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CORRES. CONTROL
OUTGOING LTR NO. 1

DE ORDER# 4700.1

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DIST.	LTR	ENC
MARAL, M.E.		
URLINGAME, A.H.	X	X
USBY, W.S.		
RANCH, D.B.		
ARNIVAL, G.J.		
AVIS, J.G.		
ERRERA, D.W.		
RAY, R.E.		
EIS, J.A.		
LOVER, W.S.		
OLAN, P.M.		
IANNI, B.J.		
IARMAN, L.K.		
EALY, T.J.		
EDAHL, T.		
ILBIG, J.G.		
UTCHINS, N.M.		
ACKSON, D.T.		
ELL, R.E.		
UESTER, A.W.		
Primrose AL	X	X
Mast EC	X	X
Busby WS	X	X
Houk RZ	X	X
LAURIN PJ	X	X
HOLSTEEN N	X	X
Buddy MA	X	X
Peterson-Wright	X	X
Roberts RS	X	X
STIGER, S.G.	X	X
Hopkins JK	X	X
CORRES. CONTROL	X	X
ERPD RECORD/COPY	X	X
TRAFFIC		
PATS/T130G		

CLASSIFICATION:

UCNI	
UNCLASSIFIED	X
CONFIDENTIAL	
SECRET	

AUTHORIZED CLASSIFIER SIGNATURE
Classification Waiver on file for ERD

DATE

IN REPLY TO RFP CC NO:
N/A.

ACTION ITEM STATUS
☐ PARTIAL/OPEN
☐ CLOSED

LTR APPROVALS:
JKH:

ORIG & TYPIST INITIALS
JKH:kld

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EG&G ROCKY FLATS

EG&G ROCKY FLATS, INC.
ROCKY FLATS PLANT, P.O. BOX 464, GOLDEN, COLORADO 80402-0464 • (303) 966-7000

July 25, 1994

94-RF-07879

Jessie M. Roberson
Acting Assistant Manager for
Environmental Restoration
DOE, RFFO

Attn: N. I. Castaneda, S. R. Grace

Action: Review & Comments, on or before August 8, 1994

FUNCTIONAL EQUIVALENCY OF RESRAD AND REMEDIAL INVESTIGATION/FEASIBILITY STUDY OUTPUTS (05262) - SGS-413-94

The attached report outlines a comparison of the RESRAD computer code outputs with the outputs referenced in DOE, RFFO's letter ER: BKT: 05262, dated May 6, 1994. EG&G Rocky Flats was requested to review the appropriate documentation for using the Residual Radioactivity (RESRAD) Computer Code Remedial Investigation/Feasibility Study (RI/FS) process. This output comparison shows that the RESRAD outputs are functionally equivalent to the outputs for the RI/FS process. Therefore, the incorporation of RESRAD outputs into the RI/FS process would be a duplication of current effort. The use of RESRAD was also not seen as a requirement during development of the Computer Transport Modeling technical memorandum at all operable units since they were reviewed and approved for use by Rocky Flats Field Office (RFFO) and the Agencies without RESRAD. An exemption from using RESRAD in the RI/FS process is requested.

Please review and comment on the attached report. Rick Roberts at extension 8508 will be setting up a meeting the week of August 8 to discuss any comments along with the exemption request. Any questions prior to the above mentioned meeting, please do not hesitate to call Rick Roberts on extension 8508.

S. G. Stiger, Director
Environmental Restoration
Program Division

JKH:kld

Orig. and 1 cc - J. M. Roberson

Attachment:
As Stated

cc:
M. N. Silverman - DOE, RFFO
L. W. Smith - DOE, RFFO
D. C. Moody - LANL

ADMIN RECORD
SW-A-003680

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Comparison of RESRAD with RI/FS Requirements

July 1994 Draft Final

Comparison of RESRAD with RI/FS Requirements

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ACRONYMS

ALARA	As Low as Reasonably Acheivable
BRA	Baseline Risk Assessment
CDH	Colorado Department of Health
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMS/FS	Corrective Measures Study/Feasibility Study
COC	contaminants of concern
DOE	Department of Energy
EPA	Environmental Protection Agency
IAG	Inter-Agency Agreement
OU	Operable Unit
PRGs	Preliminary Remediation Goals
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RDRA	Remedial Design Remedial Action
RERA	Risk Evaluation for Remedial Alternatives
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RFP	Rocky Flats Plant
RI/FS	Remedial Investigation/Feasibility Study
TM	Technical Memorandum

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Comparison of RESRAD with RI/FS Requirements

INTRODUCTION AND PURPOSE

Risk assessment activities at Operable Units (OU) at the Rocky Flats Plant (RFP) are subject to the requirements of the Inter-Agency Agreement (IAG) (IAG, 1991), including the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); and Department of Energy (DOE) Orders. The IAG and DOE Orders specify two different methods for calculating radiation dose. These two requirements are examined to identify similarities and differences, and potential equivalencies.

