November 20 2000

Dear Stakeholder

The Rocky Flats Cleanup Agreement (RFCA) Stakeholder Focus Group will meet at the **Arvada Center for Arts and Humanities** 6901 Wadsworth Blvd on November 29 2000 from 4 30 to 6 30 p m A technical discussion meeting will be held at the Center from 3 00 to 4 15 p m The agenda for the November 29 meeting is enclosed (Attachment A)

The meeting minutes from the November 8 2000 RFCA Stakeholder Focus Group are enclosed (Attachment B) Also enclosed are the following background materials requested by the Focus Group at the November 8 2000 meeting or identified by the RFCA Parties

Reprint Determining Cleanup Goals at Radiologically contaminated Sites Table 1 (AlphaTRAC Inc Attachment C)
RFCA Focus Group schedule reissue (Jeremy Karpatkin DOE Attachment D)
Post NRC guidance (1549 4006) links on RFCA site (Russell McCallister DOE Attachment E)
Answers to questions from the RFCA Focus Group about the RSAL review processes (All agencies Attachment F)

Also enclosed is the preliminary draft Computer Model Selection To Support Development Of Radionuclide Soil Action Levels (Attachment G)

You are encouraged to attend the technical discussion session for these materials that will occur at the Center from 3 00 to 4 15 p m on November 29 2000 We will have subject matter experts available to answer any questions on the packet information

If you need additional information to prepare you for the Focus Group discussion on November 29 please contact the subject matter experts listed in the packet or call Christine Bennett of AlphaTRAC Inc at 303 428 5670 (cbennett@alphatrac com) Christine will help to find the appropriate resource for you

You may call either Christine or me if you have any questions comments or suggestions concerning the RFCA Stakeholder Focus Group or the upcoming meeting

Sincerely

C Reed Hodgin CCM
Facilitator / Process Manager

1/32

RFCA Stakeholder Focus Group
Meeting Agenda

When **November 29, 2000 4 30 - 6 30 p m**

Where **Arvada Center for Arts and Humanities, 6901 Wadsworth Blvd**

4 30 Introductions Agenda Review 11/8 Meeting Minutes Review

4 40 RFCA Peer Review Meeting Update Mary Harlow

4 45 Answer Regulatory Analysis Questions All Agencies

6 20 Topics for Upcoming Meetings

6 30 Adjourn

RFCA Stakeholder Focus Group
November 8, 2000
REVISED Meeting Minutes

INTRODUCTION AND ADMINISTRATIVE

Reed Hodgin began the meeting explaining that the meeting room would again be arranged as an open square table to foster better communication among the participants Those who wished to join the conversation were asked to sit around the table those who attended the meeting to answer technical questions or to observe were seated behind and around the square

A participants list for the November 8 2000 RFCA Stakeholder Focus Group meeting is included in this report as Appendix A

Reed reviewed the Focus Group purpose

The October 11 2000 RFCA Stakeholder Focus Group meeting minutes were reviewed and approved

Reed presented the schedule of Focus Group meetings to address the Radioactive Soil Action Level (RSAL) Review (Appendix B) The RSAL review will dominate the agendas for the Focus Group through mid May 2001

Reed reviewed the agenda for this meeting Mary Harlow City of Westminster asked for time to make a presentation of the proposed Rocky Flats Cleanup Agreement (RFCA) project peer review process that she had developed at the request of the Focus Group The Focus Group agreed

RFCA PROJECT PEER REVIEW PROCESS

Mary Harlow City of Westminster presented a proposed peer review process for the RFCA regulators review of the interim RSALs for Rocky Flats (Appendix C) The draft process had been developed with the assistance and concurrence of several other Focus Group members

Mary proposed that the peer review panel review five technical documents to be prepared by the regulators

Regulatory Analysis
Model Evaluation
Parameter Evaluation
New Scientific Information and
Draft RSAL Document

She presented a draft review process in which the peer reviewers and the RFCA Focus Group would receive draft documents in parallel for review The review period would be 30 days for most documents The peer review panel would submit written comments to the regulators which would respond in writing The comments and responses would be discussed at subsequent RFCA Focus Group meetings

Mary proposed that an honorarium be provided to each peer reviewer with half of the remuneration at the beginning of the review and half at the end She also proposed that penalties be assessed for missed deadlines and that incidental expenses be paid as additional direct costs

Five criteria were suggested for selecting the peer reviewers

Positive reputation and credibility in the scientific community
Competence in the specific task areas
Minimal conflict of interest
Ability to meet the required schedule
Willingness to share all correspondence with the Focus Group

Mary recommended that five scientists who conducted a review of the Risk Assessment Corporation review of RSALs be considered as candidates Mary will send resumes for these scientists to any interested Focus Group members

Mary suggested as a next step that the draft review process be designed in detail and that contracts be issued through the Rocky Flats Citizens Advisory Board Mary asked that if anyone was interested or knows of anyone interested in participating in the peer review process to give the name and contact information to Christine Bennett of AlphaTRAC Inc

A group discussion followed Mary s presentation

John Marler (RFCLOG) indicated that the peer review might be more useful during the analysis of As Low As Reasonably Achievable (ALARA) provisions since there would be more latitude for choices in this area as opposed to the requirements analysis

It was suggested that in addition to the technical reviewers a technical advisor might be needed for the Focus Group This advisor would attend Focus Group meetings and act as an independent source of information about the RSAL review

The Focus Group agreed that a peer review process should be put into place Mary asked that a working group be put together to draft a peer review scope of work and submit names of scientists who may want to join the panel The following Focus Group members volunteered to prepare the detailed plan

Tim Rehder
John Marler
Ken Korkia
Mary Harlow
Tom Marshall
Victor Holm
Shirley Garcia
Carol Lyons
LeRoy Moore
Jeremy Karpatkin

Jeremy Karpatkin indicated that the schedule for the peer review process may necessitate extending the overall schedule for the RSAL review Joe Legare stated that the U S Department of Energy (DOE) would provide funding for the peer review

RSALS REGULATORY FRAMEWORK

Tim Rehder EPA presented a draft analysis of the regulatory framework for the RSALs (Appendix D) His presentation included six topics

Draft EPA Rule
Rationale Behind Current RSAL
Change in Regulatory Landscape
Land Use and Institutional Controls

