the DOC Office of the Federal Coordinator for Meteorological Services (OFCM) were consulted. The contributors to the EFCOG and OFCM documents were also contacted to contribute to this survey. Although more comprehensive than any previous publications, this document still does not represent an exhaustive listing.

In addition to the presentation of the 23 survey questionnaire elements, several matrices were also developed from the compiled information to provide easy-to-use lookup tables and are presented in Section 4. These easy-to-use lookup tables are

in Section 4 and include the location and primary/secondary points of contact for each model, various attributes of each model, and the computer requirements for each model. In addition, the user of this document should understand that all models are evolutionary and that this document represents only a snapshot in time. Therefore, as time passes after its publication, the more likely the information in this document may require revision.

The Working Group strongly recommends that the user consider the responses to this survey as a starting point in evaluating the utility of specific model(s) for a particular application. After a list of potential useful models has been identified, the model custodians should be contacted to obtain more comprehensive and recent information about the models.

3.0 METHODOLOGY

3.1 Definition of Survey Parameters

The Atmospheric dispersion modeling resources survey identified 23 specific questions for model developers/custodians. These questions were not revised from the 1992 survey, since it was determined that they would still obtain useful information on each of the models. The following provides a brief description of each survey parameter.

Name: Model code name (usually an acronym).

References: Listing of one or more technical documents that provide a detailed description of the model code, its application, verification and validation determinations, and other important aspects of the model.

Abstract: Brief description of the model structure and its applications, capabilities, and overall architecture.

Location: Site where the model and its documentation reside.

Information Contacts: Primary and secondary points of contact, generally the model custodians, and to provide additional details on the operation and use of the model.

Application: Brief description of general model use with emphasis on emergency management applications.

Limitations: Known limitations of the models driven by contained assumptions. Models that are designed for rapid consequence assessments (i.e., timely initial assessments) are generally simple (e.g., straight-line Gaussian) and therefore subject to more limitations in their application and future development.

Sponsor: The government department, commission, or agency that paid for the model's development and "owns" the model. The sponsor may or may not care for the model's evolution and maintenance.

Computer Requirements: The type and complexity of computer system on which the model is designed to run.

Source-Receptor Relationships: Identifies how the model treats source-receptor relationships (SRRs). For example, straight-line plume models cannot accommodate curved plume trajectories and do not account for travel time between source and receptor. Lagrangian puff models are capable of addressing curved trajectories and accounting for the travel time between source and receptor.

Emission Rates: How source emission is addressed in the model (e.g., puff, plume, puff-plume, particle-in-cell, etc.).

Chemical Composition: Which chemicals the model is designed to transport, dilute, and disperse. Examples include radionuclides with varying half-lives, hazardous chemicals, etc.

Plume Behavior: How the model addresses the emitted plume, including the ability to model heavier-than-air and lighter-than-air gases.

Wind Field: Whether the model wind field is a simple temporally and spatially invariant field in straight-line Gaussian models, or whether it increases in complexity to address temporally varying flows (e.g., wind shifts) and/or spatially varying flows (e.g., complex terrain mesoscale flow phenomena).

Dispersion Algorithms: The type of equations that govern the dispersion considerations of the model.

Chemical Reactions: Whether the model can simulate chemical reactions in the atmosphere after emission (e.g., photochemical smog and other chemical transformations).

Removal Process: Whether the model contains algorithms that account for either dry deposition (fallout), wet deposition due to precipitation scavenging (rainout or snowout), or ingrowth and decay of radionuclides.

Boundary Conditions: The boundary conditions contained in the model architecture. These include reflection from the ground and reflection from a mixing lid.

Meteorological Requirements: Meteorological data requirements to drive the plume trajectories, dilute the release, and disperse the release.

Validation: Discussion of what has been accomplished in the Verification and Validation (V&V) process. An atmospheric transport model can be verified by comparing field data, gathered in an environmental monitoring program, to predicted model results. Model revisions should then reflect what is learned from the monitoring program results to increase the confidence that the model has captured the appropriate physical forces and mechanisms. An atmospheric transport model can be validated by comparing its results to hard calculations which only assures that the computer is following the appropriate algorithms and logic. Most models undergo extensive validation, but suffer from lack of environmental monitoring data to meet strict verification criteria.

Output: Information that the model provides the "end user."

Genealogy: Brief history of model development, from concept to initial operation to various levels of refinement.

Additional Information: Any other relevant information.

It should be noted that no significant attempt was made to verify the information provided by the survey respondents. Therefore, some caution is advisable in using this information to support documentation. In addition, respondents provided various levels of detail in their descriptions. No attempt was made to reconfigure the information into similar levels of detail. Accordingly, the points of contact

should validate any information that appears to be uncertain, and/or provide additional information.

3.2 Determination of Appropriate Models and Extent of Document Use

Numerous dispersion models have been developed over the past 25 years to address a variety of applications. However, not all applications are useful for emergency response, where time is of the essence. Accordingly, not all of the available models are included in this document. Models that qualified for this survey were those which could be used to make either timely initial assessments or continuous ongoing assessments as defined in DOE Order 5500.3A (11).c.(5). These models can be used by emergency responders to make prompt dose assessments or, if enough time is available, continuous ongoing assessments. However, other models that receive widespread use for other assessment applications were also included (e.g., CAP-88; which is used for Clean Air Act NESHAP compliance).

It should be noted that this compilation of relevant information on a wide spectrum of atmospheric dispersion modeling resources does <u>not</u> intend to infer the validity of any specific code for a particular application. This is outside the scope of this document which is focused on providing a survey of atmospheric dispersion models. In order to determine model validity for a particular application, evaluation criteria need to be developed. The appropriate SCAPA Working Group may consider addressing this aspect, the next time this document undergoes revision.

3.3 Identification of Useful Matrices

It was determined that, although useful, each of the 23 model survey elements by themselves cannot reveal the intercomparisons between the various models. To make these comparisons without the aid of an extracted information matrix would be a cumbersome task. Accordingly, several extracted information matrices were developed from the information gleaned in the survey. The following three matrices were determined to be the most useful:

- Model sponsors and primary/secondary points of contact
- Model attributes
- Model computer requirements

These extracted information matrices will be presented in various tables in Section 4.

4.0 DESCRIPTION OF MODELS FROM SURVEY RESULTS

Responses were obtained, or information gathered, on 94 of the 103 candidate models. The other nine candidate models had either been retired from active use or not maintained in tables for easy use. The results of the survey are presented in this section.

MODEL 1

1.	Name	2DPUF
2.	References	1. Addis, R.P., O'Steen, B.L., WSRC-RP-90-1208, "2DPUF: A Sequential Gaussian Puff Model," Savannah River Laboratory, Aiken, SC. 2. R.P. Addis, B.L. O'Steen, WSRC-RP-91-1186, "2DPUF: A Sequential Gaussian Puff Model," Savannah River Laboratory, Aiken, SC.
3.	Abstract	2DPUF is a sequential Gaussian puff model for simulating the advection and dispersion of radioactive isotopes within a 2-D wind field created from both SRS towers and NWS regional meteorological data. Output is primarily in the form of dose contours.
4.	Location	Westinghouse Savannah River Company Savannah River Technical Center P.O. Box 616 Aiken, SC 29808
5.	Information Contacts	Primary: Lance O'Steen Savannah River Technical Center P.O. Box 616 Aiken, SC 29808 Phone: (803) 725-2449 Secondary: Rob P. Addis Phone: (803) 725-3325
6.	Application	Rapid estimates of consequences of releases of radioactive and toxic chemicals.
7.	Limitations	Forecast meteorological data available only for SRS. Ingestion pathway not included. Particle size distribution is fixed.
8.	Sponsor	DOE/Savannah River Operations Office.
9.	Computer Requirements	For VAX 8550: $\simeq$ 3 minutes using only SRS meteorological data; $\simeq$ 7 minutes using regional NWS data. Also runs on IBM RISC 6000.
10.	Source-Receptor Relationship	Model not used for SRRs.
11.	Emission Rates	User-specified.
12.	Chemical Composition	Passive contaminants and radionuclides.
13.	Plume Behavior	Sequential Gaussian puffs.
14.	Wind Field	2-D based on SRS 60-m towers and regional NWS surface observations and upper air soundings.

MODEL 1 (cont.)

15.	Dispersion Algorithms	Statistically based on Pasquill and Briggs.
16.	Chemical Reactions	None.
17.	Removal Process	Radioactive decay, dry deposition, and wet deposition.
18.	Boundary Conditions	Reflection off the surface and boundary layer top.
19.	Meteorological Requirements	Wind direction and speed, mixing layer depth, and sigma azimuth and elevation are needed for duration of model run.
20.	Validation	MATS SF_6 experiments.
21.	Output	Meteorological input data, source term information, contours of dose estimates on a polar grid (360°, 300 km).
22.	Genealogy	Developed in the early 1980s as a complement to Puff-Plume (Gaussian trajectory model at SRS).
23.	Additional Information	Compared to single puff or plume models, 2DPUF produces more accurate dose estimates for extended releases with time-varying wind direction. Population doses calculated. Linked to Reactor Accident Code (RAC) for reactor accident source terms.

MODEL 2

1.	Name	ADAM
2.	References	DOC OFCM Modeling Resources.
3.	Abstract	The ADAM model was developed by TMS, Inc., under contract to GL/LYA and AFESC/RDVS. ADAM is a modified box and Gaussian dispersion model that incorporates thermodynamics, chemistry, heat transfer, aerosol loading, and dense gas effects. Chemicals currently treated include chlorine, nitrogen tetroxide, hydrogen sulfide, hydrogen fluoride, sulfur dioxide, phosgene, and ammonia. Release scenarios include continuous and instantaneous, area and point, pressurized and unpressurized, and liquid/vapor/two-phase options.
4.	Location	AL/EQS 139 Barnes Drive Tyndall AFB, FL 32403-5319
5.	Information Contacts	Primary: Captain Michael Jones AL/EQS 139 Barnes Drive Tyndall AFB, FL 32403-5319 Phone: (904) 283-6002
6.	Application	Accidental spill Gaussian puff model with two-phase jet cryogenic releases, ground heat transfer, and thermodynamic effects features.
7.	Limitations	None provided.
8.	Sponsor	U.S. Air Force.
9.	Computer Requirements	IBM compatible with math coprocessor recommended.
10.	Source-Receptor Relationship	Standard Gaussian.
11.	Emission Rates	Continuous and instantaneous, area and point, pressurized and unpressurized.
12.	Chemical Composition	Dense gas dispersion, Cl_2, nitrogen tetroxide, H_2S, HF, SO_2, phosgene, NH_3.
13.	Plume Behavior	Gaussian puff.
14.	Wind Field	Straight-line.
15.	Dispersion Algorithms	Pasquill-Gifford-Turner.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Conditions	None provided.

MODEL 2 (cont.)

19.	Meteorological Requirements	Temperature, point winds, standard deviation of wind direction, sky and solar conditions.
20.	Validation	No information provided.
21.	Output	Concentration and dosage.
22.	Genealogy	None provided.
23.	Additional Information	Two-phase vapor/aerosol.

MODEL 3

1.	Name	Air Force Toxic Chemical Dispersion Model (AFTOX)
2.	References	AFGL-TR-88-0009 and PL-TR-91-2119.
3.	Abstract	A Gaussian dispersion model with versions that run on IBM-compatible computers. It handles continuous or instantaneous, liquid or gas, elevated or surface releases, from point or area sources. The program also contains an option for continuous heated plumes from stacks. Output consists of concentration contour plots, concentration at specified locations, and maximum concentration at a given elevation and time.
4.	Location	U.S. Air Force Weather Units.
5.	Information Contacts:	Primary: Steven Sambol 30 WS/WES Vandenberg AFB, CA 93437-5000 Phone: (805) 734-8232 Secondary: None
6.	Application	AFTOX provides estimates of toxic chemical concentrations and hazard distances.
7.	Limitations	The Gaussian equation model calculates average distances for given concentration values. As a result, a 90 percent confidence level contour is also plotted with the output.
8.	Sponsor	Mr. Bruce Kunkel (Retired) PL/GPAA Hanscom AFB, MA 01731-5000 POC: HQ AWS/XOX 102 Losey Street, Room 105 Scott AFB, IL 62225-5206 DSN 576-4721
9.	Computer Requirements	MS-DOS 3 (or later), IBM compatible using EGA or CGA video.
10.	Source-Receptor Relationship	User-defined.
11.	Emission Rates	User-input.
12.	Chemical Composition	User-input from a data base of 130 chemical files.
13.	Plume Behavior	Gaussian puff/plume dispersion model.
14.	Wind Field	Uniform wind conditions.
15.	Dispersion Algorithms	Pasquill-Gifford-Turner.
16.	Chemical Reactions	Limited.
17.	Removal Process	None.
18.	Boundary Conditions	Surface to inversion base.

MODEL 3 (cont.)

19.	Meteorological Requirements	Air temperature, wind direction, wind speed, standard deviation of wind direction and time over which it is determined (optional), cloud cover, predominant cloud category, ground condition, dry, wet, snow-covered (daytime only), inversion base height.
20.	Validation	Validated for use by HQ Air Weather Service.
21.	Output	Toxic corridor plot, concentration at a specified location and time, and maximum concentration at a given height and time.
22.	Genealogy	The AFTOX model was developed as a result of a need by the U.S. Air Force to update its toxic corridor prediction capability.
23.	Additional Information	Executable code and documentation are contained in one 5.25-inch floppy diskette. A full description in AFGL-TR-88-0009 and PL-TR-91-2119 is available from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA, 22161.

MODEL 4

1.	Name	AIRRAD
2.	References	OFCM Model Resources.
3.	Abstract	AIRRAD is a menu-driven, PC-based model for prediction of radionuclide fallout from surface and above-surface nuclear weapon explosions. The model provides hazard predictions in terms of normalized exposure rate, integrated dosage, time of first fallout, and time of last fallout. Additional features include specific receptor support, which allows any hazard indicator to be computed at a user-defined set of points in addition to the computational grid; the capability to plot contours onto a map using a digitizing pen plotter; a path dosage integration routine; a map digitization utilization utility; and extensive on-line, context-sensitive help.
4.	Location	ALO, Sandia National Laboratories.
5.	Information Contacts	Primary: Bruce A. Boughton Sandia National Laboratories P.O. Box 5800 Albuquerque, NM 87185-5800 Phone: (505) 844-8545 Secondary: None
6.	Application	Radionuclide fallout hazard predictions in terms of normalized exposure rate, integrated dosage, and fallout times.
7.	Limitations	None identified.
8.	Sponsor	ALO, Sandia National Laboratories.
9.	Computer Requirements	DOS, Turbo Pascal language.
10.	Source-Receptor Relationship	User-defined set of points, computerized grid.
11.	Emission Rates	Point, instantaneous, ground-level, and elevated.
12.	Chemical Composition	Radionuclide fallout from nuclear weapon explosions.
13.	Plume Behavior	Puff.
14.	Wind Field	None provided.
15.	Dispersion Algorithms	Puff.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Conditions	None provided.
19.	Meteorological Requirements	Vertical wind profile.
20.	Validation	None provided.
21.	Output	Radioactivity levels and dosage.

MODEL 4 (cont.)

22.	Genealogy	None provided.
23.	Additional Information	Nuclear explosions.

MODEL 5

1.	Name	ALOHA™
2.	References	(1) National Oceanic and Atmospheric Administration, Hazardous Materials Response and Assessment Division (NOAA-HMRAD), 1992, ALOHA™ (*Areal Locations of Hazardous Atmospheres*) *5.0 Theoretical Description*, Contribution No. HMRAD 92-5, draft report, Seattle, WA. (2) NOAA-HMRAD and U.S. Environmental Protection Agency, Chemical Emergency Preparedness and Prevention Office, 1992, *ALOHA™ User's Manual*, National Safety Council, Washington, D.C.
3.	Abstract	ALOHA is an emergency response model intended primarily for rapid deployment by responders, as well as for use in emergency preplanning. It incorporates source strength, as well as Gaussian and heavy gas dispersion models and an extensive chemical property library. Model output is in both text and graphic form, and includes a "footprint" plot of the area downwind of a release, where concentrations may exceed a user-set threshold level. ALOHA can accept weather data transmitted from portable monitoring stations, and can plot footprints on electronic maps displayed in a companion mapping application, MARPLOT™.
4.	Location	ALOHA™ is distributed by: National Safety Council P. O. Box 558 Itasca, IL 60143-0558 Phone: 1-800-621-7619 Fax: 1-708-285-0797
5.	Information Contacts	Primary: Dr. Jerry Galt NOAA/HAZMAT 7600 Sand Point Way N.E. Seattle, WA 98115 Phone: (206) 526-6323 E-mail: jerry_galt@hazmat.noaa.gov Secondary: Mark Miller Phone: (206) 526-6945 E-mail: mark_miller@hazmat.noaa.gov
6.	Application	Rapid prediction of source strength and dispersion during emergency response; limited preplanning.
7.	Limitations	ALOHA™ models release and disperse pure, nonreactive chemicals only. They do not account for terrain steering or changes in wind speed and horizontal direction, nor do they model particulate dispersion or account for initial positive buoyancy of a gas escaping from a heated source.

MODEL 5 (cont.)

8.	Sponsor	Joint sponsorship by the following organizations: (1) National Oceanic and Atmospheric Administration Hazardous Materials Response and Assessment Division 7600 Sand Point Way N.E. Seattle, WA 98115 (2) U.S. Environmental Protection Agency Chemical Emergency Preparedness and Prevention Office Washington, D.C. 20460
9.	Computer Requirements	ALOHA™ runs on Apple Macintosh computers in Microsoft Windows (Version 3.0 or later). It requires at least 1 megabyte of RAM and a hard drive.
10.	Source-Receptor Relationship	ALOHA does not make source-receptor estimates.
11.	Emission Rates	ALOHA computes time-dependent source strength for evaporating puddles (boiling or nonboiling), pressurized or unpressurized gas, or liquid release from a storage vessel, and pressurized gas from a pipeline. User can also enter a constant source strength and release duration.
12.	Chemical Composition	Pure, nonreactive chemicals. More than 700 pure chemicals are included in ALOHA's chemical library.
13.	Plume Behavior	ALOHA models Gaussian puff and plume, and heavy gas dispersion.
14.	Wind Field	Wind speed and direction are assumed constant in all horizontal directions. However, ALOHA accounts for the effects of vertical wind shear on both Gaussian and heavy gas dispersion, and on pool evaporation.
15.	Dispersion Algorithms	(1) Modified time-dependent Gaussian equation, based on: (a) Hanna, S.R., Briggs, G.A., and Hosker, R.P., Jr., 1982, "Handbook on Atmospheric Diffusion," Report DOE/TIC-11223, Oak Ridge Technical Information Center, U.S. Department of Energy. (b) Palazzi, E., DeFaveri, M., Fumarola, G., and Ferraiolo, G., 1982, "Diffusion from a Steady Source of Short Duration," *Atmospheric Environment* 16 (12): 2785-2790. (c) Beals, G.A., 1971, "Guide to local diffusion of air pollutants." Technical Report 214, U.S. Air Force Weather Service, Scott Air Force Base, IL. (2) Heavy gas dispersion model based on: Havens, J.A., and Spicer, T. O., 1985, "Development of an Atmospheric Dispersion Model for Heavier-Than-Air Gas Mixtures," Volume I, Report CG-D-22-85 to U.S. Coast Guard, Washington, D.C., Office of Research and Development, U.S. Coast Guard, Department of Transportation. (DEGADIS model)

MODEL 5 (cont.)

16.	Chemical Reactions	Not accounted for.
17.	Removal Process	No deposition or scavenging accounted for.
18.	Boundary Conditions	Reflection off the ground surface and reflection from a low-level atmospheric inversion layer, if present. Heat transfer from the evaporating pool and the ground is accounted for.
19.	Meteorological Requirements	ALOHA™ requires the following: Mean wind speed, wind direction, and air temperature (this information can be transmitted from a portable monitoring station to ALOHA™); ground roughness length (user can choose between "open country" and "urban or forest," or can enter a specific value); cloud cover in tenths; and relative humidity. Time, date, latitude, and longitude (geographic information for individual cities is stored in ALOHA™'s location library) are required to compute solar radiation and atmospheric pressure (computed from elevation information in the location library), which affects some source strength estimates.
20.	Validation	ALOHA™ quality assurance has been performed in two stages: (1) ALOHA source and dispersion estimates have been systematically tested against output from similar models. (2) ALOHA evaporation rate estimates have been compared against measured rates from both boiling and nonboiling pools. Neutrally buoyant gas concentration predictions have been compared against concentrations measured during Project Prairie Grass. Heavy gas dispersion predictions have been compared against DEGADIS predictions for six heavy gas field releases (Desert Tortoise, Goldfish, Maplin Sands, Burro, Eagle, and Thorney Island). In addition, ALOHA's design and computational methods were critiqued in 1989 and 1990 by a six-member peer review committee.
21.	Output	(1) Model output includes the following: Text summaries of user inputs and model results; graphs of predicted source strength and on- and off-centerline indoor and outdoor concentrations; dose over time at specific locations; and a "footprint" plot of the area downwind of a release where concentrations may exceed a user-set threshold level. (2) Complete scenario results can be saved as archive files.

MODEL 5 (cont.)

22.	Genealogy	ALOHA™ was first written in BASIC for the Apple II+ in the early 1980s as a passive gas plume model for in-house response use. It was rewritten in FORTRAN for the Apple Macintosh in the mid-1980s. A chemical property library, meteorological station serial port interface, and base mapping were added at that time, and an energy-balance pool evaporation algorithm was added in the late 1980s. ALOHA™ was rewritten again in C, and time-dependent Gaussian and heavy gas dispersion and additional source strength algorithms were added in 1991. A version for Microsoft Windows was released in 1992. New upgrades for ALOHA™ are released approximately every two years. The next version, ALOHA™ 5.2, is scheduled for release in early 1995.
23.	Additional Information	ALOHA has been designed to reduce operator error during high-stress accident response in the following ways: ● It accepts user inputs in a variety of units and redisplays all input for review and revision if necessary. ● It does extensive input checking using a rule-based formulation, which prevents many common user errors. ● It includes an extensive on-line help system and extensive chemical library. ● Frequent training classes are held nationwide, and technical support is available to registered users.

MODEL 6

1.	Name	ARAC (ARAC Emergency Response Operating System).
2.	References	(1) Taylor, A., Sugiyama, G., Walker, H., and Foster, C., 1994. User's Guide to the MATHEW/ADPIC models. Restructured Models. Lawrence Livermore National Laboratory UCRL-MA-103581, Rev. 2, Livermore, CA. (2) Sullivan, T.S., Ellis, J.S., Foster, C.S., Foster, K.T., Baskett, R.L., Nasstrom, J.S., and Schalk, W.W. III, 1993; Atmospheric Release Advisory Capability; Real-time modeling of airborne hazardous materials, *Bull. Amer. Meteor. Soc.* 74: 2343-2361.
3.	Abstract	The ARAC Emergency Response Operation System (AEROS) is a collection of real-time meteorological data acquisition, terrain, geography, dose conversion and chemical databases, and 3-D diagnostic models integrated in a centralized emergency operations center at Lawrence Livermore National Laboratory (LLNL). The system includes automated communications with remote ARAC Site Workstations at fixed facilities around the country that have on-site tower meteorological data acquisition. All model inputs may be automatically generated by the Site or Central System Questionnaire entries. The system delivers a regional-scale product to a supported site in less than 15 minutes for numerous default source terms using a high degree of automation. The model run stream includes: ● TOPOG (a topographic grid generation code) ● MEDIC (Meteorological Data Interpolation Code) ● MATHEW (Mass-Adjust Three-Dimensional Wind Field) ● ADPIC (Atmospheric Dispersion by Particle-In-Cell ● PLOT CONTOUR (a graphical contour plot generator) See MATHEW/ADPIC in this document for a description of the core models.
4.	Location	Atmospheric Release Advisory Capability Regional Atmospheric Sciences Division (L-262) Lawrence Livermore National Laboratory P.O. Box 808 Livermore, CA 94551
5.	Information Contacts	Primary: Connie Foster Lawrence Livermore National Laboratory (L-262) P.O. Box 808 Livermore, CA 94551 Phone: (510) 422-1867 E-mail: cfoster@arac.llnl.gov Secondary: Hoyt Walker Phone: (510) 422-1840 E-mail: hwalker@arac.llnl.gov

MODEL 6 (cont.)

6.	Application	The ARAC System is used by DOE HQ, several federal agencies, and numerous DOE and DOD sites for real-time emergency response modeling for a wide variety of atmospheric releases worldwide.
7.	Limitations	The ARAC System currently uses diagnostic MATHEW/ADPIC dispersion models. The MATHEW wind field is a diagnostic model that uses persistence, manual inputs, or gridded wind data for forecasted winds. The ADPIC model has no reactive chemistry.
8.	Sponsor	Department of Energy.
9.	Computer Requirements	The ARAC System currently runs on VAX/VMS 6610 and 7000 Alpha systems. Run stream time is 5-15 minutes for supported sites with known defaults.
10.	Source-Receptor Relationship	Source(s) and receptor(s) can be located anywhere on a 3-D grid, which may be placed anywhere in the world. Point, area, and volume sources can be treated. Instantaneous, average, or time-integrated air concentrations; instantaneous or time-integrated doses; or deposition can be computed at receptors.
11.	Emission Rates	Up to nine releases or species may be specified in a run. Optionally, an unlimited number of nuclides may be specified using the hybrid-particle source term. In addition, the ARAC System includes a variety of default source algorithms and emission rates at DOE and DOD facilities (see MATHEW/ADPIC).
12.	Chemical Composition	See MATHEW/ADPIC.
13.	Plume Behavior	See MATHEW/ADPIC.
14.	Wind Field	See MATHEW/ADPIC.
15.	Dispersion Algorithms	See MATHEW/ADPIC.
16.	Chemical Reactions	None
17.	Removal Process	See MATHEW/ADPIC.
18.	Boundary Conditions	See MATHEW/ADPIC.
19.	Meteorological Requirements	See MATHEW/ADPIC. In the ARAC System, MATHEW is initialized using automated worldwide metdata collection from the Air Force Global Weather Center (AFGWC). Also, analysis and forecast gridded wind data from the AFGWC, Fleet Numerical Meteorological and Oceanographic Center (FNMOC), or the Navy Oceanographic Data Distribution System (NODDS) can be used to initialize MATHEW on a regional scale.
20.	Validation	See MATHEW/ADPIC.

MODEL 6 (cont.)

21.	Output	The ARAC System is accessed through a graphical user interface, which includes menus and commands. Extensive graphical outputs and visualization tools show the inputs, terrain, wind fields, and marker particle overhead and cross-section views. Marker particles may also be displayed over terrain in 3-D. Pollutant air concentrations (instantaneous, average, or time-integrated) and dose at desired heights and ground-level deposition are presented on isopleth maps.
22.	Genealogy	The first-generation ARAC System became operational in 1979 on VAX 11/780, which acquired worldwide meteorological data from the Air Force Global Weather Center. Models were run on a separate LLNL CDC 7600 computer. The second generation system involved moving all the models to the ARAC VAXes in 1984. Subsequently, there have been several VAX and ARAC software upgrades. See MATHEW/ADPIC for the improvements in the models. Some additional features of the ARAC System include: ● On-line terrain data base for most of the world at 500-m resolution ● Display of ARAC products on a variety of map projections ● Automated initialization of model inputs ● Interactive real-time comparison between measurements and model results used to adjust source rate to a set of measurement data
23.	Additional Information	Future improvements planned for the ARAC System include significant enhancement of the core models, improved terrain and mapping data bases, automation of toxic chemical and dense gas algorithms, and integration of the Naval Operational Regional Atmospheric Prediction System (NORAPS) prognostic model into the system. Design for an entirely new third- generation system has begun.

MODEL 7

1.	Name	ARCHIE
2.	References	*Handbook of Chemical Hazard Analysis Procedures*, FEMA, DOT, and EPA.
3.	Abstract	Calculates spill rates for all sorts of tanks, pipes, and containers under a number of conditions. Calculates volatilization rates for the spilled chemical. Calculates the dispersion of the volatilized chemical downwind from the spill site using simple Gaussian dispersion formulas. Fire and explosion hazards are also considered.
4.	Location	ARCHIE Support (DHM-51/Room 8104) Office of Hazardous Materials Transportation and Special Programs Administration Department of Transportation 400 7th Street, S.W. Washington, D.C. 20590 Phone: 1-(800)-752-6367
5.	Information Contacts	Primary: Alan C. Stalker EG&G Rocky Flats P.O. Box 464 Golden, CO 80402-0464 Phone: (303) 966-8484 Secondary: None
6.	Application	ARCHIE calculates dispersion of volatilized chemical downwind from spill site.
7.	Limitations	None provided.
8.	Sponsor	DOE/Rocky Flats.
9.	Computer Requirements	Personal computer with 512K RAM.
10.	Source-Receptor Relationship	Gaussian.
11.	Emission Rates	Evaporation from spills.
12.	Chemical Composition	Hazardous chemicals from tanks, pipes, and containers.
13.	Plume Behavior	Gaussian.
14.	Wind Field	Straight-line.
15.	Dispersion Algorithms	Pasquill-Gifford-Turner.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Conditions	None provided.

MODEL 7 (cont.)

19.	Meteorological Requirements	Wind speed, wind direction, indicator of atmospheric stability.
20.	Validation	None indicated.
21.	Output	Spill rates, volatilization rates, downwind concentrations.
22.	Genealogy	None provided.
23.	Additional Information	Fire and explosion hazards also considered.

MODEL 8

1.	Name	ARCON
2.	References	1. Ramsdell, J.V., Jr., Simonan, C.A., and Smyth, S.B., 1995, *Atmospheric Relative Concentrations in Building Wakes* (ARCON). 2. Ramsdell, J.V., Jr., and Fosmire, C.J., 1995. *Atmospheric Dispersion Estimated in the Vicinity of Buildings,* PNL-10286. Pacific Northwest Laboratories, Richland, WA.
3.	Abstract	ARCON is a straight-line Gaussian plume model for use in control room habitability assessments. It uses hourly meteorological data to calculate relative concentrations (X/Q) for averaging periods from 1 hour to 30 days in duration that are exceeded no more than 5 percent of the time during a year. The model includes explicit treatment of low-wind speed dispersion and building wakes.
4.	Location	Jay Lee Radiation Protection Branch Office of Nuclear Reactor Regulation Nuclear Regulatory Commission Washington, DC 20555 Phone: (301) 415-1080
5.	Information Contacts	Primary: J.V. Ramsdell, Jr. Battelle Pacific Northwest Laboratories MS K9-30 P.O. Box 999 Richland, WA 99352 Phone: (509) 372-6316 E-mail: j_ramsdell@pnl.gov
6.	Application	ARCON was developed for use in control room habitability assessments. It is designed to estimate concentrations for sources and receptors in the vicinity of buildings.
	Limitations	ARCON has the usual limitations of straight-line Gaussian plume model. It should not be used for estimation concentrations at receptors that are more than a few hundred meters from the source.
8.	Sponsor	Nuclear Regulatory Commission.
9.	Computer Requirements	PC with 840K memory, hard disk, math coprocessor, and color monitor.
10.	Source-Receptor Relationship	Straight-line plume. Receptors assumed to be directly downwind if within 45 degrees of the transport direction.
11.	Emission Rates	Continuous unit release rate assumed. Averaging periods start each hour.
12.	Chemical Composition	Effluent is assumed to be trace gas or submicron particle. Decay and chemical reactions not included.

MODEL 8 (cont.)

13.	Plume Behavior	Straight-line, Gaussian plume. Not for heavy gases. ARCON considers three release modes: ground-level releases, vent releases, and elevated releases. Releases from vents are treated as ground-level or elevated releases depending on the ratio between the effluent vertical velocity and the wind speed.
14.	Wind Field	Simple spatially invariant field. Temporal variations included for averaging periods longer than one hour.
15.	Dispersion Algorithms	Pasquill-Gifford-Turner with modification for low wind speeds and building wakes described in Ref. 2 above.
16.	Chemical Reactions	No chemical reactions.
17.	Removal Process	No removal processes.
18.	Boundary Conditions	ARCON assumes reflection at the ground. It does not include reflection at the top of the mixing layer.
19.	Meteorological Requirements	Hourly wind speed, wind direction, and stability class data.
20.	Validation	None for ARCON. Low wind speed and building wake diffusion algorithms are based on analysis of experimental data. See Ref. 2.
21.	Output	Primary model output consists of 95th percentile relative concentrations for 10 averaging intervals ranging from 1 hour to 30 days in duration and a cumulative frequency distribution of the concentrations for each averaging interval. Additional output may be selected for code verification.
22.	Genealogy	ARCON is a new code intended to replace the Murphy-Campe procedure referenced in NRC Standard Review Plan 6.4.
23.	Additional Information	None.

MODEL 9

1.	Name	Area Evacuation (AREAEVAC)
2.	References	Hoel, D.D., "A User's Guide for the WIND System Emergency Response Functions," E.I. du Pont de Nemours & Co., DPST-85-282, Savannah River Laboratory, Aiken, SC.
3.	Abstract	A simple straight-line Gaussian plume transport and diffusion model that includes real-time input of meteorological observations and dose estimates for inhalation.
4.	Location	Westinghouse Savannah River Company Savannah River Technical Center P. O. Box 616 Aiken, SC 29808
5.	Information Contacts	Primary: Chuck H. Hunter Phone: (803) 725-2953 Secondary: Robert J. Kurzeja Phone: (803) 725-5945
6.	Application	Very rapid estimates of on-site consequences of releases of radioactive and toxic chemicals for facility evacuation decisions.
7.	Limitations	Limited area calculations; building or stack wake effects not included; fixed release height; fixed boundary layer height.
8.	Sponsor	DOE Savannah River Operations Office.
9.	Computer Requirements	Program runs on VAX 8550 (near immediate response).
10.	Source-Receptor Relationship	Model not used for SRRs.
11.	Emission Rates	User-specified.
12.	Chemical Composition	Variable.
13.	Plume Behavior	Straight-line trajectory in space and time.
14.	Wind Field	Constant in space and time, based on single 60-m tower observations.
15.	Dispersion Algorithms	Statistics based on Pasquill and Briggs.
16.	Chemical Reactions	None.
17.	Removal Process	Radioactive decay.
18.	Boundary Condition	Reflection off the surface and boundary layer top.
19.	Meteorological Requirements	Wind direction and wind speed, sigma azimuth and elevation.
20.	Validation	None.

MODEL 9 (cont.)

21.	Output	Graphic output showing centerline trajectory and isopleths of dose or concentration on a base map showing significant routes. Input information also listed.
22.	Genealogy	Developed in the late 1970's with only minor modifications up to the present.
23.	Additional Information	None.

MODEL 10

1.	Name	Advanced Statistical Trajectory Regional Air Pollution (ASTRAP)
2.	References	(1) Shannon, J.D., 1985, "User's Guide for the Advanced Statistical Trajectory Regional Air Pollution (ASTRAP) Model", Environmental Protection Agency Report EPA-600/8-85-016 (NTIS PB85-236874/XAB). (2) Shannon, J.D., and Voldner, E.C., 1992, "Deposition of NO_x Nitrogen to the Great Lakes Estimated with a Regional Deposition Model," *Environmental Sciences & Technology*, 26: 970-978.
3.	Abstract	ASTRAP is a regional-scale, long-term average deposition and air concentration model that has been applied extensively in an assessment of various air quality problems, including acid deposition, mercury, lead, visibility, and toxaphene.
4.	Location	Argonne National Laboratory.
5.	Information Contacts	Primary: Jack D. Shannon Environmental Research Division, Bldg. 203 Argonne National Laboratory Argonne, IL 60439 708-252-5807 Secondary: None
6.	Application	Calculation of source-receptor relationships and fields of concentration and deposition in an assessment-friendly mode.
7.	Limitations	Does not calculate short-term concentrations, and model is highly parameterized.
8.	Sponsor	CHO, Argonne National Laboratory.
9.	Computer Requirements	IBM mainframe; one- to five-minute execution time.
10.	Source-Receptor Relationship	Basic mode of calculation.
11.	Emission Rates	User input.
12.	Chemical Composition	Linearized transformation rates for SO_2 to SO_4^{2-}, NO_x to NO_3-/HNO_3, Hg species, passive contaminants.
13.	Plume Behavior	Mean plume from a source described by fitting bivariate normal puffs to sets of trajectory endpoints as a function of plume age.
14.	Wind Field	Time series of gridded analyses used as input for trajectory calculations.
15.	Dispersion Algorithms	Vertical dispersion is calculated in a one-dimensional, numerical integration with input profiles of K_z that vary diurnally and seasonally. Horizontal dispersion is calculated from the spread of individual trajectories about the seasonal mean trajectory.

MODEL 10 (cont.)

16.	Chemical Reactions	All reactions are linear and first-order, rates vary diurnally and seasonally.
17.	Removal Process	Input patterns of dry deposition velocity vary diurnally and seasonally. Wet removal is a function of the half-power of the six hour precipitation total.
18.	Boundary Conditions	No diffusion allowed at bottom and top of one-dimensional vertical grid. Dry deposition from lowest layer reduces concentration values. Slow leakage to free troposphere is allowed. Pollutant removed from mixed layer is subject to later wet removal, but not dry removal.
19.	Meteorological Requirements	Time series of wind and precipitation fields updated several times daily. Other meteorological variables such as mixing height are specified.
20.	Validation	Extensive validation in many studies of deposition and air quality.
21.	Output	User option; usually seasonal average concentration fields, cumulative seasonal deposition fields, and seasonal source-receptor matrices.
22.	Genealogy	Initial development in the 1970s, with continued upgrading and application since then.
23.	Additional Information	ASTRAP has been widely applied in multi disciplinary assessments of regional air quality problems such as acid rain and regional haze.

MODEL 11

1.	Name	ATMOS1/ATMOS2
2.	References	DOC OFCM Modeling Resources.
3.	Abstract	ATMOS1 is a diagnostic wind field model that uses available meteorological data to construct a mass-consistent wind field. ATMOS 2 uses this wind field as input and uses K-theory to calculate plume diffusion.
4.	Location	Los Alamos National Laboratory.
5.	Information Contacts	Primary: J.T. Lee EES-5 Los Alamos National Laboratory MS D401 Los Alamos, NM 87544 Phone: (505) 667-8352 Secondary: Don Hoard Phone: (505) 667-1715
6.	Application	Accidental spill, chemical defense, battlefield observation.
7.	Limitations	None identified.
8.	Sponsor	DOE Albuquerque Operations Office, Los Alamos National Laboratory.
9.	Computer Requirements	Digital with VAX operating system in FORTRAN language.
10.	Source-Receptor Relationship	None identified.
11.	Emission Rates	Point, continuous, ground-level, and elevated.
12.	Chemical Composition	Spills of hazardous chemicals.
13.	Plume Behavior	Continuous.
14.	Wind Field	Mass-consistent wind field generated by ATMOS1. Diagnostic categories.
15.	Dispersion Algorithms	K-theory diffusion, Pasquill-Gifford stability.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Conditions	None identified.
19.	Meteorological Requirements	Point winds, multiple point winds, and vertical wind profile.
20.	Validation	None provided.
21.	Output	Diagnostic and mass-consistent wind fields.
22.	Genealogy	None identified.

MODEL 11 (cont.)

23.	Additional Information	No software support available, and infrequent use.

MODEL 12

1.	Name	AXAIR89Q
2.	References	(1) Hamby, D.M., "Verification of the AXAIR89Q Dose Assessment Code," November 1990, WSRC-RP-90-1222, WSRC, SRTC, Aiken, SC. (2) Simpkins, A.A., "AXAIR89Q User's Manual," April 1994, WSRC-RP-94-313, WSRC, SRTC, Aiken, SC.
3.	Abstract	Estimates gamma shine and inhalation doses to the on-site and off-site population within 50 miles, and the off-site maximum individual dose. Doses are based on worst-case, worst-sector meteorology so that they will be exceeded only 0.5 percent of the time.
4.	Location	Westinghouse Savannah River Company Savannah River Technical Center Environmental Technology Section Aiken, SC 29808
5.	Information Contacts	Primary: Ali A. Simpkins Savannah River Technical Center P.O. Box 616 Aiken, SC 29808 Phone: (803) 725-9643 Secondary: None
6.	Application	Primarily used for SAR accident sequence analysis. Occasionally used for dose assessments of hypothetical accident scenarios for EIDs, EISs, etc.
7.	Limitations	Ingestion pathway is not considered for dose estimates. Age-specific dose factors not available.
8.	Sponsor	DOE Savannah River Operations Office.
9.	Computer Requirements	IBM compatible.
10.	Source-Receptor Relationship	On-site population divided into concentric rings 1 mile wide; off-site population divided into concentric rings 10 miles wide; off-site maximum individual dose located at the site boundary.
11.	Emission Rates	User specified.
12.	Chemical Composition	Radionuclides.
13.	Plume Behavior	Straight-line Gaussian plume.
14.	Wind Field	Uses statistical distribution of wind speed and direction to generate wind fields.
15.	Dispersion Algorithms	Pasquill-Gifford dispersion curves.
16.	Chemical Reactions	None.
17.	Removal Process	Radioactive decay.

MODEL 12 (cont.)

18.	Boundary Conditions	Plume reflection at surface.
19.	Meteorological Requirements	Wind direction and wind speed, sigma azimuth and elevation.
20.	Validation	Software verification completed.
21.	Output	Input echo, on-site population dose, off-site population dose, and maximum individual dose at site boundary.
22.	Genealogy	Preceded by NRC145-2 and PAVAN; modified several times at SRL.
23.	Additional Information	None.

MODEL 13

1.	Name	BNL Gaussian Plume Model (BNLGPM)
2.	References	DOC OFCM Modeling Resources.
3.	Abstract	Gaussian model to assess impacts from accidental spills.
4.	Location	Brookhaven National Laboratory.
5.	Information Contacts	Primary: Paul Michael Brookhaven National Laboratory Upton, NY 11973 Phone: (516) 282-2264 Secondary: M. Reynolds
6.	Application	Assess impacts from accidental spills.
7.	Limitations	None provided.
8.	Sponsor	DOE Chicago Operations Office, Brookhaven National Laboratory.
9.	Computer Requirements	PC VAX with DOS/VMS in FORTRAN language. Interactive.
10.	Source-Receptor Relationship	Volume source.
11.	Emission Rates	Point emission rate.
12.	Chemical Composition	Hazardous chemical spills.
13.	Plume Behavior	Gaussian plume.
14.	Wind Field	Straight-line.
15.	Dispersion Algorithms	Pasquill-Gifford-Turner.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Conditions	None provided.
19.	Meteorological Requirements	Temperature, vertical temperature profile, point winds, standard deviation of wind direction.
20.	Validation	None identified.
21.	Output	Concentrations.
22.	Genealogy	None provided.
23.	Additional Information	Automated data system.

MODEL 14

1.	Name	C-CSI
2.	References	DOC OFCM Modeling Resources.
3.	Abstract	C-CSI is a diagnostic, multiple-scale wind model of high vertical and horizontal resolution available in the ASL inventory. This three-dimensional model is a result of meteorologically coupling the three-dimensional wind field of High Resolution Winds (HRW) and its surface layer wind profile to the CANOPY wind profile in the vertical dimension. Given the mean surface wind (or U and V components), the ambient temperature for a measure of buoyancy, and a gridded terrain elevation and vegetation data base, HRW calculates the wind profile of the surface layer roughness for an area of about 5x5 km. A vertical wind profile of the surface layer is also calculated at each grid point. At those grid points where vegetative canopy roughness exists, a coupling parameterization is used with the ambient wind profile and its friction velocity value and the canopy index value for that vegetation type to compute the wind speed at the top of the canopy. From this information, the wind profile in the canopy is calculated at the same grid point. The output from this mode, therefore, is two-dimensional horizontal fields of the mean wind and friction velocity and Vertical profiles of the surface layer coupled to the canopy wind profile.
4.	Location	USAF Atmospheric Sciences Laboratory White Sands, NM 88002
5.	Information Contacts	Primary: Ronald M. Cionco USAF Atmospheric Sciences Laboratory White Sands Missile Range White Sands, NM 88002-5501 Phone: (505) 678-5210 Secondary: None
6.	Application	Wind profiles in complex terrain and canopies.
7.	Limitations	None identified.
8.	Sponsor	USAF Atmospheric Sciences Laboratory White Sands, NM 88002
9.	Computer Requirements	UNISYS 1197 and VAX in FORTRAN 7700 language.
10.	Source-Receptor Relationship	Not applicable.
11.	Emission Rates	Not applicable.
12.	Chemical Composition	Not applicable.
13.	Plume Behavior	Complex.
14.	Wind Field	Complex terrain within canopy vegetation.
15.	Dispersion Algorithms	None identified.

MODEL 14 (cont.)

16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Conditions	None identified.
19.	Meteorological Requirements	Point winds, vertical temperature profile.
20.	Validation	None identified.
21.	Output	Diagnostic wind fields.
22.	Genealogy	None provided.
23.	Additional Information	High-resolution diagnostic surface layer windfield simulation over complex terrain including vegetation domain.