Scope

Under the CERCLA process, risk assessment methodology for the Remedial Investigation/Feasibility Study (RI/FS) is described in Risk Assessment Guidance for Superfund (RAGS) A, B, and C (EPA, 1989, 1991a, 1991c). RAGS A details steps to be used for the baseline risk assessment, RAGS B describes the calculation of Preliminary Remediation Goals (PRGs), and RAGS C outlines risk evaluation for remedial alternatives (RERA). PRGs are derived to assess acceptable levels of chemicals, metals and radionuclides in soils, ground water, surface water and sediment. DOE Order 5400.5, Radiation Protection of the Public and the Environment, specifies the use of the computer code RESRAD to derive acceptable soil contamination guidelines for radionuclides except radium and thorum (DOE, 1990). Use of RESRAD for this purpose is similar to the calculation of PRGs presented in RAGS B, however, RESRAD may also be readily used to calculate exposure point concentrations, dose, and risk from radionuclide soil contamination. Use of RESRAD for these other purposes is similar to risk assessment methodology presented in RAGS A and C for radionuclides in soil only. The scope of this document is limited to the comparison of RESRAD use to derive soil guidelines compared to the RAGS B method to derive PRGs for radionuclides in soils. This is because the

DOE Orders requiring RESRAD use apply only to the derivation of soil guidelines for residual radioactivity in soils. In addition, the comparison is based on the information presented in the RESRAD user's manual (Yu, et al., 1993). No computer code runs were made to compare the results of the PRG method to the RESRAD method.

REGULATORY ANALYSIS

Pertinent requirements for risk assessment and deriving clean-up guidelines are presented in the IAG, RAGS, and DOE 5400.5. These in turn reference supporting documents, which generally provide guidance or background information. In addition to current requirements, proposed rule 10 CFR 834 (DOE, 1993), which is essentially identical to DOE 5400.5, has been subject to a public comment period and may become a final rule later this year. This would effectively supersede DOE 5400.5 (depending on the wording in the final rule) and make non-compliance subject to civil and criminal penalties.

IAG

The IAG is an agreement between the Colorado Department of Health (CDH), the Environmental Protection Agency (EPA), and the DOE which outlines work to be performed during the investigatory and study phase, but does not completely describe the specifics of submittals required during the Remedial Design/Remedial Action (RD/RA) or other implementation phases of the response program. The IAG was signed January 22, 1991 and is currently being renegotiated to revise milestone dates and incorporate more recent methodologies. The IAG specifies the documentation that is required by the milestones, and categorizes these documents as either primary or secondary.

Primary documents require a response by DOE to agency comments and must be approved by CDH and EPA. Pertinent examples of primary documents include RCRA Facility Investigation/Remedial Investigation (RFI/RI) Reports, Corrective Measures Study/Feasibility

Study (CMS/FS) Reports, Proposed Plans, and Decision Documents. Disputes over the resolution of comments are subject to a designated dispute resolution process. In contrast, secondary documents are not subject to the dispute resolution process, but deficiencies must be corrected prior to incorporation of the secondary document into a primary submittal. Pertinent examples of secondary documents include Risk Assessment Technical Memoranda (TM) required for the RFI/RI, and CMS/FS TMs.

With regard to the scope of this document, deriving soil guidelines, the CMS/FS TM for Remedial Action objectives includes risk-based PRGs. This TM is a secondary document based on the RFI/RI Report and is included to some extent in the CMS/FS Report after comments have been incorporated.