DRAFT RSAL Public Process Proposed Schedule

Tasks	First Draft Distributed	Focus Group Meet ng	Second Draft	Foc s Group Meet ng	Draft to Princ pals
Review process		CAB M·et g 10 5 00 Foc s Group 10/25/00			
Task One (Regulatory Analysis)	10/27/00	11/8/00 and 11/29/00	1/3/01	1/17/01	2/15/01
Task Two (Model Evaluation)	11/20/00	12/13/00	1/3/01	1/31/01	2/15/01
Task Three (Parameter Evaluation)	1/26/01	2/14/01 and 2/28/01	4/6/01	4/25/01	5/2/01
Task Four (New Science)	11/3/00	12/13/00	1/3/01	1/31/01	2/15/01
Task Fi e (Cleanup levels at other Sites)	10/25/00	11/8/00	12/1/00	1/3/01	1/17/01

Focus Group Meetings

10/25/00	11/8/00:	11/29/00:	12/13/00:	1/3/01
➢ Review and d scuss RSAL process	➢ Regulatory Analys s 1 ➢ Cleanup Le els 1	➢ Regulatory Analysis 2	➢ Model E al ation 1 ➢ New Science 1	➢ Cleanup Levels 2
1/17/01	**1/31/01:**	**2/14/01**	**2/28/01**	**4/11/01**
➢ Regulatory A alysis 3	➢ Model Eval 2 ➢ New Sc e ce 2	➢ Paramete Evaluation 1	➢ Parameter Evaluation 2	➢ Outl ne of Report to Focus Group
4/25/01	**5/9/01**			
➢ Paramete E aluation 3	➢ Draft Report to Focus Gr up			

Formal Public Comment Period for RSAL Report

5/16/01	7/16/01	8/15/01
➢ Public Comment begins	➢ Public Comment Ends	➢ Final Report Released

RFCA Stakeholder Focus Group
Attachment E

Title	Post NRC guidance (1549 4006) links
Date	November 20 2000
Author	Russell McCallister DOE
Phone Number	(303) 966 9692
Email Address	russell mccallister@rf doe gov

NUREG 1549
http //techconf llnl gov/cgi bin/library?source= &library=rad_cri_public&file-

Radiological Criteria for License Termination Rule Text
http //techconf llnl gov/cgi bin/library?source= &library=rad_cri_state&file=

PRELIMINARY DRAFT

COMPUTER MODEL SELECTION TO SUPPORT DEVELOPMENT OF RADIONUCLIDE SOIL ACTION LEVELS

OCTOBER 26, 2000

TABLE OF CONTENTS

9

1 Introduction

This Computer Model Selection supports the calculation of the Radionuclide Soil Action Levels (RSAL) at the Rocky Flats Environmental Technology Site (RFETS) RSALs are radionuclide concentrations in soils that are protective of human health RSALs are calculated based on the future land uses at RFETS per the Rocky Flats Cleanup Agreement (RFCA) RSALs are being developed for Pu 239 Am 241 U 234 U 235 and U 238 for inclusion in RFCA

Computer models are needed to calculate RSALs due to the complexity in calculating radiation dose to individuals associated with future land uses Radiation dose must be calculated for multiple radionuclides multiple exposure pathways and multiple exposure scenarios over a 1 000 year period Several computer models may be used to calculate the RSALs These computer models include 1) RESRAD 6 0 2) DandD 2 0 3) RESRAD 5 82 modified by RAC and 4) MEPAS/GENII/FRAMES/SUM3 package of computer codes These computer codes are considered since they can assess radiation dose from radionuclides in soils in a probabilistic manner They can also trace the movement of radionuclides in the environment over the 1 000 year assessment period

Section 2 0 of this report outlines the capabilities of each of the computer models chosen for assessment Section 3 0 outlines the model selection criteria to be used to evaluate the chosen models Section 4 0 evaluates each of the computer models with respect to the selection criteria Section 5 0 provides conclusions based on the comparison with selection criteria Section 6 0 provides references for the report

2 Model Descriptions

2 1 RESRAD 6 0

RESRAD is a computer code developed by Argonne National Laboratory for the U S Department of Energy to calculate site specific residual radioactive material guidelines using radiation dose and radiation risk These residual radioactive material guidelines can be developed on a deterministic or probabilistic basis Residual radioactive material guidelines are equivalent to an RSAL at RFETS

RESRAD uses a pathway analysis method in which the relation between radionuclide concentrations in soil and the dose to a member of a critical population group is expressed as a pathway sum which is the sum of products of pathway factors Pathway factors correspond to pathway segments connecting compartments in the environment between which radionuclides can be transported or radiation emitted The nine environmental pathway segments assessed by RESRAD are direct exposure inhalation of particulates and radon and ingestion of plant foods meat milk aquatic foods water and soil

10

2 2 DandD 2 0

DandD (Decontamination and Decommissioning) is a computer code developed by the Nuclear Regulatory Commission to support decommissioning under their License Termination Rule Screening level cleanup concentrations are calculated by DandD for surface soils and building surfaces using probabilistic analysis The DandD computer code software was developed using the environmental pathways and exposure scenarios documented in Volumes 1 and 3 of NUREG/CR 5512 Residual Radioactive Material From Decommissioning

DandD assesses a residential exposure scenario for soils and a building occupancy scenario for building surfaces The building occupancy scenario relates volume and surface contamination levels in existing buildings (presumably released following decommissioning for unrestricted commercial or light industrial use) to estimates of the total effective dose equivalent (TEDE) received during a year of exposure with the conditions defined in the scenario The more complex and generalized residential scenario is meant to address sites with contamination in soils and groundwater Input parameter distributions for each scenario and exposure pathway were developed consistent with conducting screening dose assessments increasing the likelihood of overestimating rather than underestimating potential dose

2 3 RESRAD 5 82 modified by RAC (RAC RESRAD)

RESRAD 5 82 has all of the capabilities listed above for RESRAD 6 0 except that it does not have the capability to assess parameters in a probabilistic manner The Risk Assessment Corporation (RAC) wanted to assess exposure scenarios and exposure pathways in a probabilistic manner though RAC also wanted to calculate the amount of radioactive material in the air differently than RESRAD 5 82 Therefore RAC developed probabilistic computer codes and air modeling computer codes to supplement the capabilities of RESRAD 5 82 The RAC developed computer codes were run concurrently with RESRAD 5 82 to get the desired results

RAC RESRAD can assess multiple exposure scenarios and exposure pathways in a probabilistic manner

2 4 MEPAS/GENII/FRAMES/SUM3

The MEPAS/GENII/FRAMES/SUM3 set of computer codes works as a unit to calculate radiation dose to individuals associated with multiple exposure scenarios FRAMES is the shell in which all of the other computer codes run MEPAS and GENII contain the source term definition component the fate & transport component and the radiation dosimetry component of the set of computer models SUM3 is the package that allows the use of probabilistic analysis within the set of computer codes These four computer codes are further discussed in the sections below

2 4 1 MEPAS

The MEPAS (Multimedia Environmental Pollutant Assessment System) computer code assesses the impact to individuals from radionuclides and chemicals in the environment MEPAS integrates environmental transport and exposure pathways to determine their potential impact on the surrounding environment individuals and populations MEPAS is a deterministic computer code that can assess multiple exposure pathways and exposure scenarios

MEPAS provides a user friendly interface for setting up cases and analyzing results This interface provides on line help units conversions pictorial depiction of the Conceptual Site Model ability to reference all data ability to edit most default parameters and graphical views of input and output data MEPAS is applicable to a wide range of multimedia transport and consequence analysis

2 4 2 GENII

The GENII computer code was developed at Pacific Northwest National Laboratory (PNNL) to integrate radionuclide dosimetry models with environmental pathway analysis models The resulting second generation of environmental dosimetry computer codes is compiled in the Hanford Environmental Dosimetry System (Generation II or GENII) Although the codes were developed for use at Hanford they were designed with the flexibility to accommodate input parameters for a wide variety of generic sites

The GENII system includes the capabilities for calculating radiation doses following chronic and acute releases with options for annual dose committed dose and accumulated dose Radionuclide transport via air water or biological activity may be considered GENII is a deterministic computer code that can assess multiple exposure pathways and exposure scenarios

2 4 3 FRAMES

FRAMES (Framework for Risk Analysis in Multimedia Environmental Systems) is a software platform used to link different computer codes required to perform an appropriate assessment FRAMES is an open architecture object oriented system that provides an environmental database This software platform aids the user in constructing exposure scenarios and exposure pathways applicable to site specific situations Furthermore the software allows the user to choose the most appropriate codes to solve simulation requirements and presents graphical packages for analyzing results

FRAMES currently contains sockets for a collection of computer codes that simulate elements of a source fate & transport exposure and risk assessment system FRAMES provides data file specifications that describe how all site information is stored within the framework and passed between modules These

data file specifications are not associated with the model specific information only with the transfer of information between modules or other frameworks The environmental transport and radiation dose computer codes currently available within the FRAMES software platform are MEPAS and GENII SUM3 is an additional computer code available in the FRAMES software platform that supports probabilistic analysis

2 4 4 SUM3

The FRAMES software is currently designed for deterministic environmental and human health impact models The Sensitivity/Uncertainty Multimedia Modeling Module (SUM3) software product was designed to allow statistical analysis using the existing deterministic models available in FRAMES within the FRAMES platform SUM3 randomly samples input variables and preserves the associated output values in an external file available to the user for evaluation This enables the user to calculate deterministic values with variable inputs producing a statistical distribution of results

3 Model Selection Criteria

The following criteria will be used to assess the capabilities of 1) RESRAD 6 0 2) DandD 2 0 3) RESRAD 5 82 modified by RAC and 4) MEPAS/GENII/FRAMES/SUM3 package of computer codes These criteria will be applied to each of the computer codes independently The computer code(s) that meets all or most of the criteria will be chosen for use over those computer models that meet few or none of the criteria

These criteria were developed after reviewing the current literature on computer modeling and choosing criteria based on the literature In general the literature supported the use of computer models that comply with project specific needs and that have been extensively tested A major assumption in developing these criteria is that the RSALs will be developed based on radiation dose in a probabilistic manner in accordance with the NRC s License Termination Rule

3 1 Criteria #1 Does the model incorporate key processes from the Conceptual Site Model?

The Conceptual Site Model (CSM) is developed to illustrate how an individual can be exposed to radionuclides in the soil This exposure is then translated into a radiation dose to the individual due to inhalation ingestion and external irradiation from the radionuclides in the soils The radiation dose caused by a certain soil concentration can then be translated into an RSAL

The CSM must first show the configuration of radionuclides in soil so that the source term can be adequately modeled At RFETS the source of radionuclides in soils can be in either surface soils or subsurface soils Therefore the computer model must be able to assess these two soil horizons

The CSM must then be able to trace the contaminant from the source to the exposed individual At RFETS the environmental transport mechanisms that must be assessed are surface water runoff surface water stream transport air resuspension leaching in the vadose zone and ground water transport Therefore the computer model must be able to assess all of these environmental transport mechanisms

The CSM must show all the exposure pathways through which an individual could be exposed At RFETS the exposure pathways of ingestion of soil inhalation of resuspended soils external irradiation of soils ingestion of homegrown fruits/vegetables/grains and ingestion of meat and milk are the exposure pathways of interest at RFETS Therefore the computer model must be able to assess all of these exposure pathways

The CSM has to include all the exposure scenarios associated with an individual The exposure scenarios of interest at RFETS are the industrial office worker recreational open space user wildlife refuge worker hypothetical future resident and hypothetical future resident rancher The individuals associated with these exposure scenarios may be an adult child or infant Therefore the computer model chosen to calculate the RSAL must be able to assess these exposure scenarios

3 2 Criteria #2 Does the model satisfy study objectives?

The study objective is to estimate the soil concentration that equates to an acceptable radiation dose for all applicable radionuclides over a study period of 1 000 years Therefore the chosen computer model must be able to trace a radionuclide through the environment to each applicable exposure scenario for a 1 000 year period The maximum radiation dose in this period must be calculated and the RSAL associated with this maximum concentration must be delineated It would be ideal if the computer code chosen would perform this calculation automatically

3 3 Criteria #3 – Has the model been verified using published analytical equations in scientific and technical journals?

Verification is the process of comparing model outputs with the solutions to analytical equations under the same conditions as the model was run These results need to be equivalent to assure that the analytical equations have been coded into the model correctly The model chosen to calculate the RSAL shall be verified

3 4 Criteria #4 – Has the model been validated against known site conditions?

Validation is the process of determining how well the fate and transport model describes actual system behavior Validation of the model can be achieved by matching model output to measurements It involves the process of using a set of input parameter values and boundary conditions for a calibrated model to approximate within an acceptable range an independent set of measurements made

under conditions similar to the model conditions The model chosen to calculate the RSAL shall be validated

Benchmarking may be considered supporting information when assessing the validation of a model Benchmarking is an exercise that consists of solving the same set of problems with several different computer models and comparing results

3 5 Criteria #5 – Does the model have the capability to satisfy study objectives using probabilistic analysis?

There are two ways to assess radiation dose per the CSM requirements The first method is to choose a single conservative value for each input parameter from the model This is a deterministic analysis Parameters chosen in a deterministic manner will produce a single conservative RSAL for each radionuclide in each exposure scenario The second method is to choose a distribution of values for the most sensitive parameters from the model This is a probabilistic analysis Parameters chosen in a probabilistic manner will produce an output set of radiation dose distributions over time for each radionuclide in each exposure scenario The RSAL will be chosen based on the Peak of the Mean Dose versus Time as required by the NRC The model chosen to calculate the RSAL shall have the capability to perform a probabilistic analysis

3 6 Criteria #6 – Is the model well documented?

Documentation for each model should include 1) A user s manual that discusses how to navigate through the model interface and 2) A technical basis document that outlines the technical aspects (including mathematical formulations) of the radiological source term the environmental transport algorithms the exposure pathways factors and the radiation dosimetry algorithms

3 7 Criteria #7 – Is the model available in the public domain?

The model will need to be available in the public domain This means that the model and its documentation can be accessed either through a government agency or through a private company There may also be a charge associated with the software The model may not be experimental in nature and only available to select individuals

4 Model Criteria Evaluation

The Model Selection criteria will now be applied to 1) RESRAD 6 0 2) DandD 2 0 3) RESRAD 5 82 modified by RAC (RAC RESRAD) and 4) MEPAS/GENII/FRAMES/SUM3 package of computer codes independently The results of applying these criteria to each computer model will be used to select the appropriate computer code to calculate the RSAL The results of applying these model selection criteria are outlined in Table 1 Model Selection Criteria Assessment of Section 5 0

4 1 RESRAD 6 0

4 1 1 Criteria #1 Does the model incorporate key processes from the Conceptual Site Model?

RESRAD 6 0 can assess all aspects of the CSM applicable at RFETS RESRAD 6 0 can trace a contaminant from its origin in soils to an exposed individual through all applicable exposure pathways RESRAD 6 0 can assess radionuclides in surface soils and subsurface soils RESRAD 6 0 can assess the exposure pathways of ingestion of soil inhalation of resuspended soils external irradiation of soils ingestion of homegrown fruits/vegetables/grains and ingestion of meat and milk RESRAD 6 0 can assess the industrial office worker recreational open space user wildlife refuge worker hypothetical future resident and hypothetical future resident rancher exposure scenarios RESRAD 6 0 can assess an adult child and infant within the appropriate exposure scenarios

4 1 2 Criteria #2 Does the model satisfy study objectives?

RESRAD 6 0 can estimate the soil concentration that equates to an acceptable radiation dose for all applicable radionuclides over a study period of 1 000 years RESRAD 6 0 can trace a radionuclide through the environment to each applicable exposure scenario for a 1 000 year period The maximum radiation dose in this period can be calculated by RESRAD 6 0 and the RSAL associated with this maximum concentration can be delineated by RESRAD 6 0 RESRAD 6 0 can perform this calculation automatically

4 1 3 Criteria #3 – Has the model been verified using published analytical equations in scientific and technical journals?

The RESRAD computer code has been extensively verified Verification of RESRAD has included the following

1 Argonne National Laboratory performed an internal verification of the RESRAD computer code using hand calculations before its initial release in 1989
2 An independent verification of RESRAD was performed in 1994 and is documented in Verification of RESRAD A Code for Implementing Residual Radioactive Material Guidelines Version 5 03 HNUS ARPD 94 174 Halliburton NUS Corporation June 1994

4 1 4 Criteria #4 – Has the model been validated against known site conditions?

The RESRAD computer code has been extensively validated Validation of RESRAD is documented in the following reports

1 Analysis of BIOMOVS II Uranium Mill Tailings Scenario 1 07 with the RESRAD Computer Code ANL/EAD/TM 66 Argonne National Laboratory August 1997
2 Application of the RESRAD Computer Code to VAMP Scenario S ANL/EAD/TM 70 Argonne National Laboratory March 1997

BIOMOVS (BIOspheric MOdel Validation Study) II is an international cooperative study to test models designed to quantify the environmental transfer and bioaccumulation of radionuclides and other trace substances Scenario 1 07 of the BIOMOVS study is the culmination of numerous iterations among the members of this working group in developing a hypothetical scenario comparing predictions of the intermediate scenarios and refining and clarifying the scenario to arrive at a reasonably well defined scenario to serve as the basis for comparison of deterministic predictions of the models participating in the study

VAMP (Validation of Environmental Model Predictions) is an international program established by the International Atomic Energy Agency (IAEA) in 1988 to use data from the Chernobyl fallout to test and improve biospheric models Scenario S involved the prediction of the radiological consequences of cesium 137 from Chernobyl driven fallout in southern Finland

RESRAD has been extensively benchmarked

4 1 5 Criteria #5 – Does the model have the capability to satisfy study objectives using probabilistic analysis?

RESRAD 6 0 can assess radiation dose per the CSM requirements using deterministic and/or probabilistic analysis RESRAD 6 0 has the capability to choose a single conservative value for each input parameter for the model to support a deterministic analysis RESRAD 6 0 also has the capability to choose a distribution of values for the most sensitive parameters for the model to support a probabilistic analysis RESRAD 6 0 can perform sensitivity analyses so that the most sensitive parameters can be delineated RESRAD 6 0 has the capability to produce an output set of radiation dose distributions over time for each radionuclide in each exposure scenario Therefore RESRAD 6 0 can produce the Peak of the Mean Dose versus Time

4 1 6 Criteria #6 – Is the model well documented?

RESRAD 6 0 is very well documented The following reports have been published to support the use of RESRAD 6 0

1 Probabilistic Modules for RESRAD and RESRAD BUILD Computer Code ANL/EAD/TM 91 Argonne National Laboratory June 2000

17

2 Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD Version 5 0 Working Draft For Comment ANL/EAD/LD 2 Argonne National Laboratory September 1993
3 Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil ANL/EAIS 8 Argonne National Laboratory April 1993
4 Evaluation of the Area Factor Used in the RESRAD Code for the Estimation of Airborne Contaminant Concentrations of Finite Area Sources ANL/EAD/TM 82 Argonne National Laboratory July 1998
5 External Exposure Model Used in the RESRAD Code for Various Geometries of Contaminated Soil ANL/EAD/TM 84 Argonne National Laboratory September 1998

4 1 7 Criteria #7 – Is the model available in the public domain?

RESRAD 6 0 is available in the public domain RESRAD 6 0 and its documentation can be accessed through the Nuclear Regulatory Commission website at http //www nrc gov/RES/rescodes htm There is no charge associated with this software

4 2 DandD 2 0

4 2 1 Criteria #1 Does the model incorporate key processes from the Conceptual Site Model?

DandD 2 0 is a screening level computer code and therefore cannot assess all aspects of the CSM applicable at RFETS DandD 2 0 can trace a contaminant from its origin in soils to an exposed individual through all applicable exposure pathways DandD 2 0 can assess radionuclides in surface soils only and not subsurface soils DandD 2 0 can assess the exposure pathways of ingestion of soil inhalation of resuspended soils external irradiation of soils ingestion of homegrown fruits/vegetables/grains and ingestion of meat and milk DandD 2 0 cannot assess the industrial office worker recreational open space user wildlife refuge worker hypothetical future resident and hypothetical future resident rancher exposure scenarios DandD 2 0 cannot assess an adult child and infant within the appropriate exposure scenarios DandD only assesses an adult in i residential setting

4 2 2 Criteria #2 Does the model satisfy study objectives?

DandD 2 0 can estimate the soil concentration that equates to an acceptable radiation dose for all applicable radionuclides over a study period of 1 000 years DandD 2 0 can trace a radionuclide through the environment to each applicable exposure scenario for a 1 000 year period The maximum radiation dose in this period can be calculated by DandD 2 0 and the RSAL associated with this maximum concentration can be delineated by DandD 2 0 DandD 2 0 can perform this calculation automatically

18

4 2 3 Criteria #3 – Has the model been verified using published analytical equations in scientific and technical journals?

DandD 2 0 has not been verified in a manner that can be referenced

4 2 4 Criteria #4 – Has the model been validated against known site conditions?

DandD 2 0 has not been validated or benchmarked

4 2 5 Criteria #5 – Does the model have the capability to satisfy study objectives using probabilistic analysis?

DandD 2 0 cannot assess radiation dose per the CSM requirements per Criteria #1 but DandD 2 0 has the capability to incorporate deterministic and/or probabilistic analyses DandD 2 0 though is meant to be a screening level computer model that has no inputs changed and gives a conservative cleanup level as output DandD 2 0 has the capability to choose a single conservative value for each input parameter for the model to support a deterministic analysis DandD 2 0 also has the capability to choose a distribution of values for the most sensitive parameters for the model to support a probabilistic analysis The sensitivity analysis has already been performed for DandD 2 0 and distributions of values have been incorporated into the model for the most sensitive parameters DandD 2 0 has the capability to produce an output set of radiation dose distributions over time for each radionuclide in each exposure scenario Therefore DandD 2 0 can produce the Peak of the Mean Dose versus Time

4 2 6 Criteria #6 – Is the model well documented?

DandD 2 0 is very well documented The following reports have been published to support the use of DandD 2 0

1 Residual Radioactive Contamination From Decommissioning Technical Basis for Translating Contamination Levels to Annual Effective Dose Equivalent Final Volume 1 NUREG/CR 5512 US Nuclear Regulatory Commission October 1992
2 Residual Radioactive Contamination From Decommissioning User s Manual Draft Volume 2 NUREG/CR 5512 US Nuclear Regulatory Commission May 1999
3 Residual Radioactive Contamination From Decommissioning Parameter Analysis Draft Volume 3 NUREG/CR 5512 US Nuclear Regulatory Commission April 1996

4 2 7 Criteria #7 – Is the model available in the public domain?

DandD 2 0 is available in the public domain DandD 2 0 and its documentation can be accessed through the Nuclear Regulatory Commission website at http //www nrc gov/RES/rescodes htm There is no charge associated with this software

4 3 RESRAD 5 82 Modified by RAC (RAC RESRAD)

4 3 1 Criteria #1 Does the model incorporate key processes from the Conceptual Site Model?

RAC RESRAD can assess all aspects of the CSM applicable at RFETS RAC RESRAD can trace a contaminant from its origin in soils to an exposed individual through all applicable exposure pathways RAC RESRAD can assess radionuclides in surface soils and subsurface soils RAC RESRAD can assess the exposure pathways of ingestion of soil inhalation of resuspended soils external irradiation of soils ingestion of homegrown fruits/vegetables/grains and ingestion of meat and milk RAC RESRAD can assess the industrial office worker recreational open space user wildlife refuge worker hypothetical future resident and hypothetical future resident rancher exposure scenarios RAC RESRAD can assess an adult child and infant within the appropriate exposure scenarios

4 3 2 Criteria #2 Does the model satisfy study objectives?

RAC RESRAD can estimate the soil concentration that equates to an acceptable radiation dose for all applicable radionuclides over a study period of 1 000 years RAC RESRAD can trace a radionuclide through the environment to each applicable exposure scenario for a 1 000 year period The maximum radiation dose in this period can be calculated by RAC RESRAD but the RSAL associated with this maximum concentration cannot be delineated by RAC RESRAD (See Criteria #5)

4 3 3 Criteria #3 – Has the model been verified using published analytical equations in scientific and technical journals?

RAC RESRAD has not been verified as a set of computer codes The RESRAD portion of RAC RESRAD that has not been modified has been verified but the RAC generated computer code has not been verified The documentation listed in Criteria #3 for RESRAD 6 0 are applicable to this version of RESRAD The RAC generated portion of RAC RESRAD has not been verified in a manner that can be referenced

4 3 4 Criteria #4 – Has the model been validated against known site conditions?

RAC RESRAD has not been validated as a set of computer codes The RESRAD portion of RAC RESRAD that has not been modified has been validated but the RAC generated computer code has not been validated The documentation listed in Criteria #4 for RESRAD 6 0 are applicable to this version of RESRAD The RAC generated portion of RAC RESRAD has not been validated

RAC RESRAD has not been benchmarked as a set of computer codes The RESRAD portion of RAC RESRAD that has not been modified has been benchmarked though (See RESRAD 6 0 Criteria #4)

4 3 5 Criteria #5 – Does the model have the capability to satisfy study objectives using probabilistic analysis?

RAC RESRAD can assess radiation dose per the CSM requirements using deterministic and/or probabilistic analysis RAC RESRAD has the capability to choose a single conservative value for each input parameter for the model to support a deterministic analysis RAC RESRAD also has the capability to choose a distribution of values for the most sensitive parameters for the model to support a probabilistic analysis RAC RESRAD can perform sensitivity analyses so that the most sensitive parameters can be delineated by using RESRAD 5 82 only RAC RESRAD does not have the capability to produce an output set of radiation dose distributions over time for each radionuclide in each exposure scenario Therefore RAC RESRAD cannot produce the Peak of the Mean Dose versus Time

4 3 6 Criteria #6 – Is the model well documented?

RAC RESRAD is not a well documented set of computer codes The RESRAD portion of RAC RESRAD that has not been modified is very well documented but the RAC generated computer code is not well documented The documentation listed in parts 2 through 5 of Criteria #6 for RESRAD 6 0 are applicable to this version of RESRAD RAC RESRAD is only documented through a 1 5 page README file that comes with the code RAC RESRAD is also documented through comments within the raw computer coding This README file with the raw computer code comments is insufficient to run the RAC RESRAD computer model

4 3 7 Criteria #7 – Is the model available in the public domain?

RAC RESRAD is available in the public domain RAC RESRAD and its documentation can be obtained through the Rocky Flats Citizens Advisory Board There is no charge associated with this software

4 4 MEPAS/GENII/FRAMES/SUM3

4 4 1 Criteria #1 Does the model incorporate key processes from the Conceptual Site Model?

MEPAS/GENII/FRAMES/SUM3 can assess all aspects of the CSM applicable at RFETS MEPAS/GENII/FRAMES/SUM3 can trace a contaminant from its origin in soils to an exposed individual through all applicable exposure pathways MEPAS/GENII/FRAMES/SUM3 can assess radionuclides in surface soils and subsurface soils RAC RESRAD can assess the exposure pathways of ingestion of soil inhalation of resuspended soils external irradiation of soils ingestion of homegrown fruits/vegetables/grains and ingestion of meat and milk MEPAS/GENII/FRAMES/SUM3 can assess the industrial office worker recreational open space user wildlife refuge worker hypothetical future resident and hypothetical future resident rancher exposure scenarios MEPAS/GENII/FRAMES/SUM3 can assess an adult child and infant within the appropriate exposure scenarios

4 4 2 Criteria #2 Does the model satisfy study objectives?

MEPAS/GENII/FRAMES/SUM3 can estimate the soil concentration that equates to an acceptable radiation dose for all applicable radionuclides over a study period of 1 000 years MEPAS/GENII/FRAMES/SUM3 can trace a radionuclide through the environment to each applicable exposure scenario for a 1 000 year period The maximum radiation dose in this period can be calculated by MEPAS/GENII/FRAMES/SUM3 and the RSAL associated with this maximum concentration can be delineated by MEPAS/GENII/FRAMES/SUM3

4 4 3 Criteria #3 – Has the model been verified using published analytical equations in scientific and technical journals?

The MEPAS/GENII/FRAMES/SUM3 computer code has been extensively verified Verification of MEPAS/GENII/FRAMES/SUM3 has included the following

1 Test Plan and Baseline Testing Results for the MEPAS 4 1 Computed Source Term Release Module Pacific Northwest National Laboratory R Taira December 1999
2 Test Plan and Baseline Testing Results for the MEPAS 4 1 Vadose Zone Transport Module Pacific Northwest National Laboratory J McDonald December 1999
3 Test Plan and Baseline Testing Results for the MEPAS 4 1 Saturated Zone (Aquifer) Transport Module Pacific Northwest National Laboratory J McDonald December 1999

4 Test Plan and Baseline Testing Results for the MEPAS 4 1 Surface Water (Non Tidal River) Transport Module Pacific Northwest National Laboratory J McDonald December 1999
5 Test Plan and Baseline Testing Results for the MEPAS 4 1 Atmospheric Transport Module Pacific Northwest National Laboratory J McDonald & C Fosmire December 1999
6 Test Plan and Baseline Testing Results for the MEPAS 4 1 Chronic Exposure Module Pacific Northwest National Laboratory R Taira & S Snyder December 1999
7 Test Plan and Baseline Testing Results for the MEPAS 4 1 Intake Module Pacific Northwest National Laboratory R Taira December 1999
8 Test Plan and Baseline Testing Results for the MEPAS 4 1 Human Health Impact Module Pacific Northwest National Laboratory R Taira December 1999
9 GENII Conversion Testing Verification and Validation of Software plan listing 42 tests performed as of 2/7/1989 Napier 1990
10 Hand calculations performed to support acute models in GENII Sawyer L H T A Ikenberry 1991
11 Hand Calculations performed on GENII to support NPR EIS program Nelson I C L H Sawyer T A Ikenberry 1990
12 GENII Hand Calculation Worksheets version of February 2 1994 Peloquin R A 1994
13 Test Plan and Baseline Testing Results for the FRAMES User Interface Pacific Northwest National Laboratory R Tiara December 1999
14 Test Plan and Baseline Testing Results for the FRAMES Viewers Pacific Northwest National Laboratory R Lundgren December 1999
15 Test Plan and Baseline Testing Results for the FRAMES User Defined Source Module Pacific Northwest National Laboratory M Eslinger August 1999
16 Test Plan and Baseline Testing Results for the FRAMES User Defined Water Transport Module Pacific Northwest National Laboratory M Eslinger August 2000
17 Test Plan and Baseline Testing Results for the FRAMES User Defined Air Transport Module Pacific Northwest National Laboratory M Eslinger August 2000
18 Test Plan and Baseline Testing Results for the FRAMES User Defined Exposure Pathway Module Pacific Northwest National Laboratory M Eslinger August 2000
19 Test Plan and Baseline Testing Results for the Sensitivity/ Uncertainty Multimedia Modeling Module (SUM3) Pacific Northwest National Laboratory R Taira September 2000
20 An Approach to Ensuring Quality In Environmental Software PNNL 11880 Pacific Northwest National Laboratory G M Gelston R E Lundgren J P McDonald B L Hoopes May 1998

4 4 4 Criteria #4 – Has the model been validated against known site conditions?

The MEPAS & GENII computer codes have been extensively validated Validation of MEPAS & GENII is documented in the following reports

1 A Demonstration of the Applicability of Implementing the Enhanced Remedial Action Priority System (RAPS) for Environmental Releases PNL 7102 Pacific Northwest National Laboratory G Whelan J G Droppo D L Strenge M B Walter J W Buck December 1989
2 Summary Technical Review of the Multimedia Environmental Pollutant Assessment System (MEPAS) Prepared for the Office of Federal Facilities Enforcement US EPA ICF Incorporated November 1991
3 Validation of Models using Chernobyl Fallout Data from the Central Bohemia Region of the Czech Republic Scenario CB (GENII Validation) IAEA TECDOC 795 First Report of the VAMP Multiple Pathways Assessment Working Group International Atomic Energy Agency 1995
4 A Comparison of Environmental Radionuclide Concentrations Calculated by a Mathematical Model with Measured Concentrations (GENII Validation) PNL SA 14720 In Proceedings of ANS Topical Conference on Population Exposure from the Nuclear Fuel Cycle Oak Ridge Tennessee Jaquish R E and B A Napier 1987

MEPAS & GENII have been extensively benchmarked

4 4 5 Criteria #5 – Does the model have the capability to satisfy study objectives using probabilistic analysis?

MEPAS/GENII/FRAMES/SUM3 can assess radiation dose per the CSM requirements using deterministic and/or probabilistic analysis MEPAS/GENII/FRAMES/SUM3 has the capability to choose a single conservative value for each input parameter for the model to support a deterministic analysis MEPAS/GENII/FRAMES/SUM3 also has the capability to choose a distribution of values for the most sensitive parameters for the model to support a probabilistic analysis MEPAS/GENII/FRAMES/SUM3 can perform sensitivity analyses so that the most sensitive parameters can be delineated MEPAS/GENII/FRAMES/SUM3 does have the capability to produce an output set of radiation dose distributions over time for each radionuclide in each exposure scenario Therefore MEPAS/GENII/FRAMES/SUM3 can produce the Peak of the Mean Dose versus Time

4 4 6 Criteria #6 – Is the model well documented?

MEPAS/GENII/FRAMES/SUM3 is very well documented The following reports have been published to support the use of MEPAS/GENII/FRAMES/SUM3

1 Multimedia Environmental Pollutant Assessment System (MEPAS) Guidance Guidelines for Evaluating MEPAS Input Parameters for Version 3 1 Pacific Northwest Laboratory June 1997
2 Multimedia Environmental Pollutant Assessment System (MEPAS) Formulations Compilation of Mathematical Formulations for MEPAS Version 3 2 Pacific Northwest National Laboratory February 1997
3 GENII Version 2 User s Guide Pacific Northwest National Laboratory January 1999
4 GENII Version 2 Software Design Document Pacific Northwest National Laboratory January 1999
5 Concepts of a Framework for Risk Analysis in Multimedia Environmental Systems (FRAMES) Pacific Northwest National Laboratory October 1997
6 GENII Version 2 Sensitivity/Uncertainty Multimedia Modeling Module User s Guidance Draft Pacific Northwest National Laboratory December 1998
7 Sensitivity/Uncertainty Multimedia Modeling Module (SUM3) User s Guide Pacific Northwest National Laboratory
http //mepas pnl gov 2080/earth/sum3/sum3ug/sum3ug htm

4 4 7 Criteria #7 – Is the model available in the public domain?

MEPAS/GENII/FRAMES/SUM3 is available in the public domain MEPAS/GENII/FRAMES/SUM3 and its documentation can be accessed through the Pacific Northwest National Laboratory website at http //mepas pnl gov 2080/earth/earth htm There is no charge associated with this software for Department of Energy contractors There is a charge for these computer models and documentation to the general public

5 Conclusions

Table 1 Model Selection Criteria Assessment outlines each of the four computer models with the model selection criteria RESRAD 6 0 and MEPAS/GENII/FRAMES/SUM3 are the computer codes that meet all the selection criteria Therefore RESRAD 6 0 and MEPAS/GENII/FRAMES/SUM3 may be used to calculate RSALs at RFETS

Since RESRAD has been used at RFETS to derive RSALs and the Public reviewing the RSALs is intimately familiar with RESRAD RESRAD 6 0 will be used to calculate RSALs at RFETS

TABLE 1
MODEL SELECTION CRITERIA ASSESSMENT

Computer Model vs Selection Criteria	RESRAD 6 0	DandD 2 0	RESRAD 5 82 RAC Modified	FRAMFS MEPAS GENII SUM3
Criteria #1	YES	NO	YES	YES
Criteria #2	YES	YES	NO	YES
Criteria #3	YES	NO	NO	YES
Criteria #4	YES	NO	NO	YES
Criteria #5	YES	NO	NO	YES
Criteria #6	YES	YES	NO	YES
Criteria #7	YES	YES	YES	YES

6 References

ASTM Standard Guide for Risk Based Corrective Action Applied at Petroleum Release Sites E1739 95e1 November 1995

ASTM Technical & Professional Training RBCA Fate and Transport Models Compendium and Selection Guidance 1999

DOE Rocky Flats Environmental Technology Site Human Health Risk Assessment Model Description Operable Unit 3 Technical Memorandum No 3 March 6 1995

DOE Rocky Flats Environmental Technology Site Draft Description of Models for the Human Health Risk Assessment Operable Unit 4 Technical Memorandum No 5 March 1993

DOE Rocky Flats Environmental Technology Site Final Human Health Risk Assessment Model Description Operable Unit 5 Technical Memorandum No 13 November 17 1994

EPA Fact Sheet Documenting Ground Water Modeling at Sites Contaminated with Radioactive Substances EPA 540 F 96/002 January 1996

EPA Fact Sheet Computer Models Used to Support Cleanup Decision making at Hazardous and Radioactive Waste Sites EPA/540/F 94 022 January 1996

EPA Fact Sheet Environmental Characteristics of EPA, NRC, and DOE Sites Contaminated with Radioactive Substances EPA 540 F 94 023 January 1996

EPA Fact Sheet Environmental Pathway Models – Ground Water Modeling in Support of Remedial Decision Making at Sites Contaminated With Radioactive Material EPA/540/F 94 024 January 1996

EPA Fact Sheet A Technical Guide to Ground Water Model Selection at Sites Contaminated with Radioactive Substances EPA/540/F 94 025 January 1996

Risk Assessment Corporation Task 2 Computer Models Final Report July 1999

Table 4 – Comparison of Key Residential RESRAD Input Parameters

Parameter	Units	Hanford Site	Johnston Atoll	Clean Slate Sites Nevada	Rocky Flats Cleanup Agreement	Rocky Flats Oversight Panel
Dose Limit [or risk agency]	mrem/year	15	[10 – 10^{-6}]	100	15	15
		5.7	5.82	5.61	5.61	5.82
RESRAD version						
Exposure Pathway		Active	Active	Active	Active	Active
1 External Gamma		Active	Active	Active	Active	Active
2 Inhalation		Active	Active	Active	Active	Active
3 Plant Ingestion		Active	Suppressed	Active	Suppressed	Active
4 Meat Ingestion		Active	Suppressed	Active	Suppressed	Active
5 Milk Ingestion		Active	Suppressed	Suppressed	Suppressed	Active
6 Aquatic Food		Active	Suppressed	Active	Suppressed	Active
7 Drinking Water		Active	Active	Active	Active	Active
8 Soil Ingestion		Suppressed	Active	Active	Suppressed	Suppressed
9 Radon						
Distribution						
Coefficients (K_d)						
Americium	cm/g	200	10 000	1900	76	76
Plutonium	cm/g	200	230 000	550	218	218
Uranium	cm/g	25	50	35	50	218
		10 000	98 000	248 000	40 000	
	m	4.6	0.61	0.05	0.15	0.2
Area of Contaminated Zone	m	7300	8400	6820	7000	10800
Thickness of Contamd Zone	m/yr	0.0001	0.0002	000015	000026	007
	g/m	30	10	30	30	70
	y	0.4	1	1	1	1
Inhalation Rate		0.8	0.5	0.7	0.8	0.7
Mass Loading (Inhalation)		0.6	0.25	0.58	1	0.6
		0.2	0.75	0.0155	0	0.4
Exposure Duration		--	9	--		4
Inhalation Shielding	m/s					
Factor		110	1	120.5	--	190
External Shielding	kg/y	2.7	1	10	--	64
Factor	kg/yr	36.5	73	37.4	70	75
Indoor Time Factor	g/y	730		444.6	--	730
Outdoor Time Factor	L/yr					
Wind Speed		1	--	1	--	1
		0.15		0.15	0.15	0.03
Fruits Vegetable Grain	m					
Leafy Vegetables			1E-3			5E-4
Soil Ingestion			1E-3			5E-4
Drinking Water Intake			5E-2			2E-2
Drinking/Household Water	Risk/pC		3.28E-10			
Fruit			3.16E-10			
Groundwater			6.20E-11			
Depth of Soil Mixing Layer			3.85E-8			
	Risk/pC		2.78E-8			
GI Absorption Factor (f)			1.24E-8			
Am-241			4.59E-9			
Pu-239			1.26E-11			
U-238 D			5.25E-8			
Light Slope Factor	Risk/yr per					
Am-241	pC/g					
Pu-239				4.40E-1 / 3.64E-3	4.44E-1 / 3.64E-3	1.55E-1 / 7.4E-4 / 5.9E-2 / 9.3E-4
U-238 D				4.29E-1 / 3.54E-3	3.08E-1 / 5.18E-5	3.5E-2 / 1.8E-4 / 3.1E-2 / 1.7E-4
Inhalation Slope Factor	mrem/pC					

Parameter	U ts	Hanford S te	Johnsto At ll	Clean Slate S tes N ada	Rocky Flats Cleanup Ag eement	Rocky Flats Overs ght Panel
Am 241				1 32E 1 /	1 32E 1 / 2 83E	3 0E 2 / 1 7E-4
P 239				2 83E-4	4	
U 238 D				1 23E 1 /	1 23E 1 / 2 67E	
E te I E pos e				2 67E-4	1	
Am 241				1 18E 1 /	1 18E 1 / 2 69E	
P 239				2 69E-4	4	
U 238 D						
Dose Con ersion						
Fact s						
(nhalation / ngestion)						
Am 241						
Pu 239						
U 234						
U 235 D						
U 238 D						

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DOE 1998 *Establishment of Corrective Action Level for Soils Subproject* Environmental Research Division

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EPA 1991d *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions OSWER* Directive 9355 0 30 Office of Solid Waste and Emergency Response

EPA 1991 *Risk Assessment Guidance for Superfund Volume 1 Human Health Evaluation Manual (Part B Development of Risk based Preliminary Remediation Goals) Interim* U S Environmental Protection Agency Office of Environmental Protection Agency Office of Emergency and Remedial Response Publication 385 7 01B PB92 963333 December 1991

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EPA 1992e *Guidance on Risk Characterization for Risk Managers and Risk Assessors* Memorandum from F H Habicht Deputy Administrator Washington DC 2/26/92

EPA 1993b *External Exposure to Radionuclides in Air Water and Soil Federal Guidance Report No 12* EPA 402 R 93 081 Office of Air and Radiation Washington DC

EPA 1994b *Estimating Radiogenic Cancer Risks* EPA 402 R 93 076 Office of Radiation and Indoor Air Washington DC

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