MODEL 15

1.	Name	CAP88-PC
2.	References	(1) Parks, B., March 1992, "User's Guide for CAP88-PC," EPA 401-B-92-001. (2) "AIRDOS-EPA: A Computerized Methodology for Estimating Environmental Concentrations and Dose to Man from Airborne Releases of Radionuclides," December 1979, Environmental Protection Agency, Office of Radiation Programs, Washington, D.C., 20460, EPA 520/1-79-009 (reprint of ORNL-5532/PB80147838). (3) "Estimates of Health Risk from Exposure to Radioactive Pollutants," Oak Ridge National Laboratory, Oak Ridge, TN. (4) "A Combined Methodology for Estimating Dose Rates and Health Effects from Exposures to Radioactive Pollutants," ORNL/TM-7105 Oak Ridge National Laboratory, Oak Ridge, TN. (5) International Commission on Radiological Protection, 1977, "Recommendations of the International Commission on Radiological Protection," ICRP Publication 26, Ann. ICRP, *1*, (1), Pergamon Press. (6) "DARTAB: A Program to Combine Airborne Radionuclide Environmental Exposure Data with Dosimetric Health Effect Data to Generate Tabulations of Predicted Health Impact," November 1981, ORNL-5692/DE81030434, Oak Ridge National Laboratory, Oak Ridge, TN. (7) Beal, S.K., and Cohen, S.C., 1986, "Comparison of AIRDOS-EPA Predictions of Ground-Level Airborne Radionuclide Concentrations to Measured Values," Sanford Cohen and Associates. Chmelynski, H.J., Jack Faucett Associates. Parks, B.S., and Hardin, J., Environmental Protection Agency, Washington, D.C. (8) "Risk Assessment Methodology: Draft Environmental Impact Statement for Proposed NESHAPs for Radionuclides, Volume 1, Background Information Document," EPA 520/1-89-005, February 1989, EPA Office of Radiation Programs, Washington, D.C.

3.	Abstract	(1) CAP88-PC is a personal computer version of the Clean Air Act Assessment Package-1988 (CAP-88), which is designed for assessment of dose and risk from radioactive emissions to air, and used for the preparation of EPA 520/1-89-005. CAP88-PC estimates health impacts from the inhalation, ingestion, air immersion, and ground surface irradiation pathways, and tabulates results from maximally exposed individuals and regional populations out to 80 km. CAP88-PC is self-documenting and provides risk information in a concise and easy-to-read format. The CAP88-PC system consists of personal computer versions of the mainframe programs AIRDOS-EPA, DARTAB, and the RADRISK data base, as well as a screen interface program written in C language. The interface program presents the user with menus and full screen editing capability for setting up and modifying assessment problems, storing the problems in data sets, executing stored data sets, and printing the results. Atmospheric dispersion and deposition are calculated by AIRDOS. (2) Dose and risk assessment tables are calculated by DARTAB2 from the output file produced by AIRDOS2 and a file of dose and risk factors calculated by RADRISK. Preprocessor in the screen interface program, written in the C language, for AIRDOS2 and DARTAB2 access data bases of element- and nuclide-dependent data to simplify the execution of the principal programs. AIRDOS2 implements a long-term average Gaussian plume model. The associated terrestrial model for deposition is based on NRC Regulatory Guide 1.109. The 50-year effective dose equivalent factors for DARTAB2 are calculated by RADRISK and use weighing factors from ICRP-26. Risks are calculated using a linear Life Table model consistent with BEIR. (3) The resultant risk factors are 4E-4 cancer deaths per rem and 3.6E-4 cancer deaths per person working-level-month exposure to radon decay products. CAP88-PC is able to use population data and weather data downloaded from mainframe versions of CAP88. CAP88-PC also comes with sample population arrays from some DOE facilities, and includes weather data from many DOE sites and major U.S. cities.
4.	Location	CAP88-PC is personal computer software used in DOE national laboratories, other federal and state agencies, private industry, academic institutions, and by scientists around the world.

MODEL 15 (cont.)

5.	Information Contacts	Primary: Barry Parks DOE Energy Research Office of ES&H Technical Support ER-8.2 GTN Washington, D.C. 20585 Phone: (301) 903-9649 Fax: (301) 903-7047 Secondary: Kenneth Duvall DOE EH-232 Washington, D.C. 20585 Phone: (202) 586-0242
6.	Application	CAP88-PC is specified by EPA for demonstrating compliance with the radionuclides National Emission Standards for Hazardous Air Pollutants (NESHAPs) in 40 CFR 61, Subpart H. This standard specifies that emission of radionuclides to air from DOE facilities shall not result in a dose greater than 10 millirem/year to nearby members of the public.
7.	Limitations	Assessments are limited to 36 radionuclides and to 20 downwind distances for each of the 16 compass directions. CAP88-PC is intended for use by health physicists experienced in dose assessment. CAP88-PC is based on the Gaussian plume model with its associated limitations. The model is intended for evaluating only low-level, chronic releases. It is not appropriate for evaluating short-term, accidental releases.
8.	Sponsor	DOE/Office of Assessment and Support (ER-8).
9.	Computer Requirements	CAP88-PC requires an MS-DOS compatible personal computer with a hard disk, 640 kilobytes of RAM, and a math coprocessor, running DOS Version 2.0 or higher. A complete population assessment requires approximately five to ten minutes on a 386 MS-DOS PC.
10.	Source-Receptor Relationship	Standard Gaussian.
11.	Emission Rates	User input.
12.	Chemical Composition	Day, week, or year clearance classes.
13.	Plume Behavior	Modified Gaussian plume.
14.	Wind Field	Stability array data used.
15.	Dispersion Algorithms	Pasquill and Briggs.
16.	Chemical Reactions	None.
17.	Removal Process	Wet and dry deposition.
18.	Boundary Conditions	Reflection off the surface and tropospheric mixing layer height.

MODEL 15 (cont.)

19.	Meteorological Requirements	Wind speed, wind direction, stability class, rainfall rate, mixing layer depth, tower elevation.
20.	Validation	See Reference 7.
21.	Output	Meteorological input, dose and risk factors, genetic risks, concentration tables, dose and risk as a function of pathways and radionuclides, synopsis report for reporting to EPA per 40 CFR 61, Subpart H.
22.	Genealogy	CAP88-PC traces its history back to the late 1970s, when the EPA decided to regulate radionuclides under the authority of Section 112 of the Clean Air Act. The EPA recognized the need for a mathematical model to estimate radionuclide exposures, since the relatively high level of natural background radiation often makes it a practical impossibility to measure doses from many scenarios that are now regulated by the EPA. For example, the natural background is roughly 100 to 200 millirem per year across the United States, depending on location, and the EPA standard for 40 CFR 61, Subpart H, is at a much lower level of 10 millirem per year. Clearly, the low signal-to-noise ratio for these doses makes measurement impracticable, and the EPA therefore requires modeling as an alternative means to demonstrate compliance. The EPA then began work with Oak Ridge National Laboratory (ORNL) to develop appropriate computer models for estimating doses from radionuclides in air. The first program developed was called AIRDOS, which was lacking in many respects. It was subsequently improved with the addition of the RADRISK and DARTAB programs. The combined AIRDOS, RADRISK, and DARTAB models are now referred to collectively as CAP88. CAP88 ran on large mainframe computers at ORNL, which was an expensive and time-consuming effort. The EPA and ORNL used these models while developing the 40 CFR 61 standard for regulating radionuclide releases to air at DOE facilities. EPA recognized the need to make the programs available for personal computers and to eliminate the large cost and time required to demonstrate compliance with the NESHAPs standard. The EPA and DOE began a cooperative project to produce a personal computer version of CAP88 at the Office of Radiation Programs' Las Vegas facility in the late 1980s. The final software was released in March 1992. The software system consists of a single 3.25 inch disk and a user's guide. CAP88-PC is officially distributed now by DOE EH-232 and the Oak Ridge Radiation Shielding Information Center.
23.	Additional Information	The code package includes a user's guide, a 3.5-inch HD floppy disk with executable code, sample problems, libraries of radionuclide dose and risk factors, sample wind data, sample population arrays, auxiliary routines, and data library files.

MODEL 16

1.	Name	CTDM
2.	References	(1) DOC OFCM Modeling Resources (2) NTIS PB93-107076/WSP (3) NTIS PB93-107084/WSP (4) NTIS PB88-162102 (5) NTIS PB88-162110, NTIS PB91-136564
3.	Abstract	CTDM is a point-source, steady-state model for complex terrain applications. The model is unique in the way it simulates the flow and plume distortion near fully-defined, three-dimensional terrain. Emphasis is given to windward-side impacts. The algorithms for stable and neutral conditions are based on the concept of a dividing streamline. The algorithms for plumes released into convective layers are based on recent understanding of the convective boundary layer obtained through field, numerical, and fluid modeling studies.
4.	Location	EPA Research Triangle Park, NC 27711
5.	Information Contacts	Primary: R.E. Lawson, Jr. Environmental Protection Agency Research Triangle Park, NC 27711 Phone: (919) 541-1199 Secondary: Desmond Bailey Phone: (919) 541-5248
6.	Application	CTDM simulates flow and plume distortion near various terrain obstacles.
7.	Limitations	Requires terrain contours as input.
8.	Sponsor	EPA.
9.	Computer Requirements	IBM PC.
10.	Source-Receptor Relationship	Gaussian.
11.	Emission Rates	Point, continuous, ground-level, and elevated.
12.	Chemical Composition	Passive contaminants.
13.	Plume Behavior	Plume transport responds to presence of terrain obstacles.
14.	Wind Field	Straight-line.
15.	Dispersion Algorithms	Pasquill-Gifford-Turner, lighter-than-air dispersion.
16.	Chemical Reactions	None.
17.	Removal Process	None.

MODEL 16 (cont.)

18.	Boundary Conditions	None provided.
19.	Meteorological Requirements	Temperature, vertical temperature profile, mixing depth, sky and solar conditions, point winds, multiple-point winds.
20.	Validation	None identified.
21.	Output	Concentration isopleths.
22.	Genealogy	None provided.
23.	Additional Information	Urban application.

MODEL 17

1.	Name	D2PC
2.	References	DOC OFCM Modeling Resources.
3.	Abstract	The model predicts the downwind hazard from the release of a toxic chemical. Hazard assessment is made in terms of the accumulated dosage or peak concentration resulting from instantaneous, continuous, or varying release. Options include evaporation from a spill and the rise from a heated stack or ground fire. The program is IBM compatible, written in ASCII FORTRAN, and is conversational for CRT display.
4.	Location	U.S. Army/Aberdeen Proving Ground.
5.	Information Contacts	Primary: Michael Myirski Director, U.S. Army ERDEC Attn: SCBRD-RTT Aberdeen Proving Ground, MD 21010-5423 Phone: (410) 671-3556 Secondary: None
6.	Application	Toxic chemical releases, explosions, and fires.
7.	Limitations	None identified.
8.	Sponsor	U.S. Army/Aberdeen Proving Ground.
9.	Computer Requirements	IBM PC-compatible, MS-DOS FORTRAN programming language.
10.	Source-Receptor Relationship	Gaussian.
11.	Emission Rates	Point, instantaneous, continuous, ground-level, and elevated.
12.	Chemical Composition	Hazardous chemicals, chemical warfare agents, evaporating liquids.
13.	Plume Behavior	Gaussian plume.
14.	Wind Field	Straight-line.
15.	Dispersion Algorithms	Pasquill-Gifford-Turner.
16.	Chemical Reactions	None.
17.	Removal Process	Dry deposition.
18.	Boundary Conditions	Ground reflection, mixing lid.
19.	Meteorological Requirements	Temperature, mixing depth, point winds, sky and solar conditions.
20.	Validation	None identified.
21.	Output	Concentrations and doses.
22.	Genealogy	None provided.

23.	Additional Information	None.

MODEL 18

1.	Name	Dense Gas Atmospheric Dispersion (DEGADIS)
2.	References	(1) "*DEGADIS User Guide*." EPA-450/4-89-019. (2) OFCM
3.	Abstract	The DEGADIS model was designed to simulate the atmospheric dispersion of ground-level, area-source dense gas (or aerosol) clouds released with zero momentum into an atmospheric boundary layer over flat, level terrain. DEGADIS describes the dispersion processes that accompany the ensuing gravity-driven flow and entrainment of the gas into the boundary layer. DEGADIS makes no provision for processes that occur in high-velocity releases, as from pressure relief valves.
4.	Location	EPA Research Triangle Park, NC 27711
5.	Information Contacts	Primary: R.E. Lawson, Jr. U.S. Environmental Protection Agency Research Triangle Park, NC 27711 Phone: (919) 541-1199 Secondary: Dave Guinnup Phone: (919) 541-5368
6.	Application	Atmospheric dispersion of dense gas releases.
7.	Limitations	No provision for high-velocity releases.
8.	Sponsor	EPA, Research Triangle Park, NC.
9.	Computer Requirements	PC with DOS.
10.	Source-Receptor Relationship	Gaussian.
11.	Emission Rates	Point, area, continuous, ground-level, elevated.
12.	Chemical Composition	Dense gases.
13.	Plume Behavior	Gaussian plume.
14.	Wind Field	Straight-line.
15.	Dispersion Algorithms	Dense, gas-related.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Conditions	None identified.
19.	Meteorological Requirements	Temperature, point winds, sky and solar conditions, stability class indicator.
20.	Validation	None identified.
21.	Output	Concentration.

MODEL 18 (cont.)

22.	Genealogy	None provided.
23.	Additional Information	Urban applications.

MODEL 19

1.	Name	DIFOUT
2.	References	Luna, R.E., and Church, H.W., "DIFOUT: A Model Computation of Aerosol Transport and Diffusion in the Atmosphere," SC-RR-68-555, Sandia National Laboratories, Albuquerque, NM.
3.	Abstract	DIFOUT is a model used for the computation of aerosol transport and diffusion in the atmosphere. The basic model consists of a series of vertically stacked line segments that simulate a stabilized cloud of aerosol particles from an explosive source. Particles fall and diffuse in a wind- and turbulence- specified atmosphere from surface to cloud top. Ground-level deposition and/or time-integrated air concentration by specified particle sizes are output at cylindrical grid points.
4.	Location	Sandia National Laboratories P.O. Box 5800 Albuquerque, NM 87185-0755
5.	Information Contacts	Primary: Hugh W. Church Sandia National Laboratories P.O. Box 5800 Albuquerque, NM 87185-5800 Phone: (505) 845-8705; Fax: (505) 844-0116 Secondary: None
6.	Application	DIFOUT is a tool for estimating downwind ground-level deposition or integrated air concentration patterns and subsequent consequences from an explosively released contaminant.
7.	Limitations	DIFOUT requires input of specified aerosol cloud geometry and associated meteorological conditions.
8.	Sponsor	DOE Albuquerque Operations Office.
9.	Computer Requirements	IBM-compatible.
10.	Source-Receptor Relationship	Not applicable.
11.	Emission Rates	User input.
12.	Chemical Composition	Passive contaminants and long-life radionuclides.
13.	Plume Behavior	Arbitrarily specified layer heights and widths.
14.	Wind Field	Measured or forecast wind versus height profile.
15.	Dispersion Algorithms	Choice of Sutton, Smith, and Hay, Pasquill-Gifford, or user-specified relationships.
16.	Chemical Reactions	None.
17.	Removal Process	Gravitational fall and deposition velocity concepts.

MODEL 19 (cont.)

18.	Boundary Conditions	Reflection, impaction, or interpolated function at ground.
19.	Meteorological Requirements	Wind direction, wind speed, and turbulence intensity versus height from ground to cloud top height. Barometric pressure and temperature are also used for particle terminal fall rate calculations.
20.	Validation	DIFOUT was derived from measured depositions and integrated air concentrations from Operation Roller Coaster which was a series of joint United States United Kingdom (UK) field experiments conducted at the Tonopah Test Range in 1963.
21.	Output	Input parameters, deposition values, and integrated air concentrations at specified bearings and distances.
22.	Genealogy	The concept is based on a melding of a UK code called DIFFAL, which calculated the spread of an ensemble of particles by turbulent diffusion with a U.S. fallout code used at the Nevada Test Site for particle fallout prediction.
23.	Additional Information	Modifications, improvements, and adaptation to a PC environment have occurred since the original documentation. Additional documentation exists as comments in the code.

MODEL 20

1.	Name	DOSEEP
2.	References	None provided.
3.	Abstract	DOSEEP is a Gaussian transport and diffusion model used to predict external gamma exposures/air concentrations of radionuclides from seepages due to underground nuclear detonations.
4.	Location	Nevada Test Site.
5.	Information Contacts	Primary: Doug Soule NOAA Air Resources Laboratory (ARL) Special Operations and Research Division (SORD) P.O. Box 94227 Las Vegas, NV 89193-4227 Phone: (702) 295-1266 Secondary: Charlie Steadman Phone: (702) 295-6482
6.	Application	DOSEEP provides near real-time estimates of exposures downwind.
7.	Limitations	DOSEEP assumes no deposition effects.
8.	Sponsor	DOE Nevada Test Site.
9.	Computer Requirements	DOSEEP is installed on Data General MV series computers running AOS/VS. Additional versions are running on PCs under MS-DOS, and are written in FORTRAN.
10.	Source-Receptor Relationship	Not applicable.
11.	Emission Rates	User-input.
12.	Chemical Composition	Passive contaminants and radionuclides.
13.	Plume Behavior	Gaussian plume.
14.	Wind Field	10-meter towers, raob and pibal inputs.
15.	Dispersion Algorithms	Based on Pasquill and Gifford.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Conditions	None.
19.	Meteorological Requirements	Wind direction and wind speed, stability categories A through F.
20.	Validation	Surface RAMs (radiation monitors) on-site and EPA monitors off-site.
21.	Output	Tables of exposures and concentrations as functions of time and distance.

MODEL 20 (cont.)

22.	Genealogy	Developed in the mid-1970s for use in support of underground nuclear detonations.
23.	Additional Information	Model is used for ventilation estimates of radioactive gases. It was originally used for seepage calculations following nuclear detonations.

MODEL 21

1.	Name	EDMS
2.	References	DOC OFCM Modeling Resources.
3.	Abstract	EDMS was developed in a joint FAA-AFESC effort. The microcomputer-based system is an integrated emissions data-base and dispersion model, capable of treating multiple pollutant sources and receptors in the airport/air-base environment. The model runs in both screening and refined modes, facilitating environmental assessments related to new aircraft beddown, mission changes, runway expansions, etc. Model treats emissions of NO_X, SO_X, CO, hydrocarbons, and particulates from point, area, and line sources.
4.	Location	USAF Tyndall AFB, FL
5.	Information Contacts	Primary: Captain Michael Jones AL/EQS 139 Barnes Drive Tyndall AFB, FL 32403-5319 Phone: (904) 283-6002 Secondary: Captain Jon Hayward Phone: (904) 283-6324
6.	Application	Air quality assessments for airports/air-bases.
7.	Limitations	None identified.
8.	Sponsor	USAF, Tyndall AFB, FL
9.	Computer Requirements	IBM compatible with MS-DOS. Condor DBMS programming language.
10.	Source-Receptor Relationship	Gaussian multiple sources/receptors.
11.	Emission Rates	Built-in data base.
12.	Chemical Composition	NO_X, SO_X, CO, hydrocarbons, particulates.
13.	Plume Behavior	Gaussian puff.
14.	Wind Field	Straight-line.
15.	Dispersion Algorithms	Pasquill-Gifford-Turner.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Conditions	None provided.
19.	Meteorological Requirements	Temperature, sky and solar conditions, point winds.
20.	Validation	None provided.
21.	Output	Concentration.

MODEL 21 (cont.)

22.	Genealogy	None provided.
23.	Additional Information	None.

MODEL 22

1.	Name	EMGRESP
2.	References	None provided.
3.	Abstract	EMGRESP performs liquid spills-evaporating pool source term calculations and dispersion calculations, using gaseous or particulate release source terms. EMGRESP uses a simple neutral buoyancy Gaussian plume dispersion model and a heavy gas dispersion model.
4.	Location	Ontario Provincial Government Ministry of the Environment Air Resources Branch 125 Resources Road Rexdale, M9W 5L1, Ontario, Canada
5.	Information Contacts	Primary: A.V. Savino Westinghouse Hanford Company P.O. Box 1970 (MSIN H4-64) Richland, WA 99352 Phone: (509) 376-8191 Secondary: None
6.	Application	Models hazardous chemical spills, vaporization rates, and atmospheric dispersion.
7.	Limitations	The evaporating pool model does not work correctly.
8.	Sponsor	DOE Richland Operations Office.
9.	Computer Requirements	Personal computer using FORTRAN language.
10.	Source-Receptor Relationship	None provided.
11.	Emission Rates	Liquid spills-evaporating pool gaseous or particulate releases.
12.	Chemical Composition	Toxic chemicals.
13.	Plume Behavior	Simple neutral buoyancy Gaussian model.
14.	Wind Field	Temporally and spatially invariant.
15.	Dispersion Algorithms	Gaussian.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Conditions	None provided.
19.	Meteorological Requirements	Wind direction, wind speed, and an indicator of stability.
20.	Validation	None provided.
21.	Output	None provided.

MODEL 22 (cont.)

22.	Genealogy	None provided.
23.	Additional Information	None.

MODEL 23

1.	Name	EPIcode[R] - Emergency Prediction Information Code (EPIcode)
2.	References	EPIcode Reference Manual, 103 pages, 1988. Other referenced material is documented in this manual.
3.	Abstract	EPIcode is an MS-DOS software package for health and safety professionals. EPIcode is used in emergency planning and response for fast risk assessment and estimation of the concentrations resulting from the atmospheric release of toxic substances. The EPIcode package comes with a comprehensive manual, which includes detailed user instructions, full documentation, and background on all algorithms, along with ten detailed examples.
4.	Location	Commercially available software. (See Item 5)
5.	Information Contacts	Primary: Steven Homann Homann Associates, Inc. 39831 San Moreno Court Fremont, CA 94539 Phone: (510) 490-6379 Secondary: Teresa Carter Phone: (510) 490-6379
6.	Application	EPIcode is used in emergency planning and response for fast risk assessment and estimation of the concentrations resulting from the atmospheric release of toxic substances.
7.	Limitations	EPIcode is based principally upon the Gaussian plume model and is subject to all the limitations of this model. The software is intended as a screening tool for initial assessment of emergency situations.
8.	Sponsor	This model is commercially available software.
9.	Computer Requirements	EPIcode will run on an IBM compatible including an HPI00LX palmtop. EPIcode requires only a single disk drive and at least 512 kilobytes of RAM. Software is available in either a single 3.5-inch or two 5.25-inch diskettes. Supports monochrome, LCD, and color monitors.
10.	Source-Receptor Relationship	Three-axis rectangular coordinate system. Single source located at origin, with variable release height. Receptors may be located on or off the centerline plume axis with variable height.
11.	Emission Rates	Continuous: g/s, lb/min, m^3/s, ft^3/s, gal/min. Term and instantaneous: g, lb, m^3, gal. Evaporation model: lb/min, g/s.
12.	Chemical Composition	Passive contaminant.
13.	Plume Behavior	Straight-line Gaussian (term release: Automatic transition from continuous to puff phase based on plume length at downwind receptor locations). Users can input mixing height, and momentum and buoyant plume rise.
14.	Wind Field	Uniform wind field.

MODEL 23 (cont.)

15.	Dispersion Algorithms	Gaussian algorithms for both continuous and puff (term) phase. Briggs equations (1973) for urban and rural terrain crosswind and vertical standard deviations. Users can select sample averaging times. All algorithms are fully documented.
16.	Chemical Reactions	None.
17.	Removal Process	Dry deposition (Van der Hoven integral). Default deposition velocities of 1 cm/s for solids, and 0.1 cm/s for vapors and gases. These default values may be changed by the user if more applicable information is available; e.g., increased deposition due to chemical reactivity, etc.
18.	Boundary Conditions	Gaussian model boundary conditions, applicable from a distance of 0.1 km to approximately 10 km, and thought to be extendable to 20 or 30 km.
19.	Meteorological Requirements	Wind speed at height of 2 to 10 m. Solar insolation data (sun high, low, cloudy/night), or direct input of stability class (A-F). Worst-case option, W, compares all stability classes at each receptor location, and outputs class resulting in the greatest concentration.
20.	Validation	The Gaussian model has been used and accepted by the EPA. The adequacy of the Gaussian model for making initial dispersion estimates has been tested and verified for many years.
21.	Output	Tabular data, graphical display, ASCII disk file to be imported to word processing or spreadsheet software, or printer output. Graphics consist of either plume centerline concentration versus distance, or plume concentration contours. Tabular output lists distance, concentration, arrival time, and worst-case stability class, if desired.
22.	Genealogy	Version 3.0 (1988): First release beta test complete. Version 3.5 (1989): Incorporation of user input sampling time. Version 4.0 (1990): Incorporation of liquid spill model. Version 5.0 (1993): Incorporation of high-resolution graphics. Annual library data base updates, 1988, 1989, 1990, and 1994.
23.	Additional Information	EPIcode contains a library of approximately 600 chemical substances along with the associated exposure levels accepted by various organizations and regulatory agencies; users can add other chemicals to a supplementary library.

MODEL 24

1.	Name	Explosive Release Atmospheric Dispersion (ERAD)
2.	References	(1) Boughton, B.A., DeLaurentis, J.M., and Dunn, W.E., 1987, "A Stochastic Model of Particle Dispersion in the Atmosphere," *Boundary-Layer Meteorology* 40: 147-163. (2) Boughton, B.A. and DeLaurentis, J.M., 1987, "An Integral Model of Plume Rise from High Explosive Detonations," Proceedings of the 24th National Heat Transfer Conference, American Society Mechanical Engineers, August 9-12, Pittsburgh, PA. (3) Boughton, B.A. and DeLaurentis, J.M., 1990, "Validation of an Atmospheric Dispersion Model for High Explosive Detonations," Sandia National Laboratories Report, in preparation. (4) Boughton, B.A. and DeLaurentis, J.M., 1992, "Description and Validation of ERAD: An Atmospheric Dispersion Model for High Explosive Detonations," SAND92-2069, Sandia National Laboratories, Albuquerque, NM.
3.	Abstract	The ERAD model is a three-dimensional, numerical simulation of turbulent atmospheric transport and diffusion. For buoyant releases, an integral plume rise technique is used to provide a description of the physical and thermodynamic properties of the cloud of warm gases. Particle dispersion is treated as a stochastic process, which is simulated using a discrete time Lagrangian Monte Carlo method. The stochastic process, approach permits a more fundamental treatment of buoyancy effects, calm winds, and spatial variations in meteorological conditions.
4.	Location	Sandia National Laboratories MS 0763 P.O. Box 5800 Albuquerque, NM 87185-0763
5.	Information Contacts	Primary: Bruce Boughton Sandia National Laboratories P.O. Box 5800 Albuquerque, NM 87185-5800 Phone: (505) 844-8545 Secondary: Catherine Turco Technology Transfer Organization Phone: (505) 271-7845
6.	Application	ERAD was originally developed to provide real-time estimates of the near-field consequences that result from an explosive release of hazardous material. The model has been extended to treat fire and non buoyant release mechanisms. Both gaseous and monodisperse or polydisperse particle sources can be simulated.

MODEL 24 (cont.)

7.	Limitations	The probability density for the stochastic process governing particle displacements in the vertical direction obeys a K-theory turbulence model. In the strictest sense, ERAD is then limited to travel times that are much larger than the Lagrangian time scale of the turbulent motions, a condition that is satisfied for near-surface releases. The stochastic technique is, however, independent of any underlying grid and, therefore, ERAD does not suffer from the grid resolution problem found in many other K-theory models.
8.	Sponsor	Sandia National Laboratories.
9.	Computer Requirements	The ERAD software runs on a Sun Microsystems workstation or other SPARC-compliant computer. Both the Solaris 1.x (SUNOS 4.1.x) and Solaris 2.x (SUNOS 5.x) are supported. Execution time is typically less than two minutes.
10.	Source-Receptor Relationship	To calculate the health consequences for a radioactive release, the user specifies a breathing rate and the specific activity and toxicity of the material.
11.	Emission Rates	Instantaneous and short-duration releases.
12.	Chemical Composition	Passive contaminants and radionuclides.
13.	Plume Behavior	Source buoyancy is treated using an integral plume rise model.
14.	Wind Field	A distance-weighted interpolation of multiple soundings of wind measurements is used to compute the wind field.
15.	Dispersion Algorithms	The ERAD dispersion algorithm combines some aspects of both puff models and probabilistic methods. Turbulence effects are modeled by tracking Monte Carlo "particles" that have Gaussian distributions in the horizontal direction. This conceptualization significantly reduces the number of particles necessary to produce reliable ensemble statistics. Changes in wind direction are handled rigorously; at each time step a particle is advected in the direction of the wind appropriate for its position in space. ERAD incorporates a state-of-the-art description of the planetary boundary layer based on similarity scaling derived from observational, laboratory, and numerical studies. Examples are the use of Monin-Obukhov similarity theory in the surface layer, convective scaling in the unstable boundary layer, and local scaling in the stable boundary layer. The diffusivity formulation includes a correction for the counter-gradient flux present under convective conditions.
16.	Chemical Reactions	None.
17.	Removal Process	Dry and wet deposition.
18.	Boundary Conditions	The deposition velocity (flux) boundary condition is imposed at the ground. Particles are reflected at the top of the boundary layer.
19.	Meteorological Requirements	Large-area roughness length, surface pressure, surface relative humidity, precipitation rate, and wind and temperature profiles.

MODEL 24 (cont.)

20.	Validation	The ERAD model has been evaluated against measurements obtained during Operation Roller Coaster. With few exceptions, cloud top height predictions of the integral plume rise model were within 25 percent of the field observations. The complete model was validated against dosage and deposition measurements. Predicted contour areas average within 50 percent of the observations. The validation results confirm the model's representation of the physical processes.
21.	Output	ERAD results are presented as contours of ground-level dose and deposition. Predictions may be displayed on a graphics screen or drawn to scale on any site map using a digitizing pen plotter. In addition, a listing is made of all input parameters and derived atmospheric parameters.
22.	Genealogy	Development began in the late 1980s and continues.
23.	Additional Information	An X-windows graphical user interface, including on-line help, permits practitioners with a minimum of training to effectively apply the model. The next release of ERAD will integrate model predictions with a Geographical Information System based on TIGER data.

MODEL 25

1.	Name	EXTRAN
2.	References	Ramsdell, J.V. 1990, *EXTRAN: A Computer Code for Estimating Concentrations of Toxic Substances at Control Room Air Intakes*, NUREG/CR-5656 (PNL-7510), Nuclear Regulatory Commission, Washington, D.C.
3.	Abstract	The EXTRAN code provides a method for estimation of the buildup and average concentrations of toxic chemicals resulting from a leak or catastrophic failure of a storage container. The model assumes straight-line transport and Gaussian diffusion. A time-based building wake diffusion model is included in the code. The source term for the atmospheric dispersion model is computed from information on the total amount of material released or release rate and the physical properties of the material. A library of physical properties for 20 chemicals is supplied with the code.
4.	Location	Pacific Northwest Laboratory P.O. Box 999 Richland, WA 99352
5.	Information Contacts	Primary: J.V. Ramsdell Pacific Northwest Laboratories, MS K9-30 P.O. Box 999 Richland, WA 99352 Phone: (509) 372-6316 E-mail: j_ramsdell@pnl.gov Secondary: Jason Schaperow Nuclear Regulatory Commission Washington, D.C. 20555 Phone: (301) 415-5074 E-mail: jhsl@nrc.gov
6.	Application	EXTRAN is intended to be used in the evaluation of facility designs. It may also be used in the emergency preparedness planning phase. The source term portion of the code may also be appropriate for incorporation in simple response models.
7.	Limitations	Straight-line transport and diffusion using a puff model. No deposition, decay, or chemical reactions. No corrections for heavy gases. Not for long-range transport and diffusion.
8.	Sponsor	Nuclear Regulatory Commission.
9.	Computer Requirements	IBM or compatible PC with an Epson or compatible printer.
10.	Source-Receptor Relationship	Straight-line Gaussian transport and diffusion from ground-level or elevated source. Distance to and height of a single receptor are specified by the user at run time.
11.	Emission Rates	The release scenario, total mass available, and leak rate are specified at run time.

MODEL 25 (cont.)

12.	Chemical Composition	EXTRAN treats one chemical per run. A library containing the physical properties of 20 chemicals is included with the program. The code may be used for other chemicals if the physical properties are known to the user. Model treats flashing of liquid gases and evaporation from pools.
13.	Plume Behavior	No plume rise; enhanced diffusion in building wakes.
14.	Wind Field	Straight-line transport with speed at release height estimated from the 10-m wind speed and stability class using a diabatic profile.
15.	Dispersion Algorithms	Gaussian puff model with dispersion coefficients. Building wake diffusion estimated using a theoretical model based on travel time.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Conditions	Reflection at ground level is assumed.
19.	Meteorological Requirements	Depends on release scenario.
20.	Validation	None.
21.	Output	Primary output consists of time series giving the current concentration, average concentration and time-integrated concentration at the receptor for the first few minutes after arrival of the plume at the receptor. These series are plotted and listed using a printer and are written to a disk file. The mass balance and thermodynamic conditions of the source at each time step are written to a disk file as secondary output.
22.	Genealogy	The puff diffusion algorithms are drawn from the MESOI code.
23.	Additional Information	An updated version of EXTRAN is included in a set of computer programs used for control habitability assessments called HABIT. HABIT is described in NUREG/CR-6210, *Computer Codes of Evaluation of Control Room Habitability.* Other codes in HABIT include TACT%, FPFP-2 CONHAB, and CHEM. HABIT provides a common Visual Basic shell of the codes and a method for passing files between codes.

MODEL 26

1.	Name	FEM-PBL
2.	References	(1) Lee, R.L.; Leone, J.M., Jr. Gresho, P.M.; and Chan, S.T., "A Finite Element Model for Environmental Problems Involving Complex Terrain," *Finite Element Flow Analysis*, T. Kawai (ed.), University of Tokyo Press, Tokyo, Japan, 247-254. (2) Lee, R.L.; and Leone, J.M., Jr., 1988, "A Modified Finite Element Model for Mesoscale Flows over Complex Terrain," *Comp. and Math with Applications* 16: 41-56. (3) Leone, J.M., Jr.; and Lee, R.L., 1989, "Numerical Simulation of Drainage Flow in Brush Creek, Colorado, *Journal of Applied Meteorology* 28: 530-542.
3.	Abstract	FEM-PBL solves the nonhydrostatic Boussinesqe equations of motion and energy using a modified finite element method. The model includes water vapor and condensed water, but no precipitation. It also includes the advection-diffusion of a neutral tracer. Turbulence is modeled using simple K-theory.
4.	Location	Regional Atmospheric Sciences Division Lawrence Livermore National Laboratory Livermore, CA 94550
5.	Information Contacts	Primary: John M. Leone, Jr. Lawrence Livermore National Laboratory P.O. Box 808 Livermore, CA 94550 Phone: (510) 422-6449 Secondary: Robert L. Lee
6.	Application	Meso-B simulations of flow, especially over regions of complex terrain.
7.	Limitations	FEM-PBL is a research model with only limited documentation. The model lacks a surface energy budget submodel. The model cannot be driven by boundary conditions generated by a larger- scale model.
8.	Sponsor	Lawrence Livermore National Laboratory.
9.	Computer Requirements	Cray class computer. Should be run using 64-bit floating point size to ensure accuracy of matrix solver.
10.	Source-Receptor Relationship	Not applicable.
11.	Emission Rates	Not available except as boundary fluxes.
12.	Chemical Composition	Not available.
13.	Plume Behavior	Not provided.
14.	Wind Field	Self-developed.

MODEL 26 (cont.)

15.	Dispersion Algorithms	Dispersion is usually addressed by the LLNL ADPIC model (i.e., model-predicted wind fields are passed to ADPIC for use in the dispersion calculation). The model does contain an advection-diffusion equation that will transport a neutral tracer.
16.	Chemical Reactions	Not available.
17.	Removal Process	None.
18.	Boundary Conditions	Either specified, or natural boundary conditions on u, v, w, theta-prime, q_v, q_l, concentration; radiation-type conditions available as well as sponge layer on top.
19.	Meteorological Requirements	Initial fields of u, v, w, and theta-prime (q_v, q_l, and concentration moisture and tracer are needed).
20.	Validation	A wide variety of idealized test problems and applications to ASCOT field experiments.
21.	Output	Fields of u, v, w, and theta-prime (q_v, q_l, and concentration) at specified times and time-histories of user-specified nodal variables.
22.	Genealogy	This model, which was initially named FEMCOT, is a spinoff of the original FEM3 heavy gas dispersion model. There has been continued development in both the physics and numerics by a number of researchers.
23.	Additional Information	One of the unique features of the model is the adaptability of the grid structure. It is quite easy to use variable spaced grids to achieve high resolution in regions of importance, such as boundary layers, and to simulated domains with geometrically complicated boundaries, such as coastlines or mountain ranges.

MODEL 27

1.	Name	FPFP-2
2.	References	Owczarski, P.C., Burk, K.W., Ramsdell, J.V., and Yasuda, D.D., 1990, *FPFP_2: A Code for Following Airborne Fission Products in Generic Nuclear Plants Flow Paths*, NUREG/CR-5658 (PNL-7513), Nuclear Regulatory Commission, Washington, D.C.
3.	Abstract	FPFP-2 is intended for use in estimating the concentration and flow rates of airborne fission products in generic flow paths in nuclear facilities. Flow path descriptions and source terms are entered by the user. Flow paths consist of a series of rooms, ducts, filters, and resistances. Fission products may be treated as a continuous, time-dependent, or puff release. During transit they deposit as a result of normal physical processes or the action of sprays. For particulate fission products, FPFP-2 assumes a log-normal size distribution with an aerodynamic mass median diameter of one micron and a geometric standard deviation of two.
4.	Location	Pacific Northwest Laboratories P.O. Box 999 Richland, WA 99352
5.	Information Contacts	Primary: Jason Schaperow Nuclear Regulatory Commission Washington, D.C. 20555 Phone: (301) 415-5074 Secondary: Steve Stape Pacific Northwest Laboratory, MS K9-30 Box 999 Richland, WA 99352 Phone: (509) 372-6315 E-mail: sa_stage@pnl.gov
6.	Application	Primary application of the FPFP-2 code to emergency preparedness is in planning stages in the evaluation of potential release rates to the environment.
7.	Limitations	FPFP-2 is designed only as a planning tool. It ignores diffusion along the flow path and assumes well-mixed concentrations in rooms.
8.	Sponsor	Nuclear Regulatory Commission.
9.	Computer Requirements	FPFP-2 is written in FORTRAN-77 and runs on PCs with 640 kilobytes of RAM and a math coprocessor.
10.	Source-Receptor Relationship	The source-receptor relationship is defined by the user in a preprocessor program that is used to generate a run file. It consists of a number of elements in a single path. Branches in an actual path are treated by dividing the actual path into simple components.
11.	Emission Rates	User defined.

MODEL 27 (cont.)

12.	Chemical Composition	Fission products are divided into three groups: noble gases, iodine vapors, and particulates. The user provides the emission rate for each group.
13.	Plume Behavior	FPFP-2 treats transport within a facility. Plug flow is assumed in ducts, and rooms are assumed to be well mixed.
14.	Wind Field	None.
15.	Dispersion Algorithms	None.
16.	Chemical Reactions	None.
17.	Removal Process	Dry deposition of iodine vapor and particles. Washout of particles by sprays, if installed, and filtration of particles if filters are installed.
18.	Boundary Conditions	None identified.
19.	Meteorological Requirements	User-specified flow rates, pressures, and temperatures at nodes in the flow path.
20.	Validation	None.
21.	Output	Concentrations (mass/m^3) and rates (mass/time) at which fission products pass nodes in the flow path as functions of time.
22.	Genealogy	None.
23.	Additional Information	An updated version of FPFP-2 is included in a set of computer programs used for control habitability assessments called HABIT. HABIT is described in NUREG/CR-6210, *Computer Codes of Evaluation of Control Room Habitability*. Other codes in HABIT include TACT5, CONHAB, EXTRAN, and CHEM. HABIT provides a common Visual Basic shell for the codes

MODEL 28

1.	Name	FUSCRAC3
2.	References	(1) Piet, S.J., Gilberti, V.J., and Kazimi, M.S., 1982, "FUSCRAC: Modifications of CRAC for Fusion Application," MIT Plasma Fusion Center, PFC/RR-82-20 (DOE UC-20, C, D, E). (2) Brerton, S.J. and Piet, S.J., 1988, "Modifications to FUSCRAC2 in Creating FUSCRAC3," Idaho National Engineering Laboratory, SJB-33-88.
3.	Abstract	FUSCRAC3 is a fusion-based code for calculation of reactor accident consequences that has the capability to handle a tritium source term and to provide a probabilistic treatment of site-specific meteorology. It performs atmospheric transport and deposition and radiological consequence calculations with the consideration of mitigative actions, health effects, and economic costs. It also performs uncertainty and sensitivity analyses.
4.	Location	Westinghouse Savannah River Company Safety Engineering Department P. O. Box 616 Aiken, SC 29808
5.	Information Contacts	Primary: Kevin R. O'Kula Westinghouse Savannah River Company Safety Engineering Department P.O. Box 616 Aiken, SC 29808 Phone: (803) 644-5440 Secondary: J.C. Huang Phone: (803) 644-5290
6.	Application	The code deals with dispersion and dose calculations for releases of radionuclides to the atmosphere, with particular emphasis on fusion reactor releases. Dose calculations include pathways such as inhalation, ingestion, ground shine, cloud shine, and resuspension.
7.	Limitations	Not applicable.
8.	Sponsor	DOE Idaho National Engineering Laboratory.
9.	Computer Requirements	Cray (LANL).
10.	Source-Receptor Relationship	Model is not used for source-receptor relationships.
11.	Emission Rates	User input.
12.	Chemical Composition	Passive contaminants and radionuclides.
13.	Plume Behavior	Gaussian plume.
14.	Wind Field	Based on an array of 60-meter instrumented towers. Temporally variant, but spatially invariant.

MODEL 28 (cont.)

15.	Dispersion Algorithms	Statistical, based on Pasquill-Gifford parameterization of atmospheric dispersion.
16.	Chemical Reactions	None.
17.	Removal Process	Wet and dry deposition.
18.	Boundary Conditions	Plume is reflected at the ground. Mixing layer places a limit on plume expansion in the vertical direction.
19.	Meteorological Requirements	Wind direction, wind speed, rainfall rate, sigma azimuth and sigma elevation, and mixing height.
20.	Validation	Although FUSCRAC and FUSCRAC2 were validated to some extent, FUSCRAC3 validation is unknown.
21.	Output	Meteorological input data, release characterization (i.e., duration, location, source term, etc.) centerline concentrations and doses, and doses at specified receptors.
22.	Genealogy	FUSCRAC is a modified version of CRAC (Calculation of Reactor Accident Consequences), which was developed in the early 1980's and modified by several contributors up to the late 1980's.
23.	Additional Information	This code includes the food chain ingestion of tritium and inhalation/skin absorption. The selection of options and data entry are not user-friendly.

MODEL 29

1.	Name	GAUS1
2.	References	Gifford, F.A., and Porch, W.M., "Atmospheric Diffusion Calculations on the HP-48 Series Pocket Calculators," Report LA-CC-94-5, Los Alamos National Laboratory.
3.	Abstract	A Gaussian plume atmospheric dispersion model designed for modern scientific calculator operation. It includes diffusion, deposition, and resuspension estimates, and most of the parameterizations from the Hanna, Briggs, and Hosker *Handbook on Atmospheric Diffusion*, 1982, as well as risk and radioactivity dose calculations.
4.	Location	The model is operated at Los Alamos National Laboratory.
5.	Information Contacts	Primary: William M. Porch EES-5 Los Alamos National Laboratory MS D401 Los Alamos, NM Phone: (505) 667-0971 E-mail: wmp@vega.lanl.gov Secondary: Frank A. Gifford Phone: (615) 482-1819
6.	Application	GAUS1 is a portable tool for quick assessment, and is handy for comparing simple estimates with more complex outputs.
7.	Limitations	Straight-line plume dispersion and limited graphical display capability.
8.	Sponsor	DOE Office of Environment, Safety and Health.
9.	Computer Requirements	Runs on either a HP-486SX or HP-486DX, the latter being a newer calculator model.
10.	Source-Receptor Relationship	Not used for source-receptor relationships.
11.	Emission Rates	User input.
12.	Chemical Composition	Passive contaminants with tabulated risk factors and radionuclides with supplied decay rates and dose conversions.
13.	Plume Behavior	Gaussian puff or plume with urban or rural surface roughness types.
14.	Wind Field	Single wind speed and wind direction adjustable to source height.
15.	Dispersion Algorithms	Bivariate Gaussian per Hanna, Briggs, and Hosker.
16.	Chemical Reactions	None.
17.	Removal Process	Wet and dry deposition.
18.	Boundary Conditions	Reflection off the surface and boundary layer top.

MODEL 29 (cont.)