CERCLA

As previously mentioned, risk assessment methodology under the CERCLA process for the RI/FS is described in RAGS A, B, and C. RAGS B describes how PRGs are derived in a generic fashion, similar to the use of RESRAD to derive soil guidelines, while RAGS A details the baseline risk assessment within the RFI/RI Report and RAGS C outlines risk assessment for remedial alternatives within the CMS/FS. When site-specific information is available in the risk assessment from the RFI/RI Report, generic PRGs are revised to include site-specific information so that PRGs are site-specific. Site-specific PRGs are used during the Detailed Analysis of Alternatives within the CMS/FS.

DOE 5400.5

DOE 5400.5 presents the current DOE requirements for residual radioactive material in soil for unrestricted release of a site. Chapter IV, Residual Radioactive Material, presents a two step procedure of 1) estimating soil guidelines, and 2) establishing authorized limits from those

guidelines for unrestricted release of soil. Included in this process are considerations for radionuclide mixtures, ingrowth of decay products, hot spots, and external radiation.

The soil guidelines may be generic or derived. Chapter IV lists generic guidelines of 5 pCi/g (top 15 cm) for ^{226}Ra, ^{228}Ra, ^{230}Th, and ^{232}Th. Soil guidelines for other radionuclides and mixtures are to be derived according to DOE/CH-8901, A Manual for Implementing Residual Radioactive Material Guidelines, commonly known as the RESRAD computer program (Yu, et al., 1993). By using residential exposure pathways, RESRAD derives soil guidelines based on limiting the public dose (not including occupational, natural background, medical, or consumer doses - DOE 5400.5, Section 10) to 100 mrem/year.

Once soil guidelines have been estimated, authorized limits are set equal to the guidelines unless other information suggests this is not appropriate. Authorized limits must also be consistent with other applicable state and Federal laws. The authorized limits are developed through the project offices in the field and are approved by the Headquarters Program Office (DOE 5400.5, Chapter IV, Section 5). The monitoring, cleanup and control of residual radioactive material are subject to ALARA policy.

Proposed 10CFR834

The proposed rule of 10CFR834, Radiation Protection of the Public and the Environment, may be finalized in several months and may effectively supersede DOE 5400.5. Until that time, DOE 5400.5 is still in effect. Unlike DOE 5400.5, 10CFR834 refers only to authorized limits, and not to soil guidelines. Similarly, 10CFR834 does not specifically mention RESRAD, but refers to approved models.

The proposed rule of 10CFR834 discusses authorized limits in 834.302 for the release of property containing residual radioactive material. Authorized limits for soil are given in 834.305 (a) for Ra-226 and Ra-228 as 5 pCi/g in the top 15 cm and 15 pCi/g in any subsequent 15 cm

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layer. For other radionuclides, 834.305(b) states that authorized limits shall be derived using approved models. It is expected that RESRAD will be favorably received if used for 10CFR834 implementation.

COMPARISON OF RI/FS AND RESRAD MODELING METHODOLOGY

This section presents comparative information beginning with general observations and proceeding to more specific observations. The general observations include a gross comparison of RESRAD to RAGS A, B, and C, which address the BRA, PRGs, and RERA, respectively. More specific information is then provided in relation to the specific scope of this paper, deriving soil guidelines or calculating PRGs.

In general, the RI/FS process and RESRAD have similar risk assessment steps:

- Exposure scenario and pathway analysis
- Exposure assessment including modeling
- Toxicity or dose response assessment
- Dose and or risk characterization.

In the RI/FS process under the IAG, risk assessment TMs for the RFI/RI Report must be issued on the selection of exposure scenarios, pathways, and exposure parameters; selection of models; and identification of toxicity values and corrections must be made to resolve to agency comments before incorporation into the RI/FS Report. Essentially, the RFI/RI and FS risk assessment are custom-made for each OU. With RESRAD, the flexibility is limited to selection of the options programmed into the code.

Of the four bullets listed above, risk assessment modeling objectives within the RFI/RI and CMS/FS are of primary importance and include the following considerations for all types of models used.

- The model should be capable of characterizing risk at the site
- The model should be capable of simulating physical and chemical conditions at the site
- The degree of complexity and the data needs should be balanced with the certainty of the output
- The model should be verified and benchmarked or validated
- The code documentation should be complete
- The code should be peer reviewed and in the public domain.

The RESRAD code and models selected for the RI/FS process are approximately equivalent in terms of meeting these objectives, with the exception that while modeling parameters in RESRAD are variable, the code algorithms in RESRAD are fixed.

