

FRAMES and MEPAS References

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Formulation Documents

Streile, G. P., K. D. Shields, J. L. Stroh, L. M. Bagaasen, G. Whelan, J. P. McDonald, J. G. Droppo, and J. W. Buck. 1996. Multimedia Environmental Pollutant Assessment System (MEPAS): Source Term Formulations. PNL-11248. Pacific Northwest National Laboratory, Richland, Washington. *Brief Description:* This report contains equations and assumptions used in MEPAS source term code. source term module is incorporated in MEPAS starting with version 3.2.

Droppo, J. G., Jr. and J. W. Buck. 1996. Multimedia Environmental Pollutant Assessment System (MEPAS): Atmospheric Pathway Formulations. PNL-11080. Pacific Northwest National Laboratory, Richland, Washington. *Brief Description:* This report contains equations and assumptions used in MEPAS atmospheric pathway computations.

Whelan, G., J. P. McDonald, and C. Sato. 1996. Multimedia Environmental Pollutant Assessment System (MEPAS): Groundwater Pathway Formulations. PNL-10907. Pacific Northwest National Laboratory, Richland, Washington. *Brief Description:* This report contains equations and assumptions used in MEPAS groundwater pathway computations.

Whelan, G., and J. P. McDonald. 1996. Multimedia Environmental Pollutant Assessment System (MEPAS): Riverine Pathway Formulations. PNNL-11176, UC-630. Pacific Northwest National Laboratory, Richland, Washington. *Brief Description:* This report contains equations and assumptions used in MEPAS riverine pathway computations.

Streng, D. L. and P. J. Chamberlain II. 1995. Multimedia Environmental Pollutant Assessment System (MEPAS): Exposure Pathway and Human Health Impact Assessment Models. PNL-10523. Pacific Northwest Laboratory, Richland, Washington.

Brief Description: This report contains equations and assumptions used in exposure and human health risk computations.

Droppo, J. G., Jr., G. Whelan, J. W. Buck, D. L. Streng, B. L. Hoopes, and M. B. Walter. 1989. Supplemental Mathematical Formulations: Multimedia Environmental Pollutant Assessment System (MEPAS). PNL-7201, Pacific Northwest Laboratory, Richland, Washington.

Brief Description: This report is one of original MEPAS formulation reports.

Whelan, G., D. L. Streng, J. G. Droppo, Jr., and B. L. Steelman. 1987. Remedial Action Priority System (RAPS): Mathematical Formulations. PNL-6200, Pacific Northwest Laboratory, Richland, Washington.

Brief Description: original mathematical formulations composing RAPS and subsequently, MEPAS methodology are given along with a listing of members of external peer-review panel.

Selected MEPAS Technical Articles

Whelan, G., J. W. Buck, and A. Nazarali. 1994. "Modular Risk Analysis for Assessing Multiple Waste Sites." PNL-SA-24239. In Proceedings of U.S. DOE Integrated Planning Workshop, June 1-2, 1994, Denver, Colorado. Pacific Northwest Laboratory, Richland, Washington.

Brief Description: A modular approach to conducting risk computations for large complex sites is described.

Droppo, J. G., Jr., J. W. Buck, D. L. Streng, and B. L. Hoopes. 1993. "Risk computation for environmental restoration activities." *Journal of Hazardous Materials*, 35,(1993)341-352.

Brief Description: This paper provides an overview of updated MEPAS methodology in terms of application to environmental restoration activities. role of MEPAS for environmental restoration activities is discussed in context of various types of models used to compute public health risks.

Streile, G. P., and J. L. Stroh. 1993. "Accounting for Time-Varying Vadose-Zone Water Fluxes Caused by Infiltration Caps Using MEPAS Transport, Exposure, and Risk Assessment Model." In Proceedings of ER'93 Environmental Remediation Conference, October 24-28, 1993, Augusta, Georgia.

Brief Description: This paper discusses enhancement was made to baseline RADCON code to accommodate an infiltration rate varies with time to account for influence of using a cap to remediate a hazardous waste site.