19.	Meteorological Requirements	Wind direction, wind speed, rainfall rate, mixing layer, mixing depth, and stability class.
20.	Validation	Comparison with worked problems in *Workbook of Atmospheric Dispersion Estimates*, D.B. Turner, 1969.
21.	Output	Normalized centerline or off-axis concentrations, risk and dose factors.
22.	Genealogy	Developed in 1992 with ongoing improvements.
23.	Additional Information	The strengths of this model include its portability, as well as the vast library of parameterizations such as building wake effects, urban pollution, line sources, resuspension, and long-range diffusion.

MODEL 30

1.	Name	GENII
2.	References	(1) Napier, B.A., Peloquin, R.A., Strenge, D.L. and Ramsdell, J.V., 1988, *GENII - The Hanford Environmental Radiation Dosimetry Software System* (3 Volumes), PNL-6584, Pacific Northwest Laboratories, Richland, WA. (2) Leigh, C.D., Thompson, B.M., Campbell, J.E., Longsine, D.E., Kennedy, R.A., Napier, B.A., 1993, "User's Guide for GENII-S, A Code for Stochastical and Deterministic Simulations of Radiation Doses to Humans from Radionuclides in the Environment," SAND91-0561, Sandia National Laboratories, Albuquerque, NM.
3.	Abstract	GENII is a system of seven closely linked computer codes and their associated data libraries that is used for dose computations. The system includes codes for evaluating environmental (air and water) transport and diffusion of acute (accidental) and chronic (routine) releases. A stochastic version allows propagation of parameter uncertainties via Monte Carlo/Latin-hypercube techniques. Dose computation options include annual dose, committed dose, and accumulated dose. Internal dosimetry models recommended by the ICRP are included in GENII.
4.	Location	(1) Pacific Northwest Laboratories P.O. Box 999 Richland, WA 99352 (2) Radiation Shielding Information Center Oak Ridge National Laboratory.
5.	Information Contacts	Primary: B.A. Napier Pacific Northwest Laboratories P.O. Box 999 Richland, WA 99352 Phone: (509) 375-3896 Secondary: C.D. Leigh Sandia National Laboratories Phone: (505) 844-1888 J.V. Ramsdell Pacific Northwest Laboratories Phone: (509) 372-6316 E-mail: j_ramsdell@pnl.gov

MODEL 30 (cont.)

6.	Application	GENII is intended for use in prospective consequence assessments such as site evaluations, environmental impact statements, safety analysis reports, and retrospective assessments of the potential consequences of routine releases. Although it is not intended for use during the course of an accident, the dose computation portions of the system might be used following an accident to refine earlier consequence assessments.
7.	Limitations	GENII is a large system of codes intended for use by trained individuals. Selection of options and data entry are time- consuming and require considerable expertise. GENII does not treat chemical releases.
8.	Sponsor	Department of Energy.
9.	Computer Requirements	GENII runs on IBM compatible class computers with a math coprocessor, 640 kilobytes of RAM, and a hard disk with a minimum of 5 megabytes of RAM. It requires DOS Version 3.1 or later. The GENII-S version; in addition, requires 1-2 megabytes of extended memory.
10.	Source-Receptor Relationship	For atmospheric releases, the source is assumed to be at the center of a polar grid. Doses are computed at nodes on the grid using population characteristics supplied by the user.
11.	Emission Rates	User-supplied by radionuclide.
12.	Chemical Composition	Releases are assumed to be passive.
13.	Plume Behavior	Atmospheric transport and dispersion are based on the straight-line Gaussian model. Buoyant and momentum plume rise may be used to determine effective release height for stack releases.
14.	Wind Field	The internal atmospheric transport model assumes straight-line Gaussian conditions. The 10-m wind is used for ground-level releases, and the wind speed at release height is used for elevated releases. A diabatic wind profile is used to estimate winds at the required level if it is different from the measurement level.
15.	Dispersion Algorithms	Two dispersion models are included in GENII. Concentrations associated with acute (accidental) releases are computed for the plume centerline using a straight-line Gaussian model. Concentrations associated with chronic (routine) releases are computed using a sector-average, straight-line Gaussian model. Building wakes are treated using an empirical model based on data obtained in field experiments.
16.	Chemical Reactions	None.
17.	Removal Process	The internal atmospheric models compute surface contamination from dry deposition using a constant deposition velocity. The plume is not depleted. Radioactive decay is considered, where appropriate.
18.	Boundary Conditions	The internal atmospheric dispersion model assumes reflection at the ground and top of the mixing layer.

MODEL 30 (cont.)

19.	Meteorological Requirements	GENII's internal atmospheric transport and diffusion model requires a joint frequency distribution of wind speed, wind direction, and stability. A default air temperature of 15°C is assumed, and the mixing layer is assumed to be limited to 1000 m. These values may be changed by the user.
20.	Validation	None.
21.	Output	Specific output for each run is selected by the user during initialization. Output options include an annual effective dose equivalent, and output by radionuclide or by exposure pathway. This output is stored in files that are suitable for printing. In addition, intermediate results of the calculations may be printed to the screen.
22.	Genealogy	GENII incorporates the capabilities of portions of a number of dosimetry codes used at Hanford. These codes include KRONIC, SUBDOSA, DACRIN, FOOD, ARRRG, PABLM, ONSITE/MAXI, BIOPORT/MAXI, and DITTY.
23.	Additional Information	GENII was developed and is maintained under a quality assurance plan based on ANSI Standard NQA-1. During development, the dosimetry portions of the code were subjected to external peer review on two occasions. Recommendations of the review committees have been incorporated in the current version of the code. A list of known users of GENII is maintained at PNL. When revisions are made to the code, all known users are provided with updated copies of the executable code.

MODEL 31

1.	Name	GTM
2.	References	Lee, H.N., and Feichter, J., 1994, "An Intercomparison of Wet Precipitation Scavenging Schemes and the Emission Rates of ^{222}Rn for the Simulation of Global Transport and Deposition of ^{210}Pb," submitted to *Journal of Geophysical Research (Atmosphere)* for publication.
3.	Abstract	The GTM is a three-dimensional grid model that includes wet and dry deposition. The model requires the input of three-dimensional meteorological data and the source emission.
4.	Location	Environmental Measurements Laboratory New York, NY
5.	Information Contacts	Primary: H.N. (Sam) Lee Phone: (212) 620-6607; Fax: (212) 620-3600 Secondary: None
6.	Application	Estimates of distributions of releasing radionuclides.
7.	Limitations	Global outputs with 7.83 degrees x 10 degrees resolution in the horizontal plane and nine layers in the vertical plane extending from the surface to 10 mb by using a sigma coordinate. Outputs are concentrations, not dose estimates.
8.	Sponsor	DOE/Environmental Measurements Laboratory.
9.	Computer Requirements	VAX 6410.
10.	Source-Receptor Relationship	Model not used for SRRs.
11.	Emission Rates	User input.
12.	Chemical Composition	Passive contaminants and radionuclides.
13.	Plume Behavior	Non-Gaussian plume.
14.	Wind Field	User input at each grid point.
15.	Dispersion Algorithms	Numerical solution of the three-dimensional, time-dependent transport diffusion equation.
16.	Chemical Reactions	None.
17.	Removal Process	Wet and dry deposition.
18.	Boundary Conditions	Flux is zero at the top of the model, and flux at the ground is proportional to the ground concentration.
19.	Meteorological Requirements	Wind speed and direction, precipitation and rainfall rate.

MODEL 31 (cont.)

20.	Validation	The outputs from the model were compared with the global radionuclide measurements at EML.
21.	Output	Source, sink, decay rate and mass at each latitude belt, zonally averaged mixing ratio, concentration at each grid volume.
22.	Genealogy	The model was originally developed by the Goddard Institute of Space Science (GISS) and modified by several contributors up to the present.
23.	Additional Information	Strengths of the model include the high-resolution meteorological data from the ECMWF model analyses and the accurate radionuclide source term.

MODEL 32

1.	Name	GXQ
2.	References	(1) Hey, Brit E., 1993, *GXQ Program Users' Guide*, WHC-SD-SWD-30002, Rev. 0, Westinghouse Hanford Company, Richland, WA. (2) Hey, Brit E., 1993, *GXQ Program Verification and Validation*, WHC-SD-GN-SWD-30003, Rev. 0, Westinghouse Hanford Company, Richland, WA.
3.	Abstract	GXQ is an IBM-compatible, microcomputer-based program for calculating atmospheric dispersion coefficients using site- specific joint frequency data. Based on the Gaussian straight- line plume model, several options are available to include the effects of plume depletion, building wake, plume meander, sector averaging, gravitational settling, and plume rise. Additional options control handling of the joint frequency data in order to provide annual average, population weighted, 50 percent, 99.5 percent, etc. X/Qs. Combinations of the above options allow calculation of X/Qs in accordance with Nuclear Regulatory Commission Regulatory Guide 1.145.
4.	Location	Richland, WA.
5.	Information Contacts	Primary: Mr. Brit E. Hey Westinghouse Hanford Company P.O. Box 1970 Richland, WA 99352 Phone: (509) 376-2921 Secondary: Mr. A. (Tony) V. Savino
6.	Application	GXQ was written for use in preparing accident safety analyses. In conjunction with dose conversion coefficients and deposition velocities, it can be used to directly calculate dose and ground contamination at points or in contours.
7.	Limitations	Gaussian plume model limitations apply.
8.	Sponsor	Westinghouse Hanford Company.
9.	Computer Requirements	IBM PC or compatible with math coprocessor.
10.	Source-Receptor Relationship	One ground- or stack-level point, area, or volume source. Unlimited flagpole receptors.
11.	Emission Rates	Constant continuous or puff release. Flow rate adjustment available to prevent concentration at close receptors from exceeding source.
12.	Chemical Composition	Gases or particles with motion governed by atmospheric turbulence, momentum/buoyancy rise, and/or gravitational settling.
13.	Plume Behavior	Straight-line with optional plume meander, building wake, stack downwash factors.

MODEL 32 (cont.)

14.	Wind Field	Simulates acute or chronic release using either joint frequency file or user-specified wind speed and stability class.
15.	Dispersion Algorithms	Straight-line Gaussian plume or puff.
16.	Chemical Reactions	None.
17.	Removal Process	Dry deposition.
18.	Boundary Conditions	Plume reflection at ground and mixing layer.
19.	Meteorological Requirements	Sixteen sectors, eight wind speeds, and Pasquill A-G stability classes provided in joint frequency file.
20.	Validation	None.
21.	Output	Input echo, atmospheric dispersion coefficients, and optional diagnostic information.
22.	Genealogy	Developed by Westinghouse Hanford Company for use in accident analysis.
23.	Additional Information	Updated revision to include ISC2-type momentum/buoyancy plume rise, pool evaporation, and fire modeling capability, due early 1995.

MODEL 33

1.	Name	HARM-II
2.	References	Pendergrass, W.R., 1990, The HARM-II Emergency Management Model, Vols. 1-3, National Oceanic and Atmospheric Administration, Atmospheric Turbulence Diffusion Division, Oak Ridge, TN.
3.	Abstract	HARM-II is an interactive dose assessment model designed to predict consequences of the accidental release of hazardous materials, either chemical or radioactive. The model combines both passive and heavy gas codes for chemical spills, as well as standard transport and diffusion codes for radionuclide releases. Reactive chemistry is considered for those chemicals with exothermic reaction characteristics. The calculations are performed on a scale of 10 m to 30 km.
4.	Location	National Oceanic and Atmospheric Administration Atmospheric Turbulence and Diffusion Division P.O. Box 2456 456 South Illinois Avenue Oak Ridge, TN 37831
5.	Information Contacts	Primary: Will R. Pendergrass National Oceanic and Atmospheric Administration Atmospheric Turbulence and Diffusion Division P.O. Box 2456 456 South Illinois Avenue Oak Ridge, TN 37831 Phone: (615) 576-6234 Secondary: None
6.	Application	Emergency management for accidental releases of hazardous chemicals or radionuclides. The model is designed for both scenario preplanning and actual emergency response situations.
7.	Limitations	The model is subject to the normal limitations of Gaussian modeling and simple heavy gas models. The model is site- specific, requiring data on local topography and building configurations. The model application is limited to near-field ranges (within 50 km of the site).
8.	Sponsor	DOE and NOAA.
9.	Computer Requirements	HARM-II is written in standard FORTRAN-77 using VAX extensions. The code is available for two operating systems: DEC VAX and HP UNIX. A simplified version requires a GKS graphics subsystem to display the data, while the HP UNIX version operates under x-windows.
10.	Source-Receptor Relationship	Sources may be located anywhere on the calculation grid. Two sets of receptors are available. The first is fixed to a Cartesian calculation grid; the second is specified by the operator and can be located anywhere within the calculation domain.
11.	Emission Rates	Specified by the user at any time during the simulation through either functional representation, operator input, or stack monitoring.

MODEL 33 (cont.)

12.	Chemical Composition	Both passive and heavy gas and aerosols are considered. UF_6 releases can also be considered.
13.	Plume Behavior	Plume rise, either mechanical or buoyant, is available as an option.
14.	Wind Field	HARM-II uses two wind fields. A simplistic $1/r^2$ interpolation is used to initiate the wind field based on available surface wind observations. A mass-consistent model is used to establish the three dimensional wind field. The calculations are coupled with meteorological site surveys conducted at each ORO facility.
15.	Dispersion Algorithms	For passive releases, standard Gaussian puff algorithms are used with on-site measurements of σ_θ and σ_ϕ. Heavy gas releases are modeled with a Colenbrander-type dispersion algorithm which provides for entrainment of ambient air, deentrainment of contaminants, and smooth transitions.
16.	Chemical Reactions	Includes the production of UO_2F_2 and HF by the reactions between UF_6 and H_2O.
17.	Removal Process	Dry deposition and gravitational setting. For radiological releases, a source depletion model is used.
18.	Boundary Conditions	Puff reflections at the ground. Material transported off the domain is removed from consideration.
19.	Meteorological Requirements	Wind speed and direction, upper-level wind speed and direction, atmospheric stability are required from at least one location. Up to 30 stations may be considered in the wind field calculations. Models are provided for real-time input of tower data from an observation network or from user input.
20.	Validation	The transport and diffusion codes have been evaluated using data sets from the DOE Savannah River Site. These evaluations show HARM-II to consistently predict 80-90 percent of the observed concentration to within an order of magnitude and roughly 40 percent to within a factor of 1.5-2.0.
21.	Output	Output is available graphically or in tabular form.
22.	Genealogy	None provided.
23.	Additional Information	HARM-II is the primary modeling capability for ORO and its contractors. It was developed and implemented with a tiered approach to use on-site capabilities; operations office capabilities; and the capabilities of ARAC, operated by LLNL. This provides a comprehensive approach to emergency management.

MODEL 34

1.	Name	HazCon
2.	References	(1) A.L. Dudley, et.al., *HazCon User's Manual*, May 1991, SPECTRA Research Institute for Sandia National Laboratories, Albuquerque, NM. (2) A.L. Dudley, 1989, *HazCon Model Recommendations*, Draft C8902-1289, SPECTRA Research Institute, Albuquerque, NM.
3.	Abstract	The HazCon model is a personal computer code for assessing the consequences of releases of hazardous material cargoes during transport or during loading/unloading/ballasting/cleaning of transport containments. HazCon is designed to quantitatively evaluate the consequences of releases from alternative containments under similar accident conditions. HazCon consists of several models to calculate the dispersion and consequences. The first three models are used to calculate the dispersion of a gas (both heavy and lighter-than-air) in the atmosphere. HazCon implements two Gaussian dispersion models to deal with nonreactive, lighter-than-air releases. These are the elementary SPEPUFF (EPAPUF) model and the puff/plume model called DIFOUT. For dense gases or heavier-than-air releases, HazCon uses the SLAB model. HazCon also provides a data base of hazardous materials to support source term calculations. These are the METBI data base, with 169 hazardous materials, and the CAMEO data base, with 2600 hazardous material properties.
4.	Location	Sandia National Laboratories Org. 6641, MS 0718 Albuquerque, NM 87185-5800
5.	Information Contacts	Primary: Richard Yoshimura Sandia National Laboratories Org. 6641, MS 0718 Phone: (505) 845-8181 Secondary: Louis F. Restrepo Sandia National Laboratories Org. 6513, MS 1141 Phone: (505) 845-3380
6.	Application	HazCon is to be used to model the releases of hazardous materials from outside accidents (e.g., transportation accidents). This includes both lighter- and heavier-than-air hazardous materials.
7.	Limitations	HazCon is limited to only hazardous, non-radiological outside releases. HazCon considers only a single physiochemical process at a time, directs attention to cargoes of hazardous materials that are toxic by inhalation, avoids actual damage assessment to the environment, and calculates the concentration of hazardous material in the atmosphere for the inhalation pathway only.
8.	Sponsor	Sandia National Laboratories.

MODEL 34 (cont.)

9.	Computer Requirements	PC-based computer code, with at least 6 MB of available disk.
10.	Source-Receptor Relationship	HazCon calculates concentrations to receptor specified by the user.
11.	Emission Rates	HazCon allows the modeling of both instantaneous and continuous releases.
12.	Chemical Composition	Passive; both lighter- and heavier-than-air toxic materials.
13.	Plume Behavior	Both puff/plume Gaussian models are used, along with non-Gaussian dense gas dispersion.
14.	Wind Field	None, single input meteorological for each scenario.
15.	Dispersion Algorithms	HazCon dispersion modeling includes puff/plume Gaussian modeling for lighter-than-air releases, whereas it uses dense gas dispersion models for heavier-than-air gases.
16.	Chemical Reactions	None.
17.	Removal Process	As specified by each dispersion model in SLAB, DIFOUT, and SPEPUF/EPAPUF.
18.	Boundary Conditions	Particles are reflected at the top of the boundary layer and on the ground surface for Gaussian models (DIFOUT and SPEPUF/EPAPUF).
19.	Meteorological Requirements	Wind speed, ambient temperature, surface roughness and relative humidity (for SLAB), local pressure, stability class at the time of release, mixing height, average sampling time for concentration estimates.
20.	Validation	The validation of HazCon corresponds to that performed for each of the individual modules and models (SLAB, DIFOUT, SPEPUF/EPAPUF, etc.).
21.	Output	Results from HazCon are presented as air concentrations at specified receptor locations.
22.	Genealogy	Development of HazCon began in 1989; further development is pending.
23.	Additional Information	None.

MODEL 35

1.	Name	HEFFTER
2.	References	Heffter, Jerome, I., May 1969, "ARL Fallout Prediction Technique," Air Resources Laboratory, Silver Springs, MD.
3.	Abstract	A fallout prediction model based on observations collected from atmospheric detonations. The model predicts integrated external gamma exposure.
4.	Location	HEFFTER is used at the Nevada Test Site.
5.	Information Contacts	Primary: Doug Soule NOAA Air Resources Laboratory Special Operations and Research Division P.O. Box 94227 Las Vegas, NV 89193-4227 Phone: (702) 295-1266 Secondary: None
6.	Application	Near-real-time two-dimensional estimates of downwind exposures.
7.	Limitations	Model predicts exposures due only to deposition. Limited number of layers (i.e., six) used to define atmospheric conditions.
8.	Sponsor	DOE/Nevada Test Site.
9.	Computer Requirements	Model is installed on Data General MV computers running the AOS/VS operating system. An initial version of the model is running on a PC under MS-DOS. The program is written in FORTRAN. The user specifies the location and known details of the atmospheric detonation.
10.	Source-Receptor Relationship	Not used.
11.	Emission Rates	Based on studies for gross fission products from atmospheric detonations.
12.	Chemical Composition	Passive contaminants and radionuclides.
13.	Plume Behavior	Large initial "puff" with primary emphasis on fallout.
14.	Wind Field	Local raob.
15.	Dispersion Algorithms	Analog fallout technique based on previous atmospheric tests along with winds and lapse rate.
16.	Chemical Reactions	None.
17.	Removal Process	Dry deposition.
18.	Boundary Conditions	None.
19.	Meteorological Requirements	Wind direction and wind speed through a deep layer, including direction shear, lapse rate from the surface to the top of the cloud.

MODEL 35 (cont.)

20.	Validation	Comparisons made with surface radiation measurements from previous tests.
21.	Output	Consists of graphical two-dimensional exposure contours for external gamma. The location is identified with appropriate geographical boundaries (United States only). The plots include a close-in and long distance graphic.
22.	Genealogy	Developed in the late 1960s from previous atmospheric tests.
23.	Additional Information	The model divides the atmospheric layer into six "wafers" to represent the cloud. A distribution of various-size particles is assumed to be in these wafers. Fallout proceeds to the ground level from each of these wafers. The ground pattern is integrated to get total exposures.

MODEL 36

1.	Name	HGSYSTEM/UF_6
2.	References	(1) McFarlane, K.A., Prothro, J.S., Puttock, P.T., and Witlox, H.W.M., 1990, "Development and Validation of Atmospheric Dispersion Models for Ideal Gases and Hydrogen Fluoride, Part I, Technical Reference Manual, TNER.90.015," NTIS No. DE93000953/HDM Shell Research Limited, Chester, United Kingdom. (2) Witlox, H.W.M., McFarlane, K.A., Rees, F.J., and Puttock, J.S., 1990, "Development and Validation of Atmospheric Dispersion Models for Ideal Gases and Hydrogen Fluoride, Part II, HGSYSTEM Program User's Manual, TNER.90.016, NTIS No. DE93000954/HDM, "Shell Research Limited, Chester, United Kingdom. (3) Witlox, H.W.M., 1991, "HGSYSTEM: Dispersion Models for Ideal Gases and Hydrogen Fluoride, Tutorial and Quick Reference Guide, TNER.91.007," NTIS No. DE93000952/HDM, Shell Research Limited, Chester, United Kingdom. (4) Hanna, S.R., Chang, J., and Zhang, J., 1994, "Technical Documentation of the HGSYSTEM/UF_6 Model," (draft report in preparation), Martin Marietta Energy Systems, Inc., Oak Ridge, TN.
3.	Abstract	The original HGSYSTEM simulates releases and atmospheric dispersion of buoyant, neutral, or dense ideal gases and HF. It consists of modules for spills, gaseous and flashing jets, evaporating pools, dense gas dispersion, and passive (i.e., Gaussian) dispersion. HGSYSTEM/UF_6 includes atmospheric dispersion of UF_6, along with chemical reactions.
4.	Location	The original HGSYSTEM is available through the American Petroleum Institute (API), National Technical Information Service (NTIS), and Energy Science and Technology Software Center (ESTSC). HGSYSTEM/UF_6 will be available through ESTSC; API; and Martin-Marietta Energy Systems, Inc., Oak Ridge, TN.
5.	Information Contacts	Primary: Sanford G. Bloom Martin Marietta Energy Systems, Inc. P.O. Box 2009 Oak Ridge, TN 37831 (615) 574-6638 Secondary: W.D. Goode, Jr. Phone: (615) 574-8134
6.	Application	Release and atmospheric dispersion of buoyant, neutral, or dense gases, plus HF and UF_6.
7.	Limitations	Not all initial compositions and release orientations can be modeled (see user's manuals).

MODEL 36 (cont.)

8.	Sponsor	(1) HGSYSTEM: Shell Oil Company, API, and several chemical companies. (2) HGSYSTEM/UF_6: DOE/Oak Ridge Operations Office.
9.	Computer Requirements	Personal computer.
10.	Source-Receptor Relationship	Model can be used for all combinations of sources and receptors.
11.	Emission Rates	Either user input or calculated with release module (for limited release scenarios).
12.	Chemical Composition	Original HGSYSTEM can have specific chemicals in the data base (air, H_2O, HF, and several hydrocarbons), plus a user-specified, nonreactive gas. HGSYSTEM/UF_6 adds UF_6 and UO_2F_2.
13.	Plume Behavior	Basic model is a set of ordinary differential equations that simulate the steady-state trajectory of a buoyant, neutral, or dense plume, or an instantaneous cloud.
14.	Wind Field	Constant with time and horizontal position. Vertical profile specified by power law.
15.	Dispersion Algorithms	Entrainment is a function of friction velocity and Richardson number for dense plumes. Pasquill-Gifford dispersion coefficients, modified by surface roughness and averaging time, are used in the passive gas limit.
16.	Chemical Reactions	HF polymerization and vapor-liquid equilibria with H_2O plus: $UF_6 + H_2O \rightarrow 4\ HF + UO_2F_2$
17.	Removal Process	(1) None in the original HGSYSTEM. (2) HGSYSTEM/UF_6 includes removal by chemical reaction and deposition.
18.	Boundary Conditions	Impermeable ground surface.
19.	Meteorological Requirements	Wind speed, temperature, pressure, humidity, surface roughness, and stability.
20.	Validation	Compared with several dense gas release tests (see technical reference manual). Independently tested against other models (see Hanna et al., 1993, *Atmospheric Environment*, Volume 27A, 2265-2285.
21.	Output	Concentration as a function of downwind distance plus various output files for postprocessing; input data.

MODEL 36 (cont.)

22.	Genealogy	Dense gas model (i.e., HEGADAS) developed by Shell Oil Company in the early 1980s. Release and jet dispersion modules plus HF capability were added to form the original HGSYSTEM in the late 1980s under the sponsorship of several oil and chemical companies. Recent changes by Shell Oil Company to the original HGSYSTEM sponsored by API. HGSYSTEM/UF_6 is presently being prepared by Earth Tech (S.R. Hanna).
23.	Additional Information	HGSYSTEM/UF_6 is currently being tested and should be available for general release in January 1995.

MODEL 37

1.	Name	HOTMAC/RAPTAD
2.	References	(1) "An Assessment of the Dispersion Models in the MARSS System Used at the Kennedy Space Center," NOAA ERL-ARL-205. (2) OFCM Modeling Resources.
3.	Abstract	HOTMAC/RAPTAD, developed by Los Alamos National Laboratory, is being adapted/tested for Air Force use under AFESC sponsorship. The system consists of a three-dimensional hydrodynamic windflow model and a Lagrangian diffusion model using "pseudo puffs" rather than particles. The model is prognostic in nature and treats complex terrain environments. Limited buoyant and dense gas capability will be incorporated in the future.
4.	Location	USAF Tyndall AFB, FL
5.	Information Contacts	Primary: Captain Michael Jones AL/EQS 139 Barnes Drive Tyndall AFB, FL 32403-5319 Phone: (904) 283-6002 Secondary: Captain Jon Hayward Phone: (904) 283-6324
6.	Application	Prognostic mesoscale flow model.
7.	Limitations	Relatively long computational times. Difficulties in model initialization, grid resolution issues.
8.	Sponsor	USAF, Tyndall AFB, Florida.
9.	Computer Requirements	Cray, MicroVAX, SUN computers in VMS or UNIX, FORTRAN.
10.	Source-Receptor Relationship	Not applicable.
11.	Emission Rates	Point instantaneous, continuous, ground-level, and elevated.
12.	Chemical Composition	Passive, nonreactive chemicals.
13.	Plume Behavior	Lagrangian pseudo puffs in three-dimensions.
14.	Wind Field	Lagrangian, three-dimensional.
15.	Dispersion Algorithms	K-diffusion.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Conditions	Ground reflection and mixing lid.

MODEL 37 (cont.)

19.	Meteorological Requirements	Vertical temperature profile, sky and solar conditions, winds from multiple points, standard deviation of wind direction, vertical moisture profile.
20.	Validation	None identified.
21.	Output	Three-dimensional wind field.
22.	Genealogy	None provided.
23.	Additional Information	Cloud formation and radioactive transfer.

MODEL 38

1.	Name	HOTSPOT
2.	References	1994, HOTSPOT Health Physics Codes for the PC, UCRL-MA-106315, Hazards Control Department, Lawrence Livermore National Laboratory.
3.	Abstract	The HOTSPOT programs were created to provide health physics personnel with a fast field-portable calculation tool for evaluating accidents involving radioactive material. The software package contains 11 separate programs, ranging from general programs for downwind assessment following the release of radioactive material to more specific programs dealing with the release of plutonium, uranium, or tritium. Other programs estimate the committed effective dose equivalent from the inhalation of various radionuclides, and estimate the effects of a surface-burst nuclear weapon.
4.	Location	Hazards Control Department Lawrence Livermore National Laboratory Livermore, CA 94550
5.	Information Contacts	Primary: Steven Homann Lawrence Livermore National Laboratory Hazards Control Department Livermore, CA 94550 Phone: (510) 423-4962 Secondary: None
6.	Application	The HOTSPOT codes provide a first-order approximation of the radiation effects associated with the atmospheric release of radionuclides.
7.	Limitations	HOTSPOT is based on the Gaussian plume model and is subject to all the limitations of this model. The software is intended as an initial screening tool.
8.	Sponsor	Department of Energy.
9.	Computer Requirements	HOTSPOT will run on an IBM compatibles, HPI00LX palmtop. Software is available in a single 3.5-inch disk.
10.	Source-Receptor Relationship	Three-axis rectangular coordinate system. Single source located at origin, with variable release height. Receptors may be located on or off the centerline plume axis at ground level.
11.	Emission Rates	The dosimetric methods of ICRP Publication 30 have been used throughout the HOTSPOT programs. Individual organ doses (unweighted) are produced, along with the committed effective dose equivalent.
12.	Chemical Composition	Passive contaminant.
13.	Plume Behavior	Straight-line Gaussian. Explosion and fire plume geometries users can input mixing height and buoyant plume rise.
14.	Wind Field	Uniform wind field.

MODEL 38 (cont.)

15.	Dispersion Algorithms	Standard straight-line Gaussian from *Meteorology and Atomic Energy*, 1968, edited by David H. Slade, TID-24190.
16.	Chemical Reactions	None.
17.	Removal Process	Radioactive decay, dry deposition.
18.	Boundary Conditions	Gaussian model boundary conditions, applicable from a distance of 0.1 km to approximately 10 km, and thought to be extendible to 20 to 30 km.
19.	Meteorological Requirements	Wind speed at height of 2 or 10 m. Solar insolation data (sun high, low, cloudy/night) or direct input of stability class (A-F).
20.	Validation	The Gaussian model has been used and accepted by the Environmental Protection Agency. The adequacy of HOTSPOT for making initial dispersion estimates has been tested and verified for several years.
21.	Output	Screen, printer, and file tabular output. VGA graphics.
22.	Genealogy	Version 1.0 (1984) Version 2.0 (1985) Version 2.03 (1986) Version 6.5 (1994)
23.	Additional Information	HOTSPOT contains a library of common radionuclides, and supports both classic (i.e., rem, curie, etc.) and SI (i.e., gray, becquerel, etc.) units.

MODEL 39

1.	Name	HPS
2.	References	DOC OFCM Meteorological Resources.
3.	Abstract	A combined meteorological/computer serves as a hazard prediction system at the Edgewood Area, Aberdeen Proving Ground. Meteorological data collected at six sites serve as input to an atmospheric dispersion model, providing the capability of real-time hazard assessment.
4.	Location	U.S. Army Aberdeen Proving Ground, MD
5.	Information Contacts	Primary: Michael Myirski Director, U.S. Army ERDEC Attn: SCBRD-RTT Aberdeen Proving Ground, MD 21010-5423 Phone: (301) 671-3556 Secondary: Ronald Meyers Phone: (301) 898-4037
6.	Application	Hazard assessment and real-time assessment.
7.	Limitations	None identified.
8.	Sponsor	U.S. Army, Aberdeen Proving Ground, MD.
9.	Computer Requirements	IBM-AT computer in MS-DOS environment. FORTRAN 77 language.
10.	Source-Receptor Relationship	Gaussian.
11.	Emission Rates	Point, instantaneous, area, and ground-level.
12.	Chemical Composition	Accidental spills of defense chemicals, particulates.
13.	Plume Behavior	Gaussian plume.
14.	Wind Field	Straight-line.
15.	Dispersion Algorithms	Pasquill-Gifford-Turner.
16.	Chemical Reactions	None.
17.	Removal Process	Wet deposition, vegetative scavenging.
18.	Boundary Conditions	Ground reflection, mixing depth.
19.	Meteorological Requirements	Temperature, vertical temperature profile, mixing depth, sky and solar conditions, point winds, vertical wind profile.
20.	Validation	None identified.
21.	Output	Concentration, dosage.
22.	Genealogy	None provided.

MODEL 39 (cont.)

23.	Additional Information	Treats certain types of forest terrain.

MODEL 40

1.	Name	Hanford Unified Dose Utility (HUDU)
2.	References	Scherpelz, R.I. 1991, *HUDU - The Hanford Unified Dose Utility Computer Code*, PNL-7636, Pacific Northwest Laboratories, Richland, WA.
3.	Abstract	(1) HUDU is a program developed specifically for rapid initial assessment of radiological emergency situations at the Hanford Site. It includes a standard straight-line Gaussian transport and diffusion module and calculates inhalation and semi-infinite cloud air submersion doses using ICRP 26/30 dose factors. (2) HUDU users have the option of running the program with actual meteorological and source term data, or they may use default data. Default meteorological data for the program are derived from climatological records based on month and time of day. Default release characteristics and source terms are defined for accident scenarios treated in facility Safety Analysis Reports.
4.	Location	Emergency Preparedness Project Pacific Northwest Laboratories MS A3-60 P.O. Box 999 Richland, WA 99352
5.	Information Contacts	Primary: R.I. Scherpelz Emergency Preparedness Project MS K3-55 Pacific Northwest Laboratories P.O. Box 999 Richland, WA 99352 Phone: (509) 375-2454 Secondary: None
6.	Application	Emergency response to potential or actual releases of radionuclides.
7.	Limitations	Straight-line transport and diffusion; radionuclides only; organ doses limited to lung, bone surface, and thyroid.
8.	Sponsor	DOE Richland Operations Office.
9.	Computer Requirements	IBM and compatible PCs with 256 kilobytes of RAM. A hard disk, math coprocessor, and color monitor are needed for optimum performance. HUDU data entry and model execution can be completed in less than 30 seconds if default meteorological data and predefined source terms are used.
10.	Source-Receptor Relationship	Receptor locations are assumed to be on the plume centerline. Distances to the receptor locations may be specified in miles or kilometers, or 12 default distances between 0.1 and 100 km may be used. The estimated travel time from the source to each receptor is listed in the program output.

MODEL 40 (cont.)

11.	Emission Rates	The total quantity of each radionuclide released is specified by the user. Default values for Hanford facilities may be selected from a data base included with the program. The default values are based on scenarios considered in facility Safety Analysis Reports.
12.	Chemical Composition	HUDU assumes that the effluent is passive.
13.	Plume Behavior	Buoyancy and momentum rise are computed for releases from stacks that are at least 2.5 times as high as nearby buildings. Plume rise is based on Briggs equations from Atmospheric Science and Power Production.
14.	Wind Field	Straight-line transport with speed at release height estimated from the 10-m wind speed and stability class using a diabatic profile.
15.	Dispersion Algorithms	Gaussian model with dispersion coefficients.
16.	Chemical Reactions	None.
17.	Removal Process	Radioactive decay.
18.	Boundary Conditions	Plume reflection from ground and top of mixing layer.
19.	Meteorological Requirements	Can be run using climatological data as default. Default data are provided as a function of month and time of day. User may supply stability, wind speed, mixing layer height and temperature, if available. Wind speed and cloud cover can be used with date and time to determine Pasquill-Gifford stability class.
20.	Validation	The code is undergoing numerical verification.
21.	Output	Primary output to monitor includes lists of time of arrival; external air submersion whole body dose, 50-year dose; commitments from inhalation for lung, bone surface, and thyroid; and effective dose equivalent, all as functions of distance. A file containing all input data, the diffusion coefficients and χ/Q as a function of distance, and output data is created for record purposes.
22.	Genealogy	The atmospheric transport and diffusion portion of HUDU is taken from the GENII code.
23.	Additional Information	HUDU includes an empirical building wake model based on data from field experiments.

MODEL 41

1.	Name	Hybrid Single-Particle Lagrangian Integrated Trajectories (HY-SPLIT)
2.	References	Draxler, R.R., June 1992, "Hybrid Single-Particle Lagrangian Integrated Trajectories (HY-SPLIT): Version 3.0 -- User's Guide and Model Description," NOAA Technical Memorandum ERL ARL-195, 26 pp. with appendices, National Technical Information Service, 5285 Port Royal Road, Springfield, VA, 22161.
3.	Abstract	The calculation of long-range pollutant transport and dispersion is a hybrid between Eulerian and Lagrangian approaches. A single pollutant particle represents the initial source. As the dispersion of the initial particle spreads into regions of different wind direction and speed, the single particle is divided into multiple particles to provide a more accurate representation of the complex flow field. Advection and diffusion calculations are made in a Lagrangian framework. Meteorological input fields are obtained from the analyses or forecasts from Eulerian primitive equation models. Deposition and chemical transformation models are available.
4.	Location	NOAA Air Resources Laboratory Silver Springs, MD
5.	Information Contacts	Primary: Roland R. Draxler NOAA/Air Resources Laboratory 1315 East-West Highway Room 3151 Silver Springs, MD 20910 Phone: (301) 713-0295 Extension 117 Fax: (301) 713-0119 E-mail: rdraxler@smtpgate.ssmc.noaa.gov Secondary: None
6.	Application	Mesoscale and regional transport and dispersion for concentration, deposition, and trajectory (forward or backward) calculations. Single releases, as well as continuous emissions, can be simulated using archive analyses or meteorological forecast fields.
7.	Limitations	Short range simulations within 10 km.
8.	Sponsor	National Oceanic and Atmospheric Administration.
9.	Computer Requirements	A PC version is available.
10.	Source-Receptor Relationship	Concentration simulations can be made with multiple point or area sources. Trajectory calculations can be made from the source or backward from the receptor.
11.	Emission Rates	Specified as input or from user-generated emission inventory file.
12.	Chemical Composition	Passive tracers, reactive pollutants (SO_x and NO_x), and radionuclides.
13.	Plume Behavior	Instantaneous or continuous emissions.

MODEL 41 (cont.)

14.	Wind Field	Gridded fields (analysis and forecast) from standard NOAA National Weather Service (NWS) models (e.g., AVN, NGM, ETA), mesoscale models (RAMS), or user-created file created by preprocessor program from rawinsonde and surface observations.
15.	Dispersion Algorithms	Vertical mixing parameterized through first-order closure. Linear growth Top-Hat distribution assumed for horizontal dispersion.
16.	Chemical Reactions	Optional modules include a nonlinear sulfur dioxide-to-sulfate conversion, as well as a linear NO_x module.
17.	Removal Process	Dry deposition based upon meteorology and landuse. Wet deposition scavenging for within and below cloud.
18.	Boundary Conditions	Reflection at lower boundary; parameterized mixing out of the boundary.
19.	Meteorological Requirements	Wind components, temperature, humidity, height, or pressure, at multiple levels, over a grid, and at multiple times over the duration of the simulation. Archive meteorological data available for the world from NCDC (TD-6140) and anonymous FTP.
20.	Validation	Extensive use of CAPTEX and ANATEX field experiments. See NOAA/ARL Technical Memorandum for specific results.
21.	Output	Run-time displays of concentrations or three-dimensional trajectories; output files of trajectory end points or concentration/deposition arrays; post-processing programs to view, print, and manipulate output files.
22.	Genealogy	Initiated in the early 1980s using only rawinsonde observations on a mainframe system. Modified for real-time applications using forecast model gridded output fields to support tracer field experiments. Currently used for some emergency response applications.
23.	Additional Information	Code can be easily modified for a variety of customized applications.

MODEL 42

1.	Name	IRDAM
2.	References	Poeton, R.W., Moeller, M.P., Laughlin, G.J., and Desrosiers, A.E., 1983, *Interactive Rapid Dose Assessment Model (IRDAM)*, NUREG/CR-3012, (3 volumes) Nuclear Regulatory Commission, Washington, D.C.
3.	Abstract	Dose assessment model for emergency response applications at nuclear power plants. The model is based on straight-line Gaussian atmospheric transport and diffusion and NRC Regulatory Guide 1.109 dosimetry. Originally written in interpreted BASIC for Osborne computers, later versions of the code have been developed for more recent PCs. None of the later versions is fully documented. IRDAM is being replaced by RASCAL.
4.	Location	Nuclear Regulatory Commission.
5.	Information Contacts	Primary: T.J. McKenna NRC FTS: 492-4184 Secondary: J.V. Ramsdell PNL Phone: (509) 372-6316
6.	Application	Emergency response for nuclear reactor accidents.
7.	Limitations	Straight-line transport and diffusion. Limited flexibility in specification of source terms, release scenarios, and output. ICRP dosimetry not used.
8.	Sponsor	Nuclear Regulatory Commission.
9.	Computer Requirements	Personal computer with dot matrix printer.
10.	Source-Receptor Relationship	Straight-line model with ground-level or elevated source. Receptors on centerline of the plume at 500, 1000, 2000, 3000, 8000, and 20,000 m.
11.	Emission Rates	Four release options are provided: ● Isotopic release rates may be specified for a list of 20 radionuclides (kryptons, xenons, cesiums, and iodines). ● A gross release rate in Ci/sec may be specified. ● A containment leak rate and accident type or containment activity may be specified. ● A coolant activity and release rate may be specified.
12.	Chemical Composition	Passive contaminant.
13.	Plume Behavior	Ground-level or elevated Gaussian plume without plume rise.
14.	Wind Field	Straight-line transport.

MODEL 42 (cont.)

15.	Dispersion Algorithms	Gaussian plume, dispersion coefficients selected on the basis of delta-T, sigma-theta, or wind direction range.
16.	Chemical Reactions	None.
17.	Removal Process	Radioactive decay in some cases.
18.	Boundary Conditions	Reflection at ground level without deposition is assumed. Diffusion in the vertical is unlimited.
19.	Meteorological Requirements	Wind speed and stability; default values are provided.
20.	Validation	None.
21.	Output	IRDAM sends its output to a printer. The output includes a list of the input data, a list of distances, travel times, χ/Qs, and the whole body and infant thyroid doses and dose rates.
22.	Genealogy	None.
23.	Additional Information	None.

MODEL 43

1.	Name	ISC-2
2.	References	(1) NTIS PB90-500380 (2) NTIS PB90-500398 (3) NTIS PB90-500257 (4) NTIS PB88-171475 (5) DOC OFCM Modeling Resources
3.	Abstract	The ISC model is a steady-state Gaussian plume model that can be used to assess pollutant concentrations from a wide variety of sources associated with an industrial source complex. This model can account for settling and dry deposition of particulates; downwash as a function of hourly wind direction relative to building orientation, area, line, and volume sources; plume rise as a function of downwind distance, separation of point sources; and limited terrain adjustment. It operates in both long-term (ISCLT2) and short-term (ISCST2) modes.
4.	Location	EPA Research Triangle Park, NC
5.	Information Contacts	Primary: R.E. Lawson, Jr. Environmental Protection Agency Research Triangle Park, NC 27711 Phone: (919) 541-1199 Secondary: Russ Lee Phone: (919) 541-5638
6.	Application	Chemical release assessment.
7.	Limitations	None identified.
8.	Sponsor	EPA, Research Triangle Park, NC.
9.	Computer Requirements	PC, VAX, IBM 3090 in DOS, VMS, MVS, FORTRAN language.
10.	Source-Receptor Relationship	Gaussian.
11.	Emission Rates	Point, area, line, multiple, continuous, ground-level and elevated.
12.	Chemical Composition	Criteria pollutants, particulates.
13.	Plume Behavior	Gaussian plume.
14.	Wind Field	Straight-line.
15.	Dispersion Algorithms	Pasquill-Gifford-Turner, lighter-than-air dispersion.
16.	Chemical Reactions	None.
17.	Removal Process	Dry deposition.

MODEL 43 (cont.)

18.	Boundary Conditions	Ground reflection, mixing depth.
19.	Meteorological Requirements	Temperature, vertical temperature profile, mixing depth, point winds.
20.	Validation	None identified.
21.	Output	Concentration.
22.	Genealogy	None provided.
23.	Additional Information	Addresses building downwash effects. Urban applications.

MODEL 44

1.	Name	KBERT
2.	References	None provided.
3.	Abstract	KBERT is a node-and-network model simulating the dispersal and removal of radiological and toxicological contaminants within a given accident scenario. KBERT calculates doses to in-facility workers and consequent health effects.
4.	Location	Sandia National Laboratories Albuquerque, NM (under development)
5.	Information Contacts	Primary: Kenneth E. Washington Sandia National Laboratories Albuquerque, NM 87185-5800 Secondary: None
6.	Application	Rapid estimates of acquired doses and health consequences resulting from the releases of radiological and toxicological materials within non reactor DOE facilities.
7.	Limitations	Simulates exposure and doses to workers within a facility and immediately outside a facility. Time scale is relatively short, typically including time required for workers to evacuate and reassemble.
8.	Sponsor	DOE/EH Germantown, MD
9.	Computer Requirements	IBM-compatible, Microsoft Windows 3.1, C++ language.
10.	Source-Receptor Relationship	None provided.
11.	Emission Rates	User-input.
12.	Chemical Composition	Radiological and toxicological materials.
13.	Plume Behavior	No atmospheric modeling.
14.	Wind Field	Not applicable.
15.	Dispersion Algorithms	Not applicable.
16.	Chemical Reactions	None.
17.	Removal Process	Filters and sprays.
18.	Boundary Conditions	None provided.
19.	Meteorological Requirements	Not applicable.
20.	Validation	In process.
21.	Output	Source term information, worker doses, and health consequences.