In general, the groundwater, air, and surface water models selected for RI/FS risk assessment at individual OUs are typically more sophisticated than those respective modules in the RESRAD code, because they are specifically selected to represent site characteristics. As an example, a toolbox of models best suited to an OU may be used in concert to model contaminated surface soil, subsurface soil, ground water and surface water; chemical contaminants; offsite receptors; and collective risk calculations. The RESRAD code was designed for deriving radionuclide soil guidelines at sites across the United States and is therefore more generic in nature. Depending on needs, this potential limitation may be offset by the advantage of having the pathways coupled, speed of execution, and graphical representation.

For calculating risks to onsite receptors from radionuclides in soil, the RESRAD code and models selected for the RI/FS process are generally equivalent. However, RESRAD 5.05 is

currently not capable of modeling risk for other contaminated media, chemical contaminants, or offsite receptors.

With regard to the specific task of deriving soil guidelines or calculating PRGs, methodologies are presented in DOE/CH-8901 and RAGS B, respectively. RAGS B was issued in 1991 and has been appplied at numerous commercial and government CERCLA sites across the country. Consequently, it is typically better known than RESRAD for CERCLA activities. The approach used can be summarized as combining risk equations for the more important direct pathways for a single medium, setting the risk at 10^{-6}, and solving for the concentration. Pathways that involve soil-to-air volatization, indoor water-to-air volatilization, and particulate emission from soil are considered using simple algorithms. More detail on the specifics of calculating PRGs is presented in RAGS B (EPA, 1991a). When site-specific information is available in the risk assessment from the RFI/RI Report; PRGs based on RAGS Part B are revised so that PRGs are site specific. Site specific PRGs are therefore used to assess clean-up levels.

RESRAD was issued in 1989 for use at DOE sites. The code has been revised several times and the most current version is 5.05. The 1989 user's manual has been revised once, and the most current version is 5.0.

Section 1 of the RESRAD manual states that remedial action should reduce actual or likely doses to a small fraction of the primary dose limit of 100 mrem/yr for a member of the critical population group. With the application of the "As Low as Reasonably Achievable" (ALARA) philosophy, the RESRAD user typically assumes that the critical population group is a farm family that establishes residence on a site after the site has been released for use without radiological restrictions, and that 30 mrem/yr is the dose constraint.

All significant pathways for the critical population group must be considered in deriving soil guidelines. These pathways include:

- Direct exposure to external radiation from the contaminated soil material

- Internal radiation from the inhalation of airborne radionuclides including radon progeny

- Internal radiation from the ingestion of
  - Plant foods grown in the contaminated soil,
  - Meat and milk from livestock fed with contaminated fodder and water,
  - Drinking water from a contaminated well,
  - Contaminated soil, and
  - Fish from a contaminated pond.

The RESRAD program provides default values for all input variables except radionuclide concentrations. If site-specific values are available and will result in a significant change in the calculated soil guidelines, they should be substituted for default values. Some default values, such as the assumed dust loading, are associated with the farm family scenario and should therefore be changed only with adequate justification.

Although the farm family scenario is the preferred ALARA scenario (unless it can be shown to be unlikely in the future), the use of site specific information is recommended. Therefore, for the use of RESRAD, the use of site specific information is somewhat limited to physical site characteristics. For deriving soil guidelines, it is assumed that the area is 100 m^2 and the depth is 0.15 m.

Once soil guidelines have been identified, authorized limits are set equal to the guidelines unless other information suggests this is not appropriate. For example, final cleanup standards (authorized limits) may be based on a different scenario if the resident family scenario is not appropriate for the specific property or if another plausible-use scenario would result in significantly greater potential for exposure. Authorized limits shall also be consistent with other applicable state and Federal laws. The authorized limits are developed through the DOE project

offices in the field and are approved by the DOE Headquarters Program Office (DOE 5400.5, Chapter IV, Section 5).

The monitoring, cleanup and control of residual radioactive material are subject to As Low As Reasonably Achievable (ALARA) policy. The objective of the ALARA process is the attainment of dose levels as low as reasonably achievable, taking technical, economic, safety, and social factors into account. Application of the ALARA process to planning activities occurs both in the development of guidelines and in the application of these guidelines to a specific site. This application should be well documented throughout the process, including prior to, during, and following field work.