Whelan, G., J. W. Buck, D. L. Strenge, J. G. Droppo, Jr., and B. L. Hoopes. 1992. "Overview of Multimedia Environmental Pollutant Assessment System (MEPAS)." Hazardous Waste & Hazardous Materials, Vol. 9, No. 2, pp. 191-208.

Brief Description: This journal article provides an overview of structure and mathematical formulations of underlying structure of MEPAS methodology.

Droppo, J. G., Jr. 1991. "A Climatological Model for Risk Computation Incorporating Dry Deposition Influences." In Proceedings of Precipitation Scavenging and Atmosphere-Surface Exchange Processes, Richland, WA.

Brief Description: This paper describes detailed dry deposition models are used by MEPAS to account for site-specific processes.

Poston, T. M., and D. L. Strenge. 1989. "Estimation of Sport Fish Harvest for Risk and Hazard Assessment of Environmental Constituents." In Proceedings of 6th National Conference on Hazardous Wastes and Hazardous Materials, April 12-14, 1989, Hazardous Materials Control Research Institute, New Orleans.

Brief Description: This paper discusses method is used in MEPAS of estimating quantities of fish in rivers.

Whelan, G., B. L. Steelman, D. L. Strenge, and J. G. Droppo, Jr. 1986. "Overview of Remedial Action Priority System (RAPS)." In Pollutants in a Multimedia Environment, ed. Y. Cohen, Plenum Publishing, New York.

Brief Description: This chapter in a book on multimedia transport gives an early overview of original mathematical basis of RAPS/MEPAS methodology.

Methodology Guidance and Database Documents

Buck, J. W., G. Whelan, J. G. Droppo, Jr., D. L. Strenge, K. J. Castleton, J. P. McDonald, C. Sato, and G. P. Streile. 1995. Multimedia Environmental Pollutant Assessment System (MEPAS) Application Guidance, Guidelines for Evaluating MEPAS Input Parameters for Version 3.1. PNL-10395, Pacific Northwest Laboratory, Richland, Washington.

Brief Description: This document is user's guide is distributed with MEPAS. Detailed guidance is provided for defining each input parameter.

INTERA. 1994. MEPAS Post-processing Graphics (MPG Version 1.10) Users Manual. Intera Information Technologies (Canada) Ltd. Nepean, Ontario, Canada K2E 1A2.

Brief Description: MPG is an add-on graphics software package developed for INTERA for Environment and Health, Canada for plotting MEPAS results. This manual is a user's guide for using MPG.

Warren, B. R. and D. L. Strenge. 1994. Multimedia Modeling Environmental Database and Editor (MMEDE).

Brief Description: This document is user's guide is distributed with Multimedia Modeling Environmental Database and Editor (MMEDE). MMEDE contains MEPAS environmental database and can be used in conjunction with MEPAS or as a stand alone product. This document includes formulations for parameter estimation routines are incorporated both in MMEDE interface and MEPAS.

Schramke, J. A., C. S. Glantz, and G. R. Holdren. 1994. Hanford Site Environmental Setting Data Developed for Unit Risk Factor Methodology in Support of Programmatic Environmental Impact Statement (PEIS). PNL-9801, Pacific Northwest Laboratory, Richland, Washington.

Brief Description: This document contains environmental setting data used in Hanford PEIS risk evaluation.

Strenge, D. L. and P. J. Chamberlain II. 1994. Evaluation of Unit Risk Factors in Support of Hanford Remedial Action Environmental Impact Statement. PNL-10190, Pacific Northwest Laboratory, Richland, Washington.

Brief Description: This report contains technical information on how MEPAS was used to define normalized factors for evaluating human health risks in an application at U.S. DOE Hanford Site.

Michel, K. L. 1992. An Overview of Multimedia Environmental Pollutant Assessment System. ES/ER/TM-14, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Brief Description: This report was prepared by Oak Ridge National Laboratory to provide an overview of MEPAS and an understanding of how MEPAS is used to quantify potential risks to human health.

Droppo, J. G., Jr., D. L. Strenge, J. W. Buck, B. L. Hoopes, R. D. Brockhaus, M. B. Walter, and G. Whelan. 1989. Multimedia Environmental Pollutant Assessment System (MEPAS) Application Guidance Volume 1 - User's Guide. PNL-7216, Pacific Northwest Laboratory, Richland, Washington.

Brief Description: Guidance is provided for process of defining a problem for analysis by MEPAS. Although parts of this volume refer to an early version of MEPAS user interface, problem definition guidance continues to be useful.

Strenge, D. L., and S. R. Peterson. 1989. Chemical Data Bases for Multimedia Environmental Pollutant Assessment System (MEPAS): Version 1. PNL-7145, Pacific Northwest Laboratory, Richland, Washington.

Brief Description: MEPAS methodology uses a constituent data base containing standard values of physical, chemical, and exposure parameters. This volume contains data values with citations and distribution coefficient estimation methods used in a major environmental survey by U.S. DOE.

Model Evaluation, Comparison, and Benchmarking

U.S. EPA and U.S. DOE. Benchmarking of Three Multimedia Models: RESRAD, MMSOILS, and MEPAS, DOE/ORO-2033, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Brief Description: This report contains results of a model benchmarking effort cosponsored by U.S. EPA and U.S. DOE. Comparisons are based on model runs for both simplified and real site conditions. Information is provided on reasons for comparability, or lack of comparability, of results.

Moskowitz, P.D., R. Pardi, V.M. Fthenakis, S. Holtzman, L.C. Sun, and B. Irla. 1996. "An Evaluation of Three Representative Multimedia Models Used to Support Cleanup Decision-Making at Hazardous, Mixed, and Radioactive Waste Sites," Risk Analysis, Vol. 16, No.2.

Brief Description: This journal article compares relative merits and capabilities of models based on published information.

Holmes, J. A., B. F. Lyon, M. R. Patterson, R. Phillipi, C. C. Travis, and T. C. Tucker. 1994. Description, Analysis, and Comparison of MEPAS and Other Multimedia Models for Atmospheric, Groundwater, Food Chain Transport, and Exposure Pathways. ORNL/TM-12421, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Brief Description: This report contains results of a review of models for DOE applications.

Health and Welfare Canada. 1992. Review and Assessment of Two Multimedia Exposure Models: MEPAS and MULTIMED. Prepared by Intera Information Technologies Corporation, Environmental Sciences Division, Nepean, Ontario, Canada.

Brief Description: This report is a review of two multimedia exposure models, MEPAS and MULTIMED. Assessments were made of software, models of individual pathways and exposures, and test cases.

Droppo, J. G., Jr. 1989. "Use of Environmental Monitoring Data in Evaluation of Atmospheric Modeling Results." In Proceedings of 28th Hanford Symposium on Health and Environment, October 16-19, 1989, Richland, Washington.

Brief Description: Case studies comparing atmospheric monitoring data and MEPAS predicted values are discussed.

Whelan, G., J. G. Droppo, Jr., D. L. Strenge, M. B. Walter, and J. W. Buck. 1989. A Demonstration of Applicability of Implementing Enhanced Remedial Action Priority System (RAPS) for Environmental Releases. PNL-7102, Pacific Northwest Laboratory, Richland, Washington.

Brief Description: A comprehensive component testing effort conducted for RAPS/MEPAS effort is documented.

Whelan, G., D. L. Strenge, and J. G. Droppo, Jr. 1988. "Remedial Action Priority System (RAPS): Comparison Between Simulated and Observed Environmental Constituent Levels." In Superfund '88, Proceedings of 9th National Conference, November 28-30, 1988, Washington, D.C.

Brief Description: This paper presents results from comparison of monitoring data and simulated values.

EPA. 1988. Analysis of Alternatives to Superfund Hazard Ranking System. Prepared by Industrial Economics, Incorporated, Cambridge, Massachusetts.

Brief Description: As part of EPA's revision of their Hazardous Ranking System, they evaluated models for hazardous waste sites, including RAPS/MEPAS to determine strengths and weaknesses of these models.

Morris, S. C., and A. F. Meinhold. 1988. Report of Technical Support for Hazardous Waste Remedial Action Program on Health and Environmental Risks of Inactive Hazardous Waste Sites. BNL-42339, Brookhaven National Laboratory, Long Island, New York.

Brief Description: This document evaluates MEPAS methodology for use in support of U.S. DOE Hazardous Waste Remedial Action Program.

Buck, J. W., L. M. Bagaasen, M. P. Bergeron, G. P. Streile, L. H. Straven, K. J. Castleton, G. M. Gelston, D. L. Strenge, K. M. Krupta, and R. J. Serne. 1996. Long-Term-Consequence Analysis of No Action Alternative 2, Draft, PNNL-11251, Pacific Northwest National Laboratory, Richland, Washington.

Buck, J. W., G. M. Gelston, W. T. Farris. 1995. "Integrated Risk Assessment Program: Scoring Methods and Results of Public Health Impacts from Hanford High-Level Waste Tanks." PNL-10725. Pacific Northwest Laboratory, Richland, Washington.

PNL. 1995. Volume 1: Hanford Site Spent Nuclear Fuel Management Program. Appendix A. DOE/EIS-0203-F. Prepared for U.S. Department of Energy by Pacific Northwest Laboratory, Richland, Washington.

Droppo, J. G., Jr., J. W. Buck, G. Whelan, D. L. Strenge, K. J. Castleton, and G. M. Gelston. 1995. "Large-Scale Multimedia Modeling Applications." American Institute of Chemical Engineers. Boston, Massachusetts.

Brief Description: This paper provides a historical view of development of technical tools and approaches for computing human health risks associated with U.S. DOE sites and their operations. paper starts with development of MEPAS and proceeds to Modular Risk Assessment approach.

Whelan, G., J. W. Buck, K. J. Castleton, J. P. McDonald, C. Sato, G. M. Gelston, A. deHamer, R. J. Serne, S. K. Wurstner, and R. N. Kickert. 1994. "Unit Environmental Transport Assessment of Constituents from Hanford's Past-Practice Waste Sites." PNL-10233. Prepared for U.S. Department of Energy by Pacific Northwest Laboratory, Richland, Washington.

Lewis, R. E., T. T. Jarvis, M. R. Jarvis, G. Whelan. 1994. Eielson Air Force Base Operable Unit 2 Baseline Risk Assessment. PNL-8752, Pacific Northwest Laboratory, Richland, Washington.

Brief Description: As one portion of a baseline risk assessment for an Operable Unit at an Air Force Base in Alaska, MEPAS was used in fate and transport analysis to evaluate temporal implications of site monitoring data. These results are presented in Chapter 8 of this report.

Martin, W.J. and G. Whelan. 1994. "Modeling of Radioactive Transport for Decommissioned Nuclear Reactor Waste." In Proceedings of Embedded Topical Meeting on Decommissioning, Decontamination, and Environmental Restoration--DDER '94. American Nuclear Society. Washington, DC, November 13-17, 1994.

Whelan, G., J.P. McDonald, C. Sato. 1994. Environmental Consequences to Water Resources from Alternatives of Managing Spent Nuclear Fuel at Hanford. PNL-10053, Pacific Northwest Laboratory, Richland, Washington.

Brief Description: MEPAS is used in an Environmental Impact Statement (EIS) analysis. Assessments are made of five alternatives for managing spent nuclear fuel using MEPAS to evaluate potential environmental consequences.

Buck, J. W., M. S. Peffers, and S. T. Hwang. 1991. Preliminary Recommendations on Design of Characterization Program for Hanford Site Single-Shell Tanks -- A System Analysis: Volume 2 -- Closure Related Analyte Priorities, Concentration Thresholds, and Detection Limit Goals Based on Public Health Concerns. PNL-7573, Pacific Northwest Laboratory, Richland, Washington.

Brief Description: This document describes development of data quality objectives (DQOs) for Hanford Site Single-Shell Tank Waste Characterization Program. These DQOs include priority of analytes, concentrations at which analytes are significant risk contributors (concentration threshold concept [CT]), and detection limit goals (DLGs) for analytical methods. MEPAS code was used to evaluate public health risk for these DQOs based on site- and constituent-specific data.

Droppo, J. G., Jr., J. W. Buck, J. S. Wilbur, D. L. Strenge, and M. D. Freshley. 1991. Single-Shell Tanks Constituent Rankings for Use in Preparing Waste Characterization Plans. PNL-7572. Pacific Northwest Laboratory, Richland, Washington.

Brief Description: This document describes use of MEPAS code to prioritize large number of analytes of interest for Hanford Single-Shell Tanks (SSTs) Waste Characterization Project. analysis divides SST analytes into carcinogen and noncarcinogenic groups. These groups are then ranked to indicate highest risk analytes in SSTs. Sensitivity analysis runs were made for varying infiltration rates and adsorption coefficients. This work was done for Hanford Westinghouse Company, which operated Hanford Site for U. S. Department of Energy.

Doctor, P. G., T. B. Miley, and C. E. Cowan. 1990. Multimedia Environmental Pollutant Assessment System (MEPAS) Sensitivity Analysis of Computer Codes. PNL-7296, Pacific Northwest Laboratory, Richland, Washington.

Brief Description: results of a sensitivity study of MEPAS model inputs are presented. This report was prepared to support a major U.S. DOE application of MEPAS.

Droppo, J. G., Jr., J. W. Buck, D. L. Strenge, and M. R. Siegel. 1990. Analysis of Health Impact Inputs to U.S. Department of Energy's Risk Information System. PNL-7432, Pacific Northwest Laboratory, Richland, Washington.

Brief Description: This document provides an overview of DOE Risk Information System as well as results of an analysis of preliminary application of MEPAS to potential environmental problems at 16 DOE facilities (DOE 1988).

Ecology. 1990. Draft Environmental Impact Statement - Cleanup Standards. Prepared by Toxics Cleanup Program, Washington State Department of Ecology, Olympia, Washington.

Brief Description: This document discusses proposed additions to Model Toxics Control Act Cleanup Regulation in Washington State (Chapter 173-340 WAC). regulation specifies basic requirements for cleanup actions, along with criteria for selecting among alternative cleanup actions, and establishes requirements for leaking underground storage tank corrective actions. MEPAS methodology was used to evaluate alternative actions with respect to cleanup criteria. MEPAS applications are discussed in technical appendices associated with this document.

Buck, J. W., and R. J. Aiken (U.S. DOE). 1989. "Applications of Multimedia Environmental Pollutant Assessment System (MEPAS)." In Proceedings of HAZTECH International Conference, September 27-29, 1989, San Francisco, California.

Brief Description: application of MEPAS methodology to DOE's Environmental Survey and other applications are discussed.

Streng, D. L., and J. W. Buck. 1989. "Chemical Exposure Evaluation in Multimedia Environmental Pollutant Assessment System (MEPAS)." In Proceedings of 28th Hanford Symposium on Health and Environment, October 16-19, 1989, Richland, Washington.

Brief Description: This paper presents analysis of several ranking parameters provided by MEPAS methodology. This analysis includes comparing and combining parameters to help assess environmental problems.

DOE. 1988. Environmental Survey Preliminary Summary Report of Defense Production Facilities. DOE/EH-0072, U.S. Department of Energy; Environment, Safety, and Health; Office of Environmental Audit; Washington, D.C.

Brief Description: This report presents results of a preliminary application of MEPAS to ranking environmental problems at 16 of DOE's defense waste facilities.

Droppo, J. G., Jr., and J. W. Buck. 1988. "Characterization of Atmospheric Pathway at Hazardous Waste Sites." In Proceedings of DOE Model Conference, October 3-7, 1988, Oak Ridge, Tennessee.

Brief Description: This paper compares atmospheric model rankings from DOE's Environmental Survey to groundwater and surface water pathway rankings to determine biases.

Hartz, K. E., and G. Whelan. 1988. "MEPAS and RAPS Methodologies as Integrated into RI/EA/FS Process." In Superfund '88, Proceedings of 9th National Conference, November 28-30, 1988, Washington, D.C.

Brief Description: integration of MEPAS methodology into RI/EA/FS process required by Superfund program is discussed.