MODEL 44 (cont.)

22.	Genealogy	New code designed to meet DOE/EH requirements.
23.	Additional Information	None.

MODEL 45

1.	Name	KSC-EMERGE
2.	References	Firstenberg, H, December 1987, EMERGE: An Accident Assessment Program for the Galileo and Ulysses Missions," NUS-5076.
3.	Abstract	Variable trajectory, Gaussian puff model for simple, complex, and coastal terrains. Permits data from up to 20 surface stations and an upper-air station to define the mass-consistent wind fields. Algorithms included to treat sea/land breeze circulations. Provides direct doses and surface contaminations based on particle size-dependent internal dosimetry, wet/dry deposition, radioactive decay, and depletion models.
4.	Location	NUS Corporation 910 Clopper Road Gaithersburg, MD 20877
5.	Information Contacts	Primary: Henry Firstenberg NUS Corporation 910 Clopper Road Gaithersburg, MD 20877 Phone: (301) 258-8671 Secondary: Bart Bartram
6.	Application	Designed for accidental releases of PuO_2 fuel to atmosphere from rocket launch accidents at Kennedy Space Center.
7.	Limitations	General limitations applicable to Gaussian puff models.
8.	Sponsor	NUS Corporation developed this code for NASA.
9.	Computer Requirements	Hewlett-Packard 9000.
10.	Source-Receptor Relationship	Sources are positioned in a polar receptor grid containing 56 rings and 160 receptors/ring. Four (4) arbitrary source terms with 15 particle size groups per source (60 total sources) are independently tracked.
11.	Emission Rates	Library of default accident scenarios or user-defined source terms.
12.	Chemical Composition	PuO_2 particles.
13.	Plume Behavior	Initial conditions are the stabilized configuration of the launch accident cloud (i.e., surface, stem, and fireball).
14.	Wind Field	Three-dimensional wind field determined from meteorological data and the WEST algorithm.
15.	Dispersion Algorithms	Pasquill-Gifford dispersion parameters.
16.	Chemical Reactions	None.
17.	Removal Process	Dry and wet deposition mechanisms and radioactive decay.

MODEL 45 (cont.)

18.	Boundary Conditions	Arbitrary surface topography.
19.	Meteorological Requirements	Wind speed and direction from up to 20 towers. Temperature lapse rate for vertical stability. Wind direction variance for horizontal diffusion. Upper air data from representative site.
20.	Validation	Transport/dispersion algorithms validated against SF_6 tracer test in complex terrain. Secondary validations against other accepted models.
21.	Output	Six radiological impact characteristics for current time, two hour forecast and six hour forecast.
22.	Genealogy	Evolved from NUS-developed NUSURF and AQPUF models, the original EMERGE model was developed for emergency response requirements at nuclear power plants and was adapted for applications to launch accidents at KSC.
23.	Additional Information	None.

MODEL 46

1.	Name	MAAP4-DOSE
2.	References	(1) Raines, J.C., and Davidson, G.R., "Simulating Nuclear- Power Plant Severe Accident Radiation Levels with MAAP4-DOSE." (2) Epstein, M., Fauske, H.K., and Hauser, G.M., July 1990, "A Model of the Dilution of a Forced Two-Phase Chemical Plume in a Horizontal Wind," *Journal of Loss Prevention Ind.* 3.
3.	Abstract	The MAAP4-DOSE uses in-plant fission product releases determined by the Modular Accident Analysis Package (MAAP) Version 4 to calculate gamma radiation levels inside a plant due to airborne and deposited radioactivity in the same and adjacent compartments. It also can be used to calculate doses outside a plant due to radioactivity in airborne effluents.
4.	Location	Electric Power Research Institute (EPRI) Palo Alto, CA
5.	Information Contacts	Primary: Gerald R. Davidson Fauske & Associates, Inc. 16W070 West 83rd Street Burr Ridge, IL 60521 Phone: (708) 323-8750 Fax: (708) 986-5481 Secondary: Dr. Jason Chao EPRI Palo Alto, CA Phone: (415) 855-8901
6.	Application	MAAP4-DOSE can help accident analysts and planners determine inaccessible plant areas due to high radiation, as well as determine what equipment has been degraded and what monitor readings will mandate operator action. It also can be used for off-site evacuation determination.
7.	Limitations	Those associated with Gaussian models.
8.	Sponsor	EPRI, Palo Alto, CA.
9.	Computer Requirements	VAX/VMS and DOS versions. DOS version requires 6.2 MB of disk space and 7 MB of memory.
10.	Source-Receptor Relationship	Conventional Gaussian model type.
11.	Emission Rates	Calculates radionuclide inventory for a series of nuclear power plant reactor accident sequences, which can be specified by the user.
12.	Chemical Composition	Radionuclides.
13.	Plume Behavior	First principles model treats high-momentum, high-temperature effluent jets resulting from containment rupture. Gaussian ground-level release model disperses plume outside of jet region.
14.	Wind Field	Straight-line Gaussian.

MODEL 46 (cont.)

15.	Dispersion Algorithms	Gaussian.
16.	Chemical Reactions	None.
17.	Removal Process	Dry deposition.
18.	Boundary Conditions	Ground reflection.
19.	Meteorological Requirements	Wind speed, wind direction, and an indicator of atmospheric stability.
20.	Validation	None provided.
21.	Output	Dose rates versus time for plume shine and ground shine. Dose commitment to thyroid versus time due to inhalation of radioiodines. In-plant radiation levels.
22.	Genealogy	Developed for EPRI in the 1980s.
23.	Additional Information	MAAP4-DOSE can model both severe core degradation phenomena, such as fuel meltdown, vessel failure, and containment rupture, and plant responses to actions taken to prevent severe damage.

MODEL 47

1.	Name	MELCOR Accident Consequence Code System (MACCS)
2.	References	(1) Chanin, D.I., et al., "MELCOR Accident Consequence Code System (MACCS): User's Guide, Volume I," SAND86-1562, NUREG/CR-4691, Sandia National Laboratories. (2) Jow, H-N, et al., "MELCOR Accident Consequence Code System (MACCS): Model Description, Volume II," SAND86-1562, NUREG/CR-4691 Sandia National Laboratories. (3) Rolliston, J.A., et al., "MELCOR Accident Consequence Code System (MACCS): Programmer's Reference Manual, Volume III," SAND86-1562, NUREG/CR-4691, Sandia National Laboratories. (4) Chanin, D.I., "MACCS Version 1.5.11.1: A Maintenance Release of the Code," SAND92-2146, NUREG/CR-6059, Sandia National Laboratories.
3.	Abstract	MACCS was developed to calculate the probabilistic human health and economic consequences of hypothetical accidents at nuclear power plants. The principal phenomena considered in MACCS are atmospheric transport; wet and dry deposition; mitigative actions based on dose projection; dose accumulation by a number of pathways, including food and water ingestion; early and latent health effects; and economic costs.
4.	Location	MACCS 1.5.11.1 is available from the: Energy, Science and Technology Software Center Oak Ridge National Laboratory P.O. Box 1020 Oak Ridge, TN 37831-1020 Phone: (615) 576-2606 E-mail: estsc@adonis.osti.gov
5.	Information Contacts	Primary: Mary Young MS 0478 Accident Analysis & Consequence Assessment Department Sandia National Laboratories P.O. Box 5800 Albuquerque, NM 87185-5800 Phone: (505) 844-8003 Secondary: None
6.	Application	Calculation of probabilistic consequences of nuclear accidents. Code allows input of site-specific population, density, land use, and meteorological information. Assumptions on evacuation scenarios and other mitigative actions can be input. A year of on-site weather data may be input so that consequence uncertainty due to stochastic variation of the weather may be calculated.

MODEL 47 (cont.)

7.	Limitations	MACCS uses the Gaussian dispersion model and subsequently is not currently capable of calculating on-site consequences or dispersion over complex terrain.
8.	Sponsor	Nuclear Regulatory Commission
9.	Computer Requirements	MACCS runs on IBM PC compatibles (a 386 or 486 is recommended), VAX/VMS, IBM RISC S/6000, Sun SPARC, and Cray UNICOS.
10.	Source-Receptor Relationship	Conventional Gaussian model type.
11.	Emission Rates	User input.
12.	Chemical Composition	Radionuclides.
13.	Plume Behavior	Gaussian straight-line.
14.	Wind Field	Spatially and temporally invariant.
15.	Dispersion Algorithms	Gaussian.
16.	Chemical Reactions	None.
17.	Removal Process	Wet and dry deposition.
18.	Boundary Conditions	Ground reflection.
19.	Meteorological Requirements	Wind speed, wind direction, and an indicator of atmospheric stability.
20.	Validation	None provided.
21.	Output	Human health effects, population doses, average individual risk, population-weighted risk, and economic costs.
22.	Genealogy	A beta test version of MACCS2 was distributed in April 1993.
23.	Additional Information	MACCS2 is under development for the Department of Energy. It provides more flexibility in modeling of evacuation scenarios, an expanded list of radionuclides, and an improved food chain model. These modifications are being implemented so that MACCS can more accurately model potential nuclear accidents at Department of Energy sites. MACCS2, with complete documentation, should be available the first quarter of 1995. Capabilities are also being coded into MACCS to enable MACCS to calculate the human health consequences resulting from toxicological accidents. Currently, a joint program is under way between the Commission of European Communities (CEC) and the Nuclear Regulatory Commission (NRC) to expand the capability of MACCS and the CEC consequence code, COSYMA, to include uncertainties over input parameters in the code calculations.

MODEL 48

1.	Name	MAEROS-2
2.	References	(1) EFCOG Modeling Resources.
3.	Abstract	Calculates aerosol composition and mass concentration as a function of particle size and time. The processes incorporated include coagulation due to Brownian motion, gravity, and turbulence; particle deposition due to gravitational settling, diffusion, thermophoresis, and diffusiophoresis; particle growth or shrinkage due to water vapor condensation or evaporation; and time-varying sources of particles of different sizes and chemical compositions.
4.	Location	DOE/RI
5.	Information Contacts	Primary: Mary Ann Kummerer Westinghouse Hanford Company P.O. Box 1970 (MSIN H4-62)Richland, WA 99352 Phone: (509) 376-2520 Secondary: None.
6.	Application	Aerosol behavior.
7.	Limitations	Restricted to mechanisms that are independent of chemical composition.
8.	Sponsor	DOE/Richland Operations Office.
9.	Computer Requirements	IBM compatible.
10.	Source-Receptor Relationship	Not applicable.
11.	Emission Rates	Aerosols of various sizes.
12.	Chemical Composition	Aerosols.
13.	Plume Behavior	None provided.
14.	Wind Field	None provided.
15.	Dispersion Algorithms	None provided.
16.	Chemical Reactions	Thermophoresis, diffusiophoresis, due to Brownian motion.
17.	Removal Process	Dry deposition, wet deposition.
18.	Boundary Conditions	None provided.
19.	Meteorological Requirements	None provided.
20.	Validation	Validated extensively against experimental data.
21.	Output	Aerosol composition and mass concentration as a function of particle size.
22.	Genealogy	MAEROS-2 is a PC version of the original MAEROS.

23.	Additional Information	None.

MODEL 49

1.	Name	MARSS
2.	References	(1.) Bobowicz, T.J., 1985, "The Meteorological and Range Safety Support (MARSS) System," in Proc. JANNAF Safety and Environmental Protection Subcommittee Meeting, June 11-13, Los Angeles, CA. (2.) ENSCO, Inc., 1988, "User's Manual for the Meteorological and Range Safety Support System, Version 3.0," ARS-MPR-88-15. ENSCO, Inc. (3.) Lane, R.E., Jr., and Evans, R.J., 1989, "The Meteorological and Range Safety Support (MARSS) System," in Proc. of Fifth International Conference on Interactive Information and Processing Systems for Meteorology, Oceanography, and Hydrology, Jan. 30-Feb. 3, Anaheim, CA. (4.) Taylor, G.E., and Schumann, R.A., 1986, "A Description of the Meteorological and Range Safety Support (MARSS) System, in Proc. of Fifth Joint Conference on Applications of Air Pollution Meteorology, Nov. 18-21, Chapel Hill, NC. (5.) Wiley, T.K., Schumann, R.A., Lane, R.E., McCoy, H.E., Evans, R.J., and Taylor, G.E., 1988, "Program Maintenance Manual for MARSS System," Version 3.0, Vol. 1, report ARS-MPM-88-14 Eastern Space and Missile Center, ENSCO Inc., Melbourne, FL.
3.	Abstract	MARSS Version 3.1 is a stand-alone system. Meteorological data from the Weather Information Network Display System (WINDS), effluent dispersion from REEDM, and BLAST damage assessment model outputs are obtained as ASCII files from the Cyber 860 mainframe by the microVAXes using a communication link. Several main processes are available: meteorology, diffusion, safety map, and auxiliary display. The diffusion process provides the paths and toxic corridors predicted by the dispersion models OB/DG and/or LOMPUFF. The major functions available on MARSS Version 3.1 are graphic weather data displays (wind in "wind barb" form, wind field, towers display, flow contours, and area time series); tabular weather data displays; weather data update and display every five minutes; REEDM concentration isopleth display; etc.
4.	Location	Kennedy Space Center.
5.	Information Contacts	Primary: Bill Boyd ESMC/WE Patrick Air Force Base, FL 32925-6535 Phone: (305) 495-5915 Secondary: None.
6.	Application	MARSS supports impact estimates for possible launch-related incidents at KSC.

MODEL 49 (cont.)

7.	Limitations	Although comprehensive, MARSS does not fully predict under sea breezes with thunderstorm conditions.
8.	Sponsor	NASA/KSC.
9.	Computer Requirements	Three identical DEC MicroVAXII microcomputers, each driving multiple (up to eight) Tektronix Model 4111 or 4211 colorgraphics terminals through a terminal server.
10.	Source-Receptor Relationship	None provided.
11.	Emission Rates	Calculated by OB/DG and LOMPUFF using evaporation rate algorithms.
12.	Chemical Composition	Monomethylhydrazine, N_2H_4, nitrogen tetroxide, NH_3, Freon-21, HCl, unsymmetrical dimethylhydrazine, NO_2, others.
13.	Plume Behavior	Gaussian plume. Plume path "bent" to accommodate temporal wind changes.
14.	Wind Field	Straight-line.
15.	Dispersion Algorithms	Various parameterizations using $J\theta$, $J\phi$, U_*, Z/L.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Conditions	Ground reflection.
19.	Meteorological Requirements	Mean wind speed, standard deviation of wind direction, vertical temperature difference.
20.	Validation	See "An Assessment of the Dispersion Models in the MARSS System used at NSC," ERL ARL-205, December 1993.
21.	Output	Graphic weather data displays, tabular weather data displays, weather data update and display every five minutes, concentration isopleths.
22.	Genealogy	MARSS was initially developed in 1985, and has undergone reviews and improvements over the past nine years.
23.	Additional Information	See NOAA Technical Memorandum ERL ARL-205, "An Assessment of the Dispersion Models in the MARSS System Used at Kennedy Space Center," December 1993.

MODEL 50

1.	Name	MATHEW/ADPIC (M/A)
2.	References	(1) Lange, R., 1978, "ADPIC--A Three-Dimensional Particle-in-Cell Model for the Dispersal of Atmospheric Pollutants and Its Comparison to Regional Tracer Studies, "*J. App. Meteor*. 17: 320-329. (2) Lange, R., 1989, "Transferability of a Three-Dimensional Air Quality Model Between Two Different Sites in Complex Terrain, " J. of Climate and App. Meteorology 28: 665-679. (3) Sherman, C.A., 1978, "A Mass-Consistent Model for Wind Fields Over Complex Terrain," *J. Appl. Meteor*. 17: 312-319. (4) Foster, C.S., 1992, "User's Guide to the MATHEW/ADPIC Models," UCRL-MA-103581, Rev. 1, Lawrence Livermore National Laboratory Livermore, CA. (5) Sullivan, T.S., J.S. Ellis, C.S. Foster, K.T. Foster, R.L. Baskett, J.S. Nasstrom, and Schalk, W.W., III, 1993, "Atmospheric Release Advisory Capability: Real-Time Modeling of Airborne Hazardous Materials," *Bull Amer. Meteor. Soc.* 74: 2343-2361. (6) Boughton, B.A., and DeLaurentis, J.M., 1987, "An Integral Model of Plume Rise From High Explosive Detonations," Proceedings of the 24th National Heat Transfer Conference, American Society of Mechanical Engineers, Aug. 9-12, Pittsburgh, PA.
3.	Abstract	The MATHEW model generates a mass conservative three-dimensional gridded mean wind field including terrain from available interpolated meteorological data and topography by variational methods. ADPIC is a three-dimensional, numerical diffusion and transport model capable of simulating the time- and space-varying dispersal of atmospheric pollutants under complex conditions. It is a particle-in-cell model in which Lagrangian "marker" particles are transported within a fixed Eulerian grid. MATHEW/ADPIC models form the core codes for the DOE Atmospheric Release Advisory Capability (ARAC) Program.
4.	Location	Regional Atmospheric Sciences Division (L-262) Lawrence Livermore National Laboratory P.O. Box 808 Livermore, CA 94551 Source code available from: DOE Energy Science and Technology Center P.O. Box 1020 Oak Ridge, TN 37831 Phone: (615) 576-2606

MODEL 50 (cont.)

5.	Information Contacts	Primary: John Nasstrom Lawrence Livermore National Laboratory (L-262) P.O. Box 808 Livermore, CA 94551 Phone: (510) 423-6738 E-mail: jnasstrom@arac.llnl.gov Secondary: Connie Foster Phone: (510) 422-1867 E-mail: cfoster@arac.llnl.gov Hoyt Walker Phone: (510) 422-1840 E-mail: hwalker@arac.llnl.gov
6.	Application	Atmospheric transport and diffusion of radioactive and nonreactive toxic chemical releases. MATHEW/ADPIC is the core model used in the Atmospheric Release Advisory Capability (see ARAC), which provides DOE HQ, several federal agencies, and numerous DOE and DOD sites with a real-time emergency response modeling service.
7.	Limitations	The MATHEW wind field is a diagnostic model that uses persistence, manual inputs, or gridded wind data for forecasted winds. The ADPIC model has no reactive chemistry.
8.	Sponsor	Department of Energy.
9.	Computer Requirements	LLNL runs MATHEW/ADPIC on VAX/VMS systems (8550, 6610, and 7000 Alphas). It also runs on UNIX workstations. FORTRAN-77 source codes available from ESTSC have been compiled on a variety of systems with more than 3 MB memory.
10.	Source-Receptor Relationship	Source(s) and receptor(s) can be located anywhere on a three-dimensional grid. Point, area, and volume sources can be treated. Instantaneous, average, or time-integrated air concentrations; instantaneous or time-integrated doses; or deposition can be computed at receptors.
11.	Emission Rates	Up to nine releases or species may be specified in a run. Optionally, an unlimited number of nuclides may be specified using the hybrid-particle source term. Emission rates are given in g/s or Ci (Becquerel) per second for either gases or particulate matter. Particle size distributions (minimum, mean, maximum and standard geometric deviation of the diameter) must be specified for particulate matter.
12.	Chemical Composition	Not applicable.

MODEL 50 (cont.)

13.	Plume Behavior	Release options include the following: • Static source geometry (user-specified dimensions) • Plume rise for stack releases using modified Briggs time-dependent buoyant and momentum equations • Explosive cloud rise using Boughton's (1987) time-dependent integral plume rise technique • Fires • Reactor accidents involving mixed fission products (an unlimited number of nuclides may be specified using the hybrid-particle source term) • Spills
14.	Wind Field	Three-dimensional vector winds computed by MATHEW.
15.	Dispersion Algorithms	Two basic K-theory parameterization dispersion options are available: • Hybrid Eulerian-Lagrangian gradient diffusion. • Lagrangian Monte Carlo random displacement diffusion.
16.	Chemical Reactions	Not applicable.
17.	Removal Process	Dry and wet deposition based on deposition velocities and rain rates; gravitational settling based on particle size distribution.
18.	Boundary Conditions	Constant flux in/out flow, or reflection at boundary.
19.	Meteorological Requirements	Wind speed and direction at the surface and for at least one vertical profile. Standard deviation of wind direction (σ_θ) Monin-Obukov length, mixing height, surface roughness (to compute friction velocity), optional temperature profile.
20.	Validation	The MATHEW/ADPIC model has been extensively evaluated with over a dozen of experimental data sets with a wide variety of terrain types, tracer release scenarios, and meteorological conditions. For a summary of validation reports, see Lange (1989) and Sullivan et al. (1993) for summaries.
21.	Output	Pollutant air concentrations (instantaneous, average, or time-integrated) and doses at desired heights and ground-level deposition are written as gridded, two-dimensional arrays. (None of the machine-dependent graphical products are provided with the public-domain ESTSC version of MATHEW/ADPIC.)

MODEL 50 (cont.)

22.	Genealogy	MATHEW was initially developed by Christine Sherman and ADPIC by Rolf Lange as the core models for regional-scale dispersion problems in 1975-1978. Since the initial 1979 implementation into the LLNL ARAC emergency response system (see ARAC), many improvements have been made including the following: • Controlling the initialization of the wind profiles by either measurements or a parameterized method. • Interpolated three-dimensional wind vectors between meteorological input periods (usually 15 minutes or 1 hour) for each ADPIC time step. • Four-deep nested grids in ADPIC for near-source resolution of concentration and deposition. • Optional K-profile initialization method using sigma theta profile data (validated during DOE Atmospheric Studies in Complex Terrain (ASCOT) program). • Monte Carlo random displacement diffusion option.
23.	Additional Information	None.

MODEL 51

1.	Name	MAXIGASP
2.	References	(1) Sagendorf, J.T., Goll, J.T., and Sandusky, W.F., September 1976. "XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations." NUREG/CR-2919, Nuclear Regulatory Commission, Washington, D.C. (2) Echerman, K.F., Congel, F.J., Roecklein, A.K., and Pasciak, W.J., June 1980, "User's Guide to GASPAR Code," NUREG-0597, Nuclear Regulatory Commission, Washington, D.C. (3) "Environmental Dose Assessment Manual, December 1991, WSRC-IM-91-1, "Westinghouse Savannah River Company, Savannah River Technical Center, Aiken, SC.
3.	Abstract	MAXIGASP is an SRL-modified version of the NRC computer programs XOQDOQ and GASPAR. MAXIGASP calculates the dose to the off-site individual from routine maximum or average atmospheric releases.
4.	Location	Westinghouse Savannah River Company Savannah River Technical Center Environmental Technology Section P. O. Box 616 Aiken, SC 29802
5.	Information Contacts	Primary: Ali A. Simpkins Savannah River Technical Center P.O. Box 616 Aiken, South Carolina 29808 Phone: (803) 725-9643 Secondary: None
6.	Application	Chronic atmospheric releases of up to 100 radionuclides from up to 99 release points.
7.	Limitations	Not applicable for use in calculating doses from short-term releases.
8.	Sponsor	DOE/Savannah River Operations Office.
9.	Computer Requirements	Presently resides on IBM 3090.
10.	Source-Receptor Relationship	The maximum or average dose to an individual at the perimeter of Savannah River Site.
11.	Emission Rates	User-specified at up to 99 release points.
12.	Chemical Composition	Radionuclides.
13.	Plume Behavior	Straight-line Gaussian plume.
14.	Wind Field	Uniform wind field based on joint frequency distribution of wind speed, wind direction, and stability.

MODEL 51 (cont.)

15.	Dispersion Algorithms	Pasquill-Briggs curves with modifications for aerodynamic downwash, plume rise, and terrain features.
16.	Chemical Reactions	None.
17.	Removal Process	Plume can be depleted by deposition and/or radioactive decay.
18.	Boundary Conditions	Puff reflection at ground.
19.	Meteorological Requirements	Joint frequency distributions of wind speed, wind direction, and stability class.
20.	Validation	Software validation completed.
21.	Output	Input echo. Joint frequency distribution and annual average relative concentrations. Relative deposition per unit area. Annual average radionuclide air concentrations. Off-site population distribution. Pathway-specific ALARA doses. Radionuclide-specific ALARA doses. ALARA dose summaries by pathways. ALARA dose summaries by radionuclides.
22.	Genealogy	Copies of XOQDOQ (Version 2/November 1982) and GASPAR (Version 8/1977) were merged at SRL into POPGASP. POPGASP was modified to use site-specific population, boundary, and topographic files in 11/18/81, 6/29/83 and 11/20/84.
23.	Additional Information	None.

MODEL 52

1.	Name	MDIFF
2.	References	None.
3.	Abstract	A Gaussian puff model that operates as an emergency response model at the INEL. The model calculates trajectories and TICs using meteorological information from the INEL network of meteorological stations.
4.	Location	The model is operated at the Idaho National Engineering Laboratory (INEL).
5.	Information Contacts	Primary: Jerry F. Sagendorf Phone: (208) 526-2740 Secondary: Gene E. Start Phone: (208) 526-2740
6.	Application	Estimates of trajectory and TIC due to accidental releases of hazardous materials.
7.	Limitations	Current model assumes material is a noble gas.
8.	Sponsor	DOE at the INEL.
9.	Computer Requirements	Versions available for UNIX or OS/2.
10.	Source-Receptor Relationship	Source and receptor locations are in coordinates of latitude and longitude.
11.	Emission Rates	User input.
12.	Chemical Composition	Model assumes a noble gas.
13.	Plume Behavior	Gaussian puff. Puffs released at five-minute increments. Time steps automatically adjust to ensure that puffs do not "hop over" grid points or receptors.
14.	Wind Field	Based on INEL array of meteorological stations.
15.	Dispersion Algorithms	Based on "Markee dispersion curves" from studies at the INEL.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Conditions	Reflection off the surface and boundary layer top.
19.	Meteorological Requirements	Wind direction, wind speed, and cloud cover. Stability classes are determined from wind speed, time of day and season, and cloud cover. Mixing depths are based on seasonal averages for the INEL.
20.	Validation	The model has not been validated with field testing as yet. Results have compared favorably with MESODIF results.
21.	Output	Puff trajectories and TIC isopleths are output in latitude and longitude coordinates. These results are displayed graphically by the INEL visualization programs.

MODEL 52 (cont.)

22.	Genealogy	Developed in 1994 based on the MESODIF algorithms. The model has increased the grid point resolution available in MESODIF, and all input and calculations are done in latitude and longitude to be compatible with the INEL visualization system.
23.	Additional Information	Work on the model is ongoing to add more features to the model. It operates using the on-line data base of INEL meteorological data and can give results in near-real time. Results are generally available for display in much less than one minute.

MODEL 53

1.	Name	MELSAR
2.	References	(1) Allwine, K.J., and Whiteman, C.D., 1985, *MELSAR: A Mesoscale Air Quality Model for Complex Terrain.* Volume 1 - Overview, Technical Description and User's Guide, PNL-5460, Pacific Northwest Laboratories, Richland, WA. (2) Allwine, K.J., and Whiteman, C.D., 1985, *MELSAR: A Mesoscale and Air Quality Model for Complex Terrain.* Volume 2 - Appendices, PNL-5460, Pacific Northwest Laboratories, Richland, WA. (3) Allwine, K.J., and Whiteman, C.D., 1988, "Ventilation of Pollutants Trapped in Valleys: A Simple Parameterization for Regional-Scale Dispersion Models," *Atmospheric Environment* 22: 1839-1845.
3.	Abstract	MELSAR is a mesoscale Lagrangian puff model designed for application in complex terrain environments, and is designed to be applied at long source-to-receptor distances (i.e., tens to hundreds of kilometers) and short concentration averaging times (i.e., 1 to 24 hours). The model utilizes a three-dimensional mass-consistent flow model to determine the spatial and temporal variation in winds over the model domain. Puffs diffuse in a Gaussian fashion with the vertical distribution of pollutants modified by reflection from the ground and an upper mixing lid. A special feature of the model is that it treats valleys containing sources as line-sources in the regional scale model. The release rate of material from the valley to the regional flows is specified as a function of the dynamical behavior of the valley atmosphere.
4.	Location	Pacific Northwest Laboratories.
5.	Information Contacts	Primary: C.D. Whiteman Pacific Northwest Laboratories, MS K9-30 P.O. Box 999 Richland, WA 99352 Phone: (509) 372-6147 E-mail: cd_whiteman@pnl.gov Secondary: None
6.	Application	MELSAR can be used for regional-scale air quality assessments.
7.	Limitations	No deposition or decay. Long transport distances (i.e., greater than 10 kilometers).
8.	Sponsor	Environmental Protection Agency and Department of Energy.
9.	Computer Requirements	Personal computers and up.
10.	Source-Receptor Relationship	Sources and receptors specified by the user. The receptor configuration can consist of a mix of rectangular grids and individual receptors.

MODEL 53 (cont.)

11.	Emission Rates	Time-varying emission rates are specified by the user.
12.	Chemical Composition	Gases or particles that can be assumed to follow the fluid motion.
13.	Plume Behavior	Time- and space-varying diffusion coefficients determined by travel time and computed turbulence characteristics.
14.	Wind Field	Diagnostic three-dimensional mass consistent. Treats terrain blocking and channeling during stable conditions.
15.	Dispersion Algorithms	Gaussian puff with modifications caused by wind shear.
16.	Chemical Reactions	Passive.
17.	Removal Process	None.
18.	Boundary Conditions	Plume reflections at the surface and upper boundary.
19.	Meteorological Requirements	Time- and space-varying upper-air and surface temperature and wind observations. Nighttime winds and temperature lapse rate for each valley containing a source.
20.	Validation	Limited testing for Western Colorado using data from the Department of Energy ASCOT program.
21.	Output	Files of instantaneous air concentrations for all receptors.
22.	Genealogy	MELSAR was developed during the mid-1980s by Pacific Northwest Laboratories for the Environmental Protection Agency.
23.	Additional Information	None.

MODEL 54

1.	Name	MESODIF
2.	References	EFCOG Model Resources.
3.	Abstract	PC based Lagrangian puff model. The model is driven by a two-dimensional wind field, and takes into account temperatures and stability indices. The model generates a horizontal plume track and computes dosages. Plans are to develop vertical plume tracks, and to integrate these data with information from wind profilers.
4.	Location	DOE/IDO, NOAA/ARL.
5.	Information Contacts	Primary: Jerry F. Sagendorf NOAA Air Resources Laboratory Field Research Division 1750 Foote Drive Idaho Falls, ID 83402 Phone: (208) 526-2740 Secondary: Gene E. Start Phone: (208) 526-2743
6.	Application	Lagrangian two-dimensional wind field model.
7.	Limitations	None identified.
8.	Sponsor	DOE/ID, NOAA-ARL.
9.	Computer Requirements	IBM PC in DOS environment.
10.	Source-Receptor Relationship	Not applicable.
11.	Emission Rates	Point, instantaneous, continuous, ground-level, and elevated.
12.	Chemical Composition	Radionuclides.
13.	Plume Behavior	Lagrangian puff.
14.	Wind Field	Two-dimensional Lagrangian.
15.	Dispersion Algorithms	Pasquill-Gifford-Turner.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Conditions	None identified.
19.	Meteorological Requirements	Winds from multiple points.
20.	Validation	None identified.
21.	Output	Dosage.
22.	Genealogy	None provided.

23.	Additional Information	None.

MODEL 55

1.	Name	MESOI
2.	References	Ramsdell, Athey, and Glantz, 1983, *MESOI Version 2.0: An Interactive Mesoscale Lagrangian Puff Dispersion Model with Deposition and Decay*, NUREG/CR-3344, Nuclear Regulatory Commission, Washington, D.C.
3.	Abstract	MESOI Version 2.0 is an interactive Lagrangian puff dispersion model developed for emergency response applications by the NRC and the DOE Richland Operations Office. The model computes short-term (15-minute average) and cumulative time-integrated concentrations and surface contamination at nodes on a 31x31 grid. As many as four releases may be modeled simultaneously using source terms that are a function of time. It includes a two-step decay scheme for radionuclides in which a parent radionuclide decays, and a daughter builds up and decays, if appropriate. Transport and diffusion are based on observed or externally forecasted meteorological data. Meteorological data may be updated hourly or at 15-minute intervals.
4.	Location	Energy, Science and Technology Software Center P.O. Box 1020 Oak Ridge, TN 37831-1020 Phone: (615) 576-2606 E-mail: estsc@adonis.osti.gov
5.	Information Contacts	Primary: J. Van Ramsdell Pacific Northwest Laboratories P.O. Box 999 Richland, WA 99352 Phone: (509) 375-2454 Secondary: C.S. Glantz Pacific Northwest Laboratories Phone: (509) 375-7741
6.	Application	Emergency response to potential or actual releases of radionuclides.
7.	Limitations	Maximum of one primary (parent) species, four sources, six release rates per source. Wind data may be specified for as many as 30 locations, but stability, mixing depth, and precipitation are assumed to be uniform throughout the model domain. The model's applicability is subject to the limitations that are inherent in Gaussian models.
8.	Sponsor	Nuclear Regulatory Commission and Department of Energy.
9.	Computer Requirements	MESOI Version 2.0 was written in FORTRAN-77 for VAX 11/780 computers running the VMS operating system. Modification of the code to run on similar computers can be accomplished in a few hours. It may also be converted to run on IBM-compatible PCs without reduction of the model capabilities. Model execution time is less than a minute for simulations covering less than six hours.
10.	Source-Receptor Relationship	Sources may be placed at any location within the model domain and may be elevated or at ground level. Normal receptors are uniformly spaced nodes within the domain. An additional 20 receptors may be placed in the domain.

MODEL 55 (cont.)

11.	Emission Rates	Specified by user for as many as six periods for each source. Release periods may be separated by periods with no emissions.
12.	Chemical Composition	MESOI is based on an assumption that the effluent is passive. Radioactive decay or chemical decomposition is optional.
13.	Plume Behavior	Plume rise based on buoyancy is optional. Plume rise computations are based on Briggs' equations. Momentum rise is neglected. Plume rise is limited by the top of the mixing layer. An effective release height may be specified in place of the actual release height.
14.	Wind Field	MESOI has a three-layer wind field. The field in the lowest layer is computed from available surface wind observations using $1/r^2$ interpolation. The resulting wind field may be modified to account for anticipated terrain effects as an option. This modification is based on the angle between the slope gradient and wind vectors and on the steepness of the slope. The wind field in the top layer is assumed to be uniform and is based on an upper-level wind vector (geostrophic or gradient wind) entered by the user.
15.	Dispersion Algorithms	Dispersion is based on the Gaussian model. Users select from four diffusion coefficient parameterizations provided with MESOI. All parameterizations compute coefficients from distance traveled and atmospheric stability.
16.	Chemical Reactions	None explicit: First-order decomposition of a chemical species may be simulated by providing an effective half-life for the reaction.
17.	Removal Process	Dry deposition is computed for depositing species using a source-depletion model. A default deposition velocity of 1 cm/s is assumed. Wet deposition is computed using a washout coefficient that is based on precipitation type (liquid or frozen) and precipitation rate. Material in the plume is decreased to maintain continuity of mass.
18.	Boundary Conditions	Reflection is assumed at ground level and the top of the mixing layer. Puffs are dropped from further consideration when they leave the model domain.
19.	Meteorological Requirements	The minimum meteorological data set consists of atmospheric stability, surface wind speed and direction, and upper-level wind speed and direction. Surface wind data for as many as 29 additional locations can be used by the model.
20.	Validation	The transport and diffusion portions of MESOI Version 2.0 have been evaluated using experimental data collected at DOE's Hanford and Savannah River Sites to distances of about 40 km.
21.	Output	MESOI generates numerical output in tabular form. The output may be printed or viewed at a terminal. It also provides a rudimentary alphanumeric display of the results.
22.	Genealogy	MESOI is a descendant of the MESODIF model developed at NRTS by Wendell and Start. Two prior versions of the code (i.e., 1.0 and 1.1) have been published as PNL documents.

MODEL 55 (cont.)

23.	Additional Information	MESOI, although still in use at Hanford, has not been upgraded for several years. RATCHET is a more modern version of MESOI and contains better parameterizations of atmospheric processes.

MODEL 56

1.	Name	MESOPUFF
2.	References	(1) DOC OFCM Modeling Resources. (2) NTIS PB 90-500794. (3) NTIS PB-84-181775.
3.	Abstract	MESOPUFF is a Lagrangian model suitable for modeling the transport, diffusion, and removal of air pollutants from multiple point and area sources at transport distances beyond 10-50 km.
4.	Location	EPA Research Triangle Park, NC.
5.	Information Contacts	Primary: R.E. Lawson, Jr. Environmental Protection Agency Research Triangle Park, NC 27711 Phone: (919) 541-1199 Secondary: John Irwin Phone: (919) 541-5682
6.	Application	Transport, diffusion, and removal of air pollutants from multiple point sources.
7.	Limitations	None identified.
8.	Sponsor	EPA, Research Triangle Park, NC.
9.	Computer Requirements	None provided.
10.	Source-Receptor Relationship	Not applicable.
11.	Emission Rates	Point and area sources.
12.	Chemical Composition	Passive gases.
13.	Plume Behavior	Lagrangian puff.
14.	Wind Field	Lagrangian.
15.	Dispersion Algorithms	None provided: lighter-than-air dispersion.
16.	Chemical Reactions	Yes.
17.	Removal Process	Wet deposition, dry deposition.
18.	Boundary Conditions	None provided.
19.	Meteorological Requirements	Vertical temperature profile, point winds.
20.	Validation	None identified.
21.	Output	Concentration.

MODEL 56 (cont.)

22.	Genealogy	None provided.
23.	Additional Information	Urban applications.

MODEL 57

1.	Name	MESORAD
2.	References	(1) Scherpelz, R.I., Bander, T.J., Athey, G.F. and Ramsdell, J.V. 1986, *The MESORAD Dose Assessment Model Vol. 1: Technical Basis*, NUREG/CR-4000, Nuclear Regulatory Commission, Washington, D.C. (2) Ramsdell, J.V., Athey, G.F., Bander, T.J. and Scherpelz, R.I., 1988, *The MESORAD Dose Assessment Model Vol. 2: Computer Code*. NUREG/CR-4000, Nuclear Regulatory Commission, Washington, D.C.
3.	Abstract	MESORAD is a dose assessment model developed for emergency response applications by the NRC and the DOE Richland Operations Office. It combines atmospheric transport, diffusion, and dose calculations in a single code. The transport and diffusion calculations are performed by a modification of Version 2.0 of the MESOI model. Modifications to the MESOI code include addition of a plume model and polar grid, and extended model domain. MESORAD computes short-term (15-minute average) and cumulative time-integrated concentrations and surface contamination. It also computes short-term and cumulative doses for each organ and pathway. The dose pathways represented in the model include immersion within the cloud, inhalation, and shine from elevated plumes and surface contamination.
4.	Location	Energy, Science and Technology Software Center P.O. Box 1020 Oak Ridge, TN 37831-1020 Phone: (615) 576-2606 E-mail: estsc@adonis.osti.gov
5.	Information Contacts	Primary: J.V. Ramsdell Pacific Northwest Laboratories, MS K9-30 P.O. Box 999 Richland, WA 99352 Phone: (509) 372-6316 E-mail: j_ramsdell@pnl.gov Secondary: C.S. Glantz Pacific Northwest Laboratories, MS K6-55 P.O. Box 999 Richland, WA 99352 Phone: (509) 376-7741
6.	Application	Emergency response to potential or actual releases of radionuclides.
7.	Limitations	Maximum of 50 species, 4 sources, 6 release rates per source. Stability, mixing depth, and precipitation are assumed to be uniform throughout the model domain. Model applicability is subject to the limitations that are inherent in Gaussian models.

MODEL 57 (cont.)

8.	Sponsor	NRC and DOE
9.	Computer Requirements	MESORAD was written in FORTRAN-77 for VAX 11/780 computers running the VMS operating system. Modification of the code to run on similar computers can be accomplished in a few hours. It may also be converted to run on IBM-compatible PCs with reduction of the model capabilities.
10.	Source-Receptor Relationship	Sources may be placed at any location within the model domain and may be elevated or at ground level. Normal receptors are uniformly spaced nodes within the domain. An additional 20 receptors may be placed in the domain.
11.	Emission Rates	Specified by user for as many as six periods for each source. Release periods may be separated by periods with no emissions.
12.	Chemical Composition	MESORAD is based on an assumption that the effluent is passive. Radioactive decay or chemical decomposition is optional.
13.	Plume Behavior	Plume rise based on buoyancy is optional. Plume rise computations are based on Briggs' equations. Momentum rise is neglected. Plume rise is limited by the mixing layer. An effective release height may be specified in place of the actual release height.
14.	Wind Field	MESORAD has a three-layer wind field. The field in the lowest layer is computed from available surface wind observations using $1/r^2$ interpolation. The resulting wind field may be modified to account for anticipated terrain effects as an option. The wind field in the top layer is assumed to be uniform and is based on an upper-level wind vector (geostrophic or gradient wind) entered by the user. Winds in the intermediate layer are computed by linear interpolation from the winds in the top and bottom layers.
15.	Dispersion Algorithms	Dispersion is based on the Gaussian model. Users select from among four diffusion coefficient parameterizations provided with MESORAD. All parameterizations compute coefficients from distance traveled and atmospheric stability.
16.	Chemical Reactions	No explicit chemical reactions. First-order decomposition of a chemical species may be simulated by providing an effective half-life for the reaction.
17.	Removal Process	Dry deposition is computed for depositing species using a source-depletion model. A default deposition velocity of 1 cm/s is assumed. Wet deposition is computed using a washout coefficient. Material in the plume is decreased to maintain continuity of mass.
18.	Boundary Conditions	Reflection is assumed at ground level and the top of the mixing layer. Puffs are dropped from further consideration when they leave the model domain.
19.	Meteorological Requirements	The minimum meteorological data set consists of atmospheric stability and surface wind speed and direction. Ambient temperature and precipitation data are required for plume rise and washout.

MODEL 57 (cont.)

20.	Validation	The transport and diffusion portions of MESORAD were evaluated using experimental data collected at DOE's Hanford and Savannah River Sites to distances of about 40 km. Results of the dose computation portions of MESORAD have been compared with predictions of other accepted codes.
21.	Output	MESORAD generates numerical output in tabular form. The output may be printed or viewed at a terminal. It also provides a rudimentary alphanumeric display of the results.
22.	Genealogy	MESORAD contains a version of the MESOI model and therefore is a descendant of the MESODIF model developed at NRTS by Wendell and Start. The published version of MESORAD is Version 1.4.
23.	Additional Information	MESORAD computes organ doses and combines them to arrive at a total whole body dose. The organ doses are equally weighted. Thus, the total whole body dose computation is similar, but not identical, to the ICRP 26 and 30 computation. Modification of the MESORAD code to give additional organ doses and doses computed using ICRP 26 and 30 weighing factors would be straightforward. Mesorad has not been upgraded for several years and has generally been replaced by the RASCAL code.

MODEL 58

1.	Name	MESOWIND
2.	References	DOC OFCM Modeling Resources.
3.	Abstract	A meso-beta scale model, coded MESOWIND, is a three-dimensional, multiple-level model of coarse resolution that applies to an area of about 200 km by 200 km. Presently the model is used with a horizontal grid spacing of 10 km and some 15 vertical levels, but the horizontal grid resolution can be varied from 5 to 50 km, and the number of vertical levels can also be adjusted. MESOWIND is a mass-consistent numerical solution of the primitive equations formulated in the Eulerian description and in terms of terrain-conformed coordinates. The solution is obtained under the condition of hydrostatic pressure balance and accounts for horizontal and vertical turbulent diffusion thermal forcing, the Coriolis effect, and moisture transport through the planetary boundary layer. Numerical marching solutions in discretized time steps are accomplished by a finite difference scheme with a fixed horizontal grid and generally an expanding vertical grid.
4.	Location	USAF White Sands Missile Range, NM
5.	Information Contacts	Primary: Ronald M. Cionco USAF Atmospheric Sciences Laboratory White Sands Missile Range, NM 88002-5501 Phone: (505) 678-5210 Secondary: None
6.	Application	Mesometeorology in complex terrain.
7.	Limitations	None identified.
8.	Sponsor	USAF, White Sands Missile Range, NM.
9.	Computer Requirements	UNISYS 1197 and CRAY I or II; FORTRAN 77 language.
10.	Source-Receptor Relationship	Not applicable.
11.	Emission Rates	None provided.
12.	Chemical Composition	Accidental spills, aerial spraying, defense chemicals, and battlefield obscuration.
13.	Plume Behavior	Three-dimensional Eulerian.
14.	Wind Field	None provided.
15.	Dispersion Algorithms	None provided.
16.	Chemical Reactions	None.
17.	Removal Process	None.

MODEL 58 (cont.)

18.	Boundary Conditions	None provided.
19.	Meteorological Requirements	Upper air profile to 350 mb.
20.	Validation	None identified.
21.	Output	15 levels of horizontal wind, temperature, and relative humidity fields.
22.	Genealogy	None provided.
23.	Additional Information	Time-dependent to simulate diurnal cycle.

MODEL 59

1.	Name	MICROAIRDOS
2.	References	EFCOG Modeling Resources.
3.	Abstract	MICROAIRDOS, a code used by the EPA, is a computer code for estimating radiation dose to humans from airborne radionuclides in areas surrounding nuclear facilities. A modified Gaussian plume equation is used to estimate both horizontal and vertical dispersion of radionuclides released from stacks or area sources. Both point sources and uniform area sources of atmospheric releases of radionuclides can be evaluated by AIRDOS-EPA, which estimates (1) concentrations in air, (2) rates of deposition on ground surfaces, (3) ground surface concentrations, (4) intake rates by man via food ingestion and air inhalation, and (5) radiation doses received by man.
4.	Location	DOE/ALO, Sandia National Laboratories.
5.	Information Contacts	Primary: Yvonne McClellan P.O. Box 5800 Sandia National Laboratories Albuquerque, NM 87065 Phone: (505) 848-1036 Secondary: Dr. Robert E. Moore Radiological Assessment Corporation Route 2, Box 122 Neeses, SC 29107 Phone: (803) 536-4883
6.	Application	Estimating radiation dose to humans from airborne radionuclides.
7.	Limitations	None identified.
8.	Sponsor	DOE/ALO, Sandia National Laboratories.
9.	Computer Requirements	IBM compatibles in FORTRAN IV.
10.	Source-Receptor Relationship	Gaussian.
11.	Emission Rates	Point and uniform area sources.
12.	Chemical Composition	Radionuclides.
13.	Plume Behavior	Gaussian plume.
14.	Wind Field	Straight-line.
15.	Dispersion Algorithms	Pasquill-Gifford-Turner.
16.	Chemical Reactions	None.
17.	Removal Process	Dry deposition.
18.	Boundary Conditions	None identified.

MODEL 59 (cont.)

19.	Meteorological Requirements	Wind speed, wind direction, indicator of atmospheric stability.
20.	Validation	None identified.
21.	Output	Concentrations in air, deposition rates in ground surfaces, ground surface concentration.
22.	Genealogy	None provided.
23.	Additional Information	Intake rates by man via food ingestion and air inhalation. Radiation doses received by man.

MODEL 60

1.	Name	NUATMOS/CITPUFF
2.	References	(1) Ross, D.G., Smith, I.N., Manins, P.C., and Fox, D.G., 1988, "Diagnostic Wind Field Modelling for Complex Terrain: Model Development and Testing," *J. Appl. Meteor.* 27: 785-796. (2) Ross, D.G., and Fox, D.G., 1991, "Evaluation of an Air Pollution Analysis System for Complex Terrain," *J. Appl. Meteor.* 30: 909-923. (3) Ross, D.G.; Lorimer, G.S.; Ciolek, J., Jr.; and Fox, D.G., 1993, "Development and Evaluation of a Wind Field Model for Emergency Preparedness in Complex Terrain," preprint, A & WMA 86th Annual Meeting & Exhibition, June 13-18, Denver, CO.
3.	Abstract	NUATMOS/CITPUFF represents a cost-effective air quality modeling system for predicting the concentration of air pollutants in complex terrain. CITPUFF is a multisource puff model capable of taking as its transport field fully three-dimensional wind fields from the NUATMOS wind field model. In its basic form, NUATMOS is a diagnostic wind field model that utilizes routinely available wind observations and incorporates atmospheric stability influences using conservation-of-energy arguments. For the case of drainage flows, NUATMOS has been coupled with a prognostic drainage flow submodel.
4.	Location	Centre for Applied Mathematical Modeling Monash University P.O. Box 197 Caulfield East Vic, Australia 3145 Also installed as part of: • TAPAS-RMFRES, USDA, Forest Service • Real-time emergency response system (TRAC) - Rocky Flats Plant, CO
5.	Information Contacts	Primary: Dr. D.G. Ross Phone: (+613) 903-2101 Fax: (+613) 903-2798 E-mail: graeme.ross@sci.monash.edu.au Secondary: Dr. Douglas G. FoxPhone: (303) 490-8375
6.	Application	Cost-effective estimates of consequences of routine or accidental releases in complex terrain sites.
7.	Limitations	Transport of puff centroid only.
8.	Sponsor	Monash University (Australia) and RMFRES-USDA (Forest Service).
9.	Computer Requirements	Runs comfortably on a modern-generation PC.

MODEL 60 (cont.)

10.	Source-Receptor Relationship	Not used for SRRs.
11.	Emission Rates	User-input hourly. Uses temporal interpolation.
12.	Chemical Composition	Passive gaseous contaminants and totally suspended particulates.
13.	Plume Behavior	Gaussian puffs transported by temporally and spatially variable three-dimensional wind fields.
14.	Wind Field	Three-dimensional diagnostic wind fields based on routine wind observations from towers, pibals, profilers, etc., with atmospheric stability influences based on a Froude number adjustment. Option for coupling with a prognostic wind field submodel for simulation drainage flows.
15.	Dispersion Algorithms	Options include: ● PG relations ● Briggs' rural ● Sigma theta horizontal ● Direct measurements of sigma-u, and sigma-w
16.	Chemical Reactions	Assumes simple first-order decay.
17.	Removal Process	Assumes exponential decay rate.
18.	Boundary Conditions	Reflections off the terrain surface. Partial penetration of an elevated stable layer and option to introduce an elevated layer of arbitrary stability.
19.	Meteorological Requirements	Wind speed and direction from towers, pibals, profilers, etc. Hourly values of mixing depth, surface temperature, stability class above and below mixing layer, and/or sigma theta or direct measurements of turbulence.
20.	Validation	NUATMOS/CITPUFF: Latrobe Valley Airshed Study (southeastern Australia), Cinder Cone Butte "modeller's dataset." NUATMOS: Rocky Flats Plant, Golden, CO
21.	Output	Summary input data and model options. Source term information. Gridded fields of ground level concentration or dosage at user selected periods. Puff positions in plan and elevation as a function of time. Two-dimensional graphical display procedures have been developed for a PC, including wind field information. Three-dimensional and "animated" display procedures have been developed for use on a Silicon Graphics workstation.

MODEL 60 (cont.)

22.	Genealogy	Developed in the early 1980's and has undergone continuous modification and development up to the present.
23.	Additional Information	Key features of the system include: ● A user-friendly graphical user interface (Visual Basic) ● Use in a real-time computer system for emergency response ● Extensive evaluation of the system and components with quality standards appropriate for emergency response

MODEL 61

1.	Name	PAVAN
2.	References	(1) Bander, T.J., 1982, *PAVAN: An Atmospheric Dispersion Program for Evaluating Design Basis Releases of Radioactive Materials from Nuclear Power Stations*, NUREG/CR-2858, Nuclear Regulatory Commission, Washington, D.C. (2) Snell, W.G., and Jubach, R.W., 1981, *Technical Basis for Regulatory Guide, 1.145, "Atmospheric Dispersion Models for Potential Accident Consequences Assessments at Nuclear Power Plants*," NUREG/CR-2260, Nuclear Regulatory Commission, Washington, D.C.
3.	Abstract	PAVAN estimates χ/Q for use in consequence assessments in support of licensing of nuclear power plants. It uses a straight-line Gaussian model and climatological data to compute centerline and sector-average χ/Qs for accidental releases of radionuclides. χ/Qs are computed for six averaging intervals ranging from one hour to one year.
4.	Location	Radiation Shielding Information Center (RSIC) Oak Ridge National Laboratory.
5.	Information Contacts	Primary: Jay Lee Nuclear Regulatory Commission Phone: (301) 415-1080 Secondary: None
6.	Application	PAVAN is intended for consequence assessments in support of licensing of nuclear power plants. It may also be used to support development of emergency response plans. It is not intended for use in consequence assessments during emergencies or in postaccident consequence assessments, and should not be used for these purposes.
7.	Limitations	PAVAN uses climatological data in the form of joint frequency distributions for consequence assessments. It does not have an option to use actual data. It is a straight-line Gaussian transport and diffusion model. It cannot handle multiple sources, and it does not have a toxic or heavy gas capability.
8.	Sponsor	Nuclear Regulatory Commission
9.	Computer Requirements	The code was originally written in FORTRAN IV for use on a CDC 7600 computer. Later versions exist for other computers, and may be available for PCs.
10.	Source-Receptor Relationship	An elevated or ground-level release point may be specified. Receptors are located at 2 distances, usually the exclusion area boundary and the outer boundary of the low population zone, in each of 16 direction sectors.
11.	Emission Rates	Code output is normalized concentrations, χ/Q. This assumes that release rates will be constant.

MODEL 61 (cont.)

12.	Chemical Composition	Effluent is assumed to be a nondepositing, passive gas.
13.	Plume Behavior	PAVAN options include building wake, partial building wake, entrainment of plumes released from short stacks depending on effluent vertical velocity and wind speed, plume meander correction for low wind speeds, and reduction in effective plume height resulting from topography.
14.	Wind Field	None.
15.	Dispersion Algorithms	Gaussian plume with corrections. Two diffusion coefficient parameterizations.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Conditions	Plume reflection at the ground. No upper limitation or reflection at the top of the mixing layer.
19.	Meteorological Requirements	Joint frequency distribution of wind direction, wind speed, and atmospheric stability class.
20.	Validation	No known validation.
21.	Output	PAVAN output includes a complete listing of the input data and extensive χ/Q tables. There is one set of χ/Q tables for each sector.
22.	Genealogy	See NUREG/CR-2260 and NUREG/CR-2858.
23.	Additional Information	None.

MODEL 62

1.	Name	PGEMS
2.	References	(1) Allwine, K.J., and Athey, G.F., 1988, "*User's Guide to the Pacific Gas and Electric Modelling System - An Interactive Atmospheric Transport and Diffusion Model for Application in Complex Terrain*," prepared for Pacific Gas & Electric Company by Battelle Pacific Northwest Laboratories, Richland, WA. (2) Allwine, K.J., 1993, "PGEMS - An Atmospheric Dispersion Model for Emergency Response," *Preprints, Environmental Transport and Dosimetry, American Nuclear Society*, August 31-September 3. (3) Thullier, R.H., 1992, "Evaluation of a Puff Dispersion Model in Complex Terrain," Journal of AWMA 42 (3): 290-297.
3.	Abstract	PGEMS is an atmospheric transport and diffusion model for emergency response applications in regions of nonuniform terrain. It is fully documented and operationally tested, runs on personal computers, and has been validated using tracer and meteorological data. A three-dimensional diagnostic wind module is used in PGEMS to specify the time- and space-varying winds over the model domain. A special feature of the wind model is that it accounts for flow channeling and blocking from major terrain features during stable atmospheric conditions. PGEMS predicts ground-level concentrations and deposition fields of air contaminants released from point sources. Both wet and dry deposition and radioactive decay of the released material can be treated. PGEMS is applicable at source-to-receptor transport distances from a few hundred meters to a few hundred kilometers.
4.	Location	Pacific Northwest Laboratories.
5.	Information Contacts	Primary: Jerome D. Fast Pacific Northwest Laboratories, MS K9-30 P.O. Box 999 Richland, WA 99352 Phone: (509) 372-6116 Secondary: None
6.	Application	PGEMS can be used for emergency response applications and routine air quality assessments.
7.	Limitations	Point sources. Linear radioactive decay or linear chemical reactions.
8.	Sponsor	Pacific Gas & Electric Company/Department of Energy.
9.	Computer Requirements	Personal computers and up.
10.	Source-Receptor Relationship	Sources and receptors specified by the user. The receptor configuration can consist of a mix of rectangular grids, polar grids, and individual receptors.

MODEL 62 (cont.)

11.	Emission Rates	Time-varying emission rates for up to 40 chemical species or radionuclides.
12.	Chemical Composition	Gases or particles that can be assumed to follow the fluid motion.
13.	Plume Behavior	Time- and space-varying diffusion coefficients determined by travel time or travel distance, given horizontal and vertical stability classes.
14.	Wind Field	Diagnostic three-dimensional mass consistent. Treats terrain blocking and channeling during stable conditions. Also treats drainage flows in complex terrain.
15.	Dispersion Algorithms	Gaussian puff with modifications caused by wind shear.
16.	Chemical Reactions	First-order reactions.
17.	Removal Process	Wet and dry deposition.
18.	Boundary Conditions	Plume reflections at surface and upper boundary.
19.	Meteorological Requirements	Time- and space-varying upper-air and surface wind observations, and observations of mixing heights, horizontal and vertical stability, precipitation rate, and temperature lapse rate.
20.	Validation	PGEMS has been validated using tracer and meteorological data from experiments conducted in a complex terrain region near San Luis Obispo, CA.
21.	Output	Files of cumulative and instantaneous air concentrations and deposition amounts for all receptors.
22.	Genealogy	Originally developed for Pacific Gas & Electric Company in 1986.
23.	Additional Information	None.

MODEL 63

1.	Name	PLUME
2.	References	Bloom, S.G., Just, R.A., and Williams, W.R., 1989, "A Computer Program for Simulating the Atmospheric Dispersion of UF_6 and Other Reactive Gases Having Positive, Neutral or Negative Buoyancy," Martin Marietta Energy Systems, Inc., Oak Ridge Gaseous Diffusion Plant, Oak Ridge, TN.
3.	Abstract	The model simulates atmospheric dispersion of UF_6 and other dense reactive gases. Its basis is a steady-state model of the plume trajectory, where transient three-dimensional behavior is approximated by superimposing a Gaussian model.
4.	Location	(1) Martin Marietta Energy Systems, Inc. Oak Ridge, TN (2) Energy Science & Technology Software Center, Oak Ridge, TN
5.	Information Contacts	Primary: Sanford G. Bloom Martin Marietta Energy Systems, Inc. P.O. Box 2009 Oak Ridge, TN 37831 Phone: (615) 574-6638 Secondary: None
6.	Application	Atmospheric dispersion of dense, neutral, or buoyant reactive or passive gases.
7.	Limitations	Simple approximations used for many mechanisms (e.g., entrainment) limit accuracy. In addition, transient three-dimensional behavior has the limitations of the superimposed Gaussian model.
8.	Sponsor	DOE/Oak Ridge Operations Office.
9.	Computer Requirements	The original 1989 version was written for the mainframe. The plot package requires DISSPLA software. There are PC versions without plotting that are available.
10.	Source-Receptor Relationship	Interpolated concentrations can be estimated for specific receptor locations.
11.	Emission Rates	User input.
12.	Chemical Composition	Specific chemicals in the input data base (e.g., air, UF_6, H_2O, HF, UO_2F_2, F_2, ClF_3, HCl, ClO_2, and HOCl), plus user-specified ideal gases.
13.	Plume Behavior	Basic model is a set of ordinary differential equations that simulate the steady-state trajectory of the plume centerline. The transient three-dimensional behavior is approximated by superimposing a Gaussian centerline profile onto the average concentration, which is one of the variables in the basic model.
14.	Wind Field	Constant with time and horizontal position; vertical profile is allowed.

MODEL 63 (cont.)

15.	Dispersion Algorithms	Plume expansion based on empirical entrainment function. Pasquill-Gifford dispersion coefficients are defaults in the superimposed Gaussian model. User-defined values can be input.
16.	Chemical Reactions	Data base includes HF polymerization and vapor-liquid equilibria with H_2O plus other reactions with the chemicals identified in Item #12.
17.	Removal Process	Chemical reactions and deposition.
18.	Boundary Conditions	Reflection off the surface and boundary layer top.
19.	Meteorological Requirements	Wind speed, temperature, pressure, and humidity, as functions of height, stability, and mixing layer depth.
20.	Validation	PLUME has been compared with plume rise codes, other dispersion codes, and French UF_6 release tests.
21.	Output	Principal output is trajectory of the plume centerline, velocity components, average concentration, and ground-level concentration as function of downwind distance. Concentrations at specific locations are optional. Input data is also output.
22.	Genealogy	PLUME was originally developed in the 1979-1985 time frame for safety analyses of the uranium enrichment plants. It received limited distribution in 1989. No major revisions have occurred since 1985 except for its transport to a PC in 1994.
23.	Additional Information	PLUME is unknown to most regulatory agencies. DOE, through Martin Marietta Energy Systems in Oak Ridge, is sponsoring modifications to a well-known model (i.e., HGSYSTEM) to incorporate UF_6 chemistry. HGSYSTEM/UF_6 should be available in January 1995.

MODEL 64

1.	Name	POPGASP
2.	References	(1) Echerman, K.F., Congel, F.J., Roecklein, A.K., and Pasciak, W.J., June 1980, "User's Guide to GASPAR Code," NUREG-0597, Nuclear Regulatory Commission, Washington, D.C. (2) "Environmental Dose Assessment Manual," December, 1991, WSRC-IM-91-1, Westinghouse Savannah River Company, Savannah River Technical Center, Aiken, SC.
3.	Abstract	POPGASP is an SRL-modified version of the NRC computer programs XOQDOQ and GASPAR. POPGASP calculates the dose to the off-site population from routine atmospheric releases.
4.	Location	Westinghouse Savannah River Company Savannah River Technical Center Environmental Technology Section P.O. Box 616 Aiken, SC 29808
5.	Information Contacts	Primary: Ali A. Simpkins Savannah River Technical Center P.O. Box 616 Aiken, SC 29808 Phone: (803) 725-9643 Secondary: None
6.	Application	Chronic atmospheric releases of up to 100 radionuclides from up to 99 release points.
7.	Limitations	Not applicable for use in calculating doses from short-term releases. Age-specific dose factors not available.
8.	Sponsor	DOE/Savannah River Operations Office.
9.	Computer Requirements	Presently resides on an IBM 3090.
10.	Source-Receptor Relationship	The off-site population within 80 km of the release locations at the Savannah River Site. Age-specific parameters and region-specific agricultural data are used.
11.	Emission Rates	User-specified at up to 99 release points.
12.	Chemical Composition	Radionuclides.
13.	Plume Behavior	Straight-line Gaussian plume.
14.	Wind Field	Uniform wind field based on joint frequency distribution of wind speed, wind direction, and stability.
15.	Dispersion Algorithms	Pasquill-Briggs curves with modifications for aerodynamic downwash, plume rise, and terrain features.

MODEL 64 (cont.)

16.	Chemical Reactions	None.
17.	Removal Process	Plume can be depleted by deposition and/or radioactive decay.
18.	Boundary Conditions	Puff reflection at ground.
19.	Meteorological Requirements	Joint frequency distributions of wind speed, wind direction, and stability class.
20.	Validation	Software validation completed.
21.	Output	Input echo, joint frequency distribution and annual average relative concentrations, relative deposition per unit area, annual average radionuclide air concentrations, off-site population distribution, pathway-specific ALARA doses, radionuclide-specific ALARA doses, ALARA dose summaries by pathways, ALARA dose summaries by radionuclides.
22.	Genealogy	Copies of XOQDOQ (Version 2/November 1982) and GASPAR (Version 8/1977) were merged at SRL into POPGASP. POPGASP was modified to use site-specific population, boundary, and topographic files in 11/18/81, 6/29/83, and 11/20/84.
23.	Additional Information	None.

MODEL 65

1.	Name	PUFF-PLUME
2.	References	Garrett, A.J., and Murphy, C.E., Jr., "A Puff-Plume Atmospheric Deposition Model for Use at SRP in Emergency Response Situations," DP-1595 UC-11, E.I. du Pont de Nemours & Co. Savannah River Laboratory, Aiken SC.
3.	Abstract	A Gaussian atmospheric transport and diffusion model has been developed that includes wet and dry deposition, real-time input of meteorological observations and forecasts, dose estimates from inhalation and gamma shine, and puff or plume dispersion.
4.	Location	The model is operated at the Savannah River Technical Center.
5.	Information Contacts	Primary : Robert J. Kurzeja Savannah River Technical Center P.O. Box 616 Aiken, SC 29808 Phone: (803) 725-5945 Secondary: Chuck Hunter Phone: (803) 725-2953
6.	Application	Rapid estimates of consequences of radionuclide and toxic-chemical releases.
7.	Limitations	Ingestion pathway not included in dose estimates. Particle size distribution is fixed.
8.	Sponsor	DOE/Savannah River Operations Office
9.	Computer Requirements	Program runs on VAX 8550 (response time of 30 seconds) and IBM RISC 6000.
10.	Source-Receptor Relationship	Model not used for SRRs.
11.	Emission Rates	User input.
12.	Chemical Composition	Passive contaminants and radionuclides.
13.	Plume Behavior	Option of Gaussian puff or Gaussian plume configuration.
14.	Wind Field	Based on array of 60-m towers; variable with time, but not with space.
15.	Dispersion Algorithms	Statistical based on Pasquill-Briggs.
16.	Chemical Reactions	None.
17.	Removal Process	Wet deposition, dry deposition, and radioactive decay.
18.	Boundary Conditions	Reflection off the surface and boundary layer top.
19.	Meteorological Requirements	Wind direction and wind speed, rainfall rate, mixing layer depth, and sigma azimuth and elevation are needed for duration of model run.

MODEL 65 (cont.)

20.	Validation	The model was compared with data from the MATS SF_6 experiments.
21.	Output	Meteorological input data, time of release, source term information, centerline concentrations, centerline doses, site boundary dose, maps of puff as function of time.
22.	Genealogy	Developed in the late 1970s and modified by several contributors up to the present.
23.	Additional Information	Strengths of the model include real-time assimilation of mean wind and turbulence observations and a statistical forecast based on the NWS LFM model. The model also executes quickly (less than one minute) and accepts actual source data or uses reasonable default values.

MODEL 66

1.	Name	Reactor Accident Code (RAC)
2.	References	1) Garrett, A.J., and Murphy, C.E., Jr., 1981, "A Puff-Plume Atmospheric Dispersion Model for Use at SRP in Emergency Response Situations," DP-1595, E.I. du Pont de Nemours & Co., Savannah River Laboratory, Aiken, SC. (2) Cooper, R.E., 1985, "EGAD - A Computer Program to Compute Dose Integral from External Gamma Emitters," DP-1304, E.I. du Pont de Nemours & Co., Savannah River Laboratory, Aiken, SC.
3.	Abstract	The Reactor Accident Code is an emergency response computer model designed to estimate iodine and noble gas release rates, dispersion, iodine deposition, and radiation doses from cloud shine and inhalation to receptors at various downwind distances.
4.	Location	Westinghouse Savannah River Company Savannah River Technical Center Environmental Technology Section P.O. Box 616 Aiken, SC 29808
5.	Information Contacts	Primary: Chuck H. Hunter Savannah River Technical Center P.O. Box 616 Aiken, SC 29808 Phone: (803) 725-2953 Secondary: Robert J. Kurzeja Phone: (803) 725-5945
6.	Application	Dose estimates from radioactive releases at reactor facilities resulting from fuel melt.
7.	Limitations	Assumes release rate as a function of time resembling a chi-square distribution. Cannot be used for long-term dose assessment. All gamma energies scaled to 1 MeV for dose calculation. Ingestion pathway not considered for dose estimate.
8.	Sponsor	DOE/Savannah River Operations Office.
9.	Computer Requirements	Presently on a VAX 8550.
10.	Source-Receptor Relationship	Centerline and 10 percent doses calculated at distance intervals specified by user.
11.	Emission Rates	User-specified.
12.	Chemical Composition	Radionuclides.
13.	Plume Behavior	Segmented straight-line Gaussian plume.
14.	Wind Field	Time-dependent uniform wind field from local meteorological tower measurements in real time or on user-specified winds.
15.	Dispersion Algorithms	Pasquill-Briggs dispersion curves.

MODEL 66 (cont.)

16.	Chemical Reactions	None.
17.	Removal Process	Wet and dry deposition, radioactive decay.
18.	Boundary Conditions	Plume reflection at surface.
19.	Meteorological Requirements	Wind speed and wind direction, rainfall rate, mixing depth, and sigma azimuth and elevation.
20.	Validation	Software verification complete.
21.	Output	Input echo, number of assemblies estimated to have melted, source term, centerline and 10 percent doses, iodine deposition, time-of-release met data, site map of puffs as a function of time.
22.	Genealogy	Developed from puff-plume in the early-to-mid 1980s.
23.	Additional Information	None.

MODEL 67

1.	Name	Radionuclide Transport, Removal, and Dose (RADTRAD)
2.	References	Miller, L.A., "Radionuclide Transport, Removal, and Dose Model Description."
3.	Abstract	Calculates doses for workers resulting from given accident scenarios at nuclear reactor sites. Considers workers within the control room, at the site boundary, and in the low population zone. Accounts for transport, decay, and removal of contaminants.
4.	Location	Sandia National Laboratories.
5.	Information Contacts	Primary: David K. Monroe Accident Analysis & Consequence Assessment Department MS/0748 Albuquerque, NM 87185-5800 Phone: (505) 844-9510 Secondary: None
6.	Application	Rapid determination of doses and consequences for given plant models and accident scenarios.
7.	Limitations	Current version, which is under development, does not have an atmospheric model.
8.	Sponsor	NRR Rockville, MD.
9.	Computer Requirements	IBM, PC, or compatible; Lahey FORTRAN Version 5.20.
10.	Source-Receptor Relationship	Not applicable.
11.	Emission Rates	User-input.
12.	Chemical Composition	Radionuclides.
13.	Plume Behavior	No atmospheric model; requires X/Q values from the user.
14.	Wind Field	Not applicable.
15.	Dispersion Algorithms	Not applicable.
16.	Chemical Reactions	None.
17.	Removal Process	Filters, sprays, and pools.
18.	Boundary Conditions	Not applicable.
19.	Meteorological Requirements	Not applicable.
20.	Validation	To be compared with TACT-5.
21.	Output	Source term, quantities of nuclides in various locations, and doses acquired by workers.

MODEL 67 (cont.)

22.	Genealogy	New code under development to meet NRC requirements.
23.	Additional Information	None.

MODEL 68

1.	Name	Regional Air Model (RAM)
2.	References	(1) DOC OFCM Modeling Resources. (2) NTIS PB90-500315. (3) NTIS PB88-113261.
3.	Abstract	RAM is a steady-state Gaussian plume model for estimating concentrations of relatively stable pollutants, for averaging times from an hour to a day, from point and area sources in a rural or urban setting. Level terrain is assumed. Calculations are performed for each hour.
4.	Location	EPA, Research Triangle Park, NC
5.	Information Contacts	Primary: R.E. Lawson, Jr. Environmental Protection Agency Research Triangle Park, NC 27711 Phone: (919) 541-1199 Secondary: Desmond Bailey Phone: (919) 541-5248
6.	Application	Estimation of concentrations from relatively stable air pollutants.
7.	Limitations	None identified.
8.	Sponsor	EPA Research Triangle Park, NC
9.	Computer Requirements	IBM PC in DOS.
10.	Source-Receptor Relationship	Gaussian.
11.	Emission Rates	Point, area, multiple, continuous, ground-level, and elevated.
12.	Chemical Composition	Stable air pollutants, particulates.
13.	Plume Behavior	Gaussian plume.
14.	Wind Field	Straight-line.
15.	Dispersion Algorithms	Pasquill-Gifford-Turner, lighter-than-air dispersion.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Conditions	Ground reflection and mixing depth lid.
19.	Meteorological Requirements	Temperature, vertical temperature profile, mixing depth, sky and solar conditions, point winds.
20.	Validation	None identified.
21.	Output	Concentration.

MODEL 68 (cont.)

22.	Genealogy	None provided.
23.	Additional Information	Urban applications.

MODEL 69

1.	Name	RAMS/LPDM
2.	References	(1) Pielke, R.A., Cotton, W.R., Walko, R.L., Trembeck, C.J., Lyons, W.A., Grasso, L.D., Nicholls, M.E., Moran, M.D., Wesley, D.A., Lee, T.J., and Copeland, H, 1992, "A Comprehensive Meteorological Modeling System - RAMS," *Meteorological and Atmospheric Physics* 49: 69-91. (2) McNider, R.T., Moran, M.D., and Pielke, R.A., 1988, "Influence of Diurnal and Inertial Boundary-Layer Oscillations on Long-Range Dispersion," *Atmospheric Environment* 22: 2445-2462. (3) Fast, J.D., O'Steen, B.L., and Addis, R.P., 1993, "Operational Mesoscale Atmospheric Modeling at the Savannah River Site," preprints, *ANS Topical Meeting on Environmental Transport and Dosimetry*, American Nuclear Society, Charleston, SC: 124-127. (4) Fast, J.D., O'Steen, B.L., and Addis, R.L., 1993, "Use of the 1991 ASCOT Field Study Data in a Mesoscale Model Employing a Four-Dimensional Data Assimilation Technique," preprints, *ANS Topical Meeting on Environmental Transport and Dosimetry*, American Nuclear Society, Charleston, SC: 79-84.
3.	Abstract	RAMS is a fully prognostic three-dimensional mesoscale model designed to simulate atmospheric phenomena from the synoptic scale down to large-eddy simulations of the planetary boundary layer. The output produced by RAMS is used to drive a stochastic Lagrangian particle dispersion model (LPDM) to simulate contaminant transport.
4.	Location	Westinghouse Savannah River Company Savannah River Technology Center P.O. Box 616 Aiken, SC 29808
5.	Information Contacts	Primary: B. Lance O'Steen Savannah River Technical Center P.O. Box 616 Aiken, SC 29808 Phone: (803) 725-2449 Secondary: Rob Addis Phone: (803) 725-3325
6.	Application	Atmospheric transport and diffusion of inert pollutants.
7.	Limitations	The LPDM code does not have any dosimetry.
8.	Sponsor	DOE/Savannah River Operations Office.

MODEL 69 (cont.)

9.	Computer Requirements	Requires 1-64 megabytes, depending on the particular application. Currently runs on an IBM RS/6000 workstation or a Cray supercomputer, but can be easily ported to many workstations, mainframes, and supercomputers.
10.	Source-Receptor Relationship	Both source and receptor can be located anywhere on the three-dimensional grid. Point and area sources can be treated. Receptors can provide both instantaneous and time-integrated concentrations.
11.	Emission Rates	User-input.
12.	Chemical Composition	Passive contaminants or particle size distribution can be specified.
13.	Plume Behavior	Non-Gaussian, plume dispersion determined by three-dimensional wind field from RAMS and the diffusion parameterization of the particles.
14.	Wind Field	Three-dimensional wind field predicted by RAMS.
15.	Dispersion Algorithms	Atmospheric dispersion is simulated by tracking a large number of particles in which their positions are determined by the mean velocity component produced by RAMS and a subgrid scale turbulent velocity component. The subgrid scale turbulent component is based on a finite difference analogue to the Langevin stochastic differential equation.
16.	Chemical Reactions	None.
17.	Removal Process	Gravitational settling based on particle size distribution.
18.	Boundary Conditions	Particle reflection off of the surface.
19.	Meteorological Requirements	RAMS requires either (1) a single profile of wind direction, wind speed, pressure, temperature, and humidity or (2) large-scale three-dimensional thermodynamic fields from other operational meteorological models, such as those available from the National Meteorological Center (NMC).
20.	Validation	RAMS/LPDM has been used in the past to predict the transport of pollutants in a variety of atmospheric circulations (see References 1 and 2). The modeling system has been compared with data taken from tracer experiments during DOE's ASCOT program (see Reference 3).
21.	Output	Three-dimensional meteorological concentration data as a function of time. Output available in several graphics formats.
22.	Genealogy	Developed in the 1980s at Colorado State University and modified by many contributors up to the present (see Reference 1).
23.	Additional Information	Strengths include real-time initialization from a variety of hemispheric and regional forecasts models including the NMC, MRF, NGM, and ETA models, so that RAMS/LPDM can be executed anywhere in the world. Four-dimensional data assimilation has been incorporated to improve the three-dimensional wind field. The modeling system requires a significant amount of computational time, depending on the type of application.

MODEL 70

1.	Name	Radiological Assessment System for Consequence Analysis (RASCAL)
2.	References	Sjoreen, A.L., Athey, G.F., Ramsdell, J.V., and McKenna, T.J., 1994, *RASCAL Version 2.1 User's Guide*, NUREG/CR-5247 Vol. 1 Rev. 2, Nuclear Regulatory Commission, Washington, D.C. Athey, G.F., Sjoreen, A.L., and McKenna, T.J., 1994, *RASCAL Version 2.1 Workbook*, NUREG/CR-5247, Vol. 2, Nuclear Regulatory Commission, Washington, D.C.
3.	Abstract	RASCAL is intended to be used as a screening tool to evaluate potential consequences of releases from nuclear power plants. It includes modules to estimate source terms, to evaluate the transport and diffusion in the atmosphere and deposition on surfaces, and to estimate doses from radionuclides in the environment. The output of the code relates dose estimates to both PAGs and early health effects.
4.	Location	Energy Science and Technology Software Center P.O. Box 1020 Oak Ridge, TN 37831-1020 Phone: (615) 576-2606 E-mail: estsc@adonis.osti.gov
5.	Information Contacts	Primary: Janet Quissell Office for Analysis and Evaluation of Operational Data Incident Response Branch Nuclear Regulatory Commission Washington, D.C. 20555 Phone: (301) 415-6402 Secondary: Tom McKenna Office for Analysis and Evaluation of Operational Data Incident Response Branch Nuclear Regulatory Commission Washington, D.C. 20555 Phone: (301) 415-7589
6.	Application	RASCAL is intended for use as a screening model. As such, it may be used as a planning tool or as a tool in evaluating potential actions in the event of an emergency. It is not intended for detailed assessments following an emergency.
7.	Limitations	The source term is constant once established. Multiple release points cannot be simulated. Despite using a Gaussian puff model, RASCAL is limited to meteorological data from a single location. In addition, it does not have the ability to model directional wind shears found in MESOI and MESORAD. Building wake is not included. There is no ingrowth of daughters in the radionuclide decay scheme. Decay and ingrowth of daughters are considered prior to the beginning of the release and in dose calculations. They are not considered during transit in the atmosphere.

MODEL 70 (cont.)

8.	Sponsor	Nuclear Regulatory Commission.
9.	Computer Requirements	PC with 640 kb memory (500 kb free at run time), hard disk (1.6 mb required for installation) math coprocessor.
10.	Source-Receptor Relationship	The source, which may be elevated or at ground level, is located at the center of polar and Cartesian grids. Receptors are positioned at 0.5, 1, and 2 miles on the polar grid. The Cartesian grid is used beyond 2 miles.
11.	Emission Rates	Emission rates are computed within RASCAL code given information on the power plant, its status, and the accident scenario.
12.	Chemical Composition	The effluent is assumed to be passive.
13.	Plume Behavior	Contains both Gaussian puff and plume models. Includes ground-level and elevated plumes, but no plume rise.
14.	Wind Field	Horizontally uniform, time-varying field. Wind speed increases with height, but does not change direction.
15.	Dispersion Algorithms	Gaussian diffusion with diffusion coefficients estimated using stability class and travel distance.
16.	Chemical Reactions	None.
17.	Removal Process	Dry deposition and washout with mass balance maintained by source depletion.
18.	Boundary Conditions	Reflection is assumed at ground level and top of the mixing layer.
19.	Meteorological Requirements	Wind direction, wind speed, stability class, and mixing height are required. Precipitation data may be entered if appropriate. Data may be entered for four time periods. Default values are provided by the code.
20.	Validation	The diffusion algorithms have been partially validated as part of the MESOI and MESORAD codes.
21.	Output	Many output options. Primary output to monitor, printer, and disk files. Level of detail in output controlled by user. Available output includes: total dose - EDE and acute, whole body cloud shine, whole body ground shine, inhalation dose to bone marrow - EDE (50-year commitment) and acute (30-day commitment), thyroid dose, and surface contamination. Where both EDE and acute doses are available, output to the monitor can be toggled from one type of dose to the other using the space bar on the keyboard.
22.	Genealogy	RASCAL is a replacement for the IRDAM code. The source term portion of RASCAL, which serves the purpose of the TACT code, is based on WASH-1400 and a source term estimation procedure developed by McKenna and Glitter. The transport and diffusion portion of RASCAL is taken from MESOI and MESORAD.
23.	Additional Information	The most recent version of RASCAL runs in a DOS environment as a Windows application. It no longer uses device-independent graphics drivers. The most recent DOS version of RASCAL is Version 2.0.

MODEL 71

1.	Name	RATCHET
2.	References	1. Ramsdell, J.V., Jr., Simonen, C.A., and Burk, K.W, 1994, *Regional Atmospheric Transport Code for Hanford Emission Tracking (RATCHET)*, PNWD-2224 HEDR. 2. Napier, B.A., et al., 1994, Validation of HEDR Models, PNWD-2221 HEDR. 3. Farris, W.T., et al., 1994, *Atmospheric Pathway Dosimetry Report*, 1944-1972, PNWD-2228 HEDR.
3.	Abstract	RATCHET is a Lagrangian-trajectory. Gaussian-puff dispersion model developed for the Hanford Environmental Dose Reconstruction HEDR Project. It is one of a suite of codes that were run in a Monte Carlo simulation to estimated individual dose and the uncertainty in the doses resulting from releases from Hanford Operations. The equation set implemented in RATCHET is based on turbulence and diffusion theory current through the early 1980's. Ranges of atmospheric concentrations and surface contamination estimates consistent with available input data can be obtained by running RATCHET several times.
4.	Location	Copies of the code and its documentation may be obtained from: Technical Steering Panel, c/o K. CharLee Office of Nuclear Waste Management Department of Ecology Technical Support and Publication Information Section P.O. Box 47651 Olympia, WA 98504-7651 Phone: (360) 407-7117
5.	Information Contacts	Primary: J.V. Ramsdell, Jr. MS K9-30 Battelle, Pacific Northwest Laboratories P.O. Box 999 Richland, WA 99352 Phone: (509) 372-6316 Secondary: C.W. Miller Centers for Disease Control and Prevention, MS-F35 4770 Burford Highway NE Atlanta, GA 30341-3724 Phone: (404) 488-7040
6.	Application	RATCHET was developed for the Hanford Environmental Dose Reconstruction Project. Its natural application is evaluation of consequence in the ingestion pathway zone. However, it is computationally efficient and can easily be converted for use in emergency response applications. In HEDR applications (2 sources 75,000 ml^2 domain) RATCHET calculations ran at the rate of 5 hours real time per cpu-sec.

MODEL 71 (cont.)

7.	Limitations	RATCHET is a Lagrangian-trajectory, Gaussian-puff model subject to the usual limitations of those models. It uses a single layer wind field, although the wind speed is permitted to increase with height.
8.	Sponsor	Centers for Disease Control and Prevention.
9.	Computer Requirements	RATCHET was developed on a SUN SPARCstation 2. It has been ported to PCs. Processing speed on a Pentlum-90 processor is slightly faster than on the SPARCstation 2.
10.	Source-Receptor Relationship	Sources may be placed anywhere within the model domain. The maximum number of sources is defined in a PARAMETER statement in the code. Fixed receptors are located at nodes of a Cartesian coordinate system. The spacing between nodes is an input variable, and the number of nodes is specified in PARAMETER statements. The location of the model domain is defined by coordinates of the sources and meteorological stations.
11.	Emission Rates	Emission rates are specified in files read by RATCHET. One file is required for each source. The emission rate for each source is independent of the emission rates for other sources. In the HEDR Project emission rates were changed hourly, when required. The code is easily modified to read emission rates more frequently. Continuous releases are simulated by a sequence of puffs. The number of puffs released per hour is set in an input file.
12.	Chemical Composition	The code was developed to treat gaseous and particulate radionuclides in general and specifically ^{131}I. It can handle one particulate species and two gaseous species of the same radionuclide simultaneously. The model assumes that particles are submicron and that the material released may be considered to be a trace gas. It is not intended for heavy gases.
13.	Plume Behavior	Plumes are simulated with sequences of puffs. The puff frequency may be varied by the user. Puff movement is controlled by spatially and temporally varying wind fields. Diffusion and deposition are controlled by spatially and temporally varying wind, stability, mixing-layer thickness, and precipitation fields. Effective release height is calculated using stack parameters and Briggs' equations for final plume rise.
14.	Wind Field	Wind fields are constructed from available wind data using $1/r^2$ Interpolation. Vertical variation of wind speed is calculated using gridded values of surface roughness and diabatic wind profiles. Wind direction does not change with height. The code includes an option to modify input meteorological data to account for uncertainty in the recorded values.

15.	Dispersion Algorithms	The dispersion coefficients used in RATCHET are calculated form turbulence statistics and are functions of travel time. For the first 30 minutes following release, σ_y is calculated from σ_v and the travel time. After 30 minutes, the growth of σ_y is proportional to travel time but independent of σ_v. For neutral and unstable conditions, σ_z is proportional to $\sigma_w t$ until the vertical concentration distribution becomes uniform. During stable conditions, the initial growth of σ_z is proportional to time; however, as time increases, the growth becomes proportional to $t^{1/2}$. Values of σ_v and σ_w are estimated as functions of time and position based on wind speed, stability, surface roughness, height above ground, and mixing-layer thickness.
16.	Chemical Reactions	No chemical reactions are modeled explicitly in RATCHET. First order reactions could be simulated by specifying a decay rate.
17.	Removal Process	RATCHET accounts for removal by radioactive decay, dry deposition, and wet deposition. Dry deposition is calculated using deposition velocities which are calculated using a resistance analogy and local wind and surface conditions. Wet deposition of particles is calculated using a washout model, and wet deposition of gases is calculated assuming equilibrium scavenging of the gas. All wet deposition calculations depend on precipitation rate and precipitation type.
18.	Boundary Conditions	The RATCHET domain includes reflections at the ground and the top of the mixing layer. Material released above the top of the mixing layer diffuses slowly and is permitted to enter the mixing layer where it is trapped. In addition, there is a buffer region around the main computational domain where puffs are tracked, diffuse, and are depleted. Puffs in this region may return to the main domain if there is a reversal of wind directions.
19.	Meteorological Requirements	RATCHET uses spatially and temporally varying wind, stability, precipitation, and mixing-layer thickness fields. These fields are generated internally as needed from available meteorological data using values from the closest meteorological station. In addition, RATCHET needs an ambient air temperature, preferably at release height in the vicinity of the sources. Meteorological data (wind, stability, and precipitation) may be input for at least 1 location but as many as 25 locations in and near the model domain. These data are used to prepare the fields. Mixing-layer thickness is calculated for each location, and a plane is fit to the calculated values.
20.	Validation	RATCHET has been evaluated using several Hanford data sets with releases ranging in duration from about eight hours to several days. Results are included in References 1 and 2 above. No single data set is sufficient to provide a basis for claiming the model has been validated, but the ensemble provides assurance that the model results are reasonable.
21.	Output	Primary model output consists of daily time-integrated air concentrations and surface contamination at nodes in the model domain. Secondary output includes a log file, daily mass balance and monthly total precipitation by node. The frequency of output can easily be changed.

MODEL 71 (cont.)

22.	Genealogy	RATCHET is a direct descendant of MESOI and MESORAD. It shares the computational framework of the previous codes. However, the computational algorithms used for diffusion and deposition in RATCHET are based on more recent work than represented in MESOI and MESORAD.
23.	Additional Information	RATCHET is designed to account for uncertainties in source-term and meteorological data and for some of the uncertainties in the mathematical models. In the HEDR Project RATCHET was run as part of a multicode Monte Carlo simulation.

MODEL 72

1.	Name	REEDM
2.	References	DOC OFCM Modeling Resources.
3.	Abstract	REEDM predicts the behavior of rocket engine exhaust clouds by characterizing the exhaust cloud properties and movements. REEDM was developed by the J.E. Cramer Co., Inc. REEDM basically operates on input data from rawinsonde runs, Doppler acoustic sounder data, and wind tower data, Vehicle trajectory data, fuel properties, and heat emission data provide source inputs for cloud rise, material distribution, and turbulence algorithms in the model. REEDM output is determined from either dosage, concentration, gravitational deposition, or precipitation scavenging models and algorithms.
4.	Location	USAF Vandenberg AFB, CA
5.	Information Contacts	Primary: Steven Sambol 30 WS/WES, DSN 276-2550 Vandenberg AFB, CA 93437-5000 Phone: (805) 734-8232 Ext. 62550 Secondary: None
6.	Application	Predicts behavior of rocket engine exhaust clouds.
7.	Limitations	None identified.
8.	Sponsor	USAF, Vandenberg AFB, CA
9.	Computer Requirements	Tektronic 4027.
10.	Source-Receptor Relationship	Not applicable.
11.	Emission Rates	Point.
12.	Chemical Composition	Rocket exhaust.
13.	Plume Behavior	Gaussian plume.
14.	Wind Field	Complex coastal and marine flows.
15.	Dispersion Algorithms	None provided.
16.	Chemical Reactions	Yes.
17.	Removal Process	Wet deposition.
18.	Boundary Conditions	None provided.
19.	Meteorological Requirements	Point winds, multiple point winds, vertical wind profile, rawinsonde, Doppler acoustic sounder data.
20.	Validation	None identified.
21.	Output	Concentration, dosage.

22.	Genealogy	None provided.
23.	Additional Information	None.

MODEL 73

1.	Name	RSAC-5
2.	References	(1) Wenzel, D.R., "The Radiological Safety Analysis Computer Program (RSAC-5) User's Manual," WINCO-1123, Westinghouse Idaho Nuclear Company, Idaho National Engineering Laboratory, Idaho Falls, ID. (2) "Software Verification and Validation Report for the WINCO RSAC-5 Code", Shonka Research Associates, Inc., 1993, Marietta, GA.
3.	Abstract	RSAC-5 calculates the consequences of the release of radionuclides to the atmosphere. A user can generate a fission product inventory; decay and ingrow the inventory during transport through processes, facilities, and the environment; model the downwind dispersion of the activity; and calculate doses to downwind individuals. Doses are calculated through the inhalation, immersion, ground-surface, and ingestion pathways. RSAC-5 is issued with a menu-driven companion program, RSAC+, which assists users in creating and running RSAC-5 input files. With RSAC+, a user can modify input files easily. It also allows the user to insert, edit, add, copy, move, or delete sets of instructions for RSAC-5. RSAC+ checks all fields to ensure that data are in an appropriate range for the variable and that there is consistency in the input series. A companion program for emergency preparedness, RSAC+EP, has been written in C for transportability from DOS to UNIX environments. A compilation of RSAC-5 input runs is listed for the user, permitting a choice of previously analyzed accident scenarios. Typically, these scenarios are RSAC-5 cases used in final safety analysis report calculations as the design basis for the facility. Using a graphical interface, RSAC-5 inputs can be easily modified by changing any of three key parameters: using actual meteorology rather than design basis, scaling the magnitude of the release, and taking credit for nonsafety-class cleanup systems known to be unimpaired at the time of the accident.

MODEL 73 (cont.)

3.	Abstract (cont.)	These three modifications remove the excess conservatism in safety analyses and provide dose projections that more accurately model the incident. The RSAC-5 output file is read and used to fit isopleth curves over an electronic map of the site. The combination of RSAC-5 and RSAC+EP programs offers emergency planners new and more powerful tools to assess the consequences of an accident.
4.	Location	Default parameters for RSAC-5 are set for the Idaho National Engineering Laboratory. However, the user has control over all parameters, making use of RSAC-5 applicable to all locations.
5.	Information Contacts	Primary: D.R. Wenzel WINCO P.O. Box 4000 Idaho Falls, ID 83415-5209 Phone: (208) 526-3463 Secondary: None
6.	Application	Models all aspects of a release to the atmosphere from source term generation to downwind dose.
7.	Limitations	RSAC-5 calculates inventories for fission products only. In addition, the nuclear data library contains selected activation products, actinides, and daughters of actinides in addition to fission products. Inventories for activation products and actinides are not calculated by RSAC-5. However, they can be added to the inventory by using the radionuclide direct input section of the program. Subsequent sections of the program calculate the radioactive decay and doses from these additional radionuclides.
8.	Sponsor	DOE/Idaho National Engineering Laboratory
9.	Computer Requirements	RSAC-5 runs on an IBM personal computer or compatible, with the following minimum requirements: ● Math coprocessor ● Personal computer with an 80386 ● 2.6 megabyte hard disk space ● 450 kilobytes of available memory ● One RSAC-5 installation diskette (1.44 MB) The following hardware configuration will improve the efficiency and speed of RSAC-5: ● Personal computer with 80486 or Pentium processor ● Extended memory
10.	Source-Receptor Relationship	Sources may be ground-level or elevated.
11.	Emission Rates	The release of radioactivity from containment structures is modeled using exponential functions. Instantaneous and continuous releases are modeled using a single exponential function. Complex release scenarios can be modeled using a series of up to ten exponential functions. These functions decay the radionuclide inventory while it is held up by the containment structure before it is released.

MODEL 73 (cont.)

12.	Chemical Composition	The radionuclide inventory can be fractionated as many times as desired to simulate removal of activity by cleanup systems such as HEPA filters. The inventory can be fractionated by chemical group, element, or entire inventory. In addition, the user may change the clearance class for inhalation dose calculations to be representative of the chemical species being released. The user also has complete control over all of the transfer parameters used in the ingestion dose calculations.
13.	Plume Behavior	Both puff and continuous plumes can be simulated.
14.	Wind Field	Wind fields are not calculated directly by RSAC-5. Other programs such as MESODIF are used to evaluate data from meteorological towers, and the real-time or historical data are then imported into RSAC-5.
15.	Dispersion Algorithms	Atmospheric dispersion at ground level is expressed using the time-integrated form of the universal diffusion equation. Options are available to correct dispersion for building wake effects and plume rise. Three sets of sigmas are provided: Hilsmeier-Gifford, Markee, and Pasquill-Gifford. Users may also directly enter sigmas if they wish. In addition, RSAC-5 models Pasquill Class F fumigation conditions.
16.	Chemical Reactions	None.
17.	Removal Process	Plume depletion modeling is provided for both dry and wet deposition.
18.	Boundary Condition	Plume sigmas are calculated for downwind distances of 100 to 100,000 m. Other distances require the user to directly enter sigmas. The ground and height of the mixing depth are treated as reflectors. When sigma-z becomes large compared to the mixing depth, the plume becomes uniformly mixed between the ground and the height of the mixing depth.
19.	Meteorological Requirements	Average wind speed, stack height, mixing layer depth, air density, stability class, choice of sigma values or direct sigma input, and parameters that are descriptive of plume rise.
20.	Validation	RSAC-5 has been subjected to extensive independent verification and validation for use in performing safety-related dose calculations to support safety analysis reports. This was done in accordance with guidelines presented in ANSI/ANS-10.4.
21.	Output	All input parameters used in a calculation are included in the printed output. Options are provided for the printout of radionuclide inventories and downwind doses by the inhalation, ingestion, ground surface, and plume gamma pathways. An option is also provided for dose summaries from different exposure pathways and multiple RSAC-5 calculations within the same input run. Each page of output contains the program version number, the program serial number, and the date and time the run was made.
22.	Genealogy	RSAC was originally developed at INEL in 1966. Since that time, RSAC has undergone substantial revision, incorporating current consensus modeling and that directed by the Department of Energy.

23.	Additional Information	RSAC-5 calculates the buildup and decay of all progeny in the decay chains. This is particularly important when analyzing accidents involving short-lived radionuclides, such as a criticality accident. Cloud gamma shine may be calculated using either a finite plume model or a semi-infinite model. While the finite plume model requires more computer time, it accurately calculates the dose from any plume size, location, or release point. When the plume has not diffused to ground level and is not large compared to the mean free path of the gamma rays, the commonly used semi-infinite models often produce errors of up to two orders of magnitude.

MODEL 74

1.	Name	RTVSM
2.	References	Bjorklund, J.R., 1990, User Instructions for the Real Time Volume Source Dispersion Model (RTVSM) Version 3.00, Report No. TR-90-374-02, H.E. Cramer Company, Inc, prepared for Army Dugway Proving Ground, Dugway, UT.
3.	Abstract	Implements generalized Gaussian dispersion models that calculates the concentration, dosage, and deposition fields downwind of multiple volume, line, area, and stack sources. The computer program is interactive and menu-driven, but can be executed in a batch environment. Both tabular and graphical output are available.
4.	Location	Meteorology Division West Desert Test Center U.S. Army Dugway Proving Ground Dugway, UT 84022-5000
5.	Information Contacts	Primary: James F. Bowers Meteorology Division West Desert Test Center U.S. Army Dugway Proving Ground Dugway, UT 84022-5000 Phone: (801) 831-5101 Secondary: None
6.	Application	Used to assist in the design and analysis of chemical and biological agent stimulant and military smoke/obscurant dissemination tests.
7.	Limitations	Does not consider dry deposition for particles with aerodynamic equivalent diameters less than about 10 µm. In its real-time mode, is designed to access the real-time data file for Dugway Proving Ground's network of remote automated weather stations and would have to be modified for real-time applications at other sites.
8.	Sponsor	U.S. Army.
9.	Computer Requirements	Source code is 1.5 megabytes in length, and executable binary code is 2.3 megabytes in length. The program requires one temporary direct access data file of up to 650 kilobytes, depending on the problem being run, and optionally up to 12 additional data files of varying length, depending on the options selected by the user.
10.	Source-Receptor Relationship	Source and receptor locations can be entered in Cartesian or polar coordinates. Both regular and discrete receptor arrays can be specified.
11.	Emission Rates	User-specified for instantaneous, quasi-continuous, exponentially decaying, and continuous sources.
12.	Chemical Composition	Can consider the evaporation of both falling and deposited drops. User must provide parameters such as latent heat of vaporization, liquid surface tension, and vapor pressure or Antoine constants.

MODEL 74 (cont.)

13.	Plume Behavior	Steady-state mode: Gaussian puff or plume, depending on source. Nonsteady-state mode: Gaussian puff or segmented plume, depending on source. Can consider buoyant cloud or plume rise in either mode.
14.	Wind Field	Power-law wind profile. In nonsteady-state mode can interpolate winds from real-time data base for Dugway Proving Ground's remote automated weather stations.
15.	Dispersion Algorithms	Dugway Proving Ground (Cramer).
16.	Chemical Reactions	None.
17.	Removal Process	Exponential decay, wet deposition, and dry deposition (aerodynamic equivalent diameters greater than about 10 µm).
18.	Boundary Conditions	Multiple reflections at the surface and top of the mixing layer. Dry deposition is parameterized by a surface reflection coefficient, which is related to the terminal fall velocity.
19.	Meteorological Requirements	Minimum inputs consist of wind speed and direction, mixing depth, and net radiation index (or cloud cover, time of day, etc., needed to compute net radiation index). Designed to use on-site measurements where available, including multilevel wind profiles and turbulence intensities or standard deviations of wind azimuth and elevation angles.
20.	Validation	Transport and diffusion components validated using data from Dugway Proving Ground chemical/biological agent and stimulant and smoke/obscurant field tests.
21.	Output	Source inputs, meteorological inputs, program control parameters, and tabular listings and/or isopleth maps of concentration, dosage, or deposition for regular and discrete receptors.
22.	Genealogy	Developed in the late 1980s and early 1990s as a replacement of Dugway Proving Ground's Volume Source Diffusion Model (VSDM).
23.	Additional Information	None.

MODEL 75

1.	Name	SABLE
2.	References	(1) Chan, S.T.; Leone, J.M., Jr.; and Lee, R.L., "A Hydrostatic Mesoscale Model Using Finite Element and Finite Difference Techniques," *Finite Element Analysis in Fluids*, University of Alabama at Huntsville Press: 544-553. (2) Leone, J.M., Jr.; Chan, S.T.; and Lee, R.L., 1989, "A Meso-Beta Model for Use in Emergency Response," IAMAP 89, University of Reading, Reading, United Kingdom, July 31-August 11. (3) Zhong, Shiyuan; Leone, J.M., Jr.; and Takle, E.S., 1991, "Interaction of the Sea Breeze with a River Breeze in an Area of Complex Coastal Heating," *Boundary Layer Meteorology* 56: 100-139.
3.	Abstract	This model solves the anelastic, hydrostatic equations of energy and momentum. The prognostic equations for u, v, and theta are solved via isoparametric finite elements, while the diagnostic equations for w and pi-prime are solved via second-order finite difference techniques.
4.	Location	Regional Atmospheric Sciences Division Lawrence Livermore National Laboratory
5.	Information Contacts	Primary: John M. Leone, Jr. Lawrence Livermore National Laboratory P.O. Box 808 Livermore, CA 94550 Phone: (510) 422-6449 Secondary: Stevens T. Chan Phone: (510) 422-1822
6.	Application	Simulation of meso-beta scale flows, especially for regions of complex terrain.
7.	Limitations	The model cannot yet be driven by boundary conditions from a larger-scale model. There is no surface energy budget submodel, although surface heat flux can be specified as a function of time. This is a research model with only marginal documentation.
8.	Sponsor	DOE/Lawrence Livermore National Laboratory.
9.	Computer Requirements	Cray-class computer or large workstation using 64-bit floating point numbers to ensure accuracy of matrix solver.
10.	Source-Receptor Relationship	Not applicable.
11.	Emission Rates	Not applicable.
12.	Chemical Composition	Not applicable.
13.	Plume Behavior	Not applicable.
14.	Wind Field	Self-generated.

MODEL 75 (cont.)

15.	Dispersion Algorithms	Dispersion is handled via the LLNL ADPIC model. Model-predicted wind fields are used to drive the ADPIC dispersion calculation.
16.	Chemical Reactions	Not applicable.
17.	Removal Process	Not applicable.
18.	Boundary Conditions	u, v, theta-specified, specified gradient, radiation condition, sponge layer on top, pi-prime+0 on top, and w=0 on the surface.
19.	Meteorological Requirements	Initial fields for u, v, and theta, and values for u_g and v_g and f, the Coriolis parameter.
20.	Validation	A wide variety of idealized test problems. Sea breeze development as observed by KABLE. Nocturnal dispersion experiments at Rocky Flats Plant.
21.	Output	u, v, w, theta, and pi-prime fields at user-requested intervals, and time histories of selected variables at selected nodes.
22.	Genealogy	Not provided.
23.	Additional Information	One of the unique features of this model is the adaptability of the grid structure. It is quite easy to use variable-spaced grids to achieve high resolution in regions of importance, such as boundary layers, and to simulate domains with geometrically complicated boundaries, such as coastlines or mountain ranges, with this model.

MODEL 76

1.	Name	SCREEN
2.	References	DOE OFCM Modeling Resources.
3.	Abstract	SCREEN can perform all of the single-source, short-term calculations in the screening procedures document, including estimating maximum ground-level concentrations and the distance to the maximum, incorporating the effects of building downwash on the maximum concentrations in the cavity recirculation zone, estimating concentrations in the cavity recirculation zone, estimating concentrations due to inversion breakup and shoreline fumigation, and determining plume rise for flare releases.
4.	Location	EPA Research Triangle Park, NC
5.	Information Contacts	Primary: R.E. Lawson, Jr. Environmental Protection Agency Research Triangle Park, NC 27711 Phone: (919) 541-1199 Secondary: Dennis Atkinson Phone: (919) 541-0518
6.	Application	Screening model for maximum ground-level concentrations.
7.	Limitations	None identified.
8.	Sponsor	EPA, Research Triangle Park, NC.
9.	Computer Requirements	None identified.
10.	Source-Receptor Relationship	Gaussian.
11.	Emission Rates	Point, area, continuous, ground-level, and elevated.
12.	Chemical Composition	Passive criteria pollutants, particulates.
13.	Plume Behavior	Gaussian plume.
14.	Wind Field	Straight-line.
15.	Dispersion Algorithms	Pasquill-Gifford-Turner.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Conditions	None identified.
19.	Meteorological Requirements	Wind speed, wind direction, indicator of atmospheric stability.
20.	Validation	None identified.
21.	Output	Concentration.

MODEL 76 (cont.)

22.	Genealogy	None provided.
23.	Additional Information	Includes building downwash effects, urban applications.

MODEL 77

1.	Name	SDM
2.	References	(1) DOC OFCM Modeling Resources. (2) User's Guide to SDM, EPA-450/4-88-017.
3.	Abstract	SDM is a multipoint Gaussian dispersion model that can be used to determine ground-level concentrations from tall stationary point source emissions near a shoreline environment. SDM is used in conjunction with MPTER algorithms to calculate concentrations when fumigation conditions do not exist.
4.	Location	EPA Research Triangle Park, NC
5.	Information Contacts	Primary: R.E. Lawson, Jr. Environmental Protection Agency Research Triangle Park, NC 27711 Phone: (919) 541-1199 Secondary: Joe Touma Phone: (919) 541-5381
6.	Application	Shoreline fumigation.
7.	Limitations	None identified.
8.	Sponsor	EPA, Research Triangle Park, NC.
9.	Computer Requirements	IBM PC in DOS.
10.	Source-Receptor Relationship	Gaussian.
11.	Emission Rates	Point, multiple, continuous, and elevated.
12.	Chemical Composition	Passive criteria pollutants, particulates.
13.	Plume Behavior	Gaussian plume.
14.	Wind Field	Straight-line.
15.	Dispersion Algorithms	Pasquill-Gifford-Turner.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Conditions	Mixing lid.
19.	Meteorological Requirements	Temperature, vertical temperature profile, mixing depth, sky and solar conditions, point winds.
20.	Validation	None identified.
21.	Output	Concentration.
22.	Genealogy	None provided.

23.	Additional Information	Fumigation model for shoreline environment.

MODEL 78

1.	Name	SLAB
2.	References	DOC OFCM Modeling Resources.
3.	Abstract	The SLAB model, developed by Lawrence Livermore National Laboratory, was enhanced by LLNL under support of AFESC. The model treats denser-than-air releases by solving the one-dimensional equations of momentum, conservation of mass, species, and energy, and the equation of state. SLAB handles release scenarios including ground-level and elevated jets, liquid pool evaporation, and instantaneous volume sources. The model accounts for user-selected averaging time effects.
4.	Location	USAF Tyndall AFB, FL
5.	Information Contacts	Primary: Captain Michael Jones AL/EQS 139 Barnes Drive Tyndall AFB, FL 32403-5319 Phone: (904) 283-6002 Secondary: Captain Jon Hayward Phone: (904) 283-6324
6.	Application	Denser-than-air dispersion.
7.	Limitations	None identified.
8.	Sponsor	USAF, Tyndall AFB, FL
9.	Computer Requirements	IBM PC-compatible in MS-DOS operating environment; FORTRAN 77 language.
10.	Source-Receptor Relationship	Gaussian.
11.	Emission Rates	Point, area, instantaneous, and continuous.
12.	Chemical Composition	Ground-level/elevated jets, liquid pools of hazardous chemicals.
13.	Plume Behavior	Gaussian plume.
14.	Wind Field	Straight-line.
15.	Dispersion Algorithms	K-diffusivity, heavier-than-air dispersion.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Conditions	None provided.
19.	Meteorological Requirements	Temperature, point winds.
20.	Validation	None identified.
21.	Output	Concentration.

22.	Genealogy	None provided.
23.	Additional Information	Aerosol two-phase release.

MODEL 79

1.	Name	TOXICGAS
2.	References	(1) EFCOG Modeling Resources. (2) ARB-162-83-ARSP, November 1983.
3.	Abstract	Dispersion modeling code for liquid or gaseous chemical releases. Developed for emergency responses. Manual includes mathematical modeling formulas. Also treats heavy gases.
4.	Location	DOE/Rocky Flats.
5.	Information Contacts	Primary: Terry Foppe Safety Analysis Building T886B EG&G Rocky Flats P.O. Box 464 Golden, CO 80402 Phone: (303) 966-7437 Secondary: Dr. W.C. Tam Ontario Ministry of the Environment Air Resource Branch 880 Bay Street 4th Floor Toronto, Ontario Phone: (416) 965-4081
6.	Application	Liquid or gaseous chemical releases.
7.	Limitations	None identified.
8.	Sponsor	DOE/Rocky Flats.
9.	Computer Requirements	IBM PC.
10.	Source-Receptor Relationship	Gaussian.
11.	Emission Rates	User-specified.
12.	Chemical Composition	Hazardous chemicals.
13.	Plume Behavior	Gaussian plume.
14.	Wind Field	Straight-line.
15.	Dispersion Algorithms	Pasquill-Gifford-Turner, heavier-than-air dispersion.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Conditions	None identified.
19.	Meteorological Requirements	Wind speed, wind direction, indicator of atmospheric stability.
20.	Validation	None identified.

MODEL 79 (cont.)

21.	Output	Concentrations.
22.	Genealogy	None provided.
23.	Additional Information	None.

MODEL 80

1.	Name	TOXST
2.	References	(1) DOC OFCM Modeling Resources. (2) "Toxic Modeling System Short-Term (TOXST) User's Guide," EPA-450/4-92-002.
3.	Abstract	TOXST addresses the problem of estimating expected exceedances of specified short-term health effects thresholds near continuous and intermittent toxic releases from a complex industrial site. TOXST uses ISCST2 to predict ambient concentrations for each source included in the simulation. Each concentration is then compared to a user-specified threshold to determine if an "exceedance" of that threshold occurs. Exceedances are subsequently tracked at each receptor hour of the year to obtain annual exceedance rates.
4.	Location	EPA Research Triangle Park, NC
5.	Information Contacts	Primary: R.E. Lawson, Jr. Environmental Protection Agency Research Triangle Park, NC 27711 Phone: (919) 541-1199 Secondary: Dave Guinnup Phone: (919) 541-5368
6.	Application	Short-term health effects exceedances from toxic chemical releases.
7.	Limitations	None identified.
8.	Sponsor	EPA, Research Triangle Park, NC.
9.	Computer Requirements	IBM PC in DOS; FORTRAN language.
10.	Source-Receptor Relationship	Gaussian.
11.	Emission Rates	User-specified.
12.	Chemical Composition	Toxic chemicals.
13.	Plume Behavior	Gaussian plume.
14.	Wind Field	Straight-line.
15.	Dispersion Algorithms	Pasquill-Gifford-Turner.
16.	Chemical Reactions	None.
17.	Removal Process	Dry deposition.
18.	Boundary Conditions	Ground reflection, mixing lid.
19.	Meteorological Requirements	Temperature, vertical temperature profile, point winds.
20.	Validation	None identified.

MODEL 80 (cont.)

21.	Output	Concentration.
22.	Genealogy	None provided.
23.	Additional Information	Includes building downwash effects, urban applications.

MODEL 81

1.	Name	Terrain-Responsive Atmospheric Code (TRAC)
2.	References	Hodgin, C.R. 1985, "The Terrain-Responsive Atmospheric Code (TRAC) for Plume Growth and Dispersion in Complex Terrain," RFP-3683, Rockwell International, Rocky Flats Plant, Golden, CO, 18 pp.
3.	Abstract	TRAC is a deterministic dispersion model developed at the Rocky Flats Plant to treat plume transport and diffusion in complex air flow fields. The model develops three-dimensional, time-and-space-varying meteorological fields (including winds), then releases simulated puffs of material into the flow. Customized versions of the code have been developed for applications in risk assessment, emergency response, regulatory compliance, and hazardous materials assessments.
4.	Location	Rocky Flats Environmental Technology Site P.O. Box 464 Golden, CO 80402-0464
5.	Information Contacts	Primary: Bert Crist Rocky Flats Environmental Technology Site Building 117 P.O. Box 928 Golden, CO 80402-0928 Phone: (303) 966-7793 Secondary: Carlos Schoellhorn EG&G Rocky Flats Inc. Building T-130E P.O. Box 464 Golden, CO 80402-0464 Phone: (303) 966-6321
6.	Application	Risk assessment, emergency response, regulatory compliance, hazardous materials assessments.
7.	Limitations	No chemical or physical transformations (other than ingrowth/decay). No dense gas behavior. No explosion sources. No transport beyond 80 km. No treatment of lake or sea breeze effects.
8.	Sponsor	DOE/Albuquerque Operations Office.
9.	Computer Requirements	Digital Equipment Corporation MicroVAX or VAX Micro/Mini computer with VMS operating system and FORTRAN-77 capabilities.
10.	Source-Receptor Relationship	Multiple point sources, multiple area sources, instantaneous and continuous releases. Sources user-selectable at any locations within modeling domain (100km x 100km). 25,000 model assigned receptors on 1 km x 1 km grid. Unlimited user-assigned receptors.
11.	Emission Rates	Instantaneous and continuous release rates. Continuous release rates totally variable under user control.

MODEL 81 (cont.)

10.	Chemical Composition	Inert particles, inert gases, radioactive particles, radioactive gases.
13.	Plume Behavior	Plumes simulated as overlapping ellipsoidal puffs. Each puff travels on independent, three dimensional, non-linear path through the wind field.
14.	Wind Field	Three dimensional, partially mass conservative. Horizontal resolution of 1km x 1km. Vertical resolutions continuous as profiles in four layers.
15.	Dispersion Algorithms	TRAC utilizes similarity theory. Profiles of turbulence intensity developed over each grid (bulk Richardson number and Monin-Obukhov length) using modeled winds, surface roughness, and temperatures lapse rate. Turbulence converted to dispersion rate (Lagrangian) for specific puff location and height above terrain.
16.	Chemical Reactions	None at this time. TRAC is being upgraded to treat chemical reactions for selected hazardous substance.
17.	Removal Process	TRAC treats gravitational settling for all ranges of particulates. TRAC calculates dry deposition rate for particulates on grid-by-grid basis. TRAC also treats dry and wet deposition of gases on grid-by-grid basis.
18.	Boundary Conditions	Modeling domain: 100km x 100km. Lower boundary: complex topography with 1km x 1km resolution. Upper boundary: gradient level. Meteorological monitoring stations may be located outside of the domain.
19.	Meteorological Requirements	Wind direction, wind speed, temperature, and atmospheric pressure for one or more surface observing station (no limit). 15 minute time resolutions required. Wind direction, wind speed, and temperature profiles (vertical) from one or more upper air observing stations (no limit). 15 minute to 12 hour time resolution required.
20.	Validation	Validation protocol developed. Model compared with summer tracer data set collected in 1987. Evaluation program includes verification, validation, bench marking, sensitivity analysis, and peer review. Formal DOE and EPA approved programs underway.
21.	Output	Plume path, air concentrations (gridded), ground deposition (gridded), individual dose (gridded), population dose (gridded), recommended protective action (gridded).
22.	Genealogy	Windfield module based in part on US Forest Service "Winds" Code.
23.	Additional Information	TRAC treats buoyancy and momentum plume rise. A three-year effort is underway to upgrade the model further. TRAC has been used in more than 15,000 simulations for Emergency Preparedness at Rocky Flats Plant.

MODEL 82

1.	Name	TRIAD
2.	References	Hicks, B.B., Rao, K.S., Dobosy, R.J. Hosker, R.P. Jr, Herwehe, J.A., and Pendergrass W.R., 1989, "TRIAD: A Puff-Trajectory Model for Reactive Gas Dispersion with Application to UF_6 Releases into the Atmosphere." NOAA Technical Memorandum ERL ARL-168, Air Resources Laboratory, Silver Springs, MD,136 pp.
3.	Abstract	TRIAD is a Gaussian puff trajectory model designed to simulate releases of uranium hexafluoride (UF_6), including the effects of the exothermic reaction between UF_6 and atmospheric water vapor. The variable trajectories are obtained by objective interpolation among wind data supplied to the model.
4.	Location	Atmospheric Turbulence and Diffusion Division, NOAA P.O. Box 2456 456 South Illinois Avenue Oak Ridge, TN 37831
5.	Information Contacts	Primary: K.S. Rao Atmospheric Turbulence and Diffusion Division (ATDD) NOAA/ARL 456 South Illinois Avenue Oak Ridge, TN 37830 Phone: (615) 576-1238 Secondary: R.J. Dobosy, ATDD Phone: (615) 576-1250
6.	Application	To simulate the atmospheric dispersion of UF_6 and other toxic contaminants released into the atmosphere in moderately complex terrain.
7.	Limitations	Two-dimensional wind field (interpolated from data) No dense gas effects. Assumes chemical reactions are completed at source. No building wake effects.
8.	Sponsor	DOE/Oak Ridge Operations Office.
9.	Computer Requirements	Can run on PC or any system with a FORTRAN-77 compiler.
10.	Source-Receptor Relationship	Maximum of 100 receptors at user-specified locations.
11.	Emission Rates	User-specified; they can vary with time.
12.	Chemical Composition	UF_6 and its reaction products. Can be adapted to other reactive chemicals and directly used for non-reactive pollutants.
13.	Plume Behavior	Gaussian puff algorithm.
14.	Wind Field	$1/r^2$ interpolation with empirical adjustments for terrain.

MODEL 82 (cont.)

15.	Dispersion Algorithms	Pasquill-Gifford curves or onsite measurements of σ_θ and σ_ϕ. The vertical concentration distribution becomes uniform when σ_z exceeds 80% of the mixed layer depth.
16.	Chemical Reactions	Includes the production of UO_2F_2 and HF by the reaction between UF_6 and H_2O.
17.	Removal Process	Dry deposition and gravitational settling, by analytical algorithms.
18.	Boundary Condition	Full or partial puff reflection at the ground.
19.	Meteorological Requirements	Wind speed and direction at one or more locations. Requires a Pasquill stability class or σ_θ and σ_ϕ. Ambient temperature, relative humidity, and pressure. Deposition velocity and setting velocity for removal.
20.	Validation	TRIAD has been extensively evaluated using passive tracer field data from a number of field experiments in the DOE's ASCOT program. The results are published in open literature.
21.	Output	Contaminant concentrations and deposition fluxes at user-specified receptors.
22.	Genealogy	The puff transport and diffusion is based on INPUFF-2, the wind-field interpolation is based on MESOI-2, and the UF_6 effects are partly based on the MMES plume chemistry model.
23.	Additional Information	A self-extracting version of TRIAD code is listed on EPA's electronic bulletin board, and can be downloaded via modem. The TRIAD model user's guide is available as PB89-182703/GAR from the National Technical Information Service (NTIS).

MODEL 83

1.	Name	TSCREEN
2.	References	DOC OFCM Modeling Resources.
3.	Abstract	TSCREEN (A Model of Screening Toxic Air Pollutant Concentrations) implements the procedures to correctly analyze toxic emissions and their subsequent dispersion from one of many different types of possible releases from Superfund sites.
4.	Location	EPA Research Triangle Park, NC
5.	Information Contacts	Primary: R.E. Lawson, Jr. U.S. Environmental Protection Agency Research Triangle Park, NC 27711 Phone: (919) 541-1199 Secondary: Joe Touma Phone: (919) 541-5381
6.	Application	Screening model for toxic chemical emissions.
7.	Limitations	None identified.
8.	Sponsor	USEPA, Research Triangle Park, NC.
9.	Computer Requirements	IBM PC in DOS.
10.	Source-Receptor Relationship	Gaussian.
11.	Emission Rates	User-specified.
12.	Chemical Composition	Toxic chemicals.
13.	Plume Behavior	Gaussian plume.
14.	Wind Field	Straight-line.
15.	Dispersion Algorithms	Pasquill-Gifford-Turner; lighter-than-air dispersion.
16.	Chemical Reactions	None.
17.	Removal Process	Dry deposition.
18.	Boundary Condition	Ground reflection, mixing lid.
19.	Meteorological Requirements	Temperature, vertical temperature profile, mixing depth, point winds.
20.	Validation	None identified.
21.	Output	Concentration.
22.	Genealogy	None provided.

23.	Additional Information	Urban application.

MODEL 84

1.	Name	VAFTAD
2.	References	Heffter, J.l., and Stunder, B.J.B., 1993, "Volcanic Ash Forecast Transport and Dispersion (VAFTAD) Model," *Weather Forecasting*, 8: 533-541.
3.	Abstract	The National Oceanic and Atmospheric Administration (NOAA) Air Resources Laboratory (ARL) has developed the time-dependent, three-dimensional VAFTAD model for emergency response, which does the following: (1) Focuses on aviation operations by forecasting the visual ash cloud location in time and space (2) Is user-run at any time via modem to a workstation at ARL, using screen-prompted model input (3) Automatically faxes output charts of the forecast visual ash cloud to predesignated recipients
4.	Location	NOAA Air Resources Laboratory R/E/AR SSMC3, Room 3151 1315 East-West Highway Silver Springs, MD 20910
5.	Information Contacts	Primary: Jerome L. Heffter NOAA/ARL R/E/AR SSMC 3, Room 3151 1315 East-West Highway Silver Springs, MD 20910 Phone: (301) 713-0295 Extension 124 Secondary: Barbara J.B. Stunder Phone: (301) 713-0295 Extension 114
6.	Application	Forecasts visual volcanic ash cloud for aviation operations.
7.	Limitations	None.
8.	Sponsor	NOAA/ARL.
9.	Computer Requirements	User-run via PC modem to an ARL workstation continually available for emergency response operations.
10.	Source-Receptor Relationship	Volcanic eruption of a duration of less than three hours with an estimated initial ash cloud height.
11.	Emission Rates	Unit source of 1 g for eruption mass load to the atmosphere.
12.	Chemical Composition	Spherical particles of density 2.5 E +06 g/m^3, with diameters ranging from 0.3 to 30 microns.
13.	Plume Behavior	None provided.

MODEL 84 (cont.)

14.	Wind Field	NOAA National Meteorological Center twice-daily ETA and AVN forecast cycles including horizontal wind components and vertical velocities at 50-millibar pressure level, with grid spacings of 91 km (ETA), and at mandatory pressure levels with grid spacings of 190 km in the northern and southern hemispheres (AVN).
15.	Dispersion Algorithms	Bivariate-normal horizontal diffusion. Fall velocities according to Stokes' law with a slip correction.
16.	Chemical Reactions	None.
17.	Removal Process	Dry deposition.
18.	Boundary Conditions	Surface to 100 millibars in the vertical. North America (ETA); global (AVN).
19.	Meteorological Requirements	See discussion in Attribute #14.
20.	Validation	Includes three Spurr eruptions of 1992 and Rinjani eruptions of 1994.
21.	Output	Eight-panel charts of the forecast visual ash cloud for layers applicable to aviation operations at eruption +06, +12, +18, +24, +36, +48 hours automatically faxed to the user.
22.	Genealogy	Developed in 1991 for the NOAA/FAA MOU on Volcano Hazards Alerts with usage expanding and development ongoing.
23.	Additional Information	None.

MODEL 85

1.	Name	VALDRIFT
2.	References	(1) Allwine, K.J., 1992, *Atmospheric Dispersion in Mountain Valleys and Basins*, PNL-7922, Pacific Northwest Laboratories, Richland, WA. (2) Allwine, K.J., Bian, X., and Whiteman, C.D., 1994, *User's Guide to VALDRIFT 1.0 - A Valley Atmospheric Dispersion Model*, Pacific Northwest Laboratories, Richland, WA.
3.	Abstract	VALDRIFT is a three-dimensional atmospheric transport and dispersion model for use in well-defined mountain valleys. It is especially suited for determining the extent of drift from aerial pesticide spraying activities. The model is phenomenological; that is, the dominant meteorological processes governing the behavior of the valley atmosphere are formulated explicitly in the model; albeit in a highly parameterized fashion. The key meteorological processes that can be treated are (1) nonsteady and nonhomogeneous along-valley winds and turbulent diffusivities; (2) convective boundary layer growth and inversion descent following sunrise; (3) cross-valley circulations, tributary flows, and subsidence; and (4) interactions with above-ridgetop winds. The inputs required are the valley physical characteristics, the release rate as a function of time and space, the along-valley wind speed as a function of time following sunrise, and sensible heat flux as a function of time following sunrise. Default values are provided for certain inputs in the absence of detailed observations. The outputs are air concentrations and deposition fields as a function of time and space.
4.	Location	Pacific Northwest Laboratories.
5.	Information Contacts	Primary: C.D. Whiteman Pacific Northwest Laboratories, MS K9-30 P.O. Box 999 Richland, WA 99352 Phone: (509) 372-6147 E-mail: cd_whitman@pnl.gov Secondary: None
6.	Application	VALDRIFT can be used for valley-scale air quality assessments and for assessing drift from pesticide spraying operations in mountain valleys.
7.	Limitations	Applicable to sources located in a well-defined mountain valley. Maximum of 24-hour simulation, or one diurnal cycle.
8.	Sponsor	U.S. Forest Service.
9.	Computer Requirements	Personal computers and up.
10.	Source-Receptor Relationship	Time- and space-varying point, area, and line releases are specified by the user. The air concentrations are computed on a three-dimensional grid of the valley atmosphere, and deposition fields are given on the two-dimensional grid at the surface.

MODEL 85 (cont.)

11.	Emission Rates	Time- and space-varying emission rates for one compound are specified by the user.
12.	Chemical Composition	Gases or particles that can be assumed to follow the fluid motion.
13.	Plume Behavior	Plume represented by solving the three-dimensional Eulerian conservation of species equation.
14.	Wind Field	Diagnostic three-dimensional wind field.
15.	Dispersion Algorithms	K-theory.
16.	Chemical Reactions	Passive.
17.	Removal Process	Dry.
18.	Boundary Condition	Plume reflections at the valley floor and sidewalls.
19.	Meteorological Requirements	Along-valley wind speed as a function of time and space, temperature inversion characteristics at sunrise, and sensible heat flux as a function of time following sunrise.
20.	Validation	Limited testing for a valley in western Colorado using data from the Department of Energy's ASCOT program.
21.	Output	Files of instantaneous air concentrations and deposition amounts from all grid points.
22.	Genealogy	The model was recently developed in 1993-1994 by Pacific Northwest Laboratories for the U.S. Forest Service.
23.	Additional Information	None.

MODEL 86

1.	Name	VALMET
2.	References	Whiteman, C.D., and Allwine, K.J., 1985, *VALMET - A Valley Air Pollution Model,* PNL-4728 Revision 1, Pacific Northwest Laboratories, Richland, WA.
3.	Abstract	VALMET is a two-dimensional phenomenological model that simulates atmospheric dispersion from elevated point sources located within well-defined valleys. The nighttime simulation uses a modified Gaussian plume to calculate concentrations on the valley floor and sidewalls in addition to providing concentrations on a cross-valley section at sunrise as an initial condition for the daytime simulation. A valley energy budget approach is used in the daytime simulation to predict how concentrations will vary with time as pollutants are fumigated onto the valley floor and sidewalls during the postsunrise temperature inversion breakup period.
4.	Location	Pacific Northwest Laboratories.
5.	Information Contacts	Primary: C.D. Whitman Pacific Northwest Laboratories, MS K9-30 P.O. Box 999 Richland, WA 99352 Phone: (509) 372-6147 E-mail: cd_whiteman@pnl.gov Secondary: None
6.	Application	VALMET can be used for valley-scale air quality assessments.
7.	Limitations	No deposition or decay. Applicable to a single elevated point source located in a well-defined mountain valley.
8.	Sponsor	Environmental Protection Agency.
9.	Computer Requirements	PC
10.	Source-Receptor Relationship	Source and down-valley cross-section specified by the user. The receptors are fixed on the valley sidewalls and valley floor on the cross-section specified by the user.
11.	Emission Rates	Constant emission rate for one pollutant.
12.	Chemical Composition	Gases or particles that can be assumed to follow the fluid motion.
13.	Plume Behavior	Nighttime dispersion represented as a Gaussian plume, and daytime diffusion computed on a cross-valley two-dimensional grid at the user-specified valley cross-section.
14.	Wind Field	Single value of average down-valley winds.
15.	Dispersion Algorithms	Gaussian plume for nighttime and Eulerian conservation of species equation for daytime. Lateral advection is assumed to dominate the dispersion during the daytime.
16.	Chemical Reactions	Passive.

MODEL 86 (cont.)

17.	Removal Process	None.
18.	Boundary Condition	Plume reflections at the valley floor and sidewalls.
19.	Meteorological Requirements	Single value of average nighttime down-valley winds. Valley temperature lapse rate, fraction of sensible heat going to CBL growth, and valley geometry. Typical default values for western valleys are given in the model.
20.	Validation	Limited testing for a valley in western Colorado using data from the Department of Energy's ASCOT program.
21.	Output	Listing of all inputs and output air concentrations on the valley cross-section.
22.	Genealogy	The model was developed during the mid-1980s by Pacific Northwest Laboratories for the Environmental Protection Agency.
23.	Additional Information	None.

MODEL 87

1.	Name	VARYME
2.	References	DOC OFCM Modeling Resources.
3.	Abstract	VARYME is a mesogamma-scale, three-dimensional, mass-conservative, material-layer model of fine mesoscale resolution. A material layer is a layer within which the mass is conserved, as no mass is transported across the lower terrain and upper inversion boundary surfaces. The material-layer model supplies high-resolution diagnosis of terrain effects on the meteorological variables by combining detailed terrain data with limited atmospheric observations and by applying an objective variational analysis to the material-layer equations. VARYME applies to an area of about 20 to 80 km on the side and is confined in the vertical direction within the mixed layer up to a height of about 1000 m with a horizontal grid resolution of a km.
4.	Location	USAF White Sands Missile Range, NM
5.	Information Contacts	Primary: Ronald M. Cionco USAF Atmospheric Sciences Laboratory White Sands Missile Range, NM 88002-5501 Phone: (505) 678-5210 Secondary: None
6.	Application	Complex terrain mesometeorological flows.
7.	Limitations	None identified.
8.	Sponsor	USAF, White Sands Missile Range, NM.
9.	Computer Requirements	UNISYS 1197 in FORTRAN 77 language.
10.	Source-Receptor Relationship	Not applicable.
11.	Emission Rates	Accidental spill, aerial spraying, defense chemical and battlefield obscuration.
12.	Chemical Composition	Not applicable.
13.	Plume Behavior	None provided.
14.	Wind Field	Mesoscale complex terrain.
15.	Dispersion Algorithms	None provided.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Conditions	None identified.
19.	Meteorological Requirements	One radiosonde upper air profile.

MODEL 87 (cont.)

20.	Validation	None identified.
21.	Output	Multi-level gridded fields of wind, temperature, and depth of mixed layer.
22.	Genealogy	None provided.
23.	Additional Information	Diagnostic wind and temperature field solution over complex terrain for fine mesoscale resolution (1-km grid).

MODEL 88

1.	Name	VENTSAR
2.	References	Smith, F.G., and Weber, A.H., 1983, " A Computer Code for the Estimation of Pollutant Concentrations on or Near Buildings." DP-1668.
3.	Abstract	Calculates pollutant concentrations from sources located on or near buildings. The model calculates one-hour or annually averaged surface concentrations from continuous plume releases passing over flat-roofed buildings.
4.	Location	Westinghouse Savannah River Company Savannah River Technological Center Environmental Technology Section P. O. Box 616 Aiken, SC 29808
5.	Information Contacts	Primary: Ali A. Simpkins Savannah River Technical Center P.O. Box 616 Aiken, SC 29808 Phone: (803) 725-9643 Secondary: None.
6.	Application	Downwind pollutant concentration estimates from near-building releases.
7.	Limitations	Dose estimates not performed; deposition not considered.
8.	Sponsor	DOE/Savannah River Operations Office.
9.	Computer Requirements	Presently on IBM mainframe.
10.	Source-Receptor Relationship	Downwind, ground-level air concentrations.
11.	Emission Rates	User-specified.
12.	Chemical Composition	Passive and buoyant contaminants.
13.	Plume Behavior	Straight-line Gaussian plume.
14.	Wind Field	Based on wind-rise data at source location.
15.	Dispersion Algorithms	Pasquill-Briggs dispersion with modifications for building turbulence. Momentum plume rise, buoyant plume rise, and stack downwash are considered.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Conditions	Plume reflection at surface.

MODEL 88 (cont.)

19.	Meteorological Requirements	Frequency distribution of wind speed, direction, and stability.
20.	Validation	Software verification under way.
21.	Output	Input echo, ground-level air concentrations of pollutant as a function of downwind distance and release height.
22.	Genealogy	Preceded by VENTX; written for a VAX 8550.
23.	Additional Information	Strengths of the model include real-time assimilation of mean wind and turbulence observations and a statistical forecast based on the NWS LFM model. The model also executes quickly (less than one minute) and accepts actual source data or uses reasonable default values.

MODEL 89

1.	Name	VLSTRACK
2.	References	(1) Bauer, T., and Gibbs, R., April 1994, "Software User's Manual for the Chemical/Biological Agent Vapor, Liquid, and Solid Tracking (VLSTRACK) Computer Model, Versions 1.5.1 and 2.0," NSWCDD/MP-94/111, Naval Surface Warfare Center, Dahlgren, VA. (2) Bauer, T., April 1994, "Software Design Document for the Chemical/Biological Agent Vapor, Liquid, and Solid Tracking (VLSTRACK) Computer Model, Version 1.5," NSWCDD/MP-93/451, Naval Surface Warfare Center, Dahlgren, VA. (3) Bauer, T., September 1993, "Software Design Document for the Chemical/Biological Agent Vapor, Liquid, and Solid Tracking (VLSTRACK) Computer Model, Version 2.0," NSWCDD/MP-93/453, Naval Surface Warfare Center, Dahlgren, VA. (4) Sterle, T., et al., December 1993, "Initial Validation of VLSTRACK Version 1.5 and Version 2.0", AL/CF-TR-1994-0055, Wright-Patterson Air Force Base, OH.
3.	Abstract	VLSTRACK is a user-friendly computer model that provides approximate chemical and biological warfare hazard predictions for a wide range of chemical and biological agents and munitions of military interest. Version 1.5.1 is designed for either a 386/486 PC or a UNIX workstation supporting X-Window graphics. It features a windowing interface for input of parameters via keyboard and/or mouse selections, and color graphics output. Version 2.0 is designed to use up to three-dimensional, time-variable meteorology forecast data on a UNIX workstation supporting X-Window graphics. Operation of this version is identical to that of Version 1.5.1, except for input of parameters relevant to the added meteorological capability and other minor differences. Both versions are also available using menu input and either Tektronix graphics or ASCII character graphics output for operation on other types of computer systems. VLSTRACK 1.5.1 is available by letter request to the information contacts identified below. However, VLSTRACK 2.0 is available only on special request specifying the need and capability to interface with multidimensional meteorology data.
4.	Location	The model is not restricted by location.
5.	Information Contacts	Primary: Timothy J. Bauer Commander, NSWCDD Code B51 17320 Dahlgren Road Dahlgren, VA 22448-5100 Phone: (703) 663-8621 Fax: (703) 663-4253 Secondary: Roger L. Gibbs Phone: (703) 663-8621 Fax: (703) 663-4253

MODEL 89 (cont.)

6.	Application	Downwind hazard assessment of ground or airborne releases of toxic vapor, liquid, and/or solid compounds.
7.	Limitations	Accuracy depends on quality of meteorological input. Run times can be greater than an hour for some types of runs. There is no spill evaporation capability. There is a limit on duration of plume emission.
8.	Sponsor	(1) SPAWAR (2) ONR (3) DNA (4) USASSDC (5) BMDO
9.	Computer Requirements	(1) 386/486 DOS PC with math coprocessor and more than 10 megabytes free hard disk space. SGI, SUN, HP, IBM, Tektronix, or VAX workstation, with or without X-Window graphics. (2) Apple Macintosh II, Quadra, or Powerbook PC with less than 6 megabytes RAM. (3) Other systems having a FORTRAN compiler and sufficient memory capabilities.
10.	Source-Receptor Relationship	None.
11.	Emission Rates	Total mass released plus emission duration and/or plume length for stationary or moving plume sources.
12.	Chemical Composition	Chemical or biological contaminants having known toxicity and physical properties.
13.	Plume Behavior	Single or multiple Gaussian puffs, line sources, or plumes in any orientation. Stationary, moving, or instantaneous plumes. Plumes and line sources are approximated as overlapping puffs. Optional rapid approximations of instantaneous plume computations.
14.	Wind Field	Single measurement, single vertical profile, horizontal array of towers (Version 2.0), multiple vertical profiles (Version 2.0), or three-dimensional grid (Version 2.0). All wind fields can change as a function of time.
15.	Dispersion Algorithms	Empirical relations for transport and diffusion based on Pasquill stability category, surface wind speed, air temperature, cloud cover, geographic location, surface type and elevation, date, and time of day.
16.	Chemical Reactions	None.
17.	Removal Process	Droplet or particle puff ground impaction and dissipation, droplet evaporation, vapor dissipation, and/or biological agent decay.

MODEL 89 (cont.)

18.	Boundary Condition	Partial ground and mixing layer reflections and partial mixing layer penetration.
19.	Meteorological Requirements	Wind speed and bearing, measurement height, air temperature, and cloud cover.
20.	Validation	Statistical comparison with 3426 data points from a variety of release types and meteorological conditions within the planetary boundary layer. Not validated for all chemical agent types. Version 2.0 is not validated for flow over complex terrain.
21.	Output	Scaled and rotated color hazard contours on screen. Output file containing hazard values at each output grid point. Summary file including all input data and most output data.
22.	Genealogy	Released as VLSTRACK 1.0 for chemical downwind hazard assessment in November 1990. Original methodology was from the United States Army's NUSSE3 chemical downwind hazard assessment model. BIOTRACK model for biological downwind hazard assessment released in February 1991. Later versions included VLSTRACK 1.2, VLSTRACK 1.3, and VLSTRACK 1.5. Present versions are VLSTRACK 1.5.1, and VLSTRACK 2.0.
23.	Additional Information	VLSTRACK has been designed for the military application of simulating the effects from a chemical or biological attack from exploding munitions, sprayers, or aerosol generators. However, revisions based on user requirements and criticism have resulted in the model being revised to be flexible enough to model many atmospheric dispersion situations that have no military orientation.

MODEL 90

1.	Name	WADOCT
2.	References	DOC OFCM Modeling Resources.
3.	Abstract	WADOCT is a complex terrain diffusion model that mates the Air Force Toxic Chemical Dispersion Model (AFTOX) with a surface layer windflow model (AFWIND). The model is designed to run on IBM PC-compatible microcomputers.
4.	Location	USAF Hanscom AFB, MA
5.	Information Contacts	Primary: Bruce Kunkel GL/LYA Hanscom Air Force Base, MA 01731-5000 Phone: (617) 377-2972 Secondary: None.
6.	Application	Complex terrain diffusion model.
7.	Limitations	None identified.
8.	Sponsor	USAF, Hanscom AFB, MA.
9.	Computer Requirements	IBM PC compatible.
10.	Source-Receptor Relationship	Gaussian.
11.	Emission Rates	Point, instantaneous, continuous, ground-level, and elevated.
12.	Chemical Composition	Accidental spills of hazardous chemicals.
13.	Plume Behavior	Gaussian puff.
14.	Wind Field	Complex.
15.	Dispersion Algorithms	Pasquill-Gifford-Turner.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Condition	Mixing lid.
19.	Meteorological Requirements	Temperature, vertical temperature profile, mixing depth, sky and solar conditions, point winds, multiple point winds.
20.	Validation	None identified.
21.	Output	Concentration.
22.	Genealogy	None provided.
23.	Additional Information	None.

MODEL 91

1.	Name	WHAZAN
2.	References	WHAZAN User's Guide and Theory Manual.
3.	Abstract	WHAZAN calculates spill rates and vaporization rates for a variety of scenarios (liquid/gas/two-phase outflow models) using fundamental fluid flow equations. Calculates plume rise, dense cloud dispersion, and pool fire release consequences. Airborne concentrations are based on Gaussian dispersion formulas.
4.	Location	Technical International Limited 1400 North Harbor Boulevard Suite 800 Fullerton, CA 92635
5.	Information Contacts	Primary: A.V. Savino Westinghouse Hanford Company P.O. Box 1970 (MSIN H4-64) Richland, Washington 99352 Phone: (509) 376-8191 Secondary: D.K. Oestreich Westinghouse Hanford Company M.A. Medsker Westinghouse Hanford Company
6.	Application	WHAZAN calculates spill rates and vaporization rates for a variety of scenarios (liquid/gas/two-phase outflow models).
7.	Limitations	Only 30 chemicals are available in the supplied data base. In addition, expansion of the data base is tedious.
8.	Sponsor	Department of Energy/Richland Operations Office.
9.	Computer Requirements	Personal computer, DOS 3.0.
10.	Source-Receptor Relationship	Conventional.
11.	Emission Rates	User-specified.
12.	Chemical Composition	Over 30 chemicals are available in the supplied data base.
13.	Plume Behavior	Gaussian.
14.	Wind Field	Straight-line.
15.	Dispersion Algorithms	Gaussian dispersion formulas.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Condition	Reflection from ground.

MODEL 91 (cont.)

19.	Meteorological Requirements	Wind direction, wind speed, and indicator of stability.
20.	Validation	None provided.
21.	Output	None provided.
22.	Genealogy	None provided.
23.	Additional Information	Typical running time on a 486 is from 5-20 seconds. The code is considered user-friendly since it is menu-driven.

MODEL 92

1.	Name	WINDS
2.	References	(1) Hunter, C.H., 1994, "Weather Information and Display (WIND) System User's Manual," Rev. 2, WSRC-TM-90-14. (2) Addis, R.P., and Hunter, C.H., 1988, "Savannah River Plant Emergency Response Capability," Proc. of the ANS Topical Meeting on Emergency Response - Planning, Technologies, & Implementation," September 26-28, Charleston, SC.
3.	Abstract	WINDS provides real-time, menu-driven acquisition and display of environmental data from on-site and off-site instrumentation and execution of aqueous and atmospheric emergency response models. Data archived by the system include meteorological data from a network of local towers and from NWS surface and upper air stations in the southeastern United States, hydrological data from the USGS stream gages, and process radiation data from site stack and perimeter monitors. Data are stored in data bases that are automatically accessed by consequence models. A suite of models provides customized support for a variety of emergency response situations. Models include the following: • AREAEVAC (facility-level response) • PUFFPLUME (response within SRS boundaries and adjacent areas) • 2DPUFF (local and regional response) • STREAM TRANSPORT (stream and surface releases) Access is available throughout SRS via the VAX area network, and off-site via modem.
4.	Location	Savannah River Technical Center Environmental Transport Group Westinghouse Savannah River Company Aiken, SC 29808
5.	Information Contacts	Primary: Chuck H. Hunter Phone: (803) 725-2953 Secondary: Rob P. Addis Phone: (803) 725-3325
6.	Application	Rapid display of data and model options to predict the movement of radionuclides and toxic chemicals during all phases of emergencies. Also used for environmental assessment and impact studies.
7.	Limitations	Written in FORTRAN for the DEC VMS operating system.
8.	Sponsor	DOE/Savannah River Operations Office.
9.	Computer Requirements	Program runs on two VAX 8550s operating in a clustered configuration. Written mainly in FORTRAN with some VMS system calls and IGL graphics. Portions of the system have been ported to IBM RISC systems.

MODEL 92 (cont.)

10.	Source-Receptor Relationship	Not applicable.
11.	Emission Rates	Models accessed by WINDS require user input (default values available).
12.	Chemical Composition	Varies with menu model selection. Common chemicals/isotopes are listed on menus; others must be user-input (see PUFF-PLUME).
13.	Plume Behavior	Varies with menu model selection. Can be single puff, plume, or series of puffs (see PUFF-PLUME and 2DPUFF).
14.	Wind Field	Taken automatically from 60m towers or manually from supplemental towers, e.g., 300m tower (see PUFF-PLUME and 2DPUFF).
15.	Dispersion Algorithms	Varies with model selected (see PUFF-PLUME).
16.	Chemical Reactions	None.
17.	Removal Process	Varies with model selected but includes dry and wet deposition (see PUFF-PLUME and 2DPUFF).
18.	Boundary Conditions	Varies with model selected (see PUFF-PLUME and 2DPUFF).
19.	Meteorological Requirements	Varies with model selected, usually wind speed, direction, and turbulence level.
20.	Validation	Validation is based on comparisons with analytical solutions, observational data, and other models.
21.	Output	Tabular and graphical for each model. Information shown is input meteorological data, output concentrations and doses and maps showing cloud movement.
22.	Genealogy	Developed in 1970s with additional menu items and improvements added up to the present.
23.	Additional Information	WINDS includes models, data display programs, a data base, and real-time data acquisition and QA software. Future improvements include calculations for multiple isotopes, and addition of dense gas and mesoscale (RAMS) models.

MODEL 93

1.	Name	XOQDOQ
2.	References	Sagendorf, J.F., Goll J.T., and Sandusky, W.F., 1982, *XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations, NUREG/CR-2919*, Nuclear Regulatory Commission, Washington, D.C.
3.	Abstract	XOQDOQ is an implementation of the transport and diffusion assumptions outlined in Section C of NRC Regulatory Guide 1.111. The model is basically a simple straight-line Gaussian model that assumes a continuous, uniform release. Plume centerline concentrations are computed for purge releases that are less than eight hours in duration. Sector-average concentrations are computed for releases longer than eight hours in duration. All output concentrations are normalized to the source term.
4.	Location	Radiation Shielding Information Center (RSIC) Oak Ridge National Laboratory
5.	Information Contacts	Primary: Jay Lee Nuclear Regulatory Commission Phone: (301) 415-1080 Secondary: None
6.	Application	XOQDOQ is intended for assessing consequences of routine emissions from nuclear power plants. It computes annual average, normalized concentrations, and deposition using climatological data as input.
7.	Limitations	XOQDOQ is not intended for use in consequence assessments for accidental releases of radionuclides. The PAVAN code has been developed for that purpose. XOQDOQ cannot handle multiple emission sources or wet deposition. It doesn't treat diffusion and transport of toxic or heavy gases or chemical transformations.
8.	Sponsor	Nuclear Regulatory Commission.
9.	Computer Requirements	XOQDOQ was written in FORTRAN IV for a CDC 7600 computer. It has been converted to run on minicomputers, and versions may exist that run on PCs.
10.	Source-Receptor Relationship	Elevated, ground-level, or mixed-mode releases; receptors at fixed distances in each direction sector and at specific points of interest.
11.	Emission Rates	Continuous unit release rate assumed. All concentrations are normalized to source term.
12.	Chemical Composition	The effluent is assumed to be a passive gas.
13.	Plume Behavior	Straight line transport. Diffusion may be adjusted for building wakes. Effective release height accounts for downwash, plume rise, and terrain.
14.	Wind Field	None.

MODEL 93 (cont.)

15.	Dispersion Algorithms	Gaussian plume with reflection. Standard building wake model. Diffusion coefficients limited to a 1000-m maximum value in documented code. Limitation on horizontal diffusion may be removed in later versions.
16.	Chemical Reactions	None.
17.	Removal Process	Dry deposition and radioactive decay.
18.	Boundary Conditions	Reflections at the ground; no reflection at the top of the mixing layer.
19.	Meteorological Requirements	Joint frequency distribution of wind direction, wind speed, and stability class.
20.	Validation	Monthly and annual average concentration estimates using 1975-1977 Savannah River Plant emissions data were compared with observed concentrations to determine model bias and error (First Savannah River Laboratories Model Evaluation Workshop).
21.	Output	Normalized concentrations and deposition amounts are output for all locations. Output includes a reiteration of input data and option selections.
22.	Genealogy	An earlier version of XOQDOQ was documented by Sagendorf and Goll in draft NUREG-0324.
23.	Additional Information	None.

MODEL 94

1.	Name	XQSTAT
2.	References	Jordan, H., and Weiss, R.C., December 1992, "Consequence Calculations in Support of a Radiological Sabotage Vulnerability Study," Rocky Flats Nuclear Safety Technical Report, NSTR-018-92.
3.	Abstract	XQSTAT calculates dose from release of weapons-grade plutonium using a straight-line Gaussian atmospheric diffusion model to calculate dose statistics on a complete set of meteorological observations. It includes plume meander, building wake and choice of dispersion parameter models and stability class models, and can be used for sensitivity studies. Output is tabulated for ready graphing (e.g., by importing to EXCEL).
4.	Location	Rocky Flats Plant Golden, CO 80402-0469
5.	Information Contacts	Primary: Hans Jordan EG&G Rocky Flats Plant T886B P.O. Box 464 Golden, CO 80402-0469 Phone: (303) 966-8480 Secondary: None
6.	Application	Rapid estimates of single distance dose statistics for a complete set of meteorological observations. Sensitivity study of stability class models, dispersion model parameters, building wake effects, and plume meander.
7.	Limitations	All the limitations of the Gaussian straight-line model. Inhalation dose only. No plume material losses to deposition.
8.	Sponsor	DOE/Rocky Flats Plant.
9.	Computer Requirements	FORTRAN source code and PC. Running time depends on size of meteorological observation base. Order of magnitude 25 MHz 386: 1 minute.
10.	Source-Receptor Relationship	Standard straight-line Gaussian.
11.	Emission Rates	Normalized to releases of 1 g of weapons-grade plutonium.
12.	Chemical Composition	Weapons-grade plutonium.
13.	Plume Behavior	Gaussian plume.
14.	Wind Field	Straight-line.
15.	Dispersion Algorithms	Gaussian.
16.	Chemical Reactions	None.
17.	Removal Process	None.
18.	Boundary Conditions	Ground reflection.

MODEL 94 (cont.)

19.	Meteorological Requirements	Wind direction, wind speed, and indicator of stability.
20.	Validation	None provided.
21.	Output	None provided.
22.	Genealogy	None provided.
23.	Additional Information	None.

5.0 MODEL INFORMATION MATRICES

5.1 Model Sponsors and Primary/Secondary Points of Contact

Sponsors and primary/secondary points of contact for each of the models surveyed are presented in Table 1.

5.2 Model Attributes

Various attributes of the models that were surveyed are presented in matrix form in Table 2. This will facilitate comparison of various model attributes (i.e., Lagrangian versus Eulerian frame of reference).

5.3 Model Computer Requirements

Computer requirements information is presented in Table 3.

5.1 Model Sponsors and Primary/Secondary Points of Contact

Model	Model Sponsor	Primary/Secondary Points of Contact
2DPUF	DOE/Savannah River Operations Office	Primary: Lance O'Steen Savannah River Technical Center P.O. Box 616 Aiken, SC 29808 Phone: (803) 725-2449 Secondary: Rob P. Addis Phone: (803) 725-3325
ADAM	United States Air Force	Primary: Capt. Michael Jones AL/EQS 139 Barnes Drive Tyndall Air Force Base FL 32403-5319 Phone: (904) 283-6002
AFTOX	Mr. Bruce Kunkel (Retired) PL/GPAA Hanscom AFB, MA 01731-5000 POC: HQ AWS/XOX 102 Losey Street Room 105 Scott AFB, IL 62225-5206 DSN 576-4721	Primary: Steven Sambol 30 WS/WES Vandenberg AFB CA 93437-5000 Phone: (805) 734-8232 Secondary: None
AIRRAD	DOE/ALO Sandia National Labs	Primary: Bruce A. Boughton Sandia National Laboratories P.O. Box 5800 Albuquerque, NM 87185-5800 Phone: (505) 844-8545 Secondary: None
ALOHA™	Joint sponsorship by the following organizations: National Oceanic and Atmospheric Administration Hazardous Materials Response and Assessment Division 7600 Sand Point Way Seattle, WA 98115 Environmental Protection Agency Chemical Emergency Preparedness and Prevention Office Washington, D.C. 20460	Primary: Dr. Jerry Galt NOAA/HAZMAT 7600 Sand Point Way N.E. Seattle, WA 98115 Phone: (206) 526-6323 E-mail: jerry_galt@hazmat.noaa.gov Secondary: Mark Miller Phone: (206) 526-6945 E-mail: mark_miller@hazmat.noaa.gov

5.1 Model Sponsor and Primary/Secondary Points-of-Contact (cont.)

Model	Model Sponsor	Primary/Secondary Points of Contact	
ARAC	U.S. Department of Energy	Primary:	Connie Foster Lawrence Livermore National Laboratory (L-262) P.O. Box 808 Livermore, CA 94551 Phone: (510) 422-1867 E-mail: cfoster@arac.llnl.gov
		Secondary:	Hoyt Walker Phone: (510) 422-1840 E-mail: hwalker@arac.llnl.gov
ARCHIE	DOE/Rocky Flats	Primary:	Alan C. Stalker EG&G Rocky Flats P.O. Box 464 Golden, CO 80402-0464 Phone: (303) 966-8484
		Secondary:	None
ARCON	Nuclear Regulatory Commission	Primary:	J.V. Ramsdell, Jr. Battelle Pacific Northwest Laboratories MS K9-30 P.O. Box 999 Richland, WA 99352 Phone: (509) 372-6316 E-mail: j_ramsdell@pnl.gov
		Secondary:	None
AREAEVAC	DOE/ Savannah River Operations Office	Primary:	Chuck H. Hunter (803) 725-2953
		Secondary:	Robert J. Kurzeja (803) 725-5945
ASTRAP	DOE Chicago/Argonne National Laboratory	Primary:	Jack D. Shannon Environmental Research Division Bldg. 203 Argonne National Laboratory Argonne, IL 60439 Phone: (708) 252-5807
		Secondary:	None

5.1 Model Sponsor and Primary/Secondary Points-of-Contact (cont.)

Model	Model Sponsor	Primary/Secondary Points of Contact	
ATMOS1/ATMOS2	DOE/ALO, Los Alamos National Laboratory	Primary:	J.T. Lee EES-5 Los Alamos National Laboratory MS D401 Los Alamos, NM 87544 Phone: (505) 667-8352
		Secondary:	Don Hoard Phone: (505) 667-1715
AXAIR89Q	DOE/Savannah River Operations Office	Primary:	Ali A. Simpkins Savannah River Technical Center P.O. Box 616 Aiken, SC 29808 Phone: (803) 725-9643
		Secondary:	None
BNLGPM	DOE/CHO, Brookhaven National Laboratory	Primary:	Paul Michael Brookhaven National Laboratory Upton, NY 11973 Phone: (516) 282-2264
		Secondary:	M. Reynolds
C-CSI	USAF Atmospheric Sciences Laboratory, White Sands, NM	Primary:	Ronald M. Cionco USAF Atmospheric Sciences Laboratory White Sands Missile Range NM 88002-5501 Phone: (505) 678-5210
		Secondary:	None
CAP88-PC	DOE/ER-8	Primary:	Barry Parks DOE Energy Research Office of ES&H Technical Support ER-8.2 GTM Washington, D.C. 20585 Phone: (301) 903-9649 Fax: (301) 903-7047
		Secondary:	Kenneth Duvall DOE EH-232 Washington, D.C. 20585 Phone: (202) 586-0242
CTDM	EPA	Primary:	R.E. Lawson, Jr. Environmental Protection Agency Research Triangle Park NC 27711 Phone: (919) 541-1199
		Secondary:	Desmond Bailey Phone: (919) 541-5248

5.1 Model Sponsor and Primary/Secondary Points-of-Contact (cont.)

Model	Model Sponsor	Primary/Secondary Points of Contact	
D2PC	U.S. Army/Aberdeen Proving Ground	Primary:	Michael Myirski Director, U.S. Army, ERDEC Attn: SCBRD-RTT Aberdeen Proving Ground MD 21010-5423 Phone: (410) 671-3556
		Secondary:	None
DEGADIS	EPA, Research Triangle Park, NC	Primary:	R.E. Lawson Environmental Protection Agency Research Triangle Park NC 27711 Phone: (919) 541-1199
		Secondary:	Dave Guinnup Phone: (919) 541-5368
DIFOUT	DOE/Albuquerque Operations Office	Primary:	Hugh W. Church Sandia National Laboratories P.O. Box 5800 Albuquerque, NM 87185-5800 Phone: (505) 845-8705 Fax: (505) 844-0116
		Secondary:	None
DOSEEP	DOE/Nevada Test Site	Primary:	Doug Soule NOAA Air Resources Laboratory (ARL) Special Operations and Research Division (SORD) P.O. Box 94227 Las Vegas, NV 89193-4227 Phone: (702) 295-1266
		Secondary:	Charlie Steadman Phone: (702) 295-6482
EDMS	USAF, Tyndall AFB, FL	Primary:	Captain Michael Jones AL/EQS 139 Barnes Drive Tyndall AFB, FL 32403-5319 Phone: (904) 283-6002
		Secondary:	Captain Jon Hayward Phone: (904) 283-6324

5.1 Model Sponsor and Primary/Secondary Points-of-Contact (cont.)

Model	Model Sponsor	Primary/Secondary Points of Contact	
EMGRESP	DOE/Richland Operations Office	Primary:	A.V. Savino Westinghouse Hanford Company P.O. Box 1970 (MSIN H4-64) Richland, WA 99352 Phone: (509) 376-8191
		Secondary:	None
EPIcode[R]	This model is commercially available software	Primary:	Steven Homann Homann Associates, Inc. 39831 San Moreno Court Fremont, CA 94539 Phone: (510) 490-6379
		Secondary:	Teresa Carter Phone: (510) 490-6379
ERAD	Sandia National Laboratories	Primary:	Bruce Boughton Sandia National Laboratories P.O. Box 5800 Albuquerque, NM 87185-5800 Phone: (505) 844-8545
		Secondary:	Catherine Turco Technology Transfer Organization 4202 Phone: (505) 271-7845
EXTRAN	U.S. Nuclear Regulatory Commission	Primary:	J.V. Ramsdell Pacific Northwest Laboratories, MS K9-30 P.O. Box 999 Richland, WA 99352 Phone: (509) 372-6316 E-mail: j_ramsdell@pnl.gov
		Secondary:	Jason Schaperow Nuclear Regulatory Commission Washington, D.C. 20555 Phone: (301) 415-5074 E-mail: jhsl@nrc.gov
FEM-PBL	Lawrence Livermore National Laboratory	Primary:	John M. Leone, Jr. Lawrence Livermore National Laboratory P.O. Box 808 Livermore, CA 94550 Phone: (510) 422-6449
		Secondary:	Robert L. Lee

5.1 Model Sponsor and Primary/Secondary Points-of-Contact (cont.)

Model	Model Sponsor	Primary/Secondary Points of Contact	
FPFP-2	Nuclear Regulatory Commission	Primary:	Jason Schaperow Nuclear Regulatory Commission Washington, D.C. 20555 Phone: (301) 415-5074
		Secondary:	Steve Stage Pacific Northwest Laboratories MS K9-30 Box 999 Richland, WA 99352 Phone: (509) 372-6315 E-mail: sa_stage@pnl.gov
FUSCRAC3	DOE/Idaho National Engineering Laboratory	Primary:	Kevin R. O'Kula Westinghouse Savannah River Company Safety Engineering Department P.O. Box 616 Aiken, SC 29808 Phone: (803) 644-5440
		Secondary:	J.C. Huang Phone: (803) 644-5290
GAUS1	DOE Office of Health	Primary:	William M. Porch EES-5 Los Alamos National Laboratories MS D401 Los Alamos, NM Phone: (505) 667-0971 E-mail: wmp@vega.lanl.gov
		Secondary:	Frank A. Gifford Phone: (615) 482-1819
GENII	Department of Energy	Primary:	B.A. Napier Pacific Northwest Laboratories P.O. Box 999 Richland, WA 99352 Phone: (509) 375-3896
		Secondary:	C.D. Leigh Sandia National Laboratories Phone: (505) 844-1888 J.V. Ramsdell Phone: (509) 372-6316 E-mail: j_ramsdell@pnl.gov
GTM	DOE/Environmental Measurements Laboratory	Primary:	Dr. H.N. (Sam) Lee Phone: (212) 620-6607 Fax: (212) 620-3600
		Secondary:	None

5.1 Model Sponsor and Primary/Secondary Points-of-Contact (cont.)

Model	Model Sponsor	Primary/Secondary Points of Contact	
GXQ	Westinghouse Hanford Company	Primary:	Mr. Brit E. Hey Westinghouse Hanford Company P.O. Box 1970 Richland, WA 99352 Phone: (509) 376-2921
		Secondary:	Mr. A. (Tony) V. Savino
HARM-II	DOE and NOAA	Primary:	Will R. Pendergrass National Oceanic and Atmospheric Administration Atmospheric Turbulence and Diffusion Division P.O. Box 2456 456 South Illinois Avenue Oak Ridge, TN 37831 Phone: (615) 576-6234
		Secondary:	None
HAZCON	Sandia National Laboratories	Primary:	Richard Yoshimura Sandia National Laboratories Org. 6641, MS 0718 Phone: (505) 845-8181
		Secondary:	Louis F. Restrepo Sandia National Laboratories Org. 6513, MS 1141 Phone: (505) 845-3380
HEFFTER	DOE/Nevada Test Site	Primary:	Doug Soule NOAA Air Resources Laboratory (ARL) Special Operations and Research Division (SORD) P.O. Box 94227 Las Vegas, NV 89193-4227 Phone: (702) 295-1266
		Secondary:	None
HGSYSTEM/ UF_6	(1) HGSYSTEM: Shell Oil Company, API, and several chemical companies (2) HGSYSTEM/UF_6: DOE/Oak Ridge Operations Office	Primary:	Sanford G. Bloom Martin Marietta Energy Systems, Inc. P.O. Box 2009 Oak Ridge, TN 37831 (615) 574-6638
		Secondary:	W.D. Goode, Jr. Phone: (615) 574-8134

5.1 Model Sponsor and Primary/Secondary Points-of-Contact (cont.)

Model	Model Sponsor	Primary/Secondary Points of Contact	
HOTMAC/RAPTAD	USAF, Tyndall AFB, FL	Primary:	Captain Michael Jones AL/EQS 139 Barnes Drive Tyndall AFB, FL 32403-5319 Phone: (904) 283-6002
		Secondary:	Captain Jon Hayward Phone: (904) 283-6324
HOTSPOT	Department of Energy	Primary:	Steven Homann Lawrence Livermore National Laboratory Hazards Control Department Livermore, CA 94550 Phone: (510) 423-4962
		Secondary:	None
HPS	U.S. Army, Aberdeen Proving Ground, MD	Primary:	Michael Myirski Director, U.S. Army ERDEC Attn: SCBRD-RTT Aberdeen Proving Ground MD 21010-5423 Phone: (301) 671-3556
		Secondary:	Ronald Meyers Phone: (301) 898-4037
HUDU	DOE/Richland Operations Office	Primary:	R.I Scherpelz MS K3-55 Pacific Northwest Laboratories P.O. Box 999 Richland, WA 99352 Phone: (509) 375-2454
		Secondary:	None
HY-SPLIT	National Oceanic and Atmospheric Administration	Primary:	Roland R. Draxler NOAA/Air Resources Laboratory 1315 East-West Highway Room 3151 Silver Springs, MD 20910 Phone: (301) 713-0295 Ext. 117 Fax: (301) 713-0119 E-mail: rdraxler@smtpgate.ssmc.noaa.gov
		Secondary:	None

5.1 Model Sponsor and Primary/Secondary Points-of-Contact (cont.)

Model	Model Sponsor	Primary/Secondary Points of Contact	
IRDAM	Nuclear Regulatory Commission	Primary:	T.J. McKenna NRC FTS 492-4184
		Secondary:	J.V. Ramsdell PNL Phone: (509) 375-2454
ISC-2	EPA, Research Triangle Park, NC	Primary:	R.E. Lawson Environmental Protection Agency Research Triangle Park NC 27711 Phone: (919) 541-1199
		Secondary:	Russ Lee Phone: (919) 541-5638
KBERT	DOE/EH Germantown, MD	Primary:	Kenneth E. Washington Sandia National Laboratories Albuquerque, NM 87185-5800
		Secondary:	None
KSC-EMERGE	NUS Corporation developed this code for NASA	Primary:	Henry Firstenberg NUS Corporation 910 Clopper Road Gaithersburg, MD 20877 Phone: (301) 258-8671
		Secondary:	Bart Bartram
MAAP4-DOSE	EPRI Palo Alto, CA	Primary:	Gerald R. Davidson Fauske & Associates, Inc. 16W070 West 83rd Street Burr Ridge, IL 60521 Phone: (708) 323-8750 Fax: (708) 986-5481
		Secondary:	Dr. Jason Chao EPRI Palo Alto, CA Phone: (415) 855-8901
MACCS	Nuclear Regulatory Commission	Primary:	Mary Young MS 0478 Accident Analysis & Consequence Assessment Department Sandia National Laboratories P.O. Box 5800 Albuquerque, NM 87185-5800 Phone: (505) 844-8003
		Secondary:	None

5.1 Model Sponsor and Primary/Secondary Points-of-Contact (cont.)

Model	Model Sponsor	Primary/Secondary Points of Contact	
MAEROS-2	DOE/Richland Operations Office	Primary:	Mary Ann Kummerer Westinghouse Hanford Company P.O. Box 1970 (MSIN H4-62) Richland, WA 99352 Phone: (509) 376-2520
		Secondary:	None
MARSS	NASA/KSC	Primary:	Bill Boyd ESMC/WE Patrick Air Force Base FL 32925-6535 Phone: (305) 495-5915
		Secondary:	None
MATHEW/ ADPIC	Department of Energy	Primary:	John Nasstrom Lawrence Livermore National Laboratory (L-262) P.O. Box 808 Livermore, CA 94551 Phone: (510) 423-6738 E-mail: jnasstrom@arac.llnl.gov
		Secondary:	Connie Foster Phone: (510) 422-1867 E-mail: cfoster@arac.llnl.gov Hoyt Walker Phone: (510) 422-1840 E-mail: hwalker@arac.llnl.gov
MAXIGASP	DOE/Savannah River Operations Office	Primary:	Ali A. Simpkins Savannah River Technical Center P.O. Box 616 Aiken, SC 29808 Phone: (803) 725-9643
		Secondary:	None
MDIFF	DOE at the INEL	Primary:	Jerry F. Sagendorf Phone: (208) 526-2740
		Secondary:	Gene E. Start Phone: (208) 526-2743

5.1 Model Sponsor and Primary/Secondary Points-of-Contact (cont.)

Model	Model Sponsor	Primary/Secondary Points of Contact	
MELSAR	Environmental Protection Agency and Department of Energy	Primary:	C.D. Whiteman Pacific Northwest Laboratories MS K9-30 P.O. Box 999 Richland, WA 99352 Phone: (509) 372-6147 E-mail: cd_whiteman@pnl.gov
		Secondary:	None
MESODIF	DOE/IDO, NOAA-ARL	Primary:	Jerry F. Sagendorf NOAA Air Resources Laboratories Field Research Division 1750 Foote Drive Idaho Falls, ID 83402 Phone: (208) 526-2740
		Secondary:	Gene E. Start Phone: (208) 526-2743
MESOI	Nuclear Regulatory Commission and Department of Energy	Primary:	J.V. Ramsdell Pacific Northwest Laboratory, MS K9-30 P.O. Box 999 Richland, WA 99352 Phone: (509) 372-6316 E-mail: j_ramsdell@pnl.gov
		Secondary:	C.S. Glantz Pacific Northwest Laboratories, MS K9-30 P.O. Box 999 Richland, WA 99352 Phone: (509) 375-7741
MESOPUFF	EPA, Research Triangle Park, NC	Primary:	R.E. Lawson, Jr. Environmental Protection Agency Research Triangle Park NC 27711 Phone: (919) 541-1199
		Secondary:	John Irwin Phone: (919) 541-5682

5.1 Model Sponsor and Primary/Secondary Points-of-Contact (cont.)

Model	Model Sponsor	Primary/Secondary Points of Contact	
MESORAD	NRC and DOE	Primary:	J.V. Ramsdell Pacific Northwest Laboratories MS K9-30 P.O. Box 999 Richland, WA 99352 Phone: (509) 372-6316 E-mail: j_ramsdell@pnl.gov
		Secondary:	C.S. Glantz Pacific Northwest Laboratories, MS K9-30 P.O. Box 999 Richland, WA 99352 Phone: (509) 375-7741
MESOWIND	USAF, White Sands Missile Range, NM	Primary:	Ronald M. Cionco USAF Atmospheric Sciences Laboratory White Sands Missile Range NM 88002-5501 Phone: (505) 678-5210
		Secondary:	None
MICROAIRDOS	DOE/ALO, Sandia National Laboratories	Primary:	Yvonne McClellan P.O. Box 5800 Sandia National Laboratories Albuquerque, NM 87065 Phone: (505) 848-1036
		Secondary:	Dr. Robert E. Moore Radiological Assessment Corporation Route 2 Box 122, Neeses, SC 29107 Phone: (803) 536-4883
NUATMOS/CITPUFF	Monash University (Australia) RMFRES-USDA (Forest Service)	Primary:	Dr. D.G. Ross Phone: (+613) 903-2101 Fax: (+613) 903-2798 E-mail: graeme.ross@sci/monash.edu.au
		Secondary:	Dr. Douglas G. Fox Phone: (303) 490-8375
PAVAN	Nuclear Regulatory Commission	Primary:	Jay Lee Nuclear Regulatory Commission Phone: (301) 415-1080
		Secondary:	None

5.1 Model Sponsor and Primary/Secondary Points-of-Contact (cont.)

Model	Model Sponsor	Primary/Secondary Points of Contact	
PGEMS	Pacific Gas & Electric Company/Department of Energy	Primary:	Jerome D. Fast Pacific Northwest Laboratories MS K9-30 P.O. Box 999 Richland, WA 99352 Phone: (509) 372-6116
		Secondary:	None
PLUME	DOE/Oak Ridge Operations Office	Primary:	Sanford G. Bloom Martin Marietta Energy Systems, Inc. P.O. Box 2009 Oak Ridge, TN 37831 Phone: (615) 574-6638
		Secondary:	None
POPGASP	DOE/Savannah River Operations Office	Primary:	Ali A. Simpkins Savannah River Technical Center P.O. Box 616 Aiken, SC 29808 Phone: (803) 725-9643
		Secondary:	None
PUFF-PLUME	DOE/Savannah River Operations Office	Primary :	Robert J. Kurzeja Savannah River Technical Center P.O. Box 616 Aiken, SC 29808 Phone: (803) 725-5945
		Secondary:	Chuck H. Hunter Phone: (803) 725-2953
RAC	DOE/Savannah River Operations Office	Primary:	Chuck H. Hunter Savannah River Technical Center P.O. Box 616 Aiken, SC 29808 Phone: (803) 725-2953
		Secondary:	Robert J. Kurzeja Phone: (803) 725-5945
RADTRAD	NRR, Rockville, MD	Primary:	David K. Monroe Accident Analysis & Consequence Assessment Department MS/0748 Albuquerque, NM 87185-5800 Phone: (505) 844-9510
		Secondary:	None

5.1 Model Sponsor and Primary/Secondary Points-of-Contact (cont.)

Model	Model Sponsor	Primary/Secondary Points of Contact	
RAM	EPA, Research Triangle Park, NC	Primary:	R.E. Lawson, Jr. Environmental Protection Agency Research Triangle Park NC 27711 Phone: (919) 541-1199
		Secondary:	Desmond Bailey Phone: (919) 541-5248
RAMS/LPDM	DOE/Savannah River Operations Office	Primary:	B. Lance O'Steen Savannah River Technical Center P.O. Box 616 Aiken, SC 29808 Phone: (803) 725-2449
		Secondary:	Rob Addis Phone: (803) 725-3325
RASCAL	Nuclear Regulatory Commission	Primary:	Janet Quissell Office for Analysis and Evaluation of Operational Data Incident Response Branch Nuclear Regulatory Commission Washington, D.C. 20555 Phone: (301) 415-6402
		Secondary:	Tom McKenna Office for Analysis and Evaluation of Operational Data Incident Response Branch Nuclear Regulatory Commission Washington, D.C. 20555 Phone: (301) 415-7589
RATCHET	Centers for Disease Control and Prevention	Primary:	J.V. Ramsdell, Jr. MS K9-30 Battelle, Pacific Northwest Laboratories P.O. Box 999 Richland, WA 99352 Phone: (509) 372-6316
		Secondary:	C.W. Miller Centers for Disease Control and Prevention, MS-F35 4770 Burford Highway NE Atlanta, GA 30341-3724 Phone: (404) 488-7040
REEDM	USAF, Vandenberg AFB, CA	Primary:	Steven Sambol 30 WS/WES, DSN 276-2550 Vandenberg AFB CA 93437-5000 Phone: (805) 734-8232 Ext. 62550
		Secondary:	None

5.1 Model Sponsor and Primary/Secondary Points-of-Contact (cont.)

Model	Model Sponsor	Primary/Secondary Points of Contact	
RSAC-5	DOE/Idaho National Engineering Laboratory	Primary:	D.R. Wenzel WINCO P.O. Box 4000 Idaho Falls, ID 83415-5209 Phone: (208) 526-3463
		Secondary:	None
RTVSM	U.S. Army	Primary:	James F. Bowers Meteorology Division West Desert Test Center U.S. Army Dugway Proving Ground Dugway, UT 84022-5000 Phone: (801) 831-5101
		Secondary:	None
SABLE	DOE/Lawrence Livermore National Laboratories	Primary:	John M. Leone, Jr. Lawrence Livermore National Laboratory P.O. Box 808 Livermore, CA 94550 Phone: (510) 422-6449
		Secondary:	Stevens T. Chan Phone: (510) 422-1822
SCREEN	EPA, Research Triangle Park, NC	Primary:	R.E. Lawson, Jr. Environmental Protection Agency Research Triangle Park NC 27711 Phone: (919) 541-1199
		Secondary:	Dennis Atkinson Phone: (919) 541-0518
SDM	EPA, Research Triangle Park, NC	Primary:	R.E. Lawson, Jr. Environmental Protection Agency Research Triangle Park NC 27711 Phone: (919) 541-1199
		Secondary:	Joe Touma Phone: (919) 541-5381
SLAB	USAF, Tyndall AFB, FL	Primary:	Captain Michael Jones AL/EQS 139 Barnes Drive Tyndall AFB FL 32403-5319 Phone: (904) 283-6002
		Secondary:	Captain Jon Hayward Phone: (904) 283-6324

5.1 Model Sponsor and Primary/Secondary Points-of-Contact (cont.)

Model	Model Sponsor	Primary/Secondary Points of Contact	
TOXICGAS	DOE/Rocky Flats	Primary:	Terry Foppe Safety Analysis Building T886 EG&G Rocky Flats P.O. Box 464 Golden, CO 80402 Phone: (303) 966-7437
		Secondary:	Dr. W.C. Tam Ontario Ministry of the Environment Air Resource Branch 880 Bay Street 4th floor Toronto, Ontario Phone: (416) 965-4081
TOXST	EPA, Research Triangle Park, NC	Primary:	R.E. Lawson, Jr. Environmental Protection Agency Research Triangle Park NC 27711 Phone: (919) 541-1199
		Secondary:	Dave Guinnup Phone: (919) 541-5368
TRAC	DOE/Albuquerque Operations Office	Primary:	Bert Crist Rocky Flats Environmental Technology Site Building 117 P.O. Box 928 Golden, CO 80402-0928 Phone: (303) 966-7793
		Secondary:	Carlos Schoellhorn EG&G Rocky Flats Building T-130E P.O. Box 464 Golden, CO 80402-0464 Phone: (303) 966-6321
TRIAD	DOE/Oak Ridge Operations Office	Primary:	K.S. Rao Atmospheric Turbulence and Diffusion Division (ATDD) NOAA/ARL 456 South Illinois Avenue Oak Ridge, TN 37830 Phone: (615) 576-1238
		Secondary:	R.J. Dobosy, ATDD Phone: (615) 576-1250

5.1 Model Sponsor and Primary/Secondary Points-of-Contact (cont.)

Model	Model Sponsor	Primary/Secondary Points of Contact	
TSCREEN	EPA, Research Triangle Park, NC	Primary:	R.E. Lawson, Jr. Environmental Protection Agency Research Triangle Park NC 27711 Phone: (919) 541-1199
		Secondary:	Joe Touma Phone: (919) 541-5381
VAFTAD	NOAA/ARL	Primary:	Jerome L. Heffter NOAA/ARL R/E/AR SSMC 3: Room 3151 1315 East-West Highway Silver Springs, MD 20910 Phone: (301) 713-0295 Ext. 124
		Secondary:	Barbara J.B. Stunder Phone: (301) 713-0295 Ext. 114
VALDRIFT	U.S. Forest Service	Primary:	C.D Whiteman Pacific Northwest Laboratories MS K9-30 P.O. Box 999 Richland, WA 99352 Phone: (509) 372-6147 E-mail: cd_whiteman@pnl.gov
		Secondary:	None
VALMET	Environmental Protection Agency	Primary:	C.D. Whiteman Pacific Northwest Laboratories MS K9-30 P.O. Box 999 Richland, WA 99352 Phone: (509) 372-6147 E-mail: cd_whiteman@pnl.gov
		Secondary:	None
VARYME	USAF, White Sands Missile Range, NM	Primary:	Ronald M. Cionco USAF Atmospheric Sciences Laboratory White Sands Missile Range NM 88002-5501 Phone: (505) 678-5210
		Secondary:	None

5.1 Model Sponsor and Primary/Secondary Points-of-Contact (cont.)

Model	Model Sponsor	Primary/Secondary Points of Contact	
VENTSAR	DOE/Savannah River Operations Office	Primary:	Ali A. Simpkins Savannah River Technical Center P.O. Box 616 Aiken, SC 29808 Phone: (803) 725-9643
		Secondary:	None
VLSTRACK	(1) SPAWAR (2) ONR (3) DNA (4) USASSDC (5) BMDO	Primary:	Timothy J. Bauer Commander, NSWCDD Code B51 17320 Dahlgren Road Dahlgren, VA 22448-5100 Phone: (703) 663-8621 Fax: (703) 663-4253
		Secondary:	Roger L. Gibbs Phone: (703) 663-8621 Fax: (703) 663-4253
WADOCT	USAF, Hanscom AFB, MA	Primary:	Bruce Kunkel GL/LYA Hanscom Air Force Base MA 01731-5000 Phone: (617) 377-2972
		Secondary:	None
WHAZAN	DOE/Richland Operations Office	Primary:	A.V. Savino Westinghouse Hanford Company P.O. Box 1970 (MSIN H4-64) Richland, WA 99352 Phone: (509) 376-8191
		Secondary:	D.K. Oestreich Westinghouse Hanford Company M.A. Medsker Westinghouse Hanford Company
WINDS	DOE/Savannah River Operations Office	Primary:	Chuck H. Hunter Phone: (803) 725-2953
		Secondary:	Rob P. Addis Phone: (803) 725-3325
XOQDOQ	Nuclear Regulatory Commission	Primary:	Jay Lee Nuclear Regulatory Commission Phone: (301) 415-1080
		Secondary:	None

5.1 Model Sponsor and Primary/Secondary Points-of-Contact (cont.)

Model	Model Sponsor	Primary/Secondary Points of Contact	
XQSTAT	DOE/Rocky Flats Plant	Primary:	Hans Jordan EG&G Rocky Flats Plant T886B P.O. Box 464 Golden, CO 80402-0469 Phone: (303) 966-8480
		Secondary:	None

5.2 Model Attributes

Attribute										
Model	**Emission Rates**	**Chemical Compos.**	**Plume Behavior**	**Wind Field**	**Frame of Reference**	**Dispersion Algorithms**	**Chemical Reactions**	**Removal Process**	**Boundary Conditions**	**Special Features**
2DPUF	U,C	H, R	PF	2D	E,L	ST	N	DC, DD, WD	S, ML	Time-varying wind direction
ADAM	U	H	PL	2D	E	ST, D	N	N	—	Dense gas dispersion
AFTOX	U, C	H, T	PF, PL	2D	E	MO	N	CV	S, ML	Converts N_2O_4 to NO_2
AIRRAD	U	H, R	PF	3D	L	—	N	N	—	Nuclear weapon explosions
ALOHA™	U, C	H	PF, PL	2D	E	ST, D	N	N	S, ML	Huge chemical library
ARAC	U	H, R	PIC	3D	L	K	N	DC, DD, WD	A, ML	DOE 5530.5 asset
ARCHIE	U, C	H	PL	2D	E	ST	N	N	—	Fire and explosion hazards also considered
ARCON	U, C	H	PL	2D	E	ST	N	N	S	Control room habitability, low wind speed dispersion and building wakes
AREAEVAC	U	H, R	PL	2D	E	ST	N	DC	S, ML	—
ASTRAP	U	H, T	PF	2D	E	K	Y	DD, WD	S, ML	Regional-scale

LEGEND

A-	Advection	E-	Eulerian	MO-	Monin-Obukov Similarity	SP-	Special Technique
B-	Biological	F-	Fallout	N-	None	ST-	Statistical Gaussian
BF-	Boundary Fluxes	H-	Hazardous Chemical	N/A-	Not Applicable	T-	Chemical Transformation
C-	Calculated	I-	Indoor/In-Facility	NG-	Non-Gaussian	U-	User-Specified
CC-	Chemical Compound	K-	K-Theory	PF-	Puff	V-	Various
CV-	Conversion	L-	Legrangian	PIC-	Particle-in-Cell	VF-	Valley Flow
D-	Dense Gas Algorithm	LD-	Lighter-than-Air Dispersion	PL-	Plume	VP-	Volcanic Particulates
DC-	Decay	LS-	Line Segments	R-	Radionuclide	WD-	Wet Deposition
DD-	Dry Deposition	MD-	Modeling Domain	S-	Surface Reflection	Y-	Yes
DF-	Default	ML-	Mixing Lid	SG-	Self-Generated	2D-	2-Dimensional
						3D-	3-Dimensional

5.2 Model Attributes (cont.)

Attribute										
Model	**Emission Rates**	**Chemical Compos.**	**Plume Behavior**	**Wind Field**	**Frame of Reference**	**Dispersion Algorithms**	**Chemical Reactions**	**Removal Process**	**Boundary Conditions**	**Special Features**
ATMOS1/ATMOS2	U	H	PIC	3D	L	K	N	N	—	—
AXAIR89Q	U	R	PL	2D	E	ST	N	DC	S	—
BNLGPM	U	H	PL	2D	E	ST	N	N	—	—
C-CSI	U	H	PIC	3D	L	—	N	N	—	Surface layer, canopy wind profiles
CAP88-PC	U	R	PL	2D	E	ST	N	DD, WD	S, ML	NESHAP dose risk
CTDM	U	H	PL	3D	E	ST, LD	N	N	—	Simulates flow near 3D terrain
D2PC	U	H	PL	2D	E	ST	N	DD	S, ML	Spill evaporation, ground fires
DEGADIS	U	H	PL	2D	E	ST, D	N	N	—	Dense gas dispersion
DIFOUT	U	H, R	LS	2D	E	ST	N	DD	S	Aerosols
DOSEEP	U	H, R	PL	2D	E	ST	N	N	S	External gamma exposures
EDMS	U	H	PF	2D	E	ST	N	N	—	Aircraft emission sources

LEGEND

A-	Advection	E-	Eulerian	MO-	Monin-Obukov Similarity	SP-	Special Technique
B-	Biological	F-	Fallout	N-	None	ST-	Statistical Gaussian
BF-	Boundary Fluxes	H-	Hazardous Chemical	N/A-	Not Applicable	T-	Chemical Transformation
C-	Calculated	I-	Indoor/In-Facility	NG-	Non-Gaussian	U-	User-Specified
CC-	Chemical Compound	K-	K-Theory	PF-	Puff	V-	Various
CV-	Conversion	L-	Legrangian	PIC-	Particle-in-Cell	VF-	Valley Flow
D-	Dense Gas Algorithm	LD-	Lighter-than-Air Dispersion	PL-	Plume	VP-	Volcanic Particulates
DC-	Decay	LS-	Line Segments	R-	Radionuclide	WD-	Wet Deposition
DD-	Dry Deposition	MD-	Modeling Domain	S-	Surface Reflection	Y-	Yes
DF-	Default	ML-	Mixing Lid	SG-	Self-Generated	2D-	2-Dimensional
						3D-	3-Dimensional

5.2 Model Attributes (cont.)

Attribute										
Model	**Emission Rates**	**Chemical Compos.**	**Plume Behavior**	**Wind Field**	**Frame of Reference**	**Dispersion Algorithms**	**Chemical Reactions**	**Removal Process**	**Boundary Conditions**	**Special Features**
EMGRESP	U, C	H	PF, PL	2D	E	ST, D	N	N	S	Dense gas dispersion
EPIcode[R]	U, C	H	PF, PL	2D	E	ST	N	DD	S	Rapid hazchem assessment
ERAD	U, C	R	PF	3D	L	MO	N	DD	S	High explosives, Monte Carlo
EXTRAN	U	H	PF	2D	E	ST	N	N	S	Evaporation
FEM-PBL	BF	—	—	3D	L	K	—	N	—	Research-grade
FPFP-2	U	R	I	N/A	N/A	N/A	N	DD, WD	—	In-facility transport
FUSCRAC3	U	H, R	PL	2D	E	ST	N	DD, WD	S, ML	Tritium source term
GAUS1	U	H, R	PF, PL	2D	E	ST	N	DD, WD	S, ML	Resuspension
GENII	U	R	PL	2D	E	ST	N	DC, DD	S, ML	Monte Carlo/Latin hypercube
GTM	U	H, R	PIC	3D	L	K	N	DD, WD	S, ML	Accurate radionuclide source term
GXQ	U	R	PF, PL	2D	E	ST	N	DD	S, ML	X/Q for RG 1.145 compliance

LEGEND

A-	Advection	E-	Eulerian	MO-	Monin-Obukov Similarity	SP-	Special Technique
B-	Biological	F-	Fallout	N-	None	ST-	Statistical Gaussian
BF-	Boundary Fluxes	H-	Hazardous Chemical	N/A-	Not Applicable	T-	Chemical Transformation
C-	Calculated	I-	Indoor/In-Facility	NG-	Non-Gaussian	U-	User-Specified
CC-	Chemical Compound	K-	K-Theory	PF-	Puff	V-	Various
CV-	Conversion	L-	Legrangian	PIC-	Particle-in-Cell	VF-	Valley Flow
D-	Dense Gas Algorithm	LD-	Lighter-than-Air Dispersion	PL-	Plume	VP-	Volcanic Particulates
DC-	Decay	LS-	Line Segments	R-	Radionuclide	WD-	Wet Deposition
DD-	Dry Deposition	MD-	Modeling Domain	S-	Surface Reflection	Y-	Yes
DF-	Default	ML-	Mixing Lid	SG-	Self-Generated	2D-	2-Dimensional
						3D-	3-Dimensional

5.2 Model Attributes (cont.)

Attribute										
Model	**Emission Rates**	**Chemical Compos.**	**Plume Behavior**	**Wind Field**	**Frame of Reference**	**Dispersion Algorithms**	**Chemical Reactions**	**Removal Process**	**Boundary Conditions**	**Special Features**
HARM-II	U, C	H, R	PF	3D	E	ST, D	Y	DC, DD	S	Dense gas, UF_6
HAZCON	U	H	PF, PL	3D	L	ST, D, LD	N	DD	S, M, L	—
HEFFTER	C	H, R	PF	2D	E	F	N	DD	N	Atmospheric detonations
HGSYSTEM/UF_6	U, C	H, T	PF, PL	2D	E	ST, D	Y	DD, CR	S	Dense gas, UF_6
HOTMAC/RAPTAD	U, C	H	PF	3D	L	K	N	N	S, M, L	Prognostic, complex terrain
HOTSPOT	U, C	R	PL	2D	E	ST	N	DC, DD	S	Weapons releases
HPS	U, C	H	PL	2D	E	ST	N	DD, WD	S, ML	Treats certain types of forest terrain
HUDU	U, DF	R	PL	2D	E	ST	N	DC	S, ML	Climatological data default
HY-SPLIT	U	H, R, T	PF	3D	E, L	SP	Y	DD, WD	S, ML, A	Hybrid Eulerian-Lagrangian
IRDAM	U	R	PL	2D	E	ST	N	DC	S	Interactive
ISC-2	U, C	H	PL	2D	E	ST	N	DD	S, ML	Building aerodynamic downwash

LEGEND

A-	Advection	E-	Eulerian	MO-	Monin-Obukov Similarity	SP-	Special Technique
B-	Biological	F-	Fallout	N-	None	ST-	Statistical Gaussian
BF-	Boundary Fluxes	H-	Hazardous Chemical	N/A-	Not Applicable	T-	Chemical Transformation
C-	Calculated	I-	Indoor/In-Facility	NG-	Non-Gaussian	U-	User-Specified
CC-	Chemical Compound	K-	K-Theory	PF-	Puff	V-	Various
CV-	Conversion	L-	Legrangian	PIC-	Particle-in-Cell	VF-	Valley Flow
D-	Dense Gas Algorithm	LD-	Lighter-than-Air Dispersion	PL-	Plume	VP-	Volcanic Particulates
DC-	Decay	LS-	Line Segments	R-	Radionuclide	WD-	Wet Deposition
DD-	Dry Deposition	MD-	Modeling Domain	S-	Surface Reflection	Y-	Yes
DF-	Default	ML-	Mixing Lid	SG-	Self-Generated	2D-	2-Dimensional
						3D-	3-Dimensional

5.2 Model Attributes (cont.)

Attribute										
Model	**Emission Rates**	**Chemical Compos.**	**Plume Behavior**	**Wind Field**	**Frame of Reference**	**Dispersion Algorithms**	**Chemical Reactions**	**Removal Process**	**Boundary Conditions**	**Special Features**
KBERT	U	H, R	N	N	N/A	N/A	N	N	N	Worker health consequences
KSC-EMERGE	U	R	PF	3D	L	ST	N	DC, DD, WD	S	Plutonium oxide dispersal
MAAP4-DOSE	U	R	PL	2D	E	ST	N	DD	S	Core degradation phenomena
MACCS	U	R	PL	2D	E	ST	N	DD, WD	S	Probabilistic human health
MAEROS-2	U	H	—	—	—	—	N	DD, WD	—	Aerosol transport and deposition
MARSS	U, C	H	PL	2D	E	MO, ST	N	N	S	Launch vehicle emissions
MATHEW/ADPIC	U	H, R	PIC	3D	L	K	N	DC, DD, WD	A, ML	Core model of ARAC
MAXIGASP	U	R	PL	2D	E	ST	N	DC, DD	S	—
MDIFF	U	R	PF	2D	L	ST	N	N	S, ML	Marked dispersion curves
MELSAR	U	H	PF	3D	L	ST	N	N	S, ML	Complex terrain
MESODIF	U, C	R	PF	2D	L	ST	N	N	—	Uses info from wind profiles

LEGEND

A-	Advection	E-	Eulerian	MO-	Monin-Obukov Similarity	SP-	Special Technique
B-	Biological	F-	Fallout	N-	None	ST-	Statistical Gaussian
BF-	Boundary Fluxes	H-	Hazardous Chemical	N/A-	Not Applicable	T-	Chemical Transformation
C-	Calculated	I-	Indoor/In-Facility	NG-	Non-Gaussian	U-	User-Specified
CC-	Chemical Compound	K-	K-Theory	PF-	Puff	V-	Various
CV-	Conversion	L-	Legrangian	PIC-	Particle-in-Cell	VF-	Valley Flow
D-	Dense Gas Algorithm	LD-	Lighter-than-Air Dispersion	PL-	Plume	VP-	Volcanic Particulates
DC-	Decay	LS-	Line Segments	R-	Radionuclide	WD-	Wet Deposition
DD-	Dry Deposition	MD-	Modeling Domain	S-	Surface Reflection	Y-	Yes
DF-	Default	ML-	Mixing Lid	SG-	Self-Generated	2D-	2-Dimensional
						3D-	3-Dimensional

5.2 Model Attributes (cont.)

Attribute										
Model	**Emission Rates**	**Chemical Compos.**	**Plume Behavior**	**Wind Field**	**Frame of Reference**	**Dispersion Algorithms**	**Chemical Reactions**	**Removal Process**	**Boundary Conditions**	**Special Features**
MESOI	U	R	PF	3D	L	V	N	DC, DD	S, ML, A	Simultaneous releases
MESOPUFF	U	H	PF	2D	L	LD	Y	DD, WD	—	—
MESORAD	U	R	PF	3D	E	V	Y	DC, DD, WD	S, ML	3-layer wind field
MESOWIND	U	R	PF	3D	E	—	N	N	—	Mass continuity
MICROAIRDOS	U, C	R	PL	2D	E	ST	N	DD	—	Radiation doses to humans
NUATMOS/CITPUFF	U, C	H	PF	3D	E	V	N	DC	S, ML	User-friendly GUI
PAVAN	U	R	PL	2D	E	ST	N	N	S	—
PGEMS	U, C	H, R	PF	3D	L	ST	Y	DD, WD	S, ML	Complex terrain
PLUME	U	H, R, T	PL	3D	E	ST, D	Y	DD, CR	S, ML	UF_6, dense gas
POPGASP	U	R	PL	2D	E	ST	N	DC, DD	S	—
PUFF-PLUME	U	H, R	PF, PL	2D	E,L	ST	N	DD, DC, WD	S, ML	Gamma shine, forecast winds

LEGEND

A-	Advection	E-	Eulerian	MO-	Monin-Obukov Similarity	SP-	Special Technique
B-	Biological	F-	Fallout	N-	None	ST-	Statistical Gaussian
BF-	Boundary Fluxes	H-	Hazardous Chemical	N/A-	Not Applicable	T-	Chemical Transformation
C-	Calculated	I-	Indoor/In-Facility	NG-	Non-Gaussian	U-	User-Specified
CC-	Chemical Compound	K-	K-Theory	PF-	Puff	V-	Various
CV-	Conversion	L-	Legrangian	PIC-	Particle-in-Cell	VF-	Valley Flow
D-	Dense Gas Algorithm	LD-	Lighter-than-Air Dispersion	PL-	Plume	VP-	Volcanic Particulates
DC-	Decay	LS-	Line Segments	R-	Radionuclide	WD-	Wet Deposition
DD-	Dry Deposition	MD-	Modeling Domain	S-	Surface Reflection	Y-	Yes
DF-	Default	ML-	Mixing Lid	SG-	Self-Generated	2D-	2-Dimensional
						3D-	3-Dimensional

5.2 Model Attributes (cont.)

Attribute										
Model	**Emission Rates**	**Chemical Compos.**	**Plume Behavior**	**Wind Field**	**Frame of Reference**	**Dispersion Algorithms**	**Chemical Reactions**	**Removal Process**	**Boundary Conditions**	**Special Features**
RAC	U, C	R	PL	2D	E	ST	N	DC, DD, WD	S	Gamma shine
RADTRAD	U	R	N	N	N/A	N/A	N	N	N	Worker doses
RAM	U, C	H	PL	2D	E	ST, LD	N	N	S, ML	—
RAMS/LPDM	U	H	NG	3D	L	V	N	DD	S	Boundary layer treatment
RASCAL	C	R	PF, PL	2D	E, L	ST	N	DD, WD	S, ML	PAGs early health effects
RATCHET	U	R	PF	3D	L	ST	N	DC, DD, WD	S, ML	Monte Carlo simulation, dose reconstruction
REEDM	U	H	PL	3D	E	—	Y	WD	—	Rocket engine exhaust
RSAC-5	C	R	PF, PL	N/A	N/A	V	N	DD, WD	S, ML	GUI
RTVSM	U	H	PF, PL	2D	E	DPG	N	DD, WD	S, ML	Interactive
SABLE	N/A	N/A	PIC	SG	L	N/A	N/A	N/A	S, ML	Research-grade
SCREEN	U, C	H	PL	2D	E	ST	N	N	—	Building aerodynamic downwash

LEGEND

A-	Advection	E-	Eulerian	MO-	Monin-Obukov Similarity	SP-	Special Technique
B-	Biological	F-	Fallout	N-	None	ST-	Statistical Gaussian
BF-	Boundary Fluxes	H-	Hazardous Chemical	N/A-	Not Applicable	T-	Chemical Transformation
C-	Calculated	I-	Indoor/In-Facility	NG-	Non-Gaussian	U-	User-Specified
CC-	Chemical Compound	K-	K-Theory	PF-	Puff	V-	Various
CV-	Conversion	L-	Legrangian	PIC-	Particle-in-Cell	VF-	Valley Flow
D-	Dense Gas Algorithm	LD-	Lighter-than-Air Dispersion	PL-	Plume	VP-	Volcanic Particulates
DC-	Decay	LS-	Line Segments	R-	Radionuclide	WD-	Wet Deposition
DD-	Dry Deposition	MD-	Modeling Domain	S-	Surface Reflection	Y-	Yes
DF-	Default	ML-	Mixing Lid	SG-	Self-Generated	2D-	2-Dimensional
						3D-	3-Dimensional

5.2 Model Attributes (cont.)

Attribute										
Model	**Emission Rates**	**Chemical Compos.**	**Plume Behavior**	**Wind Field**	**Frame of Reference**	**Dispersion Algorithms**	**Chemical Reactions**	**Removal Process**	**Boundary Conditions**	**Special Features**
SDM	U, C	H	PL	2D	E	ST	N	N	ML	Shoreline fumigation
SLAB	U, C	H	PL	2D	E	K, D	N	N	—	Ground/elevated jet releases
TOXICGAS	U	H	PL	2D	E	ST, D	N	N	—	Heavy gas dispersion
TOXST	U, C	H	PL	2D	E	ST	N	DD	S, ML	Building aerodynamic downwash
TRAC	U, C	R	PF	3D	L	MO	N	DD, WD	MD	Complex terrain
TRIAD	U	R	PF	3D	L	ST	Y	DD	S	UF_6, variable trajectory
TSCREEN	U	H	PL	2D	E	ST	N	DD	S, ML	Superfund site evaluations
VAFTAD	U	VP	N/A	3D	E	ST	N	DD	N	Volcanic ash cloud
VALDRIFT	U	H	PL	3D	E	K	N	DD	VF	Complex terrain
VALMET	U	H	PL	2D	E	ST	N	N	VF	Complex terrain
VARYME	N/A	H	N/A	N/A	N/A	—	N	N	—	Diagnostic mesoscale complex terrain

LEGEND

A-	Advection	E-	Eulerian	MO-	Monin-Obukov Similarity	SP-	Special Technique
B-	Biological	F-	Fallout	N-	None	ST-	Statistical Gaussian
BF-	Boundary Fluxes	H-	Hazardous Chemical	N/A-	Not Applicable	T-	Chemical Transformation
C-	Calculated	I-	Indoor/In-Facility	NG-	Non-Gaussian	U-	User-Specified
CC-	Chemical Compound	K-	K-Theory	PF-	Puff	V-	Various
CV-	Conversion	L-	Legrangian	PIC-	Particle-in-Cell	VF-	Valley Flow
D-	Dense Gas Algorithm	LD-	Lighter-than-Air Dispersion	PL-	Plume	VP-	Volcanic Particulates
DC-	Decay	LS-	Line Segments	R-	Radionuclide	WD-	Wet Deposition
DD-	Dry Deposition	MD-	Modeling Domain	S-	Surface Reflection	Y-	Yes
DF-	Default	ML-	Mixing Lid	SG-	Self-Generated	2D-	2-Dimensional
						3D-	3-Dimensional

5.2 Model Attributes (cont.)

Attribute										
Model	**Emission Rates**	**Chemical Compos.**	**Plume Behavior**	**Wind Field**	**Frame of Reference**	**Dispersion Algorithms**	**Chemical Reactions**	**Removal Process**	**Boundary Conditions**	**Special Features**
VENTSAR	U	R	PL	2D	E	ST	N	N	S	Building sources
VLSTRACK	C	B, H	PF, PL	3D	E	ST	N	DC, DD	S, ML	Chemical/biological hazards
WADOCT	U, C	H	PF	2D	E	ST	N	N	S, ML	—
WHAZAN	U	H	PF, PL	2D	E	ST, D	N	N	S	Dense gas
WINDS	U	H, R	PF, PL	2D, 3D	E, L	V	N	DC, DD, WD	S, ML, A	QA software
XOQDOQ	U	R	PL	2D	E	ST	N	DC, DD	S	—
XQSTAT	U	R	PL	2D	E	ST	N	N	S	Weapons-grade plutonium

LEGEND

A-	Advection	E-	Eulerian	MO-	Monin-Obukov Similarity	SP-	Special Technique
B-	Biological	F-	Fallout	N-	None	ST-	Statistical Gaussian
BF-	Boundary Fluxes	H-	Hazardous Chemical	N/A-	Not Applicable	T-	Chemical Transformation
C-	Calculated	I-	Indoor/In-Facility	NG-	Non-Gaussian	U-	User-Specified
CC-	Chemical Compound	K-	K-Theory	PF-	Puff	V-	Various
CV-	Conversion	L-	Legrangian	PIC-	Particle-in-Cell	VF-	Valley Flow
D-	Dense Gas Algorithm	LD-	Lighter-than-Air Dispersion	PL-	Plume	VP-	Volcanic Particulates
DC-	Decay	LS-	Line Segments	R-	Radionuclide	WD-	Wet Deposition
DD-	Dry Deposition	MD-	Modeling Domain	S-	Surface Reflection	Y-	Yes
DF-	Default	ML-	Mixing Lid	SG-	Self-Generated	2D-	2-Dimensional
						3D-	3-Dimensional

5.3 Model Computer Requirements

Model	Model Computer Requirements
2DPUF	For VAX 8550: ~ 3 minutes using only SRS meteorological data; ~ 7 minutes using regional NWS data. Also runs on IBM RISC 6000.
ADAM	512K memory IBM PC-compatible with math coprocessor recommended.
AFTOX	MS-DOS 3 (or later), IBM PC-compatible using EGA or CGA video.
AIRRAD	DOS, Turbo Pascal language.
ALOHA™	ALOHA runs on Apple Macintosh computers in Microsoft Windows (Version 3.0 or later). It requires at least one megabyte of random access memory (RAM) and a hard drive.
ARAC	The ARAC system currently runs on VAX/VMS 6610 and 7000 Alpha systems. Run stream time is 5-15 minutes for supported sites with known defaults.
ARCHIE	Personal computer with 512K RAM.
ARCON	PC with 840K memory, hard disk, math coprocessor, and color monitor.
AREAEVAC	Program runs on VAX 8550 (near immediate response).
ASTRAP	IBM mainframe; 1-5 minute execution time.
ATMOS1/ATMOS2	Digital with VAX operating system in FORTRAN language.
AXAIR89Q	Presently on an IBM mainframe.
BNLGPM	PC VAX with DOS/VMS operating system in FORTRAN language. Interactive.
C-CSI	UNISYS 1197 and VAX in FORTRAN 7700 language.
CAP88-PC	CAP88-PC requires an MS-DOS-compatible personal computer with a hard disk, 640 kilobytes of RAM, and a math coprocessor, running DOS Version 2.0 or higher. A complete population assessment requires approximately 5-10 minutes on a 386 MS-DOS PC.
CTDM	IBM PC.
D2PC	IBM PC-compatible, MS-DOS operating system, ASCII FORTRAN programming language.
DEGADIS	PC with DOS operating system.
DIFOUT	IBM-compatible PC or mainframe.
DOSEEP	DOSEEP is installed on Data General MV series computers running the AOS/VS operating system. Additional versions are running on PCs under MS-DOS, and are written in FORTRAN.
EDMS	IBM PC-compatible in MS-DOS operating system. Condor DBMS programming language.
EMGRESP	Personal computer using FORTRAN language.
EPIcode®	EPIcode will run on an IBM PC, XT, AT, or compatible, including HPI00LX palmtop. EPIcode requires only a single disk drive and at least 512 kilobytes of RAM. Software is available in either a single 3.5-inch or two 5.25-inch diskettes. Supports monochrome, LCD, and color monitors.

5.3 Model Computer Requirements (cont.)

Model	Model Computer Requirements
ERAD	The ERAD software runs on a Sun Microsystems workstation or other SPARC-compliant computer. Both the Solaris 1.x (SUNOS 4.1.x) and Solaris 2.x (SUNOS 5.x) operating systems are supported. Execution time is typically less than two minutes.
EXTRAN	IBM or compatible PC with an Epson or ASCII printer.
FEM-PBL	Cray class computer. Should be run using 64-bit floating point size to ensure accuracy of matrix solver.
FPFP	FPFP is written in FORTRAN-77 and runs on PCs with 640 kilobytyes of RAM and a math coprocessor.
FUSCRAC3	Cray (LANL).
GAUS1	Runs on either an HP-48SX or HP-48GX, the latter being a newer calculator model.
GENII	GENII runs on IBM-PC AT class computers configured with a math coprocessor, 640 kilobytes of RAM, and a hard disk with a minimum of 5 megabytes of on-line storage. It requires DOS Version 3.1 or later. The GENII-S version, in addition, requires 1-2 megabytes of extended memory.
GTM	Program runs on VAX 6410.
GXQ	IBM PC or compatible with math coprocessor.
HARM-II	HARM-II is written in standard FORTRAN-77 using VAX extensions. The code is available for two operating systems: DEC VAX and HP UNIX. A simplified version requires a GKS graphics subsystem to display the data, while the HP UNIX version operates under X-Windows.
HAZCON	PC-based computer code, with at least 6 MB of available disk.
HEFFTER	Model is installed on Data General MV computers running the AOS/VS operating system. An initial version of the model is running on a PC under MS-DOS. The program is written in FORTRAN. The user specifies the location and known details of the atmospheric detonation.
HGSYSTEM/UF_6	Personal computer.
HOTMAC/RAPTAD	Cray, MicroVAX, SUN Computers in VMS or UNIX operating system; FORTRAN language.
HOTSPOT	HOTSPOT will run on an IBM PC, XT, AT, HPI00LX palmtop, or compatible with at least 256 kilobytes of RAM. Software is available in a single 3.5-inch disk.
HPS	IBM-AT computer in MS-DOS environment; FORTRAN 77 language.
HUDU	IBM and compatible PCs with 256 kilobytes of RAM. A hard disk, math coprocessor, and color monitor are needed for optimum performance. HUDU data entry and model execution can be completed in less than 30 seconds if default meteorological data and predefined source terms are used.
HY-SPLIT	A PC version is available.
IRDAM	Personal computer with dot matrix printer.

5.3 Model Computer Requirements (cont.)

Model	Model Computer Requirements
ISC-2	PC, VAX, IBM 3090 in DOS, VMS, MVS operating environments; FORTRAN language.
KBERT	IBM-compatible PC; Microsoft Windows 3.1; C++ language.
KSC-EMERGE	Hewlett-Packard 9000 personal computer.
MAAP4-DOSE	VAX/VMS and DOS versions. DOS version requires 6.2 MB of disk space and 7 MB of memory.
MACCS	MACCS runs on IBM PC-compatibles (a 386 or 486 is recommended), VAX/VMS, IBM RISC S/6000, Sun SPARC, and Cray UNICOS.
MAEROS-2	IBM PC 80486.
MARSS	Three identical DEC MicroVAX II microcomputers, each driving multiple (up to eight) Tektronix Model 4111 or 4211 color graphics terminals through a terminal server.
MATHEW/ADPIC	LLNL runs MATHEW/ADPIC on VAX/VMS systems (8550, 6610, and 7000 Alphas). Also runs on UNIX workstations. FORTRAN-77 source codes available from ESTSC have been compiled on a variety of systems with more than 3 MB memory.
MAXIGASP	Presently resides on IBM 3090.
MDIFF	Versions available for UNIX or OS/2 operating systems.
MELSAR	Personal computers and up.
MESODIFF	IBM PC in DOS environment.
MESOI	MESOI Version 2.0 was written in FORTRAN-77 for VAX 11/780 computers running the VMS operating system. Modification of the code to run on similar computers can be accomplished in a few hours. It may also be converted to run on IBM-compatible PCs without reduction of the model capabilities. Model execution time is less than a minute for simulations covering less than six hours.
MESOPUFF	None provided.
MESORAD	MESORAD was written in FORTRAN-77 for VAX 11/780 computers running the VMS operating system. Modification of the code to run on similar computers can be accomplished in a few hours. It may also be converted to run on IBM-compatible PCs with reduction of the model capabilities.
MESOWIND	UNISYS 1197 and CRAY I or II; FORTRAN-77 language.
MICROAIRDOS	IBM-360 in FORTRAN IV language.
NUATMOS/CITPUFF	Runs comfortably on a modern-generation PC.
PAVAN	The code was originally written in FORTRAN IV for use on a CDC 7600 computer. Later versions exist for other computers, and may be available for PCs.
PGEMS	Personal computers and up.
PLUME	The original 1989 version was written for the mainframe. The plot package requires DISSPLA software. There are PC versions without plotting that are available.
POPGASP	Presently resides on IBM 3090.

5.3 Model Computer Requirements (cont.)

Model	Model Computer Requirements
PUFF-PLUME	Program runs on VAX 8550 (response time of 30 seconds), and IBM RISC 6000.
RAC	Presently on a VAX 8550.
RADTRAD	IBM PC or compatible, Lahey FORTRAN Version 5.20.
RAM	IBM PC in DOS operating environment.
RAMS/LPDM	Requires 1-64 megabytes, depending on the particular application. Currently runs on an IBM RS/6000 workstation or a Cray supercomputer, but can be easily ported to many workstations, mainframes, and supercomputers.
RASCAL	RASCAL is designed to run on a PC with 640 kilobytes of RAM, a hard disk (1.6 megabytes required), a floppy disk, and DOS 3.0 or later. An 80286 or 80386 CPU, a math coprocessor, and EGA are recommended. RASCAL has an option to generate device-independent, high resolution-graphics. The device drivers required to view or print the high-resolution graphics are not included with RASCAL.
RATCHET	RATCHET was developed on a SUN SPARCstation 2. It has been ported to PCs. Processing speed on a Pentium-90 processor is slightly faster than on the SPARCstation 2.
REEDM	Tektronic 4027.
RSAC-5	RSAC-5 runs on an IBM personal computer or compatible, with the following minimum requirements: • Math coprocessor • Personal computer with an 80386 • 2.6 megabyte hard disk space • 450 kilobytes of available memory • One RSAC-5 installation diskette (1.44 MB) The following hardware configuration will improve the efficiency and speed of RSAC-5: • Personal computer with 80486 or Pentium processor • extended memory
RTVSM	Source code is 1.5 megabytes in length, and executable binary code is 2.3 megabytes in length. The program requires one temporary direct access data file of up to 650 kilobytes, depending on the problem being run, and optionally up to 12 additional data files of varying length, depending on the options selected by the user.
SABLE	Cray-class computer or large workstation using 64-bit floating point numbers to ensure accuracy of matrix solver.
SCREEN	None identified.
SDM	IBM PC in DOS operating environment.
SLAB	IBM PC-compatible in MS-DOS operating environment; FORTRAN 77 language.
TOXICGAS	IBM PC.
TOXST	IBM PC in DOS operating environment; FORTRAN language.

5.3 Model Computer Requirements (cont.)

Model	Model Computer Requirements
TRAC	Digital Equipment Corporation MicroVAX or VAX Micro/Mini computer with VMS operating system and FORTRAN-77 capabilities.
TRIAD	Can run on PC or any system with a FORTRAN-77 compiler.
TSCREEN	IBM PC in DOS operating environment.
VAFTAD	User-run via PC modem to an ARL workstation continually available for emergency response operations.
VALDRIFT	Personal computers and up.
VALMET	Personal computers and up.
VARYME	UNISYS 1197 in FORTRAN 77 language.
VENTSAR	Presently on IBM mainframe.
VLSTRACK	(1) 386/486 DOS PC with math coprocessor and more than 10 megabytes free hard disk space. SGI, SUN, HP, IBM, Tektronix, or VAX workstation, with or without X-Window graphics. (2) Apple Macintosh II, Quadra, or Powerbook PC with less than 6 megabytes RAM. (3) Other systems having a FORTRAN compiler and sufficient memory capabilities.
WADOCT	IBM PC-compatible.
WHAZAN	Personal computer; DOS 3.0.
WINDS	Program runs on two VAX 8550s operating in a clustered configuration. Written mainly in FORTRAN with some VMS system calls and IGL graphics. Portions of the system have been ported to IBM RISC systems.
XOQDOQ	XOQDOQ was written in FORTRAN IV for a CDC 7600 computer. It has been converted to run on minicomputers, and versions may exist that run on PCs.
XQSTAT	FORTRAN source code and PC. Running time depends on size of meteorological observation base. Order of magnitude 25 MHz 386: 1 minute.

APPENDIX A

CHARTER FOR THE
SUBCOMMITTEE ON CONSEQUENCE ASSESSMENT
AND PROTECTIVE ACTIONS
JANUARY 1992

DOE Order 5500.1B. EMERGENCY MANAGEMENT SYSTEM, provides for the establishment of the Emergency Management Advisory Committee (EMAC) to assist the Director of Emergency Operations (DEO) in the identification of problem areas and issues related to the Emergency Management System and to provide recommended solutions to such problems, including the development of specific technical recommendations to enhance and implement the DOE emergency preparedness program. To provide the framework for development of technical recommendations in the areas of consequence assessment, protective actions, and other emergency preparedness topics related to health and safety of workers and the public as well as environmental protection resulting from exposure to hazardous materials (radiological and non-radiological), the Emergency Management Advisory Committee hereby establishes the Subcommittee on Consequence Assessment and Protective Actions. This subcommittee replaces the Subcommittee on Dose Assessment, which provided similar support to the former Emergency Management Coordinating Committee.

The organizational structure of the Subcommittee shall consist of a Steering Group composed of Federal employees representing the interested DOE elements on the EMAC, supported by working groups for selected topics as directed by the Steering Group. Members of the various working groups, may be DOE or DOE-contractor employees. Members of the Steering Group and working groups shall be selected on the basis of experience and expertise relevant to the work of the Subcommittee. The Chair of the Subcommittee will be selected by the DEO in consultation with the EMAC and the Assistant Secretary for Environment, Safety and Health. Operating rules and procedures for the Subcommittee shall be developed by the Steering Group and approved by a simple majority vote of the Steering Group.

APPENDIX A (cont.)

The scope of Subcommittee activities shall include:

Ongoing reviews of relevant requirements for emergency preparedness and response aspects of consequence assessments and protective actions related to releases of hazardous materials, and identification of additional requirements and/or need for specific implementing guidance;

Ongoing review of requirements for emergency preparedness and response aspects of worker and public health and safety and environmental protection;

Development/review of draft guidance and recommendations concerning emergency preparedness and response aspects of releases of hazardous materials (e.g., emergency response planning guidelines and protective action guides, predictive and assessment models, monitoring instrumental);

Identification of research and development issues related to improvements in emergency preparedness and response to releases of hazardous materials; and, performing specific reviews and providing technical recommendations as requested by the EMAC.

In addition to the above activities, the Subcommittee is intended to serve as: 1) an information-sharing forum to facilitate consistency throughout the DOE system for emergency preparedness and response aspects of releases of hazardous materials; and, 2) a source of technical expertise to advise the DEO on issues related to hazardous materials.

This charter shall be reviewed at least annually by the EMAC and DEO, and amended as appropriate.

Vincent J. McClelland
Director of Emergency
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January 10, 1992

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[2]*Information extracted from "Survey of Safety Analysis Computer Codes for Non-Reactor Nuclear Facilities," June 1993, Westinghouse Hanford Company.

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[2]Information extracted from "Survey of Safety Analysis Computer Codes for Non-Reactor Nuclear Facilities," June 1993, Westinghouse Hanford Company.

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List of Survey Participants

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[2]Information extracted from "Survey of Safety Analysis Computer Codes for Non-Reactor Nuclear Facilities," June 1993, Westinghouse Hanford Company.

APPENDIX C (cont.)
List of Survey Participants

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[1]Information extracted from "Directory of Atmospheric Transport and Diffusion Models, Equipment, and Projects," April 1993, Department of Commerce.

APPENDIX D
Acronyms

A

ADPIC	Atmospheric Dispersion Particle-in-Cell
AFB	Air Force Base
AFGL	Air Force Geophysical Laboratory
AFTOX	Air Force Toxic Chemical Dispersion Model
ALARA	As Low As Reasonably Achievable
ALOHA	Areal Locations of Hazardous Atmospheres
ANATEX	Across North America Tracer Experiment
ANL	Argonne National Laboratory
ANS	American Nuclear Society
ANSI	American National Standards Institute
API	American Petroleum Institute
ARAC	Atmospheric Release Advisory Capability
ARL	Air Resources Laboratory
ASCOT	Atmospheric Studies Over Complex Terrain
ASTRAP	Advanced Statistical Trajectory Regional Air Pollution
ATDD	Atmospheric Transport and Diffusion Division
AWMA	Air and Waste Management Association
AWS	Air Weather Service

B

BNL	Brookhaven National Laboratory

C

CAMEO	Computer-Aided Management of Emergency Operations
CAP	Clean Air Act Assessment Package
CAPTEX	Cross-Appalachian Transport Experiment
CBL	C Boundary Layer
CEC	Commission of European Communities
CRAC	Calculation of Reactor Accident Consequences
CRT	Cathode Ray Tube

APPENDIX D (cont.)
Acronyms

D

DEGADIS	Dense Gas Atmospheric Dispersion
DNA	Defense Nuclear Agency
DOC	Department of Commerce
DOD	Department of Defense
DOE/HQ	Department of Energy/Headquarters
DOS	Disk Operating System

E

EDE	Effective Dose Equivalent
EFCOG	Energy Facility Contractor Group
EH	DOE Office of Environment, Safety and Health
EID	Environmental Impact Document
EIS	Environmental Impact Statement
EML	Environmental Measurements Laboratory
EPA	Environmental Protection Agency
EPIcode[R]	Emergency Prediction Information Code
EP&R	Emergency Preparedness and Response
EPRI	Electric Power Research Institute
ERAD	Explosive Release and Dispersion
ESTSC	Energy Science and Technology Software Center

F

FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FNMOC	Fleet Numerical Meteorological and Oceanographic Center

G

GISS	Goddard Institute of Space Science
GUI	Graphical User Interface

APPENDIX D (cont.)
Acronyms

H

HEPA	High-Efficiency Particulate Air
HMRAD	Hazardous Materials Response and Assessment Division
HUDU	Hanford Unified Dose Utility
HY-SPLIT	Hybrid Single-Particle Lagrangian Integrated Trajectories

I

ICRP	International Commission on Radiological Protection
INEL	Idaho National Engineering Laboratory
IRDAM	Interactive Rapid Dose Assessment Model

J

JFD	Joint Frequency Distribution

K

KBERT	Knowledge-Based Software for Estimating Radioactive and Toxic Material Releases
KSC	Kennedy Space Center

L

LANL	Los Alamos National Laboratory
LCD	Liquid Crystal Display
LFM	Linear Fine Mesh
LLNL	Lawrence Livermore National Laboratory

APPENDIX D (cont.)
Acronyms

M

MAAP	Modular Accident Analysis Package
MACCS	MELCOR Accident Consequence Code System
MARSS	Meteorological And Range Safety Support
MATS	Mesoscale Atmospheric Transport Study
MMES	Martin Marietta Energy Systems
MOU	Memorandum of Understanding

N

NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NCDC	National Climatic Data Center
NESHAP	National Emission Standards for Hazardous Air Pollutants
NGM	Nested Grid Model
NMC	National Meteorological Center
NOAA	National Oceanic and Atmospheric Administration
NODDS	Navy Oceanographic Data Distribution System
NORAPS	Naval Operational Regional Atmospheric Prediction System
NRC	Nuclear Regulatory Commission
NRR	Nuclear Reactor Regulation
NRTS	National Reactor Test Site
NTIS	National Technical Information Service
NWS	National Weather Service

O

OB/DG	Ocean Breeze/Dry Gulch
OFCM	Office of the Federal Coordinator for Meteorological Services
ORNL	Oak Ridge National Laboratory
ORO	Oak Ridge Operations Office

APPENDIX D (cont.)
Acronyms

P

PAG	Protective Action Guide
PC	Personal Computer
PNL	Pacific Northwest Laboratories

Q

R

RAC	Reactor Accident Code
RADTRAD	Radionuclide Transport Removal and Dose
RAM	Random Access Memory
RASCAL	Radiological Assessment System for Consequence Analysis
RSAC	Radiological Safety Analysis Computer
RSIC	Radiation Shielding Information Center

S

SORD	Special Operations and Research Division
SRL	Savannah River Laboratory
SRP	Savannah River Plant
SRR	Source Receptor Relationship
SRS	Savannah River Site
SRTC	Savannah River Technical Center

T

THC	Toxic Hazard Corridor
TRAC	Terrain Responsive Atmospheric Code

U

USAF	United States Air Force
USGS	United States Geological Survey

APPENDIX D (cont.)
Acronyms

V

VLSTRACK	Vapor Liquid and Solid Tracking

W

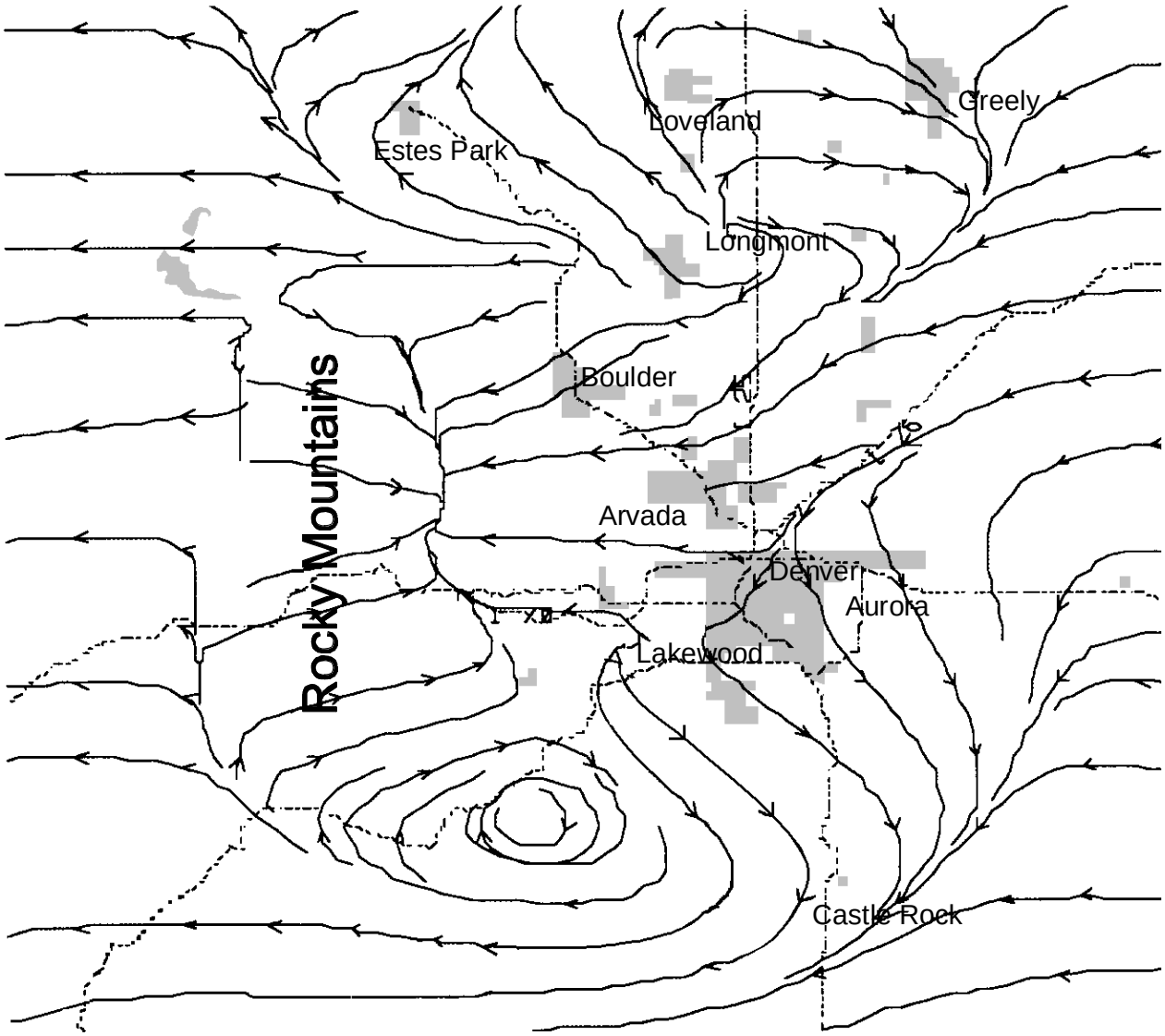
WINCO	Westinghouse Idaho Nuclear Company
WIND	Weather Information and Display
WINDS	Weather Information Network Display System
WSRC	Westinghouse Savannah River Company

X

Y

Z

ATMOSPHERIC DISPERSION MODELING RESOURCES



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