Calculation of PRGs in RAGS B uses a simplified approach to modeling and allows a more direct comparison with the derivation of radionuclide soil guidelines using RESRAD. A summary comparison of RAGS B PRG methodology with the capabilities of RESRAD 5.05 is presented in Table 1.

SUMMARY AND RECOMMENDATIONS

At this time, RESRAD and the RAGS B PRG method may be used in a functionally equivalent manner to derive radionuclide soil guidelines based on dose or risk. However, the current release of RESRAD, version 5.05, does not have the capability to model chemical contaminants or contaminated media other than soil, and is therefore not equivalent in these areas to the RAGS B PRG method.

When considering risk assessment uses other than deriving soil guidelines, such as use in BRAs and RERAs, the same limitations with RESRAD also apply. In addition, RESRAD 5.05 is not currently designed to model risk for offsite receptors or to model collective dose. For onsite receptors with soil contaminated with radionuclides, RESRAD and the RI/FS risk assessment methodology should yield similar results.

Table 1.
Summary Comparison of RAGS PRGs/PPRGs with RESRAD

Elements of Risk Assessment	RAGS B PRGs	RESRAD
Exposure scenarios	Residential, commercial/industrial, and ecological scenarios.	Farm Family Scenario, can be changed from default.
Exposure pathways	Direct ingestion of soils, inhalation of particulates, external radiation exposure, inhalation of volatile from soil, ingestion of groundwater, inhalation of volatile released from indoor water use, ingestion of surface water.	External radiation, Internal radiation-particulate and Rn inhalation, Internal radiation-plant and soil ingestion, Meat and milk- ingestion, Water- ingestion, Fish- ingestion.
Source of contamination	May be radionuclide or chemical contamination of surface soil, subsurface soil, groundwater, or surface water.	Limited to soil contamination by radionuclides.
Modeling parameters	Simple algorithms are used to determine a soil-to-air volatilization factor, an indoor water-to-air volatilization factor, and a particulate emission factor.	Contaminated zone parameters, initial concentrations of radionuclides, cover and contaminated zone hydrological data, distribution coefficients and leach rates, particulate resuspension values, and indoor Rn modeling parameters.
Intake parameters	Ingestion rates, inhalation rates, external gamma parameters, exposure frequencies, exposure durations, body weights, averaging times.	Inhalation and ingestion rates, external gamma parameters, exposure duration, and contamination fraction.
Dose and risk conversion factors	Radionuclide risk conversion factors are calculated by EPA using data and models from national and international scientific advisory organizations. Chemical risk conversion factors are calculated by EPA using data and models from published literature.	Radionuclide dose conversion factors are used from published literature and calculated by DOE using data and models from national and international scientific advisory organizations. Radionuclide risk conversion factors are those calculated by EPA.

In summary, RESRAD 5.05 is functionally equivalent to the RI/FS risk assessment methodology only for onsite receptors with radionuclide contamination in soil only. It is unable to model risk for other contaminated media, chemical contaminants, or offsite receptors. Therefore, use of RESRAD is not recommended at this time, except possibly as an internal check of RI/FS

radionuclide PRGs in soil only. Due to continuing improvements to RESRAD, its use in the RFI/FS program should be assessed periodically.

REFERENCES

DOE, 1990. DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, Office of Environment, Safety, and Health. February 8, 1990.

DOE, 1993. *Proposed Rule Part 834 Radiation Protection of the Public and the Environment.* Federal Register, Volume 58, No. 56, March 25, 1993.

EPA, 1989. *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A),* EPA 540/1-89-002, Office of Emergency and Remedial Response, Washington, D.C.

EPA, 1991a. *Human Health Evaluation Manual, Part B: Development of Risk-Based Preliminary Remediation Goals.* U.S. Environmental Protection Agency, Office of Emergency and Remedial Response.

EPA, 1991b. *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part C: Risk Evaluation for Remedial Alternatives).* U.S. Environmental Protection Agency, Office of Emergency and Remedial Response. Washington, D.C.

Yu, C., Y.C. Yuan, A.J. Zielen, M.J.Jusko, and A. Wallo III, 1993, *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0 Final Draft*

IAG, 1991. *Rocky Flats Interagency Agreement Between the State of Colorado, the Environmental Protection Agency, and the Department of Energy.